

Salesforce-The Trendy CRM Software

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ABSTRACT

With the emergence of cloud computing, organizations are increasingly considering migrating their Relationship Management (CRM) applications from an on-premise environment (local servers) to an on-demand environment hosted on cloud servers. In the on-premise environment, the organization owns and maintains the infrastructure and software within their own network. In contrast, the on-demand environment involves a third-party provider hosting the infrastructure and software, charging the organization based on a subscription model. Salesforce is the leading on-demand CRM solution in the market.

INTRODUCTION

Salesforce is a cloud-based customer relationship management (CRM) platform that helps businesses manage their sales, marketing, and customer service activities. It provides companies with a comprehensive set of tools and features to streamline their operations, improve customer engagement, and drive sales growth. With Salesforce, businesses can store and manage customer data, track leads and opportunities, automate sales processes, and generate insightful reports and analytics. The platform offers a range of modules and applications to address different aspects of customer relationship management, such as sales management, marketing automation, customer service, and collaboration.

Salesforce's key features include a centralized customer database, customizable dashboards and workflows, lead and opportunity management, email marketing automation, social media integration, customer support ticketing, and mobile access. It also offers a marketplace of third-party applications and integrations to extend its functionality and meet specific business needs. The platform's cloud-based architecture allows businesses to access their data and applications from anywhere, using any device with an internet connection. This flexibility enables sales teams to stay productive on the go, collaborate seamlessly, and respond to customer

inquiries in real-time. Salesforce has gained widespread adoption across industries and is particularly popular among sales and marketing teams. Its user-friendly interface, scalability, and extensive ecosystem of partners and developers contribute to its success. The company continues to innovate and release updates to its platform, incorporating emerging technologies like artificial intelligence and machine learning to provide deeper customer insights and automate repetitive tasks.

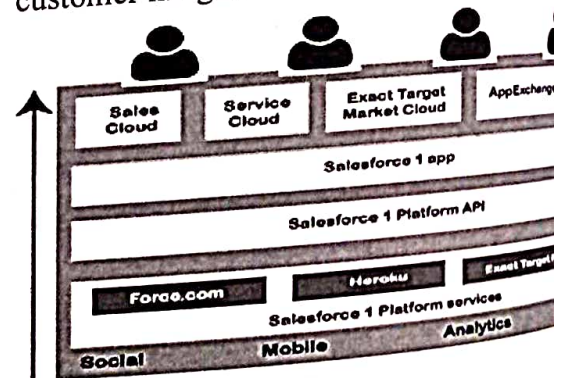


Fig. 1. Salesforce Model

Overall, Salesforce empowers businesses to build stronger customer relationships, drive sales growth, and deliver exceptional customer experiences in a highly competitive marketplace. Salesforce (Customer Relationship Management) is a cloud-based solution provided by Salesforce that allows businesses to manage their customer relationships, sales and marketing activities. The cloud aspect of S

CRM offers numerous benefits and advantages to organizations:

Accessibility: Salesforce CRM is accessible from anywhere with an internet connection. Users can access their CRM data and applications through web browsers or mobile devices, enabling flexibility and remote access for sales teams on the go.

Scalability: As a cloud-based solution, Salesforce CRM offers scalability to accommodate the needs of growing businesses. It allows organizations to add or remove users, customize features and functionality, and expand storage capacity easily as their requirements evolve.

Data Security and Reliability: Salesforce CRM leverages the security and reliability of cloud infrastructure. Salesforce invests heavily in ensuring data protection, implementing industry-standard security measures, regular backups, disaster recovery, and stringent access controls. This helps safeguard sensitive customer information and ensures business continuity.

Seamless Updates and Maintenance: With Salesforce CRM being a cloud-based solution, updates, bug fixes, and new features are regularly rolled out by Salesforce automatically. This eliminates the need for businesses to handle software installations or perform manual updates, allowing them to focus on their core operations.

Integration and Customization: Salesforce CRM offers a wide range of integration options with other cloud-based applications, allowing businesses to connect their CRM with other tools and systems for enhanced functionality and data synchronization. Additionally, Salesforce provides customization capabilities to tailor the CRM to match specific business needs and workflows.

Collaboration and Mobility: Salesforce CRM fosters collaboration among team members through shared access to customer information, documents, and communication logs. Users can collaborate on deals, tasks, and customer support cases in real-time, enhancing productivity and teamwork. The cloud-based nature of Salesforce CRM also enables mobile access, empowering sales teams to work from anywhere and engage with customers on the move.

Cost-effectiveness: The cloud-based model of Salesforce CRM eliminates the need for businesses to invest in on-premises infrastructure, hardware, or software installations. It follows a subscription-based pricing model, allowing organizations to pay for the services they use, thereby reducing upfront costs and providing predictable ongoing expenses.

ARCHITECTURE OF SALESFORCE CRM

Salesforce CRM follows a multi-layered architecture that enables organizations to manage their customer relationships effectively. The architecture of Salesforce CRM consists of the following components:

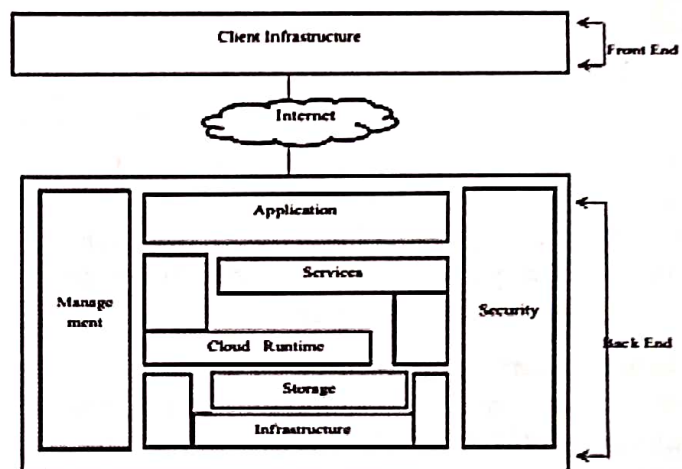


Fig. 2. Architecture of Salesforce CRM

User Interface Layer: The user interface layer is the front-end component of Salesforce CRM that provides the interface for users to interact with the system. It includes web browsers, mobile apps, and other user interfaces that allow users to access and utilize Salesforce CRM's functionalities.

Application Layer: The application layer contains the business logic and processes that drive the various functionalities of Salesforce CRM. It includes a set of pre-built applications and modules that cater to different aspects of customer relationship management, such as sales, marketing, customer service, and analytics. These applications are highly customizable and can be tailored to meet specific business requirements.

Data Layer: The data layer is where all customer data is stored in Salesforce CRM. Salesforce uses a multi-tenant architecture, where data from multiple organizations (tenants) is logically separated and stored

securely in a shared infrastructure. The data layer includes objects, fields, records, and relationships that define the structure and organization of the data within Salesforce CRM.

Integration Layer: The integration layer enables seamless integration of Salesforce CRM with other external systems and applications. It provides various integration mechanisms, such as APIs (Application Programming Interfaces), web services, and connectors, to exchange data and integrate with third-party systems, databases, and other applications. This layer allows organizations to synchronize data, automate processes, and create a unified view of customer information across different systems.

Security Layer: The security layer in Salesforce CRM ensures the protection and confidentiality of customer data. It includes robust security features such as user authentication, access controls, encryption, and data privacy measures. Salesforce implements industry-standard security practices to safeguard data and prevent unauthorized access or breaches.

Metadata Layer: The metadata layer stores the configuration and customization information of Salesforce CRM. It includes metadata components such as objects, fields, workflows, validation rules, layouts, and reports. These components define the behavior, appearance, and functionality of the CRM system and can be customized and extended to meet specific business needs.

Analytics Layer: The analytics layer in Salesforce CRM provides capabilities for data analysis and reporting. It includes features such as dashboards, reports, and data visualization tools that enable users to gain insights from their customer data. The analytics layer allows organizations to monitor key performance metrics, track sales and marketing activities, and make data-driven decisions.

Overall, the architecture of Salesforce CRM is designed to provide a scalable, secure, and customizable platform for managing customer relationships and driving business growth. Its multi-layered structure enables seamless integration, data management, and user interaction, making it a powerful CRM solution for organizations of all sizes and industries.

SALESFORCE CRM OBJECTS

Salesforce CRM includes a wide range of objects that are used to store and manage different types of data within the system. These objects represent various entities and their relationships in the customer relationship management context. Here are some of the key objects commonly used in Salesforce CRM:

Account: The Account object represents a company, organization, or individual with whom the business has a relationship. It stores information such as name, address, industry, and contact details.

Contact: The Contact object represents an individual associated with an account. It stores details such as name, title, email, phone number, and other contact information.

Lead: The Lead object is used to capture and track potential sales opportunities. It stores information about individuals or companies who have expressed interest in the organization's products or services but have not yet become customers.

Opportunity: The Opportunity object represents a potential or ongoing sales opportunity. It stores details such as the potential deal size, stage of the sales process, expected close date, and probability of closing.

Case: The Case object is used for managing customer support and service requests. It stores information about customer inquiries, issues, or complaints and tracks their resolution.

Campaign: The Campaign object is used for managing marketing campaigns. It stores details about marketing initiatives, such as email campaigns, advertising campaigns, events, and their associated responses and leads.

Product: The Product object represents the product or services offered by the organization. It stores information such as name, description, price, and other product-related details.

Opportunity Line Item: The Opportunity Line Item object is used to track individual products or services associated with an opportunity. It stores details such as quantity, price, and total amount for each line item.

Task: The Task object is used for tracking activities

and to-do items related to accounts, contacts, or opportunities. It includes information such as due dates, priorities, and status.

Event: The Event object is used to manage calendar events and meetings. It stores details such as date, time, location, attendees, and related records.

These are just a few examples of the standard objects available in Salesforce CRM. Additionally, organizations can create custom objects to address their specific business requirements and store additional data relevant to their operations. The flexibility and extensibility of Salesforce CRM allow businesses to tailor the object structure to align with their unique processes and workflows.

CHALLENGES TOWARDS SALESFORCE CRM

While Salesforce CRM offers numerous benefits and features, organizations may encounter some challenges when implementing and using the system. Here are a few common challenges faced by businesses in relation to Salesforce CRM:

User Adoption: Getting users to adopt Salesforce CRM can be a challenge. Some employees may be resistant to change or may not fully understand the benefits of using the CRM system. Proper training, communication, and ongoing support are essential to encourage user adoption and maximize the system's effectiveness.

Data Quality and Data Integration: Maintaining accurate and up-to-date data within Salesforce CRM can be challenging, especially when integrating data from multiple sources. Data inconsistencies, duplicates, and incomplete records can impact the system's reliability and hinder decision-making. Establishing data governance practices and implementing data integration strategies are crucial to ensure data quality and integrity.

Customization Complexity: Salesforce CRM offers a high level of customization to meet specific business needs. However, the complexity of customization options can be challenging for administrators and developers without proper expertise. Customization should be carefully planned and executed to avoid

creating a system that is difficult to maintain or upgrade in the future.

Scalability and Performance: As organizations grow and their data volume increases, Salesforce CRM's scalability and performance may come into question. Large data sets, complex workflows, and extensive customizations can impact system responsiveness. Proper data architecture design, performance optimization techniques, and regular monitoring are necessary to maintain system performance as usage expands.

Integration with Legacy Systems: Integrating Salesforce CRM with existing legacy systems and applications can pose challenges due to differences in data formats, protocols, or APIs. Ensuring seamless data flow and real-time synchronization between Salesforce and other systems requires careful planning, integration strategies, and potentially the use of middleware or integration platforms.

Cost Considerations: Salesforce CRM is a subscription-based service, and the cost can be a concern for some organizations, especially for smaller businesses or those with limited budgets. Understanding the pricing structure, licensing options, and evaluating the return on investment (ROI) is crucial to determine the affordability and long-term value of Salesforce CRM.

Security and Compliance: While Salesforce provides robust security measures, organizations must still ensure that their data and customer information remain secure and compliant with relevant regulations. Maintaining proper access controls, data encryption, user authentication, and monitoring user activity are essential to protect sensitive data within the CRM system.

It's important to note that while these challenges exist, Salesforce CRM provides extensive resources, support, and a vibrant community to address them. Proper planning, implementation, and ongoing management can help organizations overcome these challenges and leverage the full potential of Salesforce CRM.

SALESFORCE CRM ADVANTAGES

Salesforce CRM offers a range of advantages that can benefit organizations in managing their customer

relationships and driving business growth. Here are some key advantages of Salesforce CRM:

Comprehensive Customer View: Salesforce CRM provides a centralized platform to store and manage customer data, allowing organizations to have a 360-degree view of their customers. It enables businesses to track interactions, preferences, purchase history, and other relevant information, empowering them to deliver personalized and targeted experiences.

Increased Sales Efficiency: Salesforce CRM streamlines the sales process by providing tools for lead management, opportunity tracking, and sales forecasting. Sales teams can effectively manage their pipelines, collaborate on deals, and automate routine tasks, resulting in increased productivity and faster sales cycles.

Marketing Automation: Salesforce CRM offers robust marketing automation capabilities. Organizations can create and execute targeted marketing campaigns, track campaign performance, and analyze results. Integration with email marketing, social media, and other marketing channels allows for seamless coordination and automated workflows, enhancing marketing effectiveness.

Improved Customer Service: Salesforce CRM helps organizations deliver exceptional customer service by providing tools for case management, ticketing, and self-service portals. Customer support teams can efficiently resolve inquiries, track customer issues, and provide timely assistance, resulting in improved customer satisfaction and loyalty.

Collaboration and Communication: Salesforce CRM facilitates collaboration and communication across teams and departments. Features like Chatter, Salesforce's enterprise social network, enable real-time communication, document sharing, and team collaboration. This fosters a culture of knowledge sharing, enhances cross-functional collaboration, and improves internal communication.

Mobility and Accessibility: Salesforce CRM is accessible from anywhere via web browsers and mobile applications. This enables sales and service teams to access customer information, update records,

and collaborate on the go, improving productivity and responsiveness.

Scalability and Flexibility: Salesforce CRM is highly scalable, allowing organizations to add users, expand functionality, and accommodate growth seamlessly. The platform can be easily customized and extended through point-and-click configuration or development, enabling businesses to tailor the system to their unique requirements.

Integration Capabilities: Salesforce CRM provides robust integration capabilities, allowing seamless integration with other systems and applications. This facilitates data synchronization, automates workflows, and enables a unified view of customer information across the organization.

Analytics and Insights: Salesforce CRM includes powerful reporting and analytics features, enabling organizations to gain valuable insights into sales performance, customer behaviour and marketing effectiveness. Customizable dashboards and reports provide real-time visibility into key metrics, empowering data-driven decision-making.

Security and Data Protection: Salesforce CRM prioritizes data security and offers robust security features, including data encryption, access controls and user authentication. The platform complies with industry standards and regulations to ensure the privacy and protection of customer data.

These advantages make Salesforce CRM a popular choice for organizations seeking to enhance customer relationships, streamline sales and marketing processes and drive business growth.

CONCLUSION

In conclusion, Salesforce CRM offers significant benefits and advantages for organizations in managing customer relationships and driving business growth. With its comprehensive customer view, increased sales efficiency, marketing automation capabilities and improved customer service features, Salesforce CRM provides a powerful platform for organizations to enhance their customer engagement and deliver personalized experiences. The collaboration and communication tools within Salesforce CRM fos

teamwork and knowledge sharing, while the mobility and accessibility features enable users to access and update information on the go, improving productivity and responsiveness.

The scalability and flexibility of Salesforce CRM allow organizations to adapt and expand as their needs evolve, while the integration capabilities enable seamless connectivity with other systems and applications, ensuring data synchronization and a unified view of customer information. Furthermore, the analytics and reporting features in Salesforce CRM empower organizations to gain valuable insights into sales performance, customer behaviour and marketing effectiveness, enabling data-driven decision-making and continuous improvement.

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Securing the Digital Landscape: Examining Cybersecurity Threats, Confronting Challenges, and Embracing Best Practices

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ABSTRACT

As technology continues to evolve, the threat of cyber attacks becomes more prominent. Cybersecurity has become a top priority for organizations worldwide, and the need for effective cybersecurity measures has become increasingly important. This paper will discuss the various threats faced by organizations, including malware, phishing, and ransomware attacks. The challenges associated with implementing effective cybersecurity measures will also be explored, including budget constraints and lack of expertise.

KEYWORDS: *Cybersecurity, Cyber threat, Security*

INTRODUCTION

Cybersecurity is the practice of securing computer frameworks, systems, and delicate data from unauthorized get to, burglary, or harm. With the growing usage of technology in various industries, the risk of cyber threats has increased significantly, making cybersecurity a top priority for organizations worldwide. This paper aims to provide an overview of the threats, challenges, and best practices in cybersecurity.

TYPES OF CYBER SECURITY

Cyber security can be broadly categorized into several types or domains, based on the nature of the assets being protected or the focus of the security measures [4]. A few of the foremost common sorts of cyber security include:

Network security: This focuses on protecting computer networks from unauthorized access, intrusion, and other security threats.

Application security: This is concerned with securing software applications and systems from security vulnerabilities and exploits that can be exploited by attackers.

Information security: This points to secure the privacy, keenness, and accessibility of touchy information and data resources, both in capacity and in travel.

Cloud security: This deals with protecting cloud-based computing services, applications, and data storage from security threats and risks.

Endpoint security: This points to secure person gadgets, such as tablets, desktops, and versatile gadgets, from malware and other cyber dangers.

Identity and access management: This is concerned with managing and securing user identities and access to systems and resources.

Operational security: This focuses on securing the physical and operational aspects of IT systems, such as data centers, networks, and hardware.

Disaster recovery and business continuity: This is concerned with ensuring that systems and data can be quickly restored and recovered in the event of a disaster or other disruptive event.

CYBER THREATS

Malware is one of the most common cybersecurity threats. Malware is malicious software that can infiltrate a computer system and cause damage, steal sensitive information, or gain unauthorized access to the system. Malware can be of many forms such as viruses, worms, Trojan horses, and ransomware. Ransomware is considered as a type of malware, it encrypts an organization's data and demands a ransom payment to restore access of users[6]. According to the 2021 Verizon Data Breach Investigations Report, malware was responsible for 39% of all data breaches.

Phishing is another cybersecurity threat being faced by organizations. Phishing is a social engineering attack that involves tricking people into providing sensitive information such as usernames and passwords. Phishing attacks can happen through e-mail, content messages, or social media, and can be challenging to distinguish.

IMPACT OF CYBER THREATS

The impact of cyber threats can be devastating, both for individuals and organizations. Some of the most significant impacts of cyber threats include:

Financial loss: Cyber threats can cause significant financial losses for an organization. For example, ransomware assaults can result from the misfortune of basic information, which can be costly to recover. Additionally, cyber-attacks can result in lawsuits, regulatory fines, and damage to a company's reputation, all of which can be expensive to address.

Operational disruption: A cyberattack can disrupt an organization's operations, causing downtime, loss of productivity, and delays in the delivery of goods or services. This disruption can be particularly harmful to little and medium-sized businesses which will not have the resources to recover quickly from an attack.

Personal information breach: Cyber threats can lead to burglary of individual data such as social security numbers, credit card numbers and bank points of interest. This data can be utilized for burglary, which can have a long-term effect on individuals.

National Security: Cyber threats can pose a threat to national security. For example, cyberattacks can be utilized to disturb basic frameworks such as

control lattices and transportation, causing chaos and devastation.

RECENT SURVEY ISSUES ON CYBER SECURITY TRENDS

Cybersecurity includes awareness of various cyber threats [1] and the use of protective policies (i.e. protection) to ensure the confidentiality, reliability and availability of digital or IT technologies.

Cybersecurity experts consider malware to be the primary weapon of choice for cyberspace cyber defence efforts. Malware is a common attack that is often installed on a device without the owner's knowledge. Like viruses, worms, Trojans, spyware, and robot executables, malware can infect computers in many ways, such as spreading through viruses, tricking users into opening haptic files, or tricking users into visiting malware-infected websites. In the most extreme cases of malware, the malware installs itself on a USB drive attached to the infected computer and then spreads to all connected computers for that computer.

Common Cyber Attacks

Phishing: Phishing attacks include deceiving people into uncovering touchy data such as passwords, credit card numbers, or social security numbers. Typically ordinarily done through misleading emails, messages, or websites that show up authentic but are really false.

Malware: Malware is malicious software, it is designed to corrupt, damage devices/systems, and to gain unauthorized access to systems. Malware includes viruses, worms, Trojans, ransomware, etc. It can infect through links received from email, infected websites, or downloads from untrusted websites.

Denial-of-Service (DoS) / Distributed Denial-of-Service (DDoS) Attack: In a DoS attack, the aggressor overpowers a target framework with a surge of ill-conceived demands or information, causing the framework to end up inert or crash. DDoS assaults include different compromised gadgets (a botnet) planning an assault on a single target.

Man-in-the-Middle Attack: In Man-in-the-Middle Attack or MitM attack, an attacker intercepts and potentially alters communication between two parties without their knowledge. This allows the attacker to

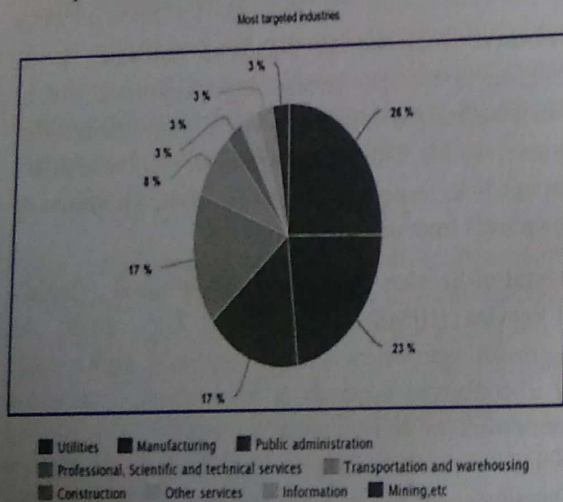
eavesdrop, steal information, or even inject malicious code into the communication flow.

SQL Injection: This type of attack targets web applications that use databases by injecting malicious SQL code into user input fields. By exploiting vulnerabilities, attackers can manipulate the application's database and gain unauthorized access, steal data, or alter data.

Cross-Site Scripting (XSS): XSS assaults happen when aggressors infuse malevolent scripts into websites or web applications that are seen by other clients. These scripts can take touchy information, divert clients to pernicious websites, or control substance on the influenced pages.

Social Engineering: Social engineering involves manipulating individuals to pick up unauthorized get to frameworks or data. Attackers may utilize different mental procedures to deceive people into revealing confidential data, such as passwords or account details.

Password Attacks: Password attacks aim to gain unauthorized access to user accounts by exploiting weak or stolen passwords. Common techniques include brute force attacks (trying all possible password combinations), dictionary attacks (trying common words or phrases), or using stolen password databases from previous breaches.



GOALS OF CYBER SECURITY

To secure the secrecy, judgment, and accessibility of data and frameworks from unauthorized get to, utilize,

divulgence, disturbance, alteration, or devastation. In other words, cyber security aims to prevent malicious actors, such as hackers, cyber criminals, and cyber terrorists, from gaining unauthorized access to sensitive information and systems, or from causing harm to them.

To achieve these goals, cyber security uses a range of technical, organizational, and procedural measures, such as firewalls, encryption, access controls, network segmentation, incident response plans, training and awareness programs, and risk assessments. Cyber security aims to ensure compliance with legal requirements, such as industry standards, privacy laws, data protection laws, etc. Overall, the ultimate goal of cyber security is to create a secure and resilient cyberspace that enables individuals, organizations, and society to benefit from the opportunities offered by the digital age.

CHALLENGES

Implementing effective cybersecurity measures can be challenging for organizations due to several reasons. One of the primary challenges is budget constraints, as implementing cybersecurity measures can be expensive. Numerous organizations battle to apportion satisfactory assets to cybersecurity, driving to vulnerabilities in their systems [2].

Another challenge is the lack of cybersecurity expertise. Many organizations do not have individuals with the necessary skills and knowledge to implement and maintain cybersecurity measures. This lack of expertise can lead to inadequate security measures or misconfigured systems, making them vulnerable to cyber threats.

Furthermore, the lack of standardization in cybersecurity practices can make it challenging for organizations to know which measures to prioritize. Different organizations have diverse security needs, and there is no one-size-fits-all approach to cybersecurity. Therefore, organizations must develop a cybersecurity strategy that meets their specific needs.

Following are few of the challenges that can be faced:

Increasing complexity of systems: As systems become more complex, they become harder to secure, as attackers have more potential attack vectors to exploit.

Insider threats: Malicious or accidental insiders can pose a critical danger to cybersecurity, as they have access to all the sensitive information and systems.

Rapidly evolving threats: Attackers are constantly developing new techniques and tools to bypass cybersecurity measures, making it challenging for defenders to keep up.

Lack of skilled personnel: There is a shortage of skilled cybersecurity personnel, making it difficult for organizations to effectively defend against cyber threats.

Balancing security with usability: Security measures that are too strict can negatively impact usability and productivity, making it a challenge to strike a balance between security and usability.

Resource constraints: Organizations may face budget constraints, making it difficult to implement comprehensive cybersecurity measures.

Third-party risks: Organizations may be vulnerable to cyber-attacks through third-party vendors or suppliers that have access to their networks or data.

Compliance requirements: Compliance requirements such as GDPR or HIPAA can add additional complexity to cybersecurity efforts and require additional resources.

Lack of awareness and training: Lack of awareness and training among employees can leave organizations vulnerable to cyber-attacks.

Emerging technologies: The emergence of new technologies such as AI, IoT, and blockchain present new cybersecurity challenges that need to be addressed.

BEST PRACTICES

Despite the challenges, there are several best practices that organizations can implement to mitigate cybersecurity threats. One of the most critical practices is employee training. Human error is a major factor in many cyber-attacks. Therefore, organizations must provide regular training to employees on cybersecurity best practices, such as how to identify phishing emails and how to create strong passwords.

Another best practice is to ensure that all software is regularly updated. Cybercriminals regularly abuse vulnerabilities in obsolete computer programs to pick up

unauthorized get to frameworks [3]. Regular upgrades to programs can fix known vulnerabilities and decrease the hazard of cyber threats.

Implementing strong passwords and multifactor authentication can also significantly improve cybersecurity. Weak passwords can lead to data breaches. Therefore, organizations must require employees to make solid passwords that are troublesome to figure out. MFA or Multi factor authentication adds an extra layer of security as it requires users to provide additional information, such as a fingerprint, a verification code sent to their devices such as mobile/tabs, to access their system.

Other measures that organizations can implement to improve cybersecurity

One important measure is to conduct regular vulnerability assessments and penetration testing. [5] Vulnerability assessments involve identifying potential vulnerabilities in systems and networks, while penetration testing involves attempting to exploit these vulnerabilities to determine whether they can be used to gain unauthorized access[2]. By conducting these assessments and tests, organizations can identify weaknesses in their systems and networks and take steps to address them before cybercriminals can exploit them.

Another important measure is to implement a data backup and recovery plan. Data backups are essential in case of a cyber-attack, as they can help organizations restore lost or corrupted data. Additionally, having a recovery plan in place can help organizations quickly recover from a cyber-attack, reducing the impact of the attack on their operations.

Implementing network segmentation is also a best practice in cybersecurity. Arrange division includes separating an organization into littler fragments, each with its own security controls. This approach can limit the spread of malware or other cyber threats, reducing the potential damage of an attack.

Organizations should consider implementing a security operations center (SOC) or managed security services provider (MSSP). SOC is a team of cybersecurity professionals responsible for monitoring systems and networks for potential threats and responding to

incidents. An MSSP is a third-party provider that offers cybersecurity services to organizations. These providers can offer advanced security solutions and expertise that organizations may not have in-house.

CONCLUSION

Cybersecurity is a critical issue for organizations, and the risks associated with cyber threats are increasing. Organizations must prioritize cybersecurity measures and allocate adequate resources to protect their systems and sensitive information. The threats to cybersecurity are numerous, ranging from malware to phishing attacks, and organizations must develop a cybersecurity strategy that meets their specific needs. Despite the challenges, there are various best practices that organizations can implement to overcome cybersecurity threats, such as training all the employees, updating softwares regularly and the implementation of strong passwords and MFA (multi factor authentication). Staying up to date with the latest threats and best practices is crucial in maintaining an effective cybersecurity strategy.

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Interactive Learning through Game

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ABSTRACT

This paper describes the development of a runner game with interactive learning features aimed at enhancing players' knowledge and skills in programming. The game is designed as a mobile app for Android and iOS platforms and targeted Computer Science students. The development process involves several phases, including game design, content creation, programming, and testing. The game mechanics are based on the endless runner genre, with the addition of interactive learning elements such as quizzes and puzzles that provide players with opportunities to reinforce their knowledge while playing. The game is evaluated through a user study with college students, which demonstrates that the game is engaging and effective in promoting learning outcomes. The results show that players who completed the game exhibited significantly higher knowledge retention [10]. The study also provided insights into the game's soundness and fragility, as well as suggestions for future improvements. Overall, this paper contributes to learning by showcasing an example of how games can be designed to promote interactive learning and engage students in meaningful educational experiences.

KEYWORDS: *Algorunner, Virtual model, Runner game, User interface(ui) component*

INTRODUCTION

According to the principle of based on games learning, students can focus intensely on a subject while playing games, which improves student accomplishment and knowledge retention. This includes gamifying instructional strategies to raise all-around student performance. With digital or non-digital gaming experiences, it is possible to give conventional classroom assignments a little extra spark, boosting student interest and engagement.

Gamification is the art of adding gameplay principles such as badges, scores, leaderboards, and other features to a game to make your journey challenging yet satisfying for each small accomplishment. Students are given clear, satisfying objectives to work towards through game projects and instructions. Using game-based learning is a fascinating topic. While some experts resist that game-based learning enhances test scores compared to conventional teaching methods, others contend that there is little to no difference in test

scores. It can take a lot of effort and money to create these games for game-based learning. There is a gap between education experts and game development experts, leading to productivity issues in the area of game-based learning.

Goals or Objectives:

- To Gamify the process of learning.
- To provide a competitive and fun way to learn boring topics.
- To provide an interactive way to learn puzzles asked in placement tests.
- To improve hand eye coordination.
- To provide a beneficial way to pass time.

LITERATURE SURVEY

Game-based learning is an innovative approach to education that involves the use of games to improve

learning outcomes. Research on game-based learning has increased in recent years, with numerous studies examining its effectiveness in improving learning outcomes. Game-based learning is a relatively new area of research that focuses on the use of games as educational tools. The body of research on game-based learning has developed over time, moving from early investigations into the potential educational value of games to more current investigations into the efficiency of certain game-based learning treatments.

Early research into the potential benefits of games for learning: The first game-based learning study explores the potential benefits of games for cognitive development and learning. An influential study was "The Effects of Video Games on Children: What Parents Need to Know", published in 2004 by Cheryl K. Olson and Lawrence A. Kutner. The study, which asked parents about their children's use of video games, found that playing video games can have positive effects on cognitive development, such as improved spatial reasoning and communication skills. problems solving. [5]

The Rise of Serious Games: In the mid-2000s, researchers began investigating the use of games designed specifically for educational purposes, known as serious games. A key article in this area is "Serious Games: Advergaming, Edugaming, Training, and More" by Clark C. Abt in 2006. This article defines the concept of serious games and identifies several categories of serious games, such as adgames (games used for advertising) and edugames (games used for education). [3]

Research on how well game-based learning interventions work. The success rate of educational game interventions has been the subject of greater study in recent years. An example well known is "Learning from Play: A Panel Discussion Using Games for Learning" by Katie Salen,

James Paul Gee and Colleen Macklin, 2009. This article features a panel discussion between game designers and educators, discusses the potential benefits and limitations of game-based learning, and shares examples of successful game-based learning interventions. [6]

Digital instructional games can be useful teaching tools, according to research. When examining the learning process and success, researchers advise concentrating on motivation, game load, and their interactions. When non-native speakers play an English game, gaming knowledge and English skill of the students appear to be additional crucial factors in learning achievement. However, more information is required and has to be clarified concerning the motivational and cognitive effects of games and learner characteristics on learning outcomes. The goal of the current study was to meet this demand. [7]

Shute and Ventura (2013) *Measuring and Supporting Learning in Games: The concept of invisible evaluation in game-based educational settings is the main topic* Invisible evaluation. The authors explain how data can be used to measure and assess learners' knowledge, skills, and abilities without interrupting their gaming experience. They describe different types of stealth assessment methods and provide practical guidance for their implementation in game-based learning environments. The book also explores the potential benefits and challenges of using stealth assessment and identifies future research directions for this approach to game assessment. [2]

Mayer (2014) *The Cambridge Handbook of Multimedia Learning* explores the potential of game-based learning as an effective teaching method. The book discusses cognitive and motivational mechanisms of game-based learning and provides practical guidelines for designing effective game-based learning environments. It also highlights the benefits and challenges of using games for learning and identifies future directions for research to advance the field of game-based learning. Overall, this book provides valuable information to educators and researchers interested in using games as a tool to improve learning outcomes. [4]

Among the authors Arnab, S., Lim, T., et al. (2012) provided game mechanic mapping for game analysis. This article begins an overview of serious games and their potential as educational tools. The framework is then presented, which consists of four components including gaming environments, learning objectives,

and game mechanisms. The author provides detailed definitions and examples of each component, emphasizing their interdependence and the need to consider them when analyzing serious games. The authors suggest that the framework could help game designers create more effective serious games by providing a structured approach for understanding the connection between game mechanics and educational results. Additionally, the framework can help researchers and educators evaluate the effectiveness of serious games by providing a common language and set of analytical criteria. Overall, this document provides a comprehensive and practical framework for the analysis of serious games and emphasizes how crucial it is to take the connection between game design and learning objectives into account.[8]

Kiili and Ketamo's (2017) article "Game-Based Digital Learning: A Meta-Analysis" offers a comprehensive literature review on game-based digital learning. The authors conducted 87 empirical studies published between 2006 and 2016 were analysed in a meta-analysis to determine the efficacy of game-based digital learning across a variety of educational contexts and topics. The article begins with an overview of game-based digital learning and its potential benefits, such as increased engagement, motivation, and learning outcomes. The authors then describe their approach to meta-analysis, including systematic review of relevant databases, selection of articles based on inclusion criteria, and extraction and analysis of data from selected studies. The results of the meta-analysis suggest that digital game-based learning is an effective teaching tool across a range of disciplines and educational contexts. The authors found that digital gaming improves learning outcomes such as knowledge acquisition, skill development, and problem solving. Additionally, the authors found that digital game-based learning was particularly effective for low-achieving students and students with learning disabilities. These findings have important implications for educators and policy makers interested in using digital games as educational tools. [9]

The research literature on game-based learning provides insight into the benefits, challenges, and effective design principles of using digital games for educational purposes. Here are some key findings from the research paper:

- Game-based learning can improve motivation and engagement: Games have been shown to be effective in increasing learners' motivation and engagement in the learning process. This is due to immersive nature of game, the presence of clear goals, immediate feedback, and element of challenge and competition.
- Games can improve learning outcomes: Digital games have been shown to be effective in promoting learning outcomes, such as knowledge acquisition, skills development, and problem-solving abilities.
- The secret to good game development is: The usefulness of the game as a teaching tool is greatly influenced by its design. Clear learning objectives, a suitable degree of difficulty, and insightful feedback should all be included in the design of game-based learning. The game should also take the learners' interests and competency levels into consideration.

Overall, the studies on game-based learning offer proof of the potential advantages of adopting computer games as a teaching tool. The findings suggest that game-based learning can improve motivation, engagement, and learning outcomes, and that effective game design is key to its success. However, more study is required to determine the best game-based learning design and execution as well as to solve the difficulties and restrictions related to its application.

PROPOSED WORK

The intent of our project is to gamify the process of learning and provide a competitive and fun way to learn academics topics and interactive way to learn puzzles asked in placement tests. This includes the system's architecture, functional modules, and overall system flow.

System Architecture

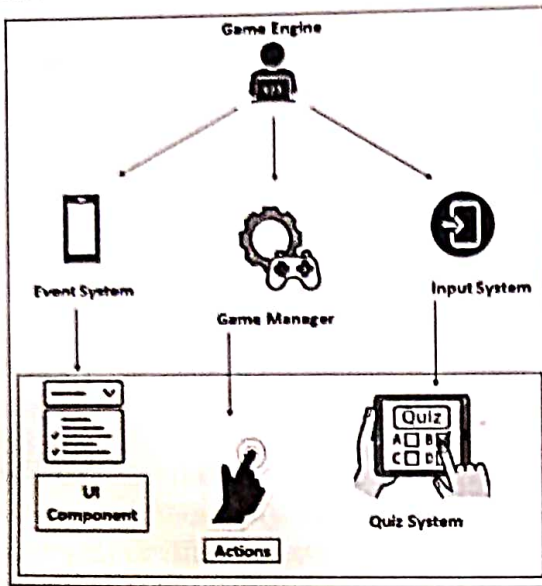


Fig.1: System Architecture for AlgoRunner

Flow of the System

We have shown the flow of our project in Fig.2. The student is the main user which will use the app. The User will start playing, he/she can move left or right according to rescue from obstacle. If user meets with an obstacle he will die and the game will end. If the user does not meet with an obstacle, after some interval of time questions along with three options as an answer will pop up on screen. The user has to choose the correct option, if the selected answer is correct, he can continue to play else he will have to retry the game.

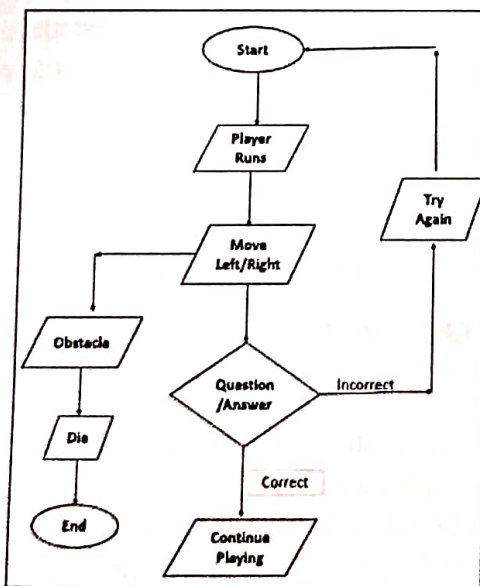


Fig.2: Flowchart for AlgoRunner

Functional Modules

Three modules make up the entire system. Those are Component, Actions, Quiz Manager.

UI Component

This will act as a base for the application where the user just has to swipe the character (Runner) and dodge the oncoming obstacles.

Actions

The character can JUMP, SLIDE, MOVE LEFT, MOVE RIGHT to dodge the obstacles. If the runner meets with an obstacle, he will die and the game will end.

Quiz Manager

While the user is playing the game they will receive questions randomly in between they will have to answer the questions correctly within a specified time else they will have to start over. The user has to choose the correct option, if the selected answer is correct, he can continue to play else he will have to retry the game.

Score formula

$$\text{Score} = (\text{int}) \text{zaxis_distance} * 0.5 + \text{answer_score}$$

RESULT

When the user starts the game, it will look like an endless road and there will be obstacle generation as shown in Fig.3. The user can move left or right to rescue from obstacle which are getting generated with the endless road generation. It will also display the highest score of the user at the top of the screen which will help improve the performance of the user.

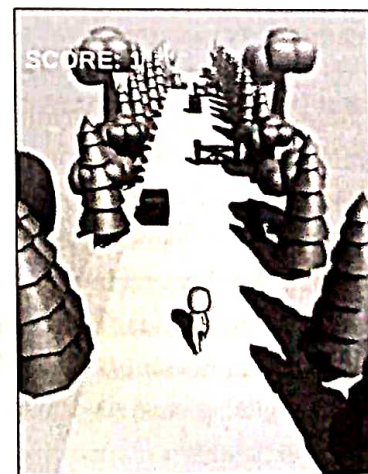


Fig. 3. Endless Road/Obstacle Generation

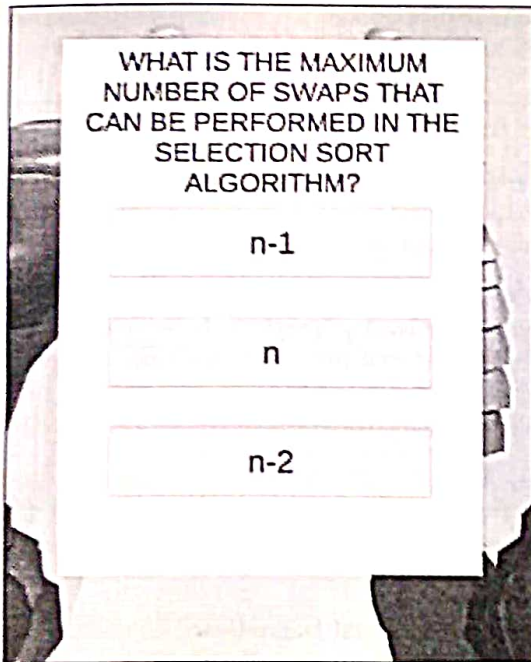


Fig. 4. Quiz Generation

When the question screen as shown in Fig. 4 pops the user has to answer the question correctly to progress further otherwise the game ends and shows “try again” screen. If the user has answered correctly the question screen will pop again after a set amount of time and this process is repeated endlessly until the user either answer incorrectly or collides with an obstacle.



Fig. 5: Fail Screen

If the user gets stuck with the obstacle that are generated along with way, it will end the game and a screen will pop up as try again as shown in Fig.5. Also, if the answer got incorrectly, it will also show the fail screen as shown above and automatically the score board will be calculated.

APPLICATIONS

- A. **Schools and Universities:** The same teaching model has been followed for decades where teachers focus more on curriculum completion resulting in an unproductive learning system. Spark interest in coding in schools where students are new to coding. At a university where students improve their skills and knowledge. Education centers should establish healthy competition among students.
- B. **Competitive Learning:** Competitive learning is a teaching method that lets students try out new research skills without worrying about making mistakes or getting low grades. It can be a fun way to learn and can help students become more engaged in their studies.

CONCLUSION

In this research paper, the developed application addresses the tediousness of learning programming concepts among students. We applied our engineering knowledge to analyze the problem and designed a modern engineering solution in two modules. Through investigating available applications, we identified new solutions and updates. The implementation of the application was done using modern tools such as Visual Studio.

Our study acknowledged the positive influence of game-based learning on motivation, participation, and overall satisfaction with learning. Throughout the project, we applied professional ethics and understood the importance of individual and team work and communication skills while presenting the project in various competitions and conferences for project management.

This research paper presents a proposed solution that can be developed at a generalized level for multiple sectors for life-long learning. It contributes to the advancement of mobile application development for

game-based learning, addressing the educational needs of students in a modern and interactive manner. Future research can further explore the effectiveness and impact of game-based learning applications in different educational settings and contexts.

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Routing Mechanism with Fuzzy Logic Approach in Wireless Sensor Networks: A Survey

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ABSTRACT

Wireless sensor networks are currently widely employed in a number of applications and scenarios due to their adaptability and capacity to build scalable and reliable wireless networks. A large group of scattered sensor nodes designed for the purpose of acquiring data about the physical environment and transferring it to the base station makes up a wireless sensor network (WSN). These sensors' main function is to collect physical data and turn it into valuable information by combining, analyzing, and disseminating it. WSNs frequently employ non-rechargeable sensor nodes in hazardous locations. As a result, they have power supply restrictions, which creates a variety of difficulties for energy consumption optimization. Improving the way data is transported throughout the network is crucial because the transmission unit uses a significant amount of the sensors' energy. To improve routing protocols used in WSNs becomes prolong interest to extend network life and improve energy saving. This paper illustrates the benefits and drawbacks of a variety of fuzzy logic-based routing systems.

KEYWORDS: WSN, Fuzzy logic, Routing.

INTRODUCTION

WSN known Wireless sensor Network is a grouping of autonomous, small, sparsely dispersed objects known as sensors that cooperate to gather data and send it to a base station for later use. For example, a system of geographically dispersed sensors called a wireless sensor network is designed to gather, track, and store physical data before sending it to a hub [1]. Numerous industries, including agriculture, the military, environmental management, industrial use, healthcare, security, and safety, now have new perspectives thanks to sensor technology. WSNs were developed to make sure that a physical event would always be monitored. They must therefore enable efficient and long-lasting connections between the base station and nodes.

Consequently, a number of factors are required when developing a sensor network. to be considered, including node for real-time location and mobility,

data collection, deployment, bandwidth(B/W), and the management of traffic. Furthermore, since sensors are typically battery-powered and are not known for being rechargeable, their ability to deliver power is limited. In these high-risk situations, WSNs are typically used despite the fact that significant human intervention is risky. The difficulty of recharging or replacing sensor nodes despite their low cost (change). In order to maximize the networks' longevity, it is imperative to carefully regulate their energy consumption. As smart devices become more prevalent, energy efficiency is now a key component of the Internet of Things architecture [2]. In order to sense, process, send, or receive data, a sensor node needs energy. Nearly half of the total energy is used in this scenario by a sensor node's transmission unit, according to research [3]. Optimizing data transfer between sensors throughout the network becomes essential as a result. It is common knowledge that the "network layer" is where data transmission management happens. The best routing protocol should

be selected by this layer in order to send accurate data with a respectable latency and while taking energy constraints into account. Without a doubt, to achieving high transmission effectiveness one of the major key factors we select appropriate routing protocol. The importance of and need for research into WSN routing strategies is widely held among academics and industry professionals. This paper's main goal is to demonstrate how WSN routing techniques can be improved by using fuzzy logic (FL). The study covers a variety of effective routing techniques. Second, it will outline a variety of research projects that aim to improve routing techniques through the use of intelligent algorithms. Our final topic will focus on the numerous ways that fuzzy logic has been used into LEACH.

FUZZY LOGIC FOR SENSOR NETWORK

A subfield of mathematics known as fuzzy logic was developed to simulate human reasoning [4]. People simulate the decision using fuzzy logic get employed [12]. Fuzzy logic takes into account intermediate belonging values in the range of [0,1], whereas conventional computational systems only take into account the two values 0 for true and 1 for False. Starting with precise variables, the method converts them into linguistic inputs. Fuzzing is the method in question. On the other hand, defuzzification refers to the conversion of a system-generated linguistic variable into a crisp (digital) variable. A fuzzy inference engine is used to divide the output between these two methods while taking into account the membership functions and the fuzzy rules table. For each language input, fuzzy membership functions are used to estimate the membership of the provided values [16]. Membership functions are used to translate a precise (numerical) input into the corresponding linguistic value. Every membership function specifies the values connected to a specific fuzzy metric. For each measure that the fuzzy system takes into account, the inference engine can integrate the inputs and produce outputs that are suitable. The fuzzy rules table always taken a list of if X and Y, X or Y, is taken into account by this engine. As a result, Z. Multiple measures can be combined into a single metric with the help of the fuzzy logic module [17]. Architecture of the basic fuzzy system shown below.

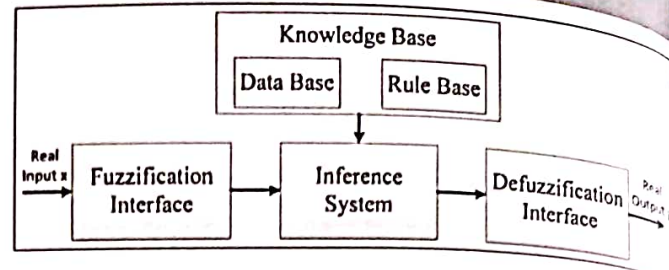


Fig. 2. Architecture of the basic fuzzy system

Bhajantri et al. [2018] look into the failure node pattern in WSNs. The effectiveness of the distributed system identification approach for defect detection is supported by simulation results. Each sensor node periodically sends a beacon message to inform neighbouring nodes of its status. With the sensor node, you can keep an eye on how well your links are working as well as how much energy and bandwidth your neighbours are using. Each node evaluates the observed data while it is being transmitted using fuzzy logic estimate methods to detect faulty sensors.

To create deterministic model for the placement of sensor node that employs a fuzzy approach to identify inactive nodes will discuss by the authors of this paper [2017]. Using the fuzzified approximation, faults of various types can be located both within and between clusters. It assesses the fault rating during each interaction and relays its conclusions to the cluster central server. Each group's cluster leaders assess the index value against a predetermined limit. A sensor is deemed to be malfunctioning and its status is sent to the node behind it in the network if its cluster value drops below a set threshold.

In their 2017 paper, Sasmita and colleagues discuss a method for fault tolerance based on hazy knowledge. The author uses artificial neural network routing and fuzzy knowledge to implement fault tolerance for WSNs (ANNR). The system uses an Intelligent Sleeping Mechanism (ISM) in addition to an exponential bi-directional memory formation (eBAM) for network decoding and encryption. Several fuzzy heuristics are used to locate the problematic nodes in the network. Data aggregation within the cluster is the responsibility of the Cluster Head (CH). Node Appraisal Technique (NAT), a technique for locating problematic nodes in the network, is based on fuzzy knowledge. The study uses a sleep state method to save energy and a fuzzy

rule to find network problems. Prasenjit et al. (2015) suggested a scalable network failure detection system based on fuzzy rules. Regardless of the nature of their fault, defective nodes are not grouped or under control. To achieve better results in the WSN context, fuzzy logic is used. A non-fuzzy control is developed to obtain the correct sensed values from different types of nodes after nodes are categorized using a set of functions [14]. Raghunath, Thirukumaran, et al. (2019) created instant synchronization using damaged nodes. A fuzzy-based predictor is also used in this strategy to find routing challenges. By avoiding collisions, it reduces gearbox lag times. The fuzzy support method is used to construct the system for speedy installation [15].

Farnaz Pakdel et al. (2016) recommended using fuzzy techniques to spot cluster head issues. If no response is received within a certain amount of time, this method finds a cluster head defect. For selecting a new cluster head replacement, a fuzzy logic system evaluates residual energy and the shortest distance from the damaged sensor node [16]. A heuristic approach grounded in probabilistic theory was proposed by Saeed et al. (2012). When using the variable rating approach, the presented process might only have one issue, namely a different sensing value than what is accepted. The node is obviously flawed if the result significantly differs from the rate variables of surrounding nodes [17]. By Sai Krishna and associates, a fuzzy-based delay-aware routing system has been proposed (2019). The surveyed fuzzy-based clustering protocols comparison shown in below table.

Saeed et al. (2012)	Fixed	Yes	No	Yes
Sai Krishna (2019)	Fixed	Yes	No	Yes

CONCLUSION: OUR PROPOSITION FOR A FUTURE WORK.

It should be suggested that by two fuzzy system integrating concurrently in the same network with the purpose of expand the scope of the previous fuzzy solutions based on the results of this survey: To select first CH value for the fuzzy system with three inputs, such as the energy current CH, the remaining node energy, the distance from the centroid, or the distance to the base station, will be used. The communication between the CHs is the second parameter will use less energy than data transmission from the CH to the BS. With the aim of decide whether should we transmit aggregated data directly to the base station or the nearby CH, choosing second fuzzy system that will only be used by CHs. The distance from the base station, the neighbour's distance with base station, the residual energy, and neighbours' residual energy are examples of fuzzy inputs. Given that fuzzy rules must be updated each time the topology changes, it would be exciting to incorporate additional intelligent algorithms in addition to fuzzy logic, such as neural networks, to automatically optimize the fuzzy rules table. RL is more flexible and adaptable to dynamic networks; By combining its advantages with a fuzzy system to improve the membership functions and the fuzzy rules table.

Author	Cluster Size	Fuzzy Based	Multi Hop	Fault Detection
Bhajantri et al. [2018]	Not Fixed	Yes	Yes	Yes
Sasmita et al. [2021]	Not Fixed	Yes	Yes	Yes
Prasenjit et al. (2020)	Not Fixed	Yes	Yes	Yes
Raghunath, Thirukumaran, et al. (2019)	Not Fixed	Yes	Yes	Yes
Farnaz Pakdel et al. (2016)	Not Fixed	Yes	No	Yes

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ABSTRACT

Plant disease detection and quarantine following plant leaf image provided insights into the severity of the impact of the disease on the crop yield and the loss of the crop yield. The proposed system provides a fast and accurate method for the detection of the plant disease. The system is designed to detect the plant disease and provide the user with the necessary information to take the appropriate action. The system is designed to detect the plant disease and provide the user with the necessary information to take the appropriate action. The system is designed to detect the plant disease and provide the user with the necessary information to take the appropriate action.

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A Review on Scheduling Algorithm for CREW System Management of Railway Operations

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ABSTRACT

Our proposed algorithm aims to more precisely and consistently allocate a driver on a network. This algorithm will be improving operational safety and it is used to automate manual operations. After thorough observation and analysis of several departments on drivers in general and links to those drivers in particular, this algorithm offers safe and consistent schedules for drivers, which reduces the need for manual rescheduling. The digitalized schedule will allow the drivers to locate their leisure days in advance because it can be implemented in web-based applications in future.

KEYWORDS: Automation, Days, Time, Transportation, Crew scheduling concepts, Scheduling algorithm.

INTRODUCTION

The issue of driver scheduling affects all modes of transportation, but in this paper, we focused specifically on public transportation, such as trains. Effective time management can have a big financial saving for transportation companies since driver wages make up a significant portion of costs. For instance, about 45% of the total operating expenses are attributable to train driver wages. Terminologies must be introduced in order to make the issue more understandable. A driver schedule is a method that divides up all the necessary driving duties into a set of shifts. The quantity of labor one driver completes in a single day is called a shift. The shifts are just hypothetical because they haven't been assigned to real workers yet. After that, the work is packaged for actual drivers. scheduling theory is concerned with the location of resources to activities over time. The driver typically signs in at a depot to begin a shift. The

motorist then performs one or multiple spells separated by breaks. Usually, there is at least one sufficiently long break. in order to eat.

The main objectives and constraints for driver scheduling are as follows:

- Each task is assigned to a shift, which also has to abide by all operational constraints and labour rules.
- There are a limited amount of shifts overall.
- The entire expense is minimal.

LITERATURE REVIEW

Crew planning in railway operations

Various planning levels can be used to categorize train crew choices. This section discusses crew planning actions in relation to operational planning, disruption management, and strategic/tactical planning. For

a comprehensive understanding of the planning procedure, models, and problem-solving methods used in railroad operations, we recommend the following book. We also define the technical words used in crew scheduling and go through the distinct characteristics of the various kinds of railway transit.

Strategic and tactical planning in Crew management

Crew planning considers the availability and long-term capabilities of personnel members with a time horizon longer than a year, as well as the location and capacity of crew depot. Realizing a balanced crew composition in terms of experience and age, as well as making future plans for the requirement for diverse crew types, is crucial for reliable long-term operations. This involves choosing to hire, train, or transfer a crew between depots. Decisions about the locations of the crew depots, including whether to open or close them, are also crucial at this point.

Scheduling of crew in operational planning

Crew planning is the process of creating work plans for crew members in order to adhere to a predetermined schedule. It demonstrates the standard operational planning process for rail transit. The lines, their origin/destination stations, and their pauses at the start of the operation are all determined by the line planning issue. Train types and frequency on each route are set in order to satisfy all travel requirements while optimizing service or reducing operational expenses. Then, for each station and track segment, the arrival and departure timings of each train are computed, taking into consideration all applicable safety constraints. After the timetable for each route is published, trains must be assigned to platforms.

A self-Adapting algorithm for Driver Scheduling

The main advantages of employing metaheuristics are a relatively efficient way to search through extremely large solutions. Regardless of the type of problem being solved, each class of meta-heuristics has a methodical and consistent approach that always returns a solution. Strategic structure GAs, or genetic algorithms, are a significant class of meta-heuristics that have been extensively used in driver scheduling algorithms.

THE S-TRAIN NETWORK

DSB S-tog A/S, a part of the Danish State Railways, serves Greater Copenhagen, the largest train in the Danish firm, on the S-train network. It displays the network of S-trains. There are 85 stations over its 170 kilometres of twin tracks. Every network section is serviced by a minimum of two railway lines that operate three trains per hour, cyclically, in each direction. There are two types of lines: the main line, which runs from around five in the morning until one in the morning the following day, and the supplementary line, which runs all day long. around 6 am to 7 pm. The principal line, such as a line connecting networks, is designated by a colour and a capital letter.

The only two rail routes that do not pass through Copenhagen H are F and F+ (Copenhagen Central Station). The network segment in issue is known as a circular rail segment. The fingers are the last components of the network. The obstacle separating Copenhagen H from Svanemlæn station in North Copenhagen is the network. Here is where the network is busiest. Considering each train separately.

A train ride between two terminal stations is referred to as a train task in a timetable. Copenhagen Central Station, KBH, and Farum Station for Lines H and H+ are just a few examples of termini on S-tog train lines. Another train task (w) refers to the responsibility of a train driver that comes after the previous train task.

Relief terminal stations, or locations where a driver can give over control of a train to another driver and take a break or check out, include check-in depots and crew depots. In a non-stop timetable, the conductor designated to operate the first train from a non-relief terminal station likewise conducts the train that arrives at the station. line B.

On a workday, up to 19 drivers may be placed in reserve, while on a weekend day, up to 12 drivers may be placed in reserve. A few reserve drivers are stationed at the Hilliard and Kage check-in depots, but the bulk are in Copenhagen H. The majority of the backup drivers are at work. The majority of reserve drivers work the whole shift, however a small percentage work for a portion of the day before receiving training assignments.

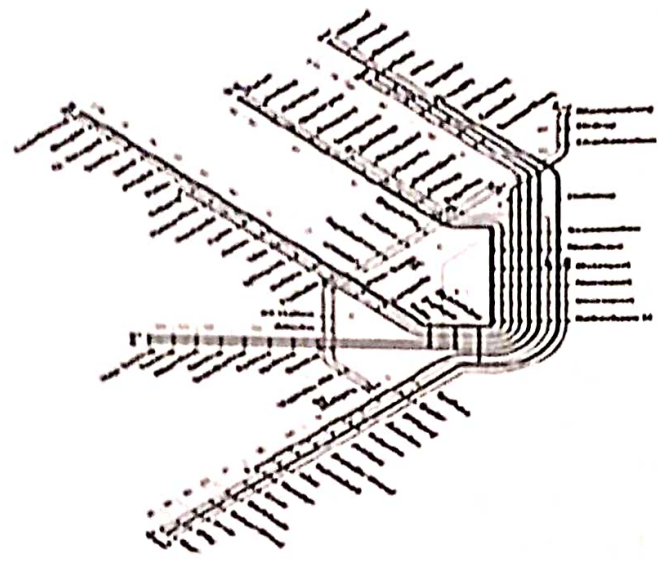


Fig. 1. S-Train Network

DISCUSSION

Link scheduling algorithm:

Every Algorithm is a set of rules, instructions, and conditions to solve a problem in an efficient manner. In this automated driver Link data scheduler, we are designing a link scheduling algorithm to make the process of link scheduling much easier and faster. This link scheduling algorithm can schedule the drivers on their fixed link automatically according to the certain condition, times, and availability of a driver. Right now, the process of scheduling drivers on their allocated link is manual and it is a very hectic process it wastes a lot of time and resources. That is why we are creating an automated driver link scheduling algorithm to make the driver scheduling process much easier.

The algorithm should follow certain conditions.

- Number of Drivers for a particular link
- The number of links and their number of drivers is fixed.
- Time

Each link has its own traveling time, so according to that time, the link scheduling algorithm should have to decide the driver's duty and the driver's rest time.

- Rest time
- The drivers will get a fixed time duration for rest in a week.
- Rescheduling

The algorithm should reschedule the driver to the link again based on the availability of the driver.

- Problems in the scheduling algorithm

In real life, there could be certain problems arise because of weather conditions, link maintenance issues, loco maintenance issues, driver problems, and other unplanned events. These can create an error or abnormal termination in the working of the algorithm. When such unpredictable errors occur, the algorithm recovery procedure will update the scheduled drivers again according to the availability of drivers of that particular link.

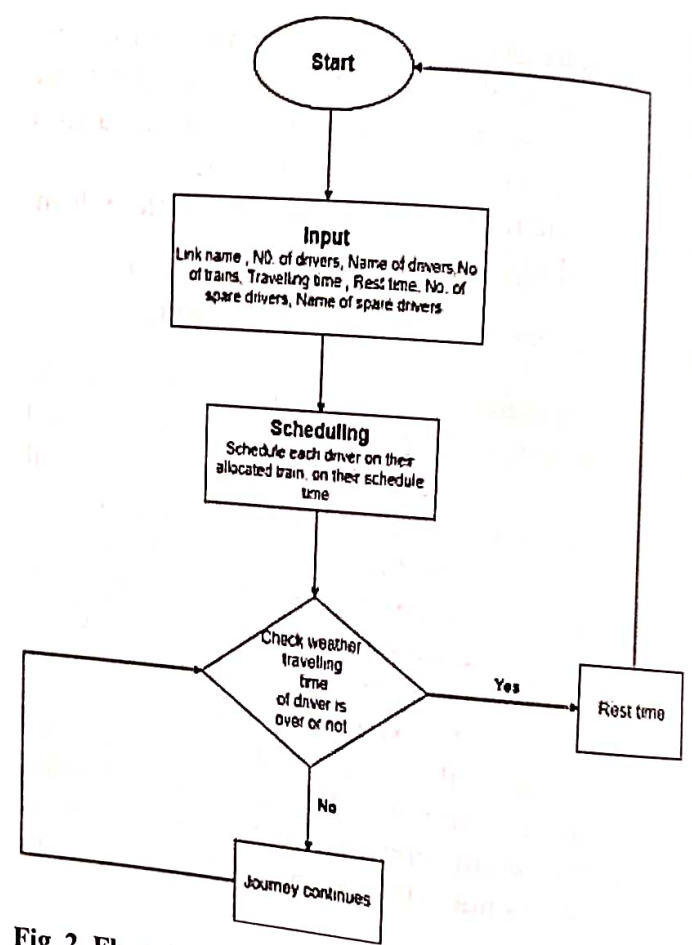


Fig. 2. Flow chart of Link Scheduling

IMPLEMENTATION

The Automated driver data link scheduling algorithm will works in many stages. The working Stages of the system are given below:-

- **Data Input:** The system will be updated with information regarding the driver's availability, working hours, and rest times. Both the drivers

themselves and the transportation company's scheduling system can offer this data.

- **Check for Availability:** The scheduler will initially check to see whether any drivers are available for the next shifts. A list of available drivers will contain the drivers who can perform the shift.
- **Working Hour Check:** The scheduler will next ascertain how many working hours each driver has racked up over the course of the preceding day or week, depending on the policies of the transportation company. If a driver has used up their permitted number of hours, they will be taken out of the pool of available drivers. The scheduler will also take a look at each driver's rest time. The transportation company's rest time policy will determine the minimum length of downtime required before a driver can start a new shift. Unrested drivers won't be included in the pool of available drivers.
- **Shift Allocation:** Based on the pool of drivers that are now available, the scheduler will assign drivers to the upcoming shifts. The allocation will be determined by a number of factors, such as the driver's preferences, seniority, and credentials.
- **Shift Reassignment:** In the event of any unanticipated circumstances, such as a driver reporting sick or an emergency, the scheduler will reassign drivers to the impacted shifts. The shift will be reassigned in accordance with priority and other drivers' availabilities. The system will notify the drivers of their future shifts by email, SMS, or a mobile application after they are assigned to their shifts.
- The system will generate daily, weekly, and monthly data on driver scheduling. The reports will provide details on each driver's shift and hour totals as well as the efficiency of the scheduling system. To improve scheduling efficiency, reduce expenses, and improve driver satisfaction, the scheduler will gradually improve its algorithms.

ADVANTAGES

- The railway department benefits greatly from the Automated Driver Link Data Scheduler technology. The fact that this system replaces the current manual

driver scheduling method with an automated digital system is one of its most important features.

- Drivers must be manually scheduled on their assigned link, which takes a lot of time and work. The automated driver scheduling system, however, can do the same duty considerably more quickly and effectively. The railway department may concentrate on other important activities by employing the system to ease the burden of human scheduling.
- The Automated Driver Link Data Scheduler technology also has the benefit of letting drivers see their impending tasks in advance. Drivers will be aware of their upcoming responsibilities as a result, allowing them to plan accordingly. Drivers can better arrange their professional and personal lives if they are aware of their future responsibilities in advance.
- In case of an emergency, the admin can designate a substitute for that driver. This means that the admin may assign another driver to that duty if a driver is unable to complete their tasks due to illness or another circumstance. This guarantees that the train services won't be hampered by a lack of drivers.
- All under-government officials can also utilise this system to keep track of the data for their current and upcoming officials. This indicates that the system may keep and access all data pertaining to the drivers, including their personal data, training records, and employment history. This enables the railway department to monitor all driver information and make sure that they are appropriately educated and equipped to perform their jobs.
- The Automated Driver Link Data Scheduler system benefits the railway department in several ways overall. It eliminates the tedious manual scheduling process for drivers and replaces it with an automated digital system. Additionally, it enables drivers to view their impending tasks in advance, which might assist them in planning their personal and professional lives.
- In the event of an emergency, the admin can designate a replacement driver, preventing a disruption in the train services owing to a lack of

drivers. Finally, all under-government officials can utilize this system to keep track of their past and future officials' information, enabling the railway department to monitor all driver information and make sure that all drivers are suitably educated and certified for their jobs.

FUTURE SCOPE

The automated driver link data scheduler is a software application that is used to schedule the link of train drivers automatically. It uses various algorithms and data analytics to process real-time data and determine the best schedule for train drivers. The system is beneficial for transportation companies as it helps to optimize driver scheduling and reduce costs associated with manual scheduling. As technology evolves, the future scope of the automated driver link data scheduler is promising.

Artificial Intelligence (AI) and Machine Learning (ML) integration: The integration of AI and ML technologies can improve the efficiency of the automated driver link data scheduler. AI can be used to predict potential issues and suggest optimal schedules based on historical data. ML algorithms can analyze real-time data and make adjustments to the schedule as needed. This will improve the accuracy of the scheduler and reduce the need for manual intervention.

Real-time monitoring of driver fatigue: One of the biggest challenges in driver scheduling is driver fatigue. Future versions of the automated driver link data scheduler could integrate real-time monitoring of driver fatigue using sensors and wearables. This data can be used to adjust schedules and ensure that drivers are adequately rested to prevent accidents.

Integration with IoT-enabled devices: IoT-enabled devices such as smart sensors, cameras, and other monitoring devices can be integrated with the automated driver link data scheduler. This will provide more accurate data and enable the system to make real-time adjustments to the schedule based on the data collected.

Predictive maintenance of trains: The automated driver link data scheduler can be used to predict maintenance issues with the trains. This can be done using AI and ML algorithms to analyze data collected

from sensors installed on the train. The system can then schedule maintenance activities during periods when the train is not scheduled for use, reducing downtime and minimizing the impact on the transportation network.

Integration with blockchain technology: The automated driver link data scheduler can be integrated with blockchain technology to improve data security and transparency. This will ensure that data is tamper-proof and can be accessed by authorized personnel only. This will improve the overall efficiency of the transportation network and increase trust between stakeholders.

Augmented Reality (AR) and Virtual Reality (VR) integration: The integration of AR and VR technologies can help train drivers to prepare for their scheduled trips. AR can be used to provide drivers with real-time information about the train's location, speed, and other relevant parameters. VR can be used to provide drivers with simulated training scenarios, improving their skills and reducing the risk of accidents.

In conclusion, the future scope of the automated driver link data scheduler is promising. With the integration of advanced technologies such as AI, ML, IoT, blockchain, AR, and VR, the system can be further improved to optimize driver scheduling, reduce costs, and improve the overall efficiency of the transportation network. The system is highly scalable and customizable, making it a valuable asset for any transportation company. As technology continues to evolve, the automated driver link data scheduler will continue to be an essential tool for optimizing driver scheduling in the transportation industry.

CONCLUSIONS

Issue and a plan for using the Branch & Price algorithm to fix it A small number of drivers are used in the construction of the problem, and the recovery period is set at a time that is limited by the drivers' initial commitments. Additional drivers are added to the problem or the recovery period is prolonged if the initial problem size is too large to find a workable recovery solution. Data from the Danish passenger railway operator DSB S-tog A/S is used to test the solution method. In test scenarios, a train line and all tasks connected to it are suspended for the duration of the recovery period. The best integer solutions are found in

5 seconds for test instances with recovery times of 3 to 5 hours.

An algorithm will have clearly specified, explicit phases in its growth. The steps will be detailed enough to make clear what has to be done at each stage, All stages in an algorithm must be feasible (effectively computable), receive a well-defined set of inputs, and provide some sort of result as an output. An algorithm's exact sequence of operations must also be concretely described.

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A Novel Approach for Human Emotion Detection with Speech Recognition using Support Vector Machine in Machine Learning

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ABSTRACT

Speech emotion recognition (SER) is a significant area of research dedicated to identifying and interpreting human emotions based on voice signals. With the rapid advancements in machine learning (ML) techniques, SER has gained substantial attention due to its potential applications in diverse fields such as healthcare, entertainment, and human-computer interaction. This abstract provides a concise overview of research work focused on speech emotion recognition using ML algorithms. The main objective of this study is to create an accurate and efficient system for emotion recognition from speech signals. The proposed approach utilizes a combination of feature extraction techniques and ML models to extract relevant information from the speech data and classify it into distinct emotion categories. The key features extracted from the speech signals include pitch, intensity, Mel-frequency cepstral coefficients (MFCCs), and spectral features. Proposed work worked on accuracy and confusion matrix and overall accuracy achieved by this model is 85.7%, and matric value are in diagonal fashion which indicate good performance for classifier.

KEYWORDS: *Speech emotion recognition (SER), Machine learning (ML), Support vector machines (SVM), Feature extraction.*

INTRODUCTION

Speech emotion recognition (SER) is an expanding field focused on comprehending and interpreting human emotions via voice signals. Emotions play a crucial role in human communication and have a significant impact on various aspects of our lives, including social interactions, mental health, and decision-making processes. Traditional methods of emotion recognition primarily relied on subjective assessments or self-reporting, which are subjective and prone to biases. The emergence of machine learning (ML) techniques has opened up new possibilities for automatic and objective emotion recognition from speech data. ML algorithms can learn patterns and relationships from large amounts of data, enabling the development of robust and accurate emotion recognition systems. This project builds upon the advancements in ML and focuses on developing a

system that can effectively recognize and classify emotions from speech signals. The project aims to address several challenges associated with speech emotion recognition. These challenges include feature extraction from speech signals, selection of appropriate ML algorithms, handling of diverse and imbalanced datasets, and achieving high accuracy and efficiency in emotion classification. By addressing these challenges, the project seeks to contribute to the advancement of SER technology and its practical applications in various domains. The project also takes into account the potential real-world applications of speech emotion recognition. Emotion-aware virtual assistants can adapt their responses based on the user's emotional state, providing more personalized and empathetic interactions. Mental health monitoring systems can utilize speech emotion recognition to assess individuals' emotional well-being and provide timely interventions

when necessary. Interactive entertainment platforms can enhance user experience by incorporating emotion recognition to create more immersive and engaging content.

LITERATURE SURVEY

- “Emotion Recognition in Speech Using Neural Networks” by Kim et al. (2013): In this study, the authors investigate the application of deep neural networks, specifically deep belief networks, for speech emotion recognition. They obtained competitive outcomes on standard datasets, emphasizing the effectiveness of deep learning techniques.
- “Speech Emotion Recognition Using Support Vector Machines” by Schuller et al. (2003): In this research, the authors explore the use of support vector machines (SVM) in speech emotion recognition. They evaluate various feature sets, such as prosodic and spectral features, and demonstrate the effectiveness of SVM in classifying emotions.
- “A Survey of Speech Emotion Recognition: Features, Classifiers, and Databases” by El Ayadi et al. (2011): This comprehensive survey provides an overview of feature extraction techniques, classification algorithms, and available emotion databases for speech emotion recognition. It serves as a valuable reference for researchers entering the field.
- “Deep Convolutional Neural Networks for Speech Emotion Recognition” by Satt et al. (2017): In this study, the authors investigate the application of convolutional neural networks (CNN) in speech emotion recognition. They introduce a deep CNN architecture that learns distinctive features directly from spectrograms, resulting in promising outcomes on widely recognized datasets.
- “Speech Emotion Recognition Using Recurrent Neural Networks with Local Attention” by Zadeh et al. (2018): In this research, the authors present a novel approach to speech emotion recognition using a recurrent neural network (RNN) model with a local attention mechanism. They showcase the effectiveness of their proposed method on various emotion recognition tasks and emphasize the significance of attention mechanisms in capturing pertinent information.
- “Speech Emotion Recognition using Transfer Learning from Raw Waveforms” by Eyben et al. (2016): In this research, the authors delve into the implementation of transfer learning techniques in speech emotion recognition. They put forward a transfer learning framework that takes advantage of pre-trained models on extensive audio datasets, effectively adapting them for the purpose of emotion recognition tasks.
- “Speech Emotion Recognition Using Hidden Markov Models” by Deng and Wu (2013): In this study, the authors explore the application of Hidden Markov Models (HMMs) in speech emotion recognition. They present an HMM-based framework that effectively models the temporal dynamics of speech features, leading to competitive results in emotion classification tasks.
- “Joint Speech Emotion and Speaker Recognition Using Deep Neural Networks” by Han et al. (2014): This work addresses the challenge of simultaneous speech emotion and speaker recognition. The authors propose a joint deep neural network (DNN) architecture that learns representations for both tasks and demonstrates improved performance compared to separate models.
- “Adversarial Training for Speech Emotion Recognition” by Xing et al. (2018): This study introduces adversarial training techniques to enhance speech emotion recognition. The authors propose a generative adversarial network (GAN) framework that improves the discriminative capabilities of the emotion recognition model by generating more realistic speech samples.
- “Speech Emotion Recognition using Attention-based Convolutional Recurrent Neural Networks” by Zhang et al. (2019): In this study, the authors aim to harness the benefits of both convolutional neural networks (CNNs) and recurrent neural networks (RNNs) in speech emotion recognition. They introduce an attention-based CNN-RNN model that effectively captures both local and global dependencies present in speech signals. By

doing so, the proposed model achieves state-of-the-art performance on emotion recognition tasks.

- “Efficient Speech Emotion Recognition using Transfer Learning and Autoencoders” by Ramakrishnan et al. (2020): This study explores the use of transfer learning and autoencoders to improve the efficiency of speech emotion recognition systems. The authors propose a framework that leverages pre-trained models and applies autoencoders for feature compression, achieving comparable performance with reduced computational complexity.

These are just a few examples of the proposed works in speech emotion recognition. The field is continuously evolving, with researchers introducing innovative techniques, exploring different algorithms, and leveraging advancements in deep learning and multimodal approaches.

These studies showcase a wide array of approaches and techniques utilized in speech emotion recognition, encompassing traditional models such as HMMs, as well as more advanced deep learning architectures and transfer learning methods. Each of these works contributes to the continuous endeavor to enhance the accuracy, efficiency, and resilience of speech emotion recognition systems.

PURPOSE OF STUDY

This study aims to develop a robust system for speech emotion recognition using machine learning techniques. By addressing the limitations of traditional methods, the study seeks to provide an automated and objective approach to accurately classify emotions from speech signals. The primary objective is to contribute to the advancement of speech emotion recognition technology and its practical applications. The study’s overarching goal is to enhance human-computer interaction, enable emotion-aware virtual assistants, support mental health monitoring systems, and improve user experiences in interactive entertainment platforms. The findings of this study can have implications in various fields, including healthcare, entertainment, customer service, and human-computer interaction, where understanding and responding to human emotions are crucial factors. The study aims to contribute to the existing knowledge

in the field of speech emotion recognition and provide valuable insights for further research and development in this area. In summary, the purpose of studying speech emotion recognition is to deepen our understanding of human emotions, develop objective and automated emotion recognition systems, advance machine learning techniques, enable personalized technology interactions, and facilitate mental health monitoring and interventions. These purposes collectively contribute to enhancing various aspects of human life, communication, and well-being, Figure 1 describe the same.

Objectives:

- To develop an automated system for accurate speech emotion recognition using machine learning.
- Compare and evaluate different machine learning algorithms for emotion classification.
- Address challenges related to dataset characteristics to enhance the system’s robustness.
- Provide insights and recommendations for improving the system’s performance and enabling practical applications.

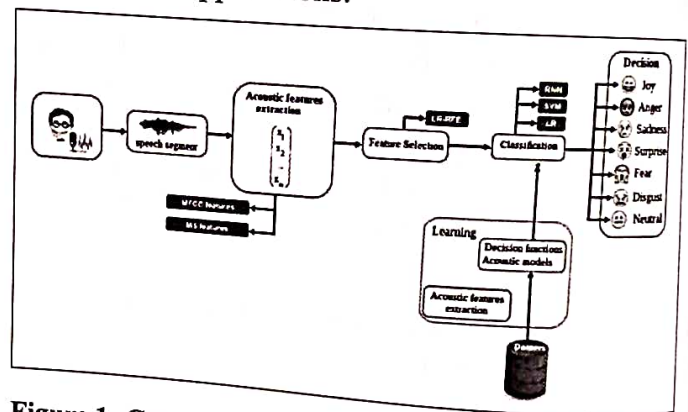


Figure 1: General Block diagram of the proposed system

METHODOLOGY

- Data Collection: Collect the necessary audio datasets for emotion classification, such as RAVDESS, CREMA, TESS, and SAVEE. Ensure that the datasets are properly downloaded and stored in the specified directories.
- Data Preprocessing and Exploration: Import the required libraries, including pandas, numpy, os, librosa, matplotlib, and pydub. Load the audio files from each dataset and extract relevant information

such as file paths, gender, and emotion labels. Combine the data from all datasets into a single dataframe using the concatenation technique. Visualize the distribution of emotions and genders using bar plots to gain insights into the dataset

- Support Vector Machines (SVM): SVM is a widely used algorithm for classification tasks, including SER. It can effectively separate data points in high-dimensional feature spaces and handle non-linear relationships.
- Data Preparation: Filter the dataset to include only female samples as specified in the problem statement. Drop the 'sex' column from the dataframe since it is no longer needed. Preprocess the audio files by applying trimming, padding, and feature extraction techniques (e.g., ZCR, RMS, MFCCs) using librosa and pydub libraries. Encode the emotion labels into numerical values suitable for classification using a predefined emotion dictionary.
- Data Splitting: To divide the preprocessed data into training, validation, and testing sets, the train_test_split function from the sklearn library can be utilized. This function enables the specification of desired proportions for the splits. For example, one can assign 85% of the data to training, 15% to testing, and 30% of the remaining data to validation.
- Model Building: Import the necessary libraries for building the emotion classification model, including keras and sklearn. Define the model architecture using the Sequential API from Keras. Add LSTM layers to the model for sequence modeling and a dense layer with softmax activation for multiclass classification. Compile the model with an appropriate loss function, optimizer, and evaluation metric.
- Model Training and Evaluation: To train the model on the training data, the fit function can be employed, specifying the desired number of epochs and batch size. It is important to monitor the model's training progress by plotting the loss and accuracy curves for both the training and validation sets. This provides insights into how the model is learning over time. Following the training

process, it is crucial to evaluate the trained model's performance on the testing set using metrics such as accuracy. This assessment helps gauge how well the model generalizes to unseen data.

- Model Performance Analysis: To analyze the model's predictions compared to the ground truth, a confusion matrix can be generated using the predicted labels from the model and the true labels from the testing set. Visualizing the confusion matrix using a heat-map provides a clear representation of the model's performance.
- Model Improvement and Iteration: Analyze the model's performance and identify areas for improvement based on the evaluation metrics and confusion matrix. Experiment with different hyper parameters, such as learning rate, number of LSTM units, and batch size, to optimize the model's performance. Consider adding additional layers or modifying the model architecture to enhance its capacity to capture emotion-related features.
- Deployment and Application: Save the trained model for future use and deployment in a production environment or application. Integrate the model into an application or system that can perform real-time emotion classification on new audio inputs.

Figure 2a shows the block diagram of proposed system and figure 2b shows the Flow of proposed system.

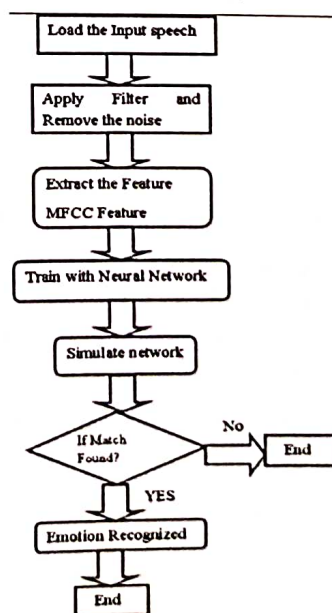


Figure 2a : Block diagram of proposed system

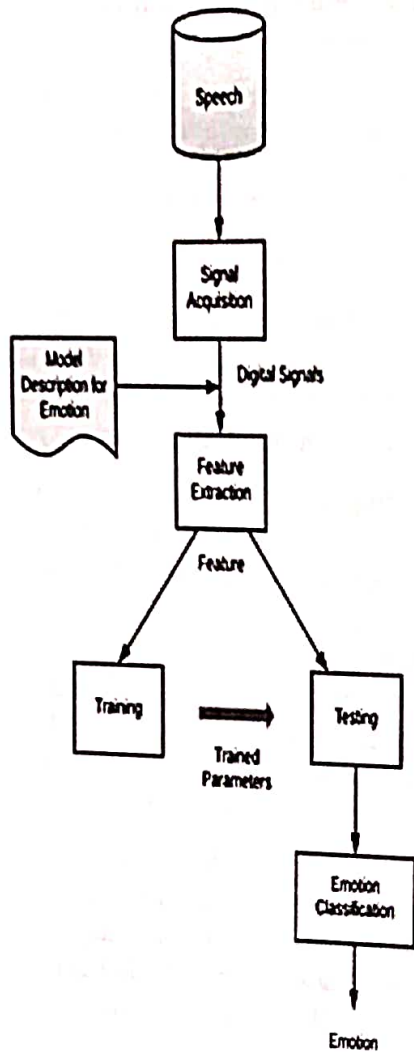


Figure 2b : Flow of proposed system

TESTING, RESULTS & DISCUSSION

Testing

```
from sklearn.model_selection import train_test_split
from tensorflow.keras.utils import to_categorical
```

Splitting the data into training and testing sets

```
X_train, X_to_split, y_train, y_to_split = train_test_split(X, y, test_size=0.15, random_state=1)
X_val, X_test, y_val, y_test = train_test_split(X_to_split, y_to_split, test_size=0.3, random_state=1)
```

Convert class labels to one-hot encoded format num_classes = 6

```
y_train_class = to_categorical(y_train, num_classes)
y_val_class = to_categorical(y_val, num_classes)
```

Hyperparameter tuning and optimizer selection

```
# Experiment with various optimizers for better results
# For simplicity, we'll use RMSProp with default learning rate and decay optimizer = 'RMSProp'
```

```
# Training the model for 100 epochs epochs = 100
model.fit(X_train, y_train_class, validation_data=(X_val, y_val_class), epochs=epochs) # Evaluate the model on the test set
```

```
loss, categorical_accuracy = model.evaluate(X_test, y_test)
print(f"Loss: {loss}, Categorical Accuracy: {categorical_accuracy}")
```

```
# Plotting the train and test accuracy for better understanding of the training process
plot_accuracy(history)
```

Note: The code assumes that you have defined and compiled the model before training it. Also, the plot_accuracy function is a custom function that you need to define to plot the accuracy, as shown in Figure 3 about the same.

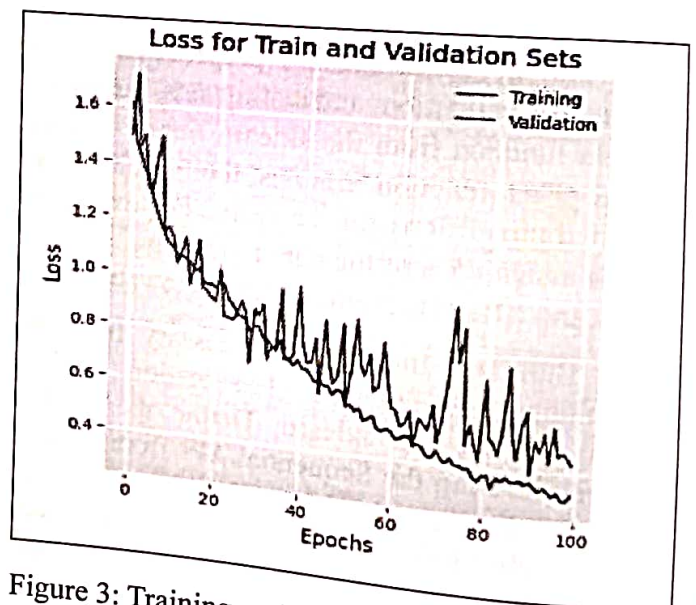


Figure 3: Training and testing

RESULTS AND DISCUSSIONS

This level of accuracy (figure 4) suggests that the model has learned patterns and features in the audio data that are indicative of different emotions. It shows the effectiveness of the chosen approach, including the pre-processing techniques and the LSTM-based model architecture.

However, it's important to consider certain aspects when

interpreting the accuracy. First, the accuracy achieved on the validation set may not necessarily generalize to unseen data, so further evaluation on an independent test set is recommended.

The above confusion (Figure 5) matrix shows the relation between the true label and the predicted label. The colors and numbers show how each label is related to each other.

ADVANTAGES

1. **Non-Invasive:** Speech emotion recognition is a non-invasive technique that can analyze emotions based on acoustic features of speech signals. It doesn't require any physical contact or invasive methods, making it convenient and comfortable for users.
2. **Real-Time Emotion Monitoring:** Speech emotion recognition can provide real-time emotion monitoring by analyzing speech signals as they are being spoken. This capability is valuable in applications such as call centers, virtual assistants, or mental health monitoring systems, where immediate emotion detection and response are important.
3. **Wide Applicability:** Speech emotion recognition can be applied across various domains and industries. It has applications in customer service, human-computer interaction, psychological research, entertainment, voice assistants, and more. It can enhance user experiences, improve communication, and enable personalized interactions.
4. **Objective Measurement:** Emotions can be subjective and challenging to measure accurately. Speech emotion recognition provides an objective and quantitative measure of emotions by analyzing acoustic features in speech signals. This objective measurement can be valuable in research, clinical settings, or any context where reliable emotion assessment is needed.
5. **Automated Processing:** With advancements in machine learning and signal processing techniques, speech emotion recognition can be automated and performed at scale. Large volumes of speech data can be processed efficiently, enabling the analysis of emotions in a timely and cost-effective manner.
6. **Multi-Modal Integration:** Integrating multiple modalities, such as facial expressions, body gestures, or physiological signals, with speech

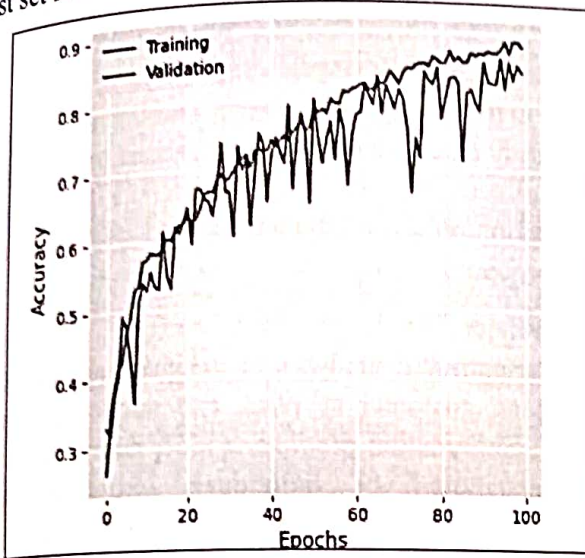


Figure 4: Accuracy

Second, the accuracy might vary depending on the distribution and quality of the dataset, as well as the complexity and variability of the emotions being classified. Overall, achieving 85% accuracy on emotion classification in audio data is a promising result. It suggests that the developed model has the potential to be useful in practical applications such as emotion recognition systems, speech analysis, or human computer interaction. Further refinements and evaluations can be performed to improve the model's performance and robustness.

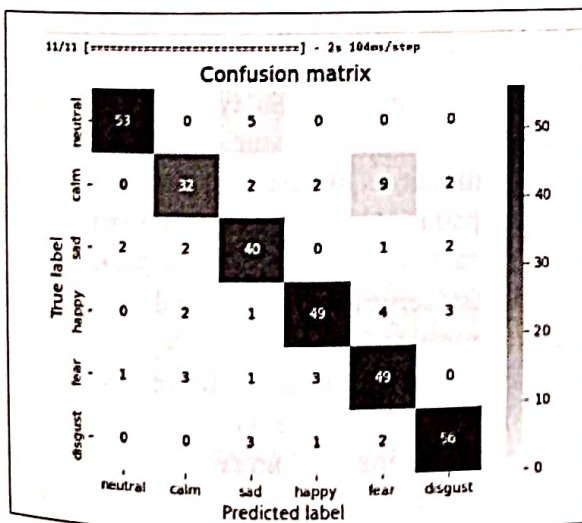


Figure 5: Confusion Matrix

emotion recognition can significantly enhance emotion recognition accuracy. This multi-modal approach provides a more comprehensive and robust understanding of emotions by leveraging information from different sources.

APPLICATIONS

1. **Education and E-Learning:** Speech emotion recognition can be used in educational settings and e-learning platforms to assess students' engagement, attention, and emotional states during online courses or virtual classrooms. It can provide feedback to instructors and help personalize the learning experience based on students' emotional responses.
2. **Human-Computer Interaction:** Speech emotion recognition can enhance human-computer interaction by enabling computers and machines to understand and respond to human emotions. Emotionaware systems can adapt their responses, such as virtual assistants providing empathetic and personalized responses based on the user's emotional state.
3. **Call Center Analysis:** Speech emotion recognition can be used in call centers to analyze customer-agent interactions. It can automatically detect customer emotions, such as frustration or satisfaction, during phone conversations. This information can help improve customer service, identify training needs, and enhance overall customer experience.
4. **Mental Health Monitoring:** Speech emotion recognition can be used as a non-invasive tool for monitoring mental health conditions. By analyzing changes in speech patterns and detecting emotional cues, it can assist in diagnosing and monitoring conditions such as depression, anxiety, or bipolar disorder
5. **Market Research and Advertising:** SER can be employed in market research to analyze consumers' emotional responses to products, services, or advertisements. It helps businesses understand consumer preferences, optimize marketing strategies, and develop emotionally appealing content.

6. **Entertainment and Gaming:** SER can enhance user experiences in entertainment and gaming industries. It can be utilized to personalize game interactions, adapt game difficulty based on user emotions, and create immersive virtual reality experiences.
7. **Psychological Research:** SER plays a significant role in psychological research, enabling researchers to study emotional expressions, social interactions, and affective states. It helps in understanding human behavior, emotion dynamics, and psychological disorders.
8. **Sentiment Analysis:** SER can be integrated with sentiment analysis to analyze social media content, customer reviews, and public opinions. This combination provides a more comprehensive understanding of individuals' emotions and sentiments expressed in textual and audio data.
9. **Biometric Security:** SER can be utilized as a biometric modality for user authentication and security systems. By analyzing speech patterns and emotional cues, it can help in verifying users' identities and detecting impostors.

CONCLUSION

Our project successfully accomplishes the main objective of utilizing recurrent neural networks with long short-term memory (LSTM) for identifying emotions in individuals. To achieve this, we work with a dataset comprising 1440 files that encompass various emotions such as calm, happy, sad, fear, disgust, surprise, and neutral. The LSTM machine learning model is employed for testing the system. As machine learning models typically operate with numeric inputs, we convert our data into arrays prior to feature extraction. In this model, we utilize Mel-frequency cepstral coefficients (MFCC) as the feature, which is extracted using the librosa package. These extracted values serve as inputs to the developed LSTM model, which utilizes these features to predict the final emotion. The overall accuracy achieved by this model is 85.7%. To further enhance the model's accuracy, we can consider removing random silences from the audio clips and augmenting the data volume by acquiring additional annotated audio clips. These steps have the potential to improve the model's performance.

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Unveiling the Research Landscape of the Metaverse in Asia

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ABSTRACT

In order to give a thorough picture of the current state and trends within this burgeoning discipline, this report presents a bibliometric analysis of the Metaverse research environment in Asian nations. A sizable corpus of academic works on the Metaverse was extensively examined using bibliometric methods with help of VOS viewer and R Package- Bibliometrix, providing information on publishing output, teamwork dynamics, and topic focus. The results show that Asian nations have an increasing interest in the Metaverse, with a consistent rise in research output over time. Research efforts in the region were sparked by contributions from nations including China, Japan, and South Korea. It was discovered that collaborative efforts were common, with international partnerships significantly contributing to knowledge transfer and the development of the area. Virtual reality, augmented reality, virtual worlds, immersive technologies, and social interactions within the Metaverse were among the primary topics of concentration within the Asian Metaverse research landscape that were identified through thematic analysis. These results serve as a resource for academics and policymakers interested in improving the development and use of the Metaverse and offer insightful information on the research goals and directions in Asian nations.

KEYWORDS : *Metaverse, Bibliometric, Content analysis, Cluster analysis, Bibliographic coupling*

INTRODUCTION

Users can interact with a computer-generated environment and with others in real-time in the metaverse, a virtual reality setting. It creates an immersive and linked digital realm by fusing aspects of virtual reality, augmented reality, and the internet. The metaverse provides a variety of opportunities for social interaction, virtual world exploration, digital asset trade, gaming, and commercial dealing (Yang, 2023). Companies are investigating the metaverse's possibilities in many industries as a result of technological advancements, which have increased interest in it. Technical difficulties, ethical issues, privacy concerns, standardisation, and equal access are all problems, nevertheless (Schöbel & Leimeister, 2023).

In order to address these issues and comprehend how the metaverse affects behaviour, identity, job, and social

interactions (Syuhada et al., 2023). In order to create the metaverse as an inclusive environment that improves human experiences, stimulates creativity, cooperation, and meaningful relationships, interdisciplinary research in computer science, virtual reality, sociology, economics, and philosophy is being done (Zalan & Barbesino, 2023). The ultimate objective is to develop a digital environment that is transformational and advantageous to both people and society (Joseph Ng et al., 2023). The introduction of the metaverse has generated a great deal of attention and debate throughout the world and revolutionised the way we engage with digital surroundings and connect with one another (Joseph Ng et al., 2023). This virtual world has grabbed both academics and business experts because to its immersive experiences, augmented reality, and interconnection (Buhalis et al., 2023). Examining the metaverse's development and effects in various parts of the world is more important than ever as it continues

to develop and pick up steam (Kar & Varsha, 2023). This study presents a thorough survey of the current literature and research initiatives within this dynamic and quickly growing subject with a particular focus on the bibliometric analysis of the metaverse in Asian nations (Uyar et al., 2020). This study uses bibliometric methods to examine the academic environment, pinpoint significant contributors, and highlight new metaverse-related trends and patterns in Asian nations (Quarles et al., 2023).

Asian nations have been in the forefront of embracing and implementing cutting-edge technology because of their reputation for technical achievements and vibrant digital ecosystems (Dolata & Schwabe, 2023). Asian countries have taken a major role in determining the metaverse's future thanks to their various technology landscapes and rich cultural history (Zabel et al., 2023). This work aims to give useful insights into the regional research environment and throw light on the many elements of metaverse development and utilisation in this setting by exploring the bibliometric analysis of the metaverse in Asian nations (Weking et al., 2023).

This study will map the research trajectory, identify significant authors and institutions, and analyse the thematic clusters that have emerged within the metaverse discourse in Asian nations through a thorough analysis of scholarly articles, conference papers, and other pertinent publications (Reig-Mullor et al., 2022). This study also aims to highlight the interdisciplinary nature of metaverse research, emphasising the social sciences, virtual reality, gaming, and other relevant fields that contribute to the comprehension and development of the metaverse concept (Goldberg & Schär, 2023).

This article intends to present a thorough overview of the metaverse environment in Asian nations using bibliometric analysis, laying the groundwork for future research, policy development, and strategic decision-making (Kraus et al., 2023). The results of this study may serve as a roadmap for academics, government officials, and business leaders interested in discovering knowledge gaps, pursuing cooperative possibilities, and utilising the metaverse's potential in Asian contexts (Dwivedi et al., 2023).

In conclusion, this study offers a bibliometric analysis of the metaverse in Asian nations with the goal of providing a comprehensive picture of the academic landscape and

insightful information on the developments, trends, and consequences of the metaverse phenomena in this dynamic area (Fang et al., 2023). We hope that our in-depth analysis will add to the corpus of knowledge and promote a better comprehension of the transformational potential of the metaverse in Asian nations.

RESEARCH QUESTIONS

RQ1: What are the inclusive trends and total number of research publications published in Asia about the metaverse?

RQ2: Which major authors and nations are involved in the study of the metaverse in the chosen Asian nations?

RQ3: In Asian nations, what are the citation trends and effects of papers concentrating on the metaverse?

RQ4: What are the most popular metaverse research themes and areas of study in Asian nations?

RQ5: What possible research implications could result from the findings of this bibliometric analysis?

METHODOLOGY

To conduct the bibliometric analysis of the metaverse in Asian countries, a systematic search was performed using the Scopus database. The search string used was "TITLE-ABS-KEY (metaverse) AND (LIMIT-TO (AFFILCOUNTRY, 'China') OR LIMIT-TO (AFFILCOUNTRY, 'India') OR LIMIT-TO (AFFILCOUNTRY, 'Japan') OR LIMIT-TO (AFFILCOUNTRY, 'Singapore') OR LIMIT-TO (AFFILCOUNTRY, 'Malaysia') OR LIMIT-TO (AFFILCOUNTRY, 'Saudi Arabia') OR LIMIT-TO (AFFILCOUNTRY, 'Iran') OR LIMIT-TO (AFFILCOUNTRY, 'Thailand') OR LIMIT-TO (AFFILCOUNTRY, 'Pakistan') OR LIMIT-TO (AFFILCOUNTRY, 'Jordan'))".

This search phrase was created to discover papers that were linked to institutions in specified Asian nations, notably China, India, Japan, Singapore, Malaysia, Saudi Arabia, Iran, Thailand, Pakistan, and Jordan, and that had the word "metaverse" in their title, abstract, or keywords. The Scopus database, a large and frequently used repository for scholarly papers, was the only source that was included in the search (Zerbino, 2022). By concentrating on these Asian

nations, we sought to identify regional contributions to and trends in metaverse research. The Scopus search results were exported and then imported for additional examination into bibliometric analysis tools. From the retrieved publications, information such as publication year, authors, affiliations, citations, and keywords were extracted (Hassani & Bahini, 2022).

Numerous quantitative measurements, such as citation counts, co-authorship networks, keyword co-occurrence analysis, and trend analysis across time, will be used in the bibliometric study. These studies will offer perceptions into the research environment, significant contributors, topic clusters, and the development of the idea of the metaverse in the chosen Asian nations. By using this technique, we want to present a thorough and data-driven assessment of the scholarly output and trends connected to the metaverse in Asian nations, providing insightful information for academics, decision-makers, and business experts working in this area (De Jong et al., 2019).

RESULTS AND DISCUSSION

Annual Scientific Production

Figure 01 displays the number of articles that were released per year between 2008 and 2023. The number of publications varies with time, with very few papers published in previous years and a progressive rise in subsequent years. The number of articles increases noticeably in 2022 and then significantly in 2023. This shows a rise in research effort and interest in the field throughout those years (Wichianrak et al., 2023).

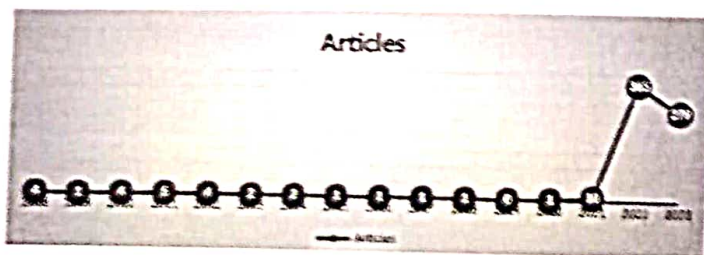


Figure 1. Annual Scientific Production

Most Influential Documents

Top 10 documents based on local and global citation is shown in the Table 01, together with information on each one's publication year, local and worldwide citation counts, LC/GC ratio (%), normalised local citation count, and normalised global citation count.

The quantity of citations from one source or document are referred to as "local citations," whilst citations from other sources are referred to as "global citations." It is clear from the statistics that the quantity of citations differs between the papers. Some papers, like Duan et al. (2021) and Dwivedi et al. (2022), have more local and international citations, demonstrating their major effect and influence within the discipline. Conversely, works by Suzuki et al. (2020) and Barry et al. (2015) have far less citations. The distribution of citations between local and international sources may be analysed using the LC/GC ratio. A lower LC/GC ratio denotes a more balanced or significant contribution from global sources, whereas a larger ratio implies a higher percentage of citations from local sources. A standard measure of citations is provided by the normalised local and global citations, enabling comparisons between texts. Higher numbers suggest a greater influence in terms of the number of citations compared to other papers. The table gives an overview of the citation performance of the listed publications, showing differences in citation counts, local-global citation distribution, and normalised effect within the field of study (Andreoli & Batista, 2020).

Most Prolific Authors

The Figure 02 lists researchers and shows how frequently their names appear in various contexts. The most often occurring names are Li Y, Wang X, and Wang Y, with 23, 22, and 21 occurrences each. These researchers are well-represented in the relevant environment. With 20 and 19 instances, respectively, Wang J and Wang F-Y also show very often. The number of occurrences for Liu Y, Niyato D, Chen Y, Li J, and Zhang X ranges from 18 to 13. The researchers who are most commonly cited or active in the field under examination are highlighted in the table (Boncinelli et al., 2023).

Most Influential Sources

Top 10 prolific sources are included in the Figure 03, along with the number of articles linked to each source (Ktisti et al., 2022). The most papers are found in "Lecture Notes in Computer Science," which has subseries on bioinformatics and artificial intelligence. With 17 papers, "IEEE Transactions on Systems, Man, and Cybernetics: Systems" comes in second place. Other noteworthy sources with 12 and 10 articles each are "ACM International Conference Proceeding

series" and "Sustainability (Switzerland)". Each of the following journals contributes 9 to 7 articles: "Frontiers in Psychology," "Lecture Notes in Networks and Systems," "Electronics (Switzerland)," "Frontiers in

Artificial Intelligence and Applications," "Proceedings - 2023 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops, VRW 2023," and "Proceedings of SPIE - The International Society for Optical Engineering."

Table I. Most Influential Documents

S.N.	Document	Year	Local Citations	Global Citations	LC/GC Ratio (%)	Normalized Local Citations	Normalized Global Citations
1	DUAN H, 2021, MM - PROC ACM INT CONF MULTIMED	2021	54	164	32.93	6.75	6.72
2	DWIVEDI YK, 2022, INT J INF MANAGE	2022	37	151	24.50	37.72	33.04
3	YANG Q, 2022, IEEE OPEN J COMPUT SOC	2022	26	46	56.52	26.51	10.07
4	TLILI A, 2022, SMART LEARN ENVIRON	2022	20	52	38.46	20.39	11.38
5	SHEN B, 2021, APPL SCI	2021	16	48	33.33	2.00	1.97
6	YANG D, 2022, CLIN EHEALTH	2022	14	37	37.84	14.27	8.10
7	WANG F-Y, 2022, IEEE TRANS COMPUTAT SOC SYST	2022	14	42	33.33	14.27	9.19
8	SUZUKI S-N, 2020, PROCEDIA COMPUT SCI	2020	14	50	28.00	1.00	1.00
9	BARRY DM, 2015, PROCEDIA COMPUT SCI	2015	13	33	39.39	1.00	1.00
10	KANEMATSU H, 2014, PROCEDIA COMPUT SCI	2014	12	28	42.86	2.00	1.87

Bibliographic Coupling of Countries

Based on common references in scientific papers, a technique called bibliographic coupling is used to evaluate international collaboration (Niñerola et al., 2021). It aids in the identification of research collaborations, interests, and new trends. Researchers and policymakers can learn more about global networks of collaboration and information sharing by examining bibliographic coupling patterns. This knowledge supports effective international research collaborations as well as strategic planning and research assessment. Based on the quantity of papers, citations, and overall link strength, the table provides information on the research production and influence of a few chosen nations. China has the most documents and citations, which shows that it is actively engaged in research. In spite of having fewer papers, the United States comes in second with a sizable number of citations. India has a modest research output and a comparatively strong

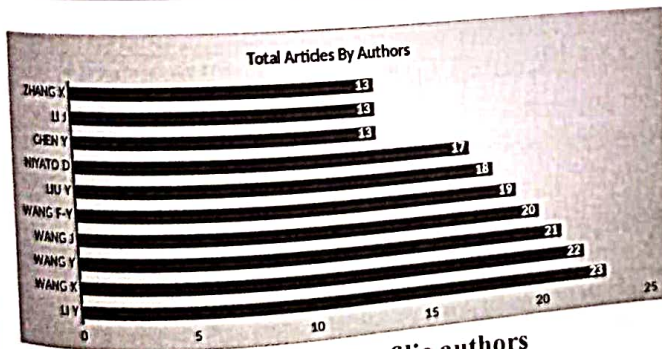


Figure 2. Most Profiling authors

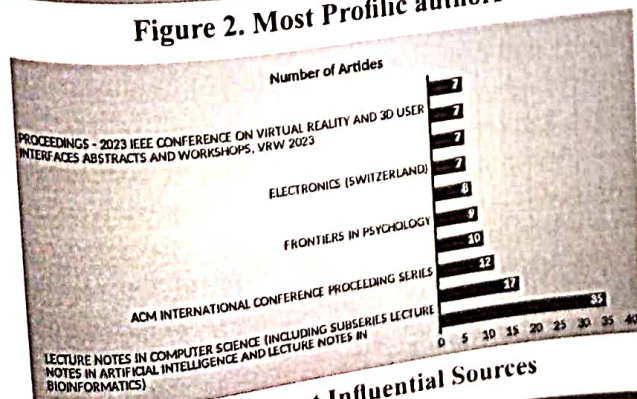


Figure 3. Most Influential Sources

overall linkage. Germany and the United Kingdom have lower research outputs but significant citations and link strength as shown in Figure 04.

themes represent brand-new, developing study fields. Fundamental concepts act as the field's knowledge's building blocks.

THEMATIC MAP

A thematic map aids in the visualisation of the properties of several research themes within a dataset during bibliometric analysis(Johnpaul et al., 2021). The thematic map incorporates a number of characteristics, including motor theme, emerging theme, specialty theme, and basic theme, as well as development degree and relevance degree. The level of development reflects the sophistication and depth of study in a certain topic. The degree of relevance reveals a theme's significance and influence within the larger study domain. Other themes are driven and shaped by motor themes, which serve as important and key notions. While niche themes indicate specialised and narrow issues, emerging

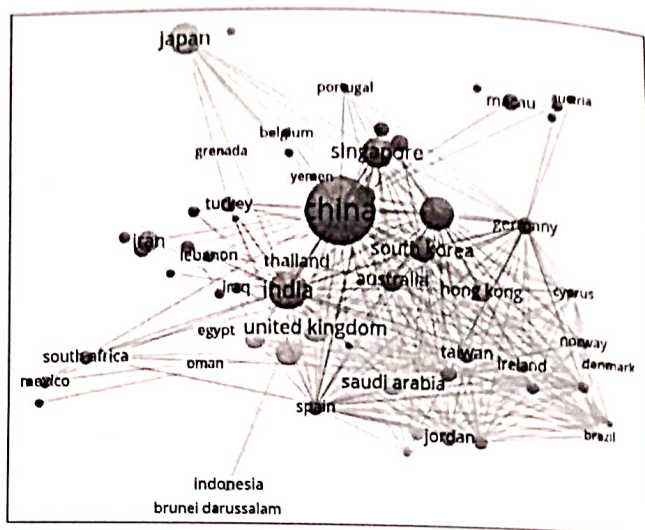


Figure 4. Collaboration among Countries

Centrality and Density details of Cluster Formed by Thematic Analysis

Table 2. Details of cluster

S.N O	Cluster	Callon Centrality	Callon Density	Rank Centrality	Rank Density	Cluster Frequency
1	reinforcement learning	2.28131533	33.99613041	9	9	117
2	3d modeling	1.41886022	32.04822955	6	8	81
3	e-learning	2.43224504	25.97081137	10	4	228
4	block-chain	5.78722389	25.96857443	12	3	406
5	human machine interface	0.74590277	40.01234568	3	11	46
6	machine-learning	3.50783770	23.95964482	11	2	139

The table provides a summary of various clusters related to different research topics in the field of Metaverse. It includes columns such as Callon Centrality, Callon Density, Rank Centrality, Rank Density, and Cluster Frequency. These metrics offer insights into the prominence and frequency of each cluster within the analyzed dataset. The Callon Centrality and Density values represent the centrality and density of the cluster, respectively, indicating the level of importance and interconnectedness of the research within that specific topic. Higher values suggest greater centrality and density, indicating a more prominent and cohesive

research area. The Rank Centrality and Density values denote the rank position of each cluster in terms of centrality and density, respectively. A lower rank value indicates higher centrality or density compared to other clusters, signifying a more influential or concentrated area of research. Lastly, the Cluster Frequency column indicates the number of publications associated with each cluster, providing an indication of the research activity and interest within each topic. Higher frequencies suggest a greater volume of research within a specific cluster. By evaluating these metrics, researchers can identify the most influential and

interconnected research areas (based on centrality and density), as well as the most prolific topics (based on cluster frequency). This information can guide further research efforts, collaborations, and the allocation of resources within the field of Metaverse research.

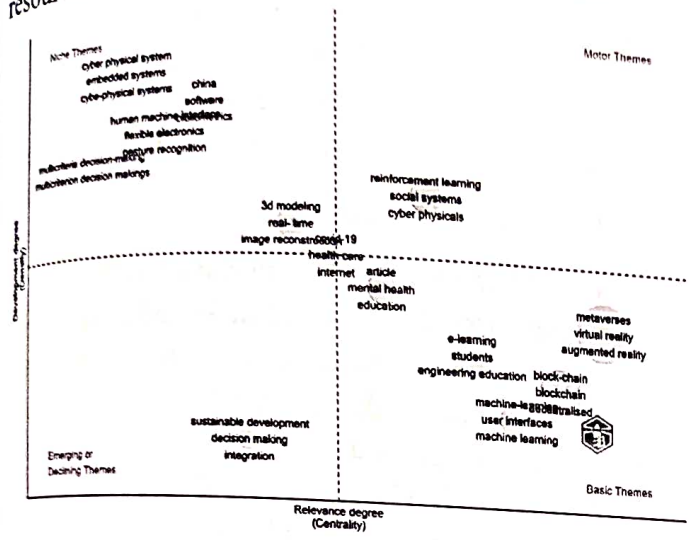


Figure 5. Thematic Map

Content Analysis

A technique for analysing and classifying textual or qualitative material into significant clusters or groupings is called content analysis using cluster analysis. It entails locating recurring themes, patterns, or subjects in a dataset. According to their content, such as words, phrases, or concepts, comparable objects are grouped together using mathematical methods in cluster analysis. This method offers a systematic method for organising and condensing enormous volumes of data and aids researchers in revealing hidden structures or links within the data. Researchers can better identify the major themes or categories included in the dataset and investigate the links between various clusters by clustering the data. Here from thematic map, we have examined 06 major clusters as follows:

Cluster analysis 1: Reinforcement Learning

The blending of “reinforcement learning,” “social systems,” “cyber physicals,” “cyberspaces,” “reinforcement learnings,” “task analysis,” and “computational modelling” creates an enthralling tapestry of interrelated topics in the vast metaverse. Reinforcement learning algorithms are essential in the metaverse for optimising user interactions and experiences, adjusting to unique preferences, and enhancing virtual worlds. In the metaverse, social

systems flourish, giving rise to vibrant communities, cooperative networks, and engaging interpersonal relationships. Cyber physicals smoothly combine digital and physical components, bridging the gap between the virtual and physical worlds, and turning interactions into palpable experiences. The metaverse’s digital cyberspaces, which provide limitless opportunities for connection and self-expression, serve as the setting for exploration, creativity, and participation. In the metaverse, task analysis assures effective job execution and boosts efficiency, while computational modelling enables designers and developers to create complex virtual environments and engaging simulations. These ideas come together to form the metaverse, a vast digital environment that is full of invention, connections, and life-changing events.

Cluster analysis 2: 3d Modelling

The fusion of “real-time,” “image reconstruction,” “three-dimensional displays,” “cameras,” “textures,” “holographic displays,” “3D modelling,” “algorithms,” and “image processing” in the metaverse results in an enthralling digital environment. While image reconstruction techniques completely meld digital and physical worlds, real-time interactions and experiences immerse users in dynamic virtual environments. The visual fidelity of the metaverse is improved through holographic and three-dimensional technology, allowing for lifelike representations and immersive experiences. The incorporation of aspects from the real world into the metaverse is made possible by cameras, which record the essence of the physical world. The complexity of virtual surroundings is enhanced by point clouds and textures, which replicate fine features and textures. The production and manipulation of 3D models is made possible by cutting-edge algorithms and image processing techniques, which help to shape the digital architecture of the metaverse. Liquid crystals aid in the creation of high-caliber displays by enhancing visual realism and clarity. These connected components serve as the building blocks of immersive experiences in the metaverse, allowing users to engage, create, and explore in a colourful and interesting digital world.

Cluster 03: E-learning

Students may engage in dynamic and engaging learning experiences outside of the typical classroom

environment because to the metaverse's immersive platform for e-learning. Teachers may use the metaverse to create personalised and adaptable learning experiences catered to each student's requirements using computer-aided education and knowledge-based systems. The establishment of engaging and dynamic learning environments where multimedia technologies excite students' perception and improve their grasp of difficult subjects is made possible by the educational metaverse. Students can successfully use problem-based learning approaches in the metaverse to address real-world issues and hone their critical thinking abilities. Additionally, the metaverse creates possibilities for online education, allowing students to access learning materials and participate in the learning process from any location.

Cluster 04: Blockchain

The metaverse uses blockchain technology to provide safe, decentralised transactions, digital asset ownership, and smart contract-based authentication. It offers a platform for immersive and interactive experiences inside of video games and other virtual worlds, having an influence on many different facets of everyday life, society, and the digital economy. The metaverse intends to provide the secure and effective flow of digital assets and electronic documents with an emphasis on information management, data privacy, and cybersecurity. In order to give consumers a smooth and engaging experience, it embraces intelligent systems, optimisations for displaying visuals, network security, and distributed computer systems. As Industry 4.0's metaverse develops, it attracts investments and spurs advancements in web 3.0, intelligent systems, and artistic computing. The metaverse aims to offer a safe and revolutionary digital environment for people and businesses alike by embracing decentralisation, cloud computing, and network optimisations.

Cluster 05: Machine Learning

Wearable technology and virtual avatars are only two examples of how "human-computer interaction" is made easy in the metaverse through the combination of "machine learning" and "user interfaces." The "complex networks" that support the metaverse grow, and it depends on effective "data handling" methods to manage massive volumes of data. "Decision trees" and

"learning algorithms" are used to improve decision-making processes so that "intelligent robots" can move around and interact in virtual settings. Advanced methods like "speech recognition" and "neural networks" enable intuitive and natural communication between people and the metaverse. The metaverse is researching topics like "convolution" and "brain-computer interfaces" in an effort to close the gap between the "human brain" and virtual experiences as technology advances.

Cluster 06: Human Interface

The idea of a "human-machine interface" is crucial in the metaverse because it allows for seamless communication between real world surroundings and virtual ones. New "flexible electronics" developments open the door to creative solutions that improve user experiences. "Gesture recognition" is essential for converting physical human motions into digital commands in the metaverse. By generating power from user interactions, cutting-edge technologies like "nanogenerators" and "triboelectricity" can power "wearable sensors" and other metaverse devices in a sustainable way. In order to record and decipher neural impulses, electrodes are used, enabling direct communication between the human brain and the virtual world. The metaverse experience gains an additional degree of expressiveness and control because to the recognition and interpretation of "gestures," which also makes it more user-friendly and immersive. The incorporation of these technologies results in a more seamless and interesting virtual world as the metaverse continues to develop.

CONCLUSION

The Metaverse in Asian nations was subjected to a thorough bibliometric study in this work, which offered insightful information on the state of the field and upcoming trends. This study provided insight into a variety of topics, including publishing productivity, collaborative patterns, and subject focus by methodically analysing a sizable corpus of scholarly publications. The results of this investigation showed that Asian nations have an increasing interest in the Metaverse, with a consistent rise in research output over time. The findings also showed how important particular nations—including China, Japan, and South Korea—have been in promoting study on the Metaverse in the area.

Collaboration was discovered to be a crucial component of research in the Metaverse, with a sizeable portion of publications coming from cross-border partnerships. This demonstrates the international scope of the topic and the necessity of international collaboration and knowledge exchange among academics. Additionally, the theme analysis revealed major areas of interest within Asia's Metaverse research environment. These included subjects including immersive technology, virtual reality, augmented reality, virtual worlds, and social interactions in the Metaverse. Such results are a useful resource for academics and policymakers interested in boosting the development and uptake of the Metaverse in Asian nations, and they also help us comprehend the existing research environment.

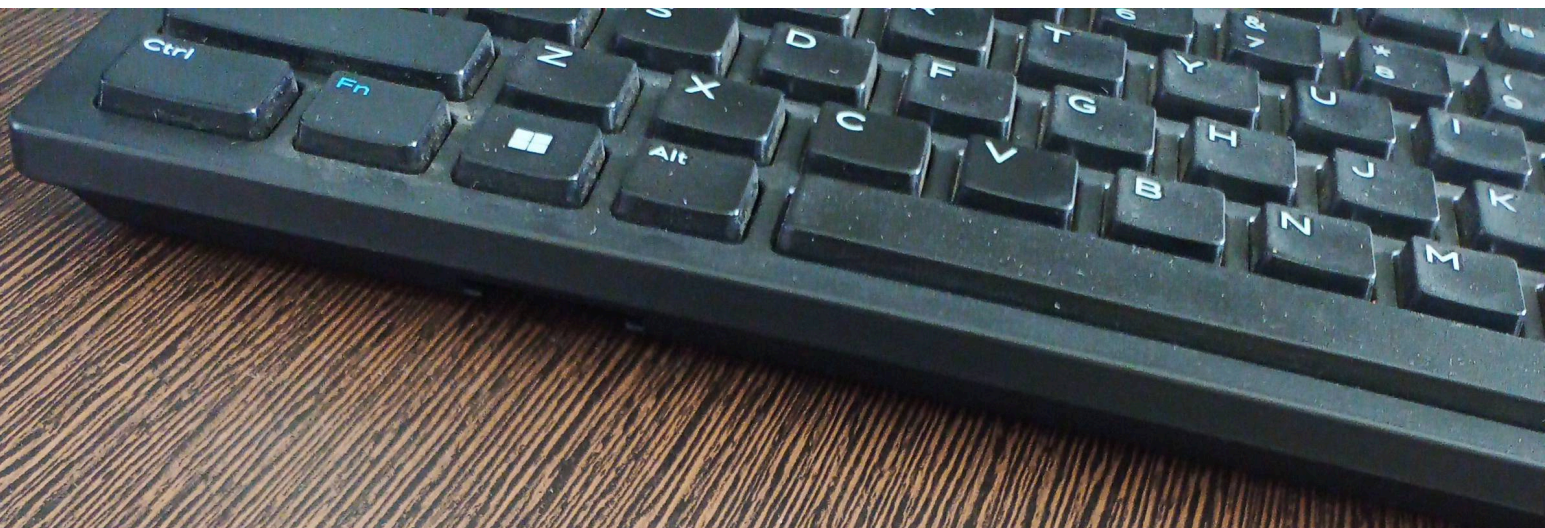
FUTURE SCOPE OF STUDY

Future research in the metaverse will focus on a number of important subjects in Asian nations. First, more investigation might focus on the qualitative components of Metaverse adoption, investigating user experiences, moral issues, and social effects. Investigations into how cutting-edge technology like blockchain and artificial intelligence are used in the Metaverse might also yield insightful results. Comparative research between Asian nations and other regions may also point up commonalities, discrepancies, and prospective opportunities for cooperation. The Metaverse's larger ramifications may be better understood through interdisciplinary study that combines disciplines like psychology, sociology, and economics. This will also help Asian nations develop the Metaverse responsibly and sustainably.

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Object Detection Models From Classical Methods To The Latest Deep Learning-Based Approaches

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ABSTRACT

Object detection is a fundamental task in computer vision with numerous applications across various domains. This research paper provides an overview of the state-of-the-art techniques, challenges, and advancements in the field of object detection. The paper begins by explaining the importance of object detection, from its role in autonomous vehicles and surveillance systems to its applications in healthcare, agriculture, and robotics. It then delves into the evolution of object detection models, from classical methods to the latest deep learning-based approaches. A comprehensive analysis of popular models such as YOLO, Faster R-CNN, and EfficientDet is provided, highlighting their architectures and performance metrics. Challenges associated with object detection, including occlusion, scale variation, and real-time processing, are discussed. Transfer learning and domain adaptation techniques are explored, showcasing the versatility of object detection across different domains. The paper emphasizes the ethical and privacy considerations surrounding object detection, particularly in surveillance and facial recognition applications, and highlights the need for responsible development and deployment.

1. INTRODUCTION

Object detection is a critical task in computer vision, with applications ranging from autonomous driving and surveillance to augmented reality and healthcare. Among the various object detection methods, YOLO (You Only Look Once) stands out as a revolutionary approach known for its speed and accuracy.

YOLO is a real-time object detection system that significantly simplifies the object detection process. Unlike traditional methods that involve multiple complex stages, YOLO performs detection and classification in a single pass through a neural network. This unique approach allows it to achieve remarkable real-time performance, making it suitable for applications where quick, accurate detection is essential.

The key innovation of YOLO is its ability to divide an image into a grid and predict bounding boxes and class probabilities for objects within each grid cell. This grid-based approach allows YOLO to handle multiple objects in a single image efficiently. YOLO also offers versatility by supporting different model architectures, such as YOLOv3 and YOLOv4, each with varying trade-offs in terms of accuracy and speed.

2. RELATED WORK

Early Object Detection Methods:

Early approaches to object detection relied on handcrafted features and traditional machine learning algorithms. Prominent methods include the Viola-Jones face detection framework [Viola and Jones, 2001] and the Histogram of Oriented Gradients (HOG) method [Dalal and Triggs, 2005]. While these methods provided valuable insights, they were limited in their ability to handle complex object categories and variations.

Region-Based Approaches:

The introduction of convolutional neural networks (CNNs) revolutionized object detection. Region-based methods, such as R-CNN [Girshick et al., 2014] and its successors, Fast R-CNN [Girshick, 2015] and Faster R-CNN [Ren et al., 2015], combined CNNs with region proposal networks, significantly improving object detection accuracy. These models set the stage for the deep learning-driven object detection revolution.

Single-Shot Object Detectors:

Single-Shot detectors, such as the Single-Shot MultiBox Detector (SSD) [Liu et al., 2016], prioritize real-time performance by predicting bounding boxes at multiple scales and aspect ratios in a single forward pass. SSD's design allows it to achieve competitive results while being well-suited for applications requiring low latency.

Efficient Object Detection:

EfficientDet [Tan et al., 2020] is a recent model designed to balance model size and accuracy. By using a compound scaling technique, it optimizes object detection models for various computational constraints. This approach has opened up possibilities for deploying object detection in resource-constrained environments.

3. TECHNOLOGY STACK

Hardware:

GPU: Graphics Processing Units are crucial for accelerating deep learning inference, as many object detection models are computationally intensive. NVIDIA GPUs are often preferred due to their excellent support for deep learning frameworks.

TPU: Google's Tensor Processing Units, or other specialized AI accelerators, can also be considered for high-performance object detection applications.

Software Frameworks:

Deep Learning Frameworks: Use deep learning frameworks to build and train object detection models. Popular choices include:

TensorFlow: Offers the TensorFlow Object Detection API for building and training custom models.

PyTorch: Known for its flexibility and ease of use in developing custom models.

Keras: A high-level API that runs on top of TensorFlow or other backend engines.

Caffe: While less common today, Caffe can be used for object detection and is known for its speed and efficiency.

Object Detection Libraries:

OpenCV: An open-source computer vision library that provides various tools for object detection and image processing.

YOLO (You Only Look Once): YOLO comes with pre-trained models and is known for real-time object detection. YOLOv4 and YOLOv5 are popular versions.

Faster R-CNN: A widely-used region-based object detection framework.

SSD (Single Shot MultiBox Detector): Another real-time object detection framework that's known for its efficiency.

4. SYSTEM ARCHITECTURE

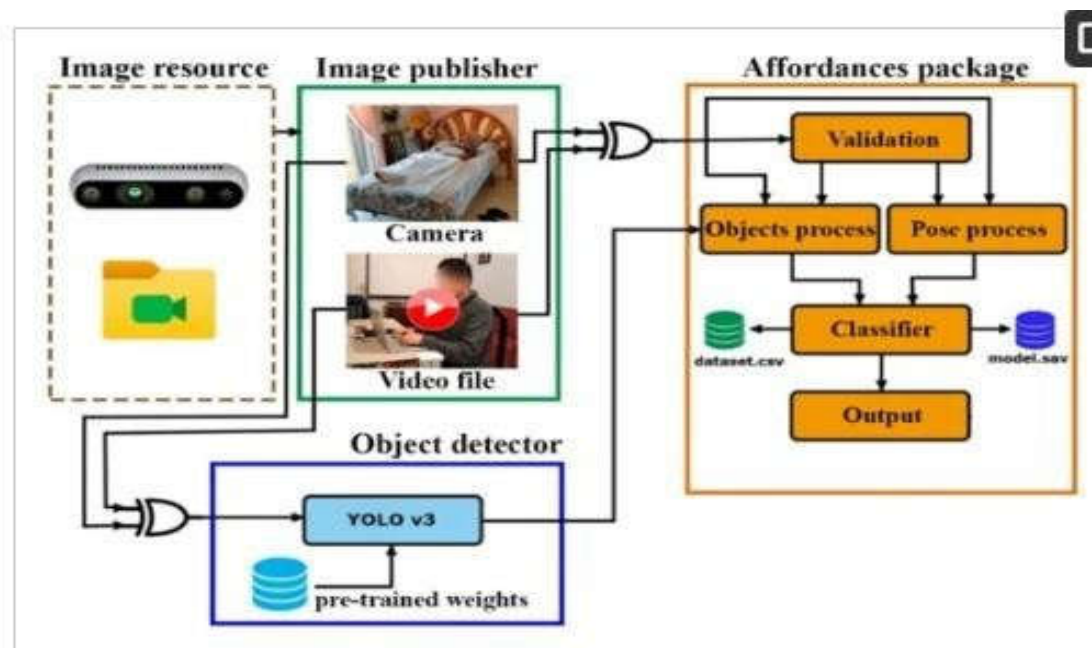


Figure : System Architecture

The image resources could be any sensor like camera from where the image is captured for further processing. The image is processed using YOLO algorithm for object detection and then the model gives the detection boundary for each object with its identity name and accuracy of its detection.

5. OUTPUT

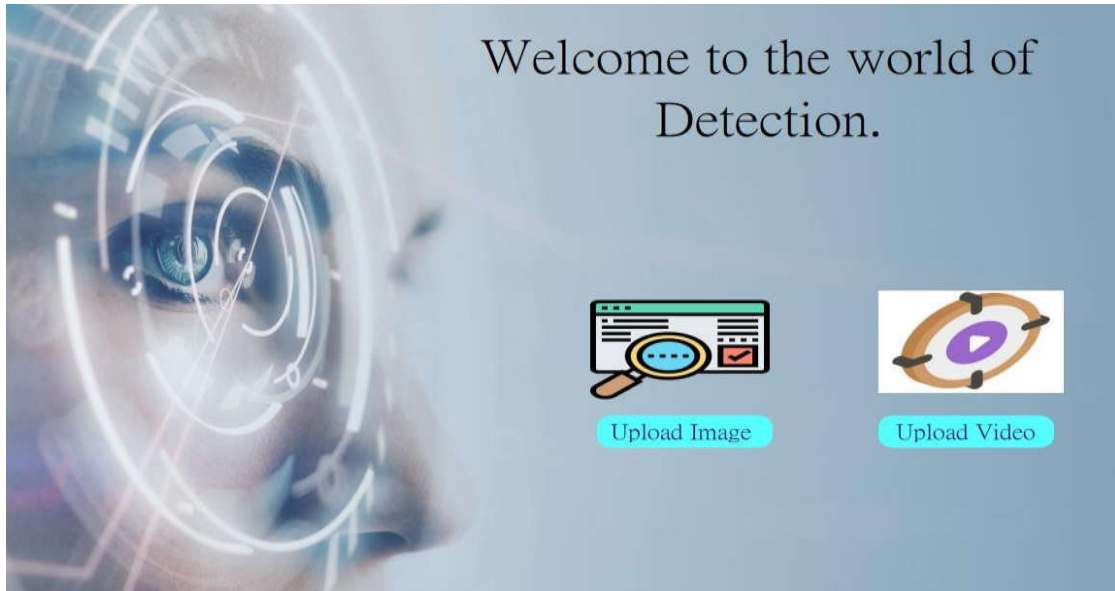


Figure -5.1 frontend user interface for object detection

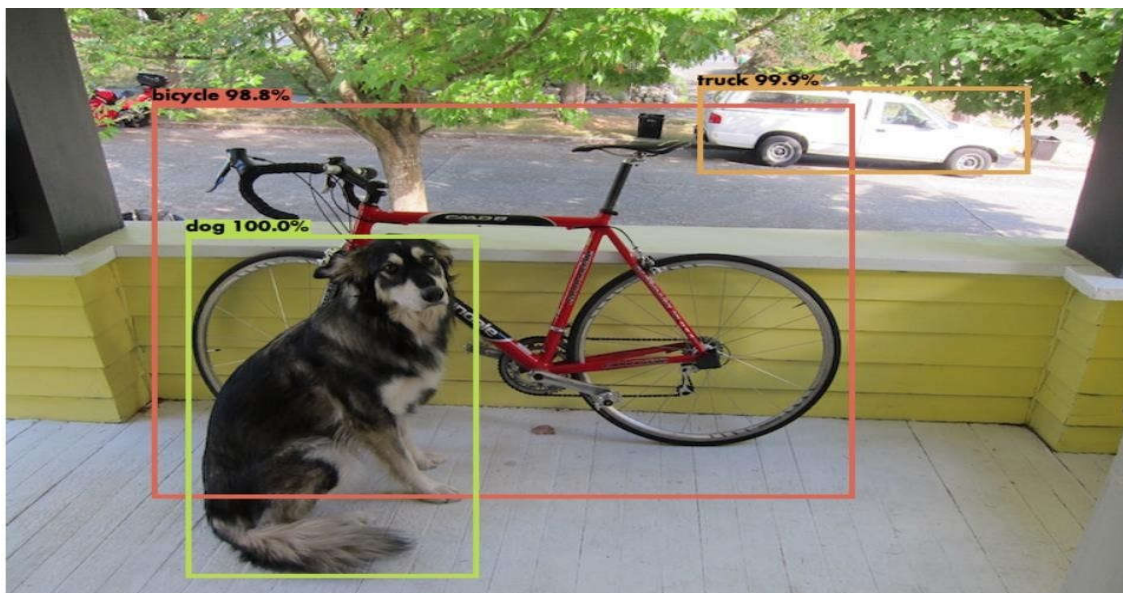


Figure -5.2 Object detected using YOLO algorithm

The above object detection image shows a dog sitting next to a bicycle on a porch. The dog is in the foreground of the image and the bicycle is in the background. The dog is a brown and white Labrador retriever. It is sitting upright with its head turned to the right. The bicycle is a black mountain bike. It is leaning against the porch wall.

The object detection model has identified the dog and the bicycle in the image and has drawn bounding boxes around them. The model has also assigned class labels to the objects: "dog" for the dog and "bicycle" for the bicycle.

The object detection model has high confidence in its predictions. The confidence scores for the dog and the bicycle are 100.0% and 98.8%, respectively. This means that the model is very confident that it has correctly identified the objects in the image.

Overall, the object detection model has performed well on this image. It has correctly identified the dog and the bicycle and has drawn bounding boxes around them with high confidence.

5. TECHNOLOGY USED

We used Pyqt 5 for designing frontend and python for backend. For final output i.e., the object detection, we used YOLO algorithm with Tensorflow library.

6. CONCLUSION

Object Detection stands at the intersection of cutting-edge technology and real-world applicability. Its evolution has been characterized by a relentless pursuit of accuracy, efficiency, and ethical responsibility. As the field continues to evolve, it will undoubtedly contribute to transformative solutions and push the boundaries of what is possible in computer vision, reaffirming its status as an indispensable tool for understanding and interacting with the visual world. The journey of object detection is far from complete, and the next chapters promise to be as thrilling and impactful as those that have come before.

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Solovyov Studies ISPU

An UGC Care Group 2 Journal

Journal ISSN: 2076-9210, An ISO: 7021 - 2008 Certified

Email: editor.ispu@gmail.com, Web: <https://solovyov-studies.ispu.com/>



CERTIFICATE OF PUBLICATION

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*"Profanity Identification Reloaded: Unraveling Offensiveness Using
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S.B. Jain Institute of Technology, Management & Research, Nagpur, Maharashtra

Has been published in

Solovyov Studies ISPU, VOLUME 72, ISSUE 3, 2024



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Editor-in-Chief

Development of an IoT based Real-Time Monitoring and Automatic Water Level Control System with Alert Notification through IFTTT

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ABSTRACT

Waste of water monitoring and controlling is an essential service that many utilizes and perform for their industrial and larger commercial applications. The Internet of Things (IoT) could prove to be one of the most important methods for developing more utility, proper system and for making consumptions of water resources more efficient. Liquid monitoring through cloud is effective and it provides an feasible solution for remote monitoring. In this work, the new approach for monitoring and controlling the water level with the help of various cloud service. Wastage of water is very important for the part of focus so, the conservation of water resources is very essential. The water level inside the tank can potentially be determined by this project and the display will show it appropriately. NodeMCU module work on the WI-FI which is use for automatically operation of system. This is close loop control system. IFTTT (If This Then That) web service has been used for sending SMS on mobile.

KEYWORDS: *Water monitoring, Water controlling, NodeMCU module, IFTTT service, Thing speak platform.*

INTRODUCTION

Today, the world is facing the environmental problems and challenges. One of the main issues of the current situation is the lack of drinking water. Clean drinking water and water used for utility purpose is very significant to sustain life and it plays a major role in well-being of human society. In a civilized society, overflowing of water is very concernful matter which leads to precious water wastage and energy losses. This issue can be resolved by just monitoring and controlling the water level with some kind of alertness such as notification on mobile or any android application which can make aware the user about the water level. To overcome the problem of the wastage of water, the monitoring and analysis of roof top tank water level at house hold or any type of buildings with alert notification and demonstrated in the project.

In this project, the aim is to monitor the liquid level using IoT technology specifically by utilizing the





NodeMCU and an ultrasonic sensor. The NodeMCU is chosen as it integrates an ESP8266 Wi-Fi module making it cost-effective, compact and efficient. This system utilizes the ThingSpeak platform as a web server which is freely available for use. This platform provides real-time data visualization in the form of a graphical representation and percentage based liquid level on an Android application.

MAIN OBJECTIVES

- To ease the monitoring & controlling the water level through IoT.
- To monitor and control water level at industry and commercial establishments.
- To overcome the problem of low level & overflowing of water occurred during manual observation.
- To enable the human to manage their water level time to time.

The specification of the required components has been given in the Table 1.

Table 1: Used components in the circuit

Sr No	Component	Rating	Pictures	Quantity
1	Node MCU with Wi-Fi module ESP8266	Memory 128 Kb Stroke 4 Mb		01
2	Ultrasonic sensor (HC-SR04) (Simple and water proof)	5V		01
3	Connecting wires			As per requirement
4	Water pump	12V		01
5	Plywood			
6	Adapter	5.5V		01

7	OLED Display	5V		01
8	Battery	9V		01

METHODOLOGY OF THE PROPOSED WORK

The internet of things brings up prospects for more direct integration between the physical world and computer-based systems, improving efficiency, accuracy and economic value. This is made possible by the ability to remotely manage objects through existing network infrastructure. The Hardware, NodeMCU, Ultrasonic sensor and relay that make up an IOT-based water level monitoring system are joined by an IOT platform like Things Speak and IFTTT. There is a Wi-Fi module included into NodeMCU that handles wireless connectivity, allowing for quick, secure and precise information sharing. This method for wirelessly monitoring water use in the water tank is based on a hardware and software integrated solution.

WORK FLOW

It's distributed into two phases as follows:

Phase 1: Phase 1 consists of understanding the different hardware components, sensor and microcontroller viz. OLED display, Single channel Relay, Pump, Ultrasonic sensor, NodeMCU and their interconnection.

Phase 2: It consists of understanding and using the Software i.e. Arduino IDE, Things speak, IFTTT and related programming.

System Architecture: This system indicates the architecture of IOT based water level monitoring system with alert notification. The Fig 1 system indicates the architecture of IOT based water level monitoring system with alert notification. The flow of data transfer is from ultrasonic sensor to Node MCU after that with the help of Wi-Fi module the information is given to the web server and then it shows the real time data on the android application and it controls the water level.

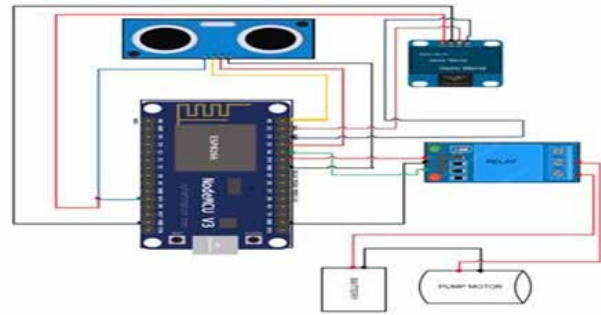


Fig 1: System architecture

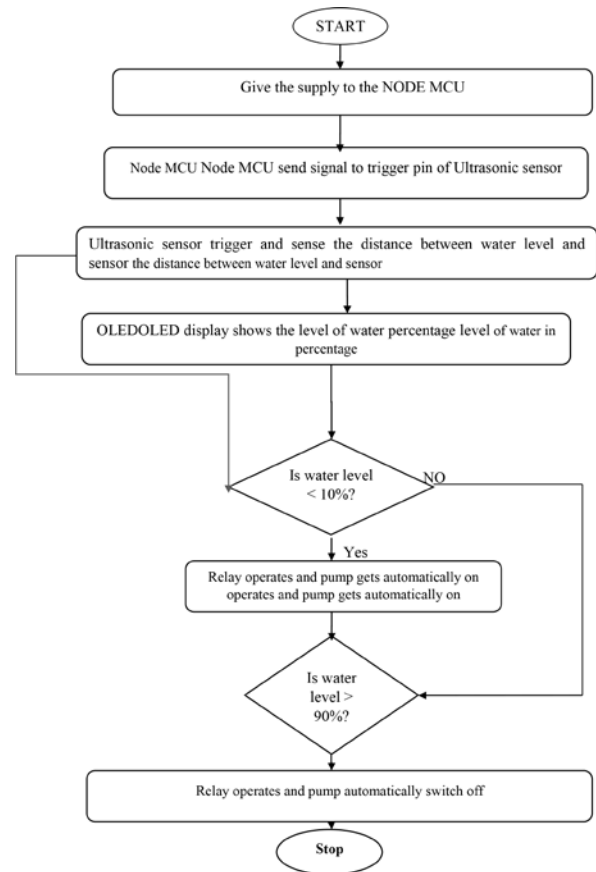


Fig 2: Flowchart of the proposed water monitoring and controlling system

Working of NodeMCU with ultrasonic sensor: The NodeMCU is used with Ultrasonic sensor, ThingSpeak cloud service & Android application (Mobile). The NodeMCU has a 30 pin but out of that, it is used only 10 pins i.e., D0, D21, D2, D3, D4,2(3V3), 3(GND) which is (GPIO16, GPIO5, GPIO4, GPIO0, PIO2) pin, 3V3 pin & GND. O-LED display has 4 pins i.e. Ultrasonic sensor (HC-SR04) which has 4 pin VCC, TRIGGER, ECHO and GND as shown in Fig 3. For notification and displaying the real time water level on cloud, the ultrasonic sensor which calculate the distance and give in the percentage form of present water in the tank. To calculate distance, there is a requirement to dump the program in NodeMCU which contain Wi-Fi module with the help of Arduino software.

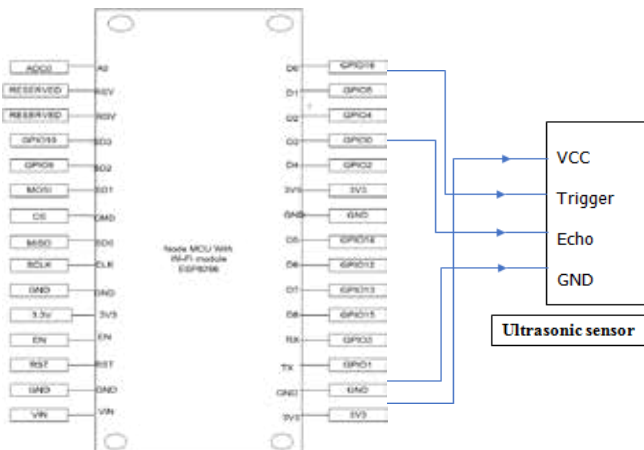


Fig 3: Interfacing of NodeMCU with Ultrasonic sensor

Ultrasonic sensor calculates the distance and that is giving NodeMCU where the EP8266 Wi-Fi is inbuilt and connected to web server which give a real time data of water level and the result can view on the android application and shows the notification. Here firstly, set the overflow level of water tank and the level of water. By considering this, if water is field up to the overflow level then it shows the 100% and also firstly set the upper threshold value i.e., 90% & lower threshold i.e., 10% then it shows notification and give an alert notification regarding the water level and analysis time to time.

Once the echo goes high (5V) and external interrupt get that data then the counter is start in ISR (Interrupt Service Routine) for start and start counter for updated. Update memory of NodeMCU to get the distance

continuously.

$$\text{Distance} = \frac{D - 340\mu S}{2}$$

$$\% \text{ Level} = \frac{H - D}{H} \times 100$$

H= Total Height of tank in cm

D= Distance between water level and sensor

Input of relay is connected to the output of NodeMCU and its 3v3 part has been connected to the VCC of relay. GND of relay is connect to GND of NodeMCU. IN pin of relay is connected D4 of node MCU which is shown in Fig 4. Output of relay is connected to the battery positive of battery is connect to the NO of relay and positive of pump is connect to common of relay. Negative of battery and pump is short. Battery gives the supply to the pump. When the water level less than 10% according to calibration motor on automatically and fill the tank above 90%. When water reach above 90% relay sense and motor is off automatically.

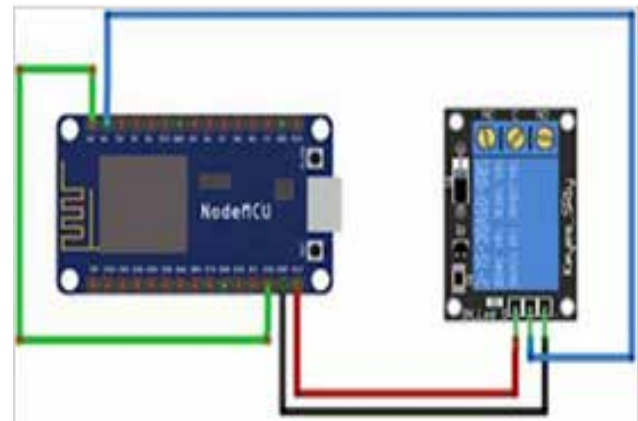


Fig 4: Interfacing of NodeMCU with Relay

Advantages:

- It is low cost with integrated support for Wi-Fi module.
- It is very compact product with very less component, reliable and highly efficient.
- It is the most modern IOT based it technology used for worldwide monitoring and low energy consumption.
- Water leakage detection and reduces the wastage of water.

Applications:

- Liquid level indication and control in industry.
- Oil and Fuel and all types of liquid level monitoring.
- STP (Sewage Treatment Plant) level indication.
- It's used in all types of commercial buildings.
- Offers RTC (Real Time Control) and RTA (Real Time Access).

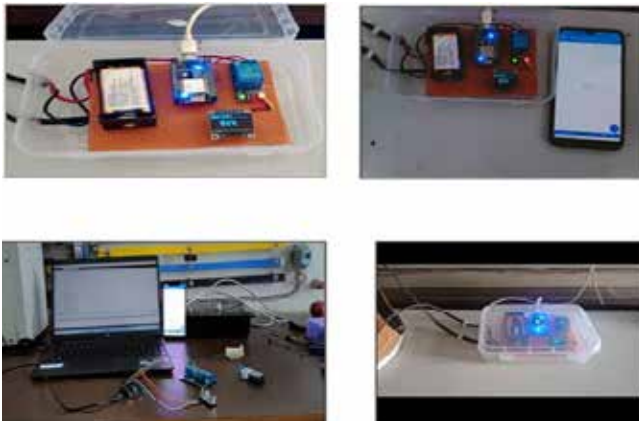
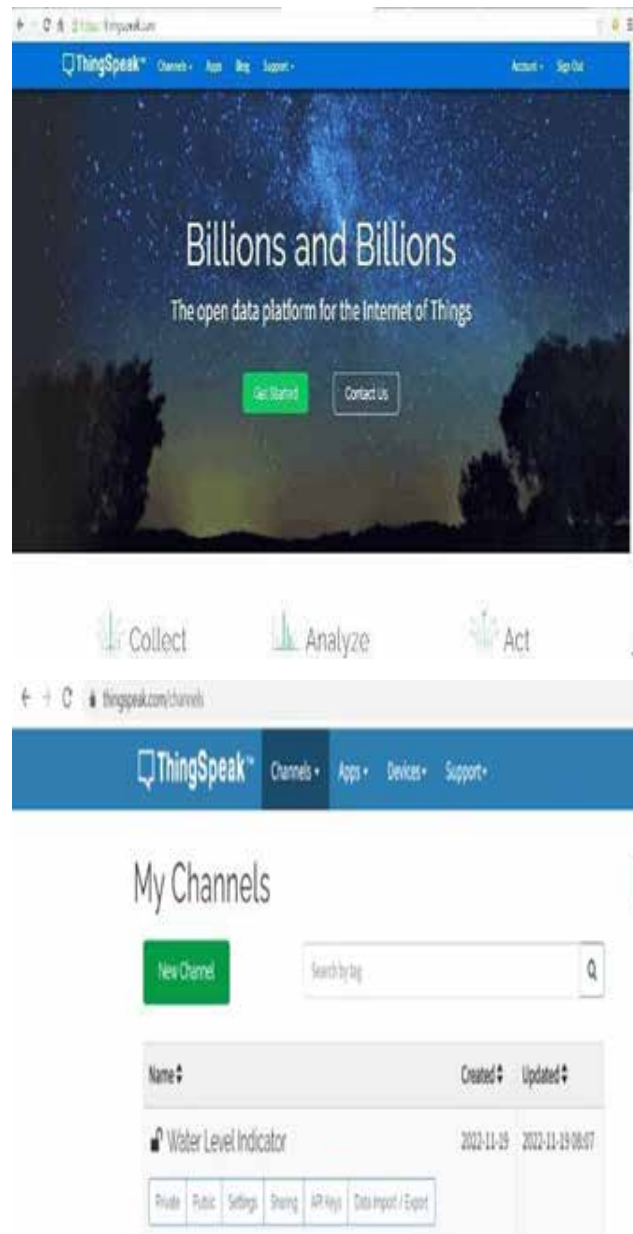
HARDWARE AND IMPLEMENTATION

Fig 5: Hardware Implementation of Water Level Monitoring and Controlling System

RESULTS AND DISCUSSION

- 1) Arduino IDE: Arduino IDE (Integrated Development Environment) is an open-source software tool used for writing, compiling and uploading code to Arduino boards.
- 2) Things speak application: Thing Speak is a web-based application and IoT platform that allows users to collect, analyze, and visualize data from connected devices
- 3) IFTTT: IFTTT (If This Then That) is a popular web-based service that allows users to create automated workflows and connect various internet-enabled devices and services together. It enables users to create applets, which are simple conditional statements that specify an action to be performed when a certain trigger event occurs.
- 4) Sending data to thing speak: Prior to getting started, one must first register for a ThingSpeak

account, sign in and select “Get Started”. Go to the “Channels” menu now and on the following page, select “New Channel” to continue. Now, a form for creating the channel is displayed and then completes the “Name and Description fields” as necessary. Next, fill in the label for Field 1 with water and check the boxes next to both Fields. Additionally, check the box next to “Make Public” on the form, then click “Save” as shown in Fig 6. The new channel has now been established.



Now click on “API keys” tab and save the Write and Read API keys, here the use of only using “Write key”. Get link as marked in the image which is need to “Copy” the key and link in the program.

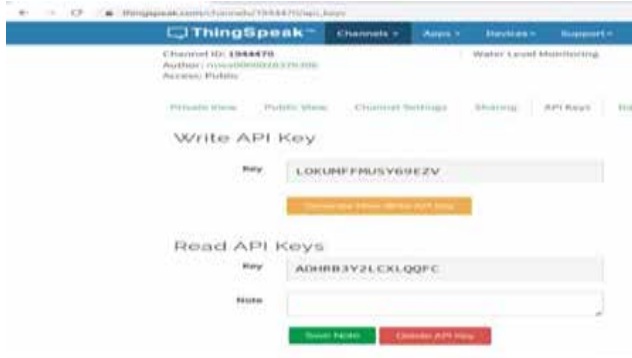


Fig 6: Data is transferred to ThingSpeak IOT based paltform

IFTTT: There are many applications for sending SMS alert, in which mostly GSM module is used. But in this work, there has been a use of IFTTT which is a free web-based service to create chains of simple conditional statement called applets as shown in Fig 9.



Fig 7: Creating an applet

Steps use for IFTTT: It is necessary to create an IFTTT applet that links to Particle in order to send messages to the phone. Set up the SMS service first. The present connection should function if this has already been configured. Setup the Particle service right away. Create the new applet now, as seen in Fig 10. For the service field (then), select “Particle”. Choose “new event published” from the list. The “Event Name Field” can be given any distinctive name, as illustrated in Fig 11. Select SMS in the “that” field as displayed in Fig 12. The message is written as “Water level monitoring” as per the work.

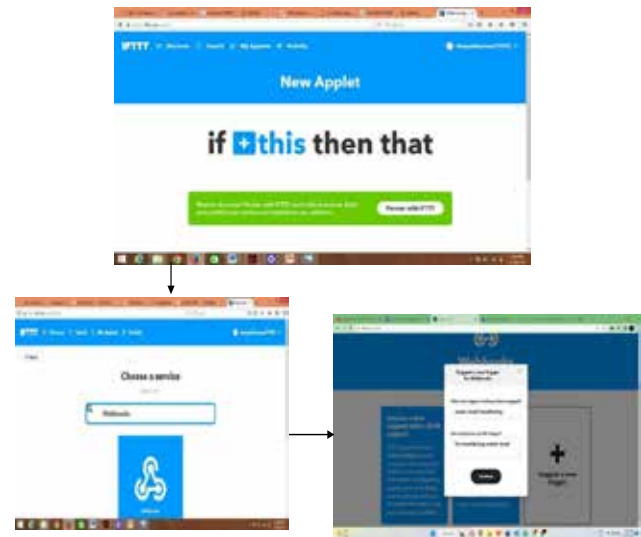


Fig 10: Making a applet with an trigger block for the required service accordingly

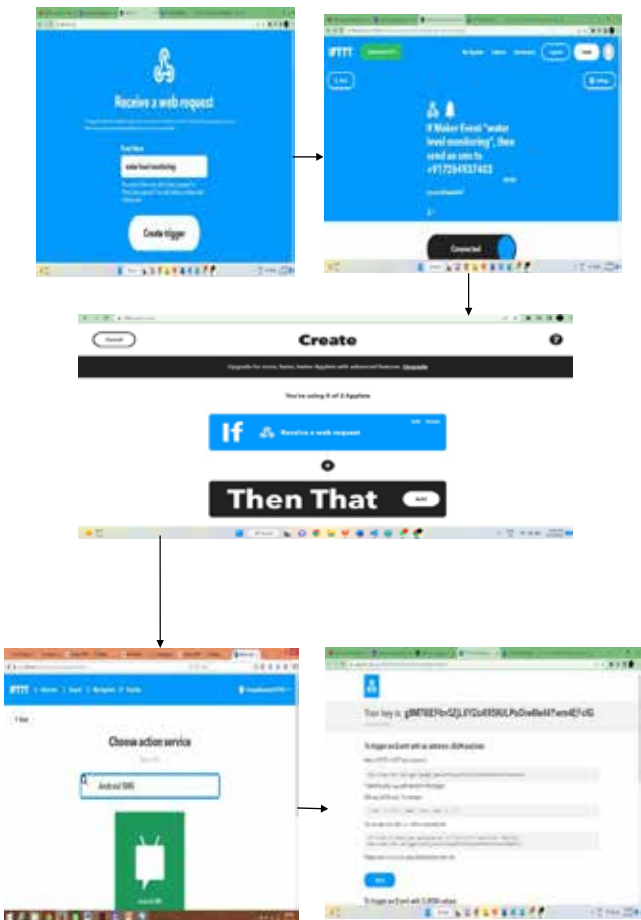


Fig 11: Choosing an Android SMS service with publishing an event name



Fig 12: Receiving an SMS of alert notification as per the applet title

CONCLUSION

The main objective of the proposed system is to implement smart water quality monitoring in a planted tank. Monitoring water quality in real-time is crucial for maintaining the health and safety of aquatic plants and animals. The system described in this paper offers a cost-effective and efficient model for continuous water monitoring. To automate the control of water level, a relay is incorporated into the system. The relay acts as a switch that can turn the water pump or any other water control mechanism on or off. When the water level reaches 90%, the relay is triggered to turn off the water supply, preventing overflow. Conversely, when the water level drops below 10%, the relay is activated to turn on the water supply ensuring that the adequate level is maintained.

Additionally, the Thing Speak mobile application can also be used to monitor the values remotely. To enhance the system's functionality, IFTTT (If This Then That) applets are incorporated. These applets utilize the services offered by Thing Speak such as Thing HTTP and Thing Speak Reacts. By setting up appropriate applets in IFTTT using Things peak's URL, the system can notify the owner when the calculated sensor values exceed a predefined threshold.

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Development of Laboratory Prototype for Soft Starting of Induction Motor

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ABSTRACT

The induction motor is widely used in various industrial applications due to its simplicity, robustness and cost-effectiveness. However, the abrupt starting current of an induction motor can cause mechanical stress, voltage dips and disturbances in the electrical network. To mitigate these issues, soft starting techniques have been developed to gradually increase the motor voltage during startup thereby reducing the inrush current and enhancing motor performance. This work proposes development of a laboratory prototype for soft starting of an induction motor using Arduino Uno and BTA16 triac. The control algorithm programmed in the microcontroller ensures a gradual increase in motor voltage thereby reducing the inrush current and minimizing mechanical stress on the motor. Current waveforms, voltage waveforms and startup time are analyzed using PROTEUS software. Experimental testing results demonstrate that the developed prototype effectively achieves soft starting characteristics, resulting in smoother motor operation and reduced electrical disturbances.

KEYWORDS : *Arduino uno, BTA16 triac, Induction motor, Soft starter*

INTRODUCTION

Induction motors play a crucial role in various industries. However, the starting an induction motor directly across the line can lead to several issues such as high inrush current, voltage dips, mechanical stress and decreased motor lifespan. In an industry where several low rating induction motors are connected (less than 5 HP) then if all induction motors are switched on simultaneously the resultant high current can cause voltage sags affecting other equipment connected to the same electrical network. This condition compromises the overall power quality. To overcome these issues, there is a need for a suitable soft starter solution for induction motors. The development of a soft starter specifically tailored for small induction motors presents unique challenges. Factors such as cost-effectiveness, compactness, ease of installation and compatibility with various load types must be considered in the design and implementation process.

Purpose of Study

- A soft starter can eliminate problem of high starting current by gradually increasing the voltage providing a controlled ramp-up to full speed.
- It controls starting torque and reduces mechanical shocks to the motor.
- It is useful extending the life of motor and reduces motor heating. So, a soft starter provides
- a gentle acceleration up to full speed. The function of the work has been shown in the Fig 1.

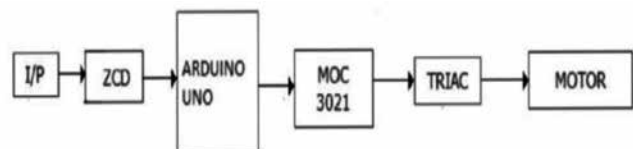
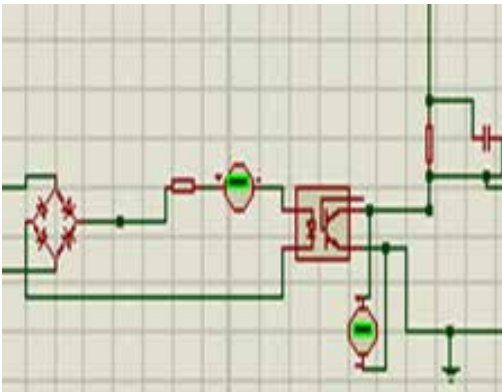
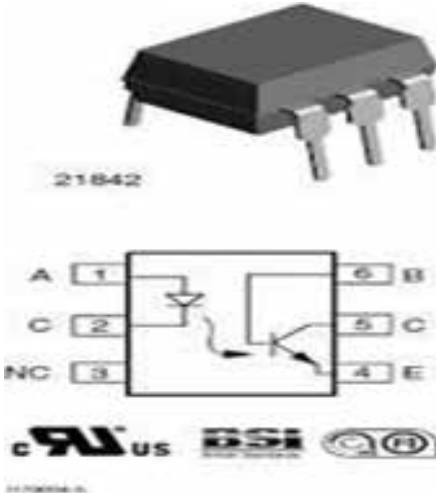
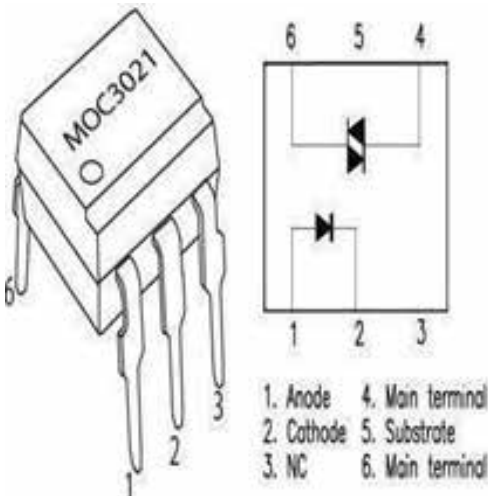


Fig 1: Proposed block diagram

In Table 1, the specification of the components required for making the prototype.

Table 1: Overview of the components

SR. NO.	Name of Components	Diagram	Description
1	ZCD		<p>A zero crossing detector circuit is used to detect the moment when the AC voltage signal crosses zero. It is typically implemented using a simple circuit composed of optocoupler that detects the zero- crossing point of the AC voltage signal.</p>
2	4N25 (OPTOCOUPLER)		<p>The 4N25 optocoupler is a device that is commonly used to provide isolation between the control circuitry and the high voltage circuitry that is used to control the motor, protecting the control circuitry from damage and increasing the safety of the system.</p>
3	MOC3021 (OPTOCOUPLER)		<p>The MOC3021 optocoupler is a device that is used to provide isolation between two circuits i.e. controller circuit and triac circuit.</p>

The process of this project has been shown in the Fig 2.

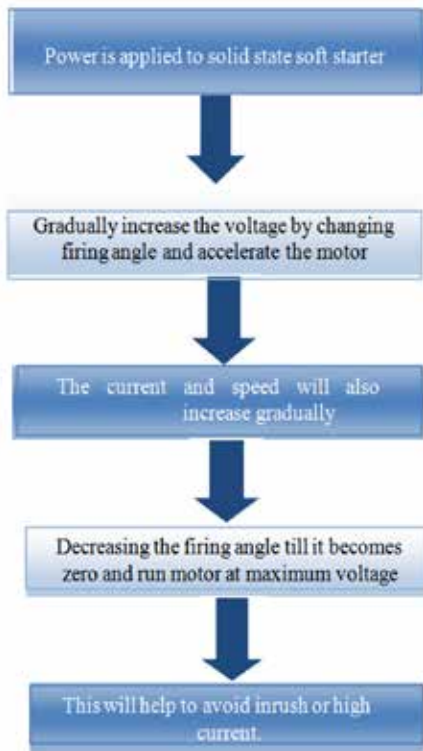


Fig 2: Flowchart of working of solid state soft starter

HARDWARE IMPLEMENTATION

Manual firing angle control: In Fig 3, when analyzing motor current with a soft starter, the inrush current is significantly reduced which leads to a smoother and more controlled starting process. This can help to increase the life of the motor and other electrical components in the system.

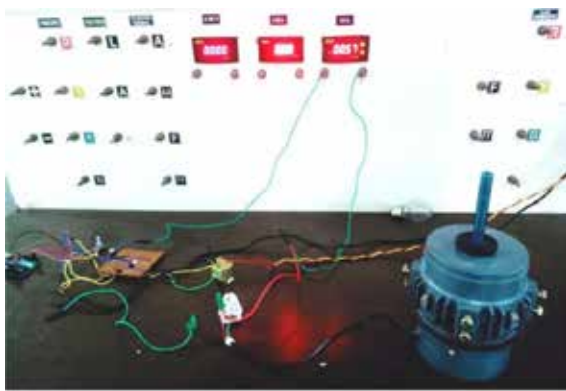


Fig 3: Hardware test of single phase manual firing angle controller on motor

Automatic firing angle control: After successful testing of manual firing angle controller on resistive and inductive load, the hardware implementation of automatic soft starter prototype has been carried out as shown in Fig 4. The firing angle is controlled automatically without using potentiometer and it is done by the program. This initializes the motor and zero crossing pins attach the interrupt and enter a loop that waits for a zero crossing event. The output of Arduino is given in the Fig 5. When a zero crossing is detected, the program sets the motor speed based on the soft start duration and then gradually increases it until it reaches the maximum speed.



Fig 4: Hardware test of single phase automatic soft starter prototype

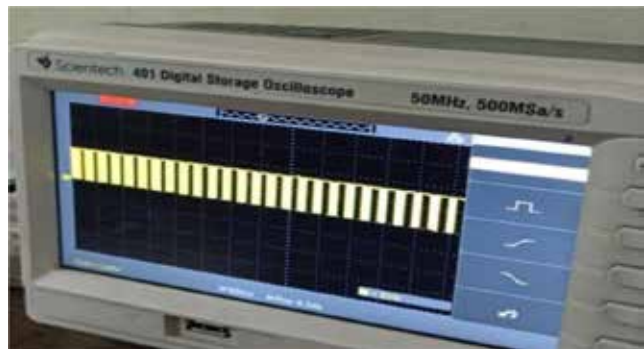


Fig 5: Gate pulse generated at output pin of Arduino

RESULTS AND DISCUSSION

Simulink model: The prototype of a soft starter for manual firing angle control with resistive load and their characteristics is implemented in PROTEUS Simulink first. The reason for using PROTEUS simulation is to operate multiple simulations in the Simulink atmosphere and it has dedicated various tools for modeling simulation without directly performing on

hardware. The Fig 6 shows the PROTEUS Simulink model of a soft starter in a 3 phase induction motor.

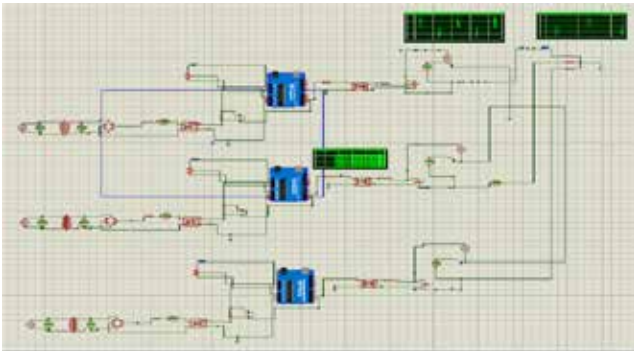


Fig 6: Circuit diagram of proteus simulation soft starter prototype with resistive load

Basically the main aim of this work is to slowly increase the starting current. For the implementation of soft starting rather than going directly on hardware, the status of current on resistive load. For that in the above circuit diagram, potentiometer is used for manual firing angle control. According to position of potentiometer, firing angle of triac as well as how much current should flow through the load is decided. If position of potentiometer is at 50% then the 50% output voltage and current is obtained. Circuit diagram of proteus simulation for manual firing angle control is as shown in Fig 7. In this Resistive load is replaced by inductive load that is motor. According to position of potentiometer, the output current and voltage has been obtained.

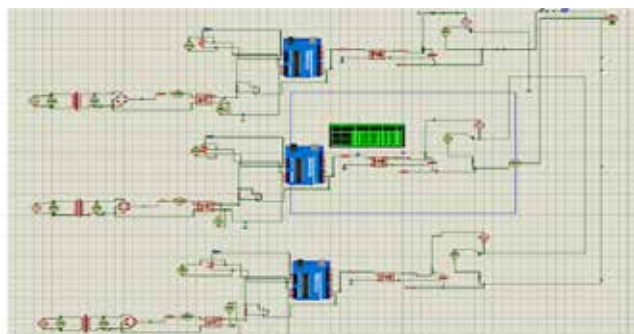


Fig 7: Circuit diagram of proteus simulation of manual firing angle controller

Manual firing angle controller has a problem of adding external resistance in the circuit thereby making it complicated and less efficient. Therefore, an automatic firing angle control is the alternative solution as given

in fig 8, where firing angle is controlled without potentiometer that means it is automatically done by the program which is dumped into the Arduino.

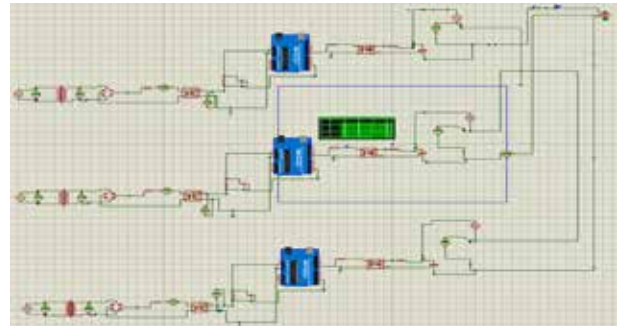


Fig 8: Circuit diagram of proteus simulation of automatic firing angle controller

Output at Resistive Load

PROTEUS simulation of soft starter prototype was carried out with resistive load and the results of the same are discussed accordingly. The lamp light intensity is controlled with varied voltage according to the position of potentiometer. The gate pulse responsible for firing triac is provided by Arduino at an interval of 10 micro seconds as shown in the Fig 9. For 90 degree firing angle i.e. the first gate pulse is given at 500 micro seconds. The firing is gradually reduced from 90 degree to 0 degree i.e. time decreases from 500 microseconds to 0 seconds.

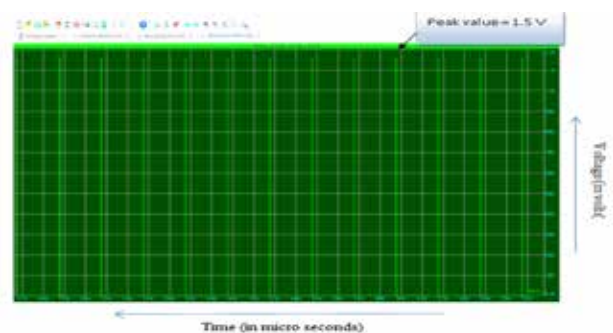


Fig 9: Waveform of gate pulse of triac

The position of potentiometer decides the firing and thereby output current and voltage of triac. With 50% position of potentiometer i.e. 90 degree firing angle the output current was observed to be peak value of its rated current which is shown in Fig 10. Therefore, this result proved that by changing the position of potentiometer the output triac current is also changed.

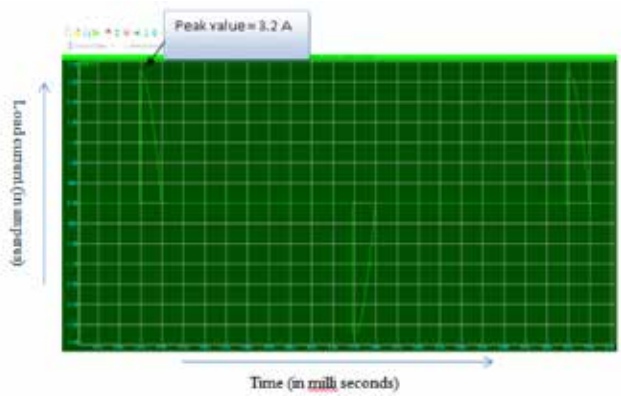


Fig 10: Waveform of output current of triac

In case of resistive load current and voltage are in phase. Therefore, the chopping instant of current and voltage for 90 degree firing angle is same and resulting into peak voltage output as shown in Fig 11.

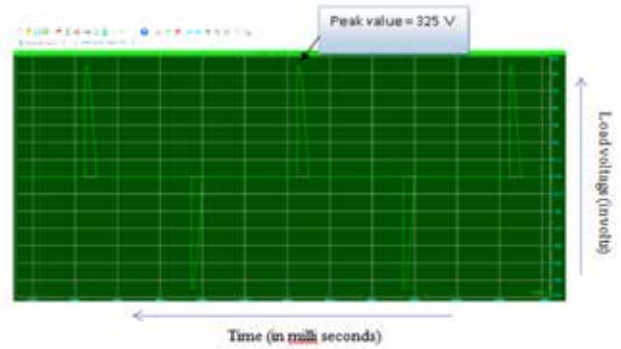


Fig 11: Waveform of output voltage of triac

Results of manual firing angle controller: The starting current is significantly reduced corresponding to the position of potentiometer. In terms of motor current analysis, using a soft starter can provide more accurate data because the starting current is more controlled and predictable. Following Table 2 shows value of load current at different position of potentiometer.

Table 2: Load current at different position of potentiometer

Position of potentiometer	Output voltage of triac
40%	90 V
60%	128 V
80%	170 V

Results of automatic firing angle controller: In case of automatic firing angle controller, it was observed that within 10 seconds after starting the motor normal

voltage was reached. During soft starting time (in this case 10 seconds), voltage is increased step by step with every second of time. Following observations in Table 3 were made during testing of automatic firing angle controller:

Table 3: Per-phase voltage corresponding to starting time

Time (in sec)	Per-phase voltage at the time of starting (in volts)
1	94
2	110
3	120
4	136
5	150
6	166
7	182
8	194
9	202
10	211
11	211
12	211
13	211
14	211
15	211

The output voltage of soft starter at the time of starting is directly proportional to time. This relation holds true only for soft starting duration after which during normal running condition of motor the voltages settles to rated voltage. This linear relationship between output voltage of soft starter at the time of starting and time is proved graphically in Fig 12.

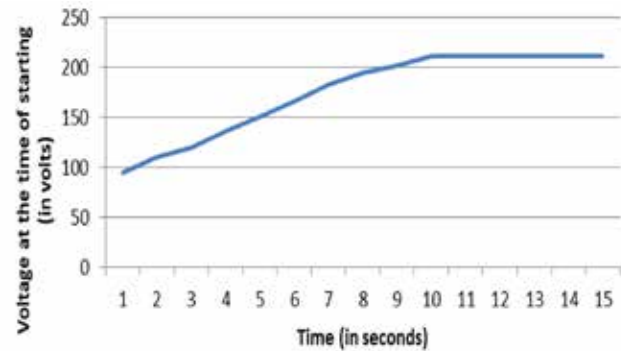


Fig 12: Graph of voltage at the time of starting versus time

CONCLUSION

The automatic soft starter system using an Arduino Uno and a TRIAC offers a cost-effective and accessible solution for controlling and starting induction motors. It provides a smooth and controlled startup process, reducing the initial high current and torque that can damage the motor and connected equipment. By implementing this system, several benefits can be achieved such as it enhances motor reliability by reducing mechanical stress during startup, extends the motor's lifespan and prevents excessive power demand from the electrical grid. This project presents a comprehensive model using PROTUES/SIMULINK in the simulation of the impact of a soft starter controller on the induction motor. The soft starter also eliminates the starting losses in the motor. Hence, the result gives an increased life and efficiency of an electrical motor.

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Development of Human Machine Interface Android App for Monitoring and Control of Induction Motor

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ABSTRACT

The AC induction motor is the most popular motor used in consumer and industrial applications which is represented as the muscle behind the industrial revolution. In this paper, the switching ON & OFF the induction motor is controlled and the monitoring will be done by the Android app. Android application is used here as a transmitter and remote control to do switching ON and OFF the motor with the help of a WIFI module i.e., NODE MCU. The main objective of this work is to reduce the human time to do the similar job which can also be controlled by an HMI wirelessly. In industries, there is the absence of a direct human machine interface and so the machine's switching mechanism has to be done manually through a control panel which can be eliminated by this work. With a microcontroller interfaced with a Wi-Fi module, the data shall be sent over the internet. The data is logged in the cloud platform that can be assessed using mobile phones, tablets, laptops, etc. The data logged can be further analyzed for load flow studies, load forecasting and load management which further enhancing the electrical power system stability & control. It's implemented to monitor the electrical parameters at every instant in the mobile devices. This will be helpful for accuracy, fast work, less time consuming, storage of data, etc. Data collection, storage, analysis and early alert system are important for the efficient controlling and monitoring of a power system.

KEYWORDS : *Android application, Cloud platform, IOT, NodeMCU, Parameter monitoring, Relay*

INTRODUCTION

Induction motors are widely used in industrial applications due to their simplicity, low cost and high reliability. However, traditional methods of controlling induction motors often require the manual adjustment of switches or knobs which can be time consuming and prone to human error.

The development of a human machine interface Android app for controlling an induction motor is necessary to address the complexities and limited accessibility of current methods. The objective is to develop an app that provides a simple and intuitive interface for controlling an induction motor, using a user-friendly design and appropriate programming languages and frameworks. The expected outcome of this work is an Android app that improves the efficiency of induction motor control

and enables wider access to this technology.

The main objective of this work is as follows:

- To improve the efficiency of industrial processes by reducing the time and effort required to control the motor.
- To reduce the risk of human error which can lead to safety hazards and equipment damage.
- To enable remote control & monitoring of multiple induction motors which can be useful in situations where physical access to the motor is limited.

PROPOSED METHODOLOGY

This section is majorly focuses on the controlling and monitoring of the induction motor using the IoT which will be controlled by an Android Application.

Monitoring of the System

- For monitoring purposes, PZEM-004T has been used. It utilizes the current principle of the transformer which converts the current into the voltage and further uses the inbuilt logic to calculate the current, voltage, power factor, frequency and active power of the system (load connected in the system).
- A 100 A CT is required with this PZEM -004T. It is connected with the NodeMCU (ESP8266) for receiving and sending data to the NodeMCU.
- Further, the NodeMCU sends the data to the Google based cloud server i.e. google firebase and the same data is reflected in the mobile application. The circuit diagram and pin details of the PZEM-004T with the system are shown in the Fig 1. Flowchart has been shown in Fig 2.

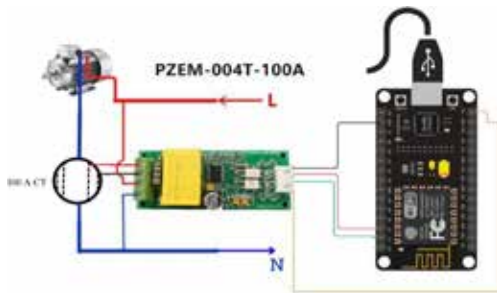


Fig 1: Circuit diagram for monitoring purpose

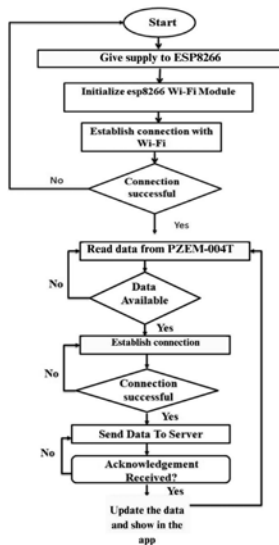


Fig 2: Flowchart of the electrical parameter monitor through cloud

Controlling of the System

- There is a use of NodeMCU ESP8266 (Wi-Fi Module), relay channel (5V DC-230VAC) for controlling the Induction motor.
- The Relay channel is connected with the NO and NC switches for controlling of the motor.
- The command from the NodeMCU is given to the relay channel 5V side as the relay channel receives the signal in DC form only.
- This 5V DC signal which is received on the relay channel end depends on the command received by the ESP8266. The command is given to the NodeMCU from the google firebase.
- A Mobile based application is used to send the command which is stored in the Google Firebase at a particular private database. Depending on the updates in the database, the signal (command) is received at the NodeMCU end which further transfers to the 5V DC side of the relay channel for the further operation of the relay. The circuit diagram and pin details are shown in the Fig 3 respectively. The flowchart of this part is shown in Fig 4.

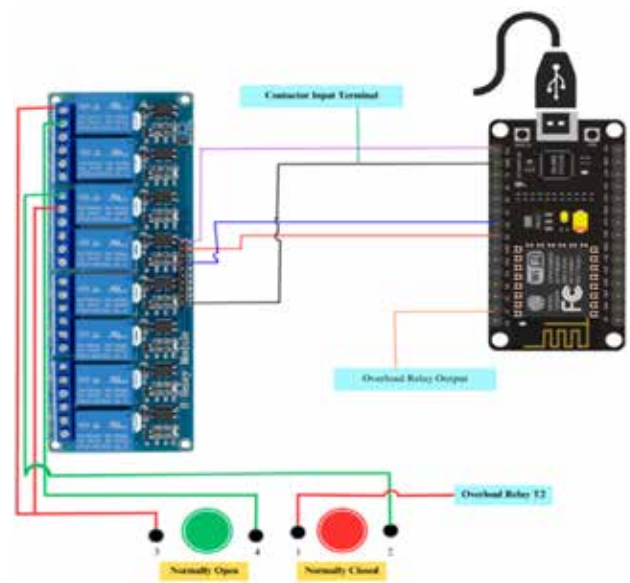


Fig 3: Circuit diagram for switching purpose

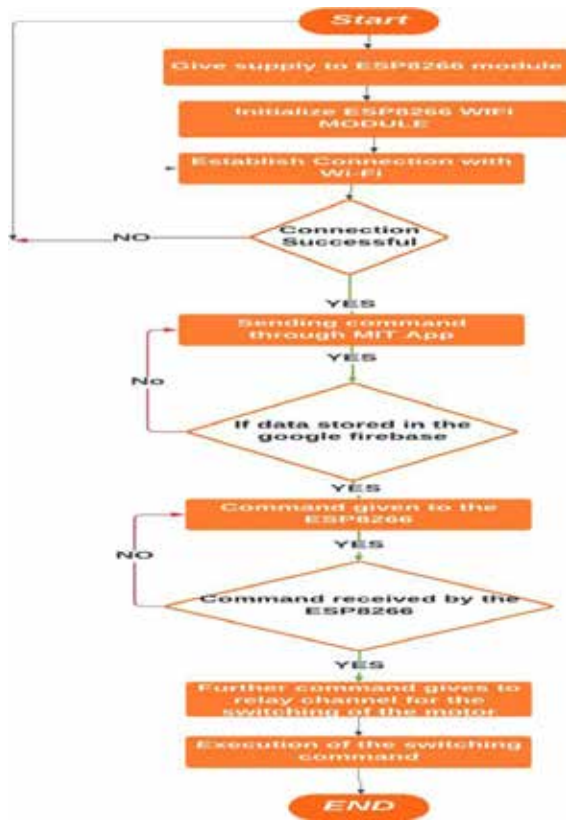


Fig 4: Flowchart of the switching purpose

PROPOSED SYSTEM

- This project includes the use of the Internet of Things which allows the user to control and monitor the multiple numbers of the motor using a single mobile-based Android application.
- The whole project is based on industrial automation and the automation purpose to send/receive the data to the Google Firebase with the help of Wi-Fi module.
- Micro-controller is connected to a Wi-Fi module and internet connection.
- This electrical parameter of the load is monitored by PZEM -004T which is connected to the IOT devices for further processing.
- This system is affordable and suitable for the industrial sector.
- The block diagram of the proposed system is shown in Fig 5.

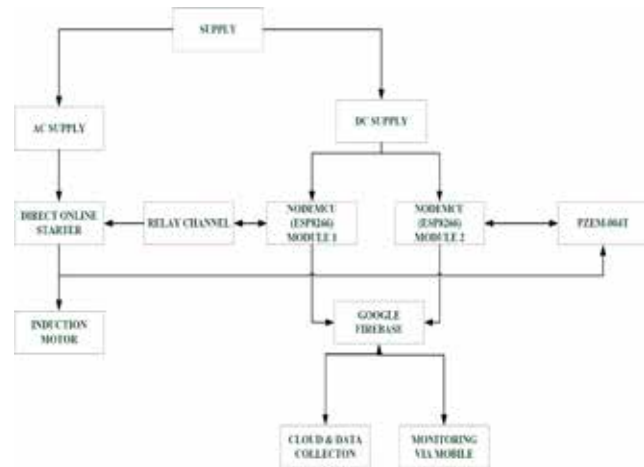


Fig 5: Block diagram of the prototype

Advantages

- It is Low cost and a simple circuit.
- It is a compact product with very less components.
- It is reliable and highly efficient.
- Low Energy consumption , reduced physical effort and maintainance.

Applications

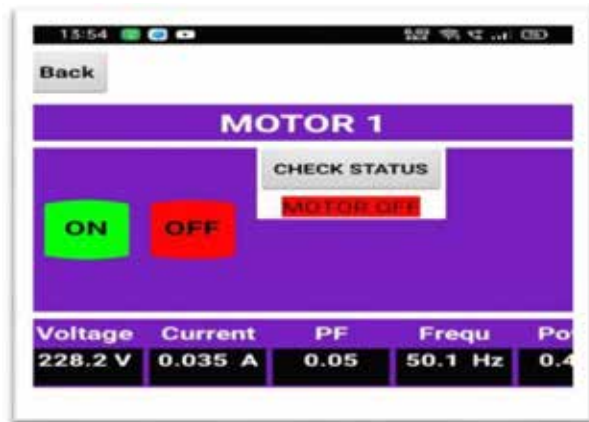
- Use for Industrial automation , agricultural application, load forecasting.
- Use in industries like coal fields, petrol refining, etc.

RESULT

The HMI android app has been successfully tested on a motor. The final view of the app is shown in Fig 6. The app provided a user-friendly interface for controlling and monitoring the motor which makes easy for users to operate and manage the motor. It is capable to control the motor by performing ‘ON’ & ‘OFF’ the motor. It can control multiple motors using a single mobile application. This is also monitor the parameters like voltage, current, power factor, frequency and active power. The tests that are conducted during this work include tests like load tests, usability tests, performance tests, etc. The application is suitable for a wide range of android mobiles. The no-load test that is performed on the 0.25 HP motor. The results obtained are listed on Table 1.

Table 1: Monitoring results of the 0.25 HP Single Phase Induction Motor on No-Load

Voltage (V)	Current (A)	Power Factor	Frequency (Hz)	Active Power (W)	Time (sec)
239	0.036	0.5	50	0.4	8.9
240.6001	0.036	0.5	50	0.4	4.7
239.7	0.036	0.5	50	0.4	2.5
240.6001	0.036	0.5	50.1	0.4	4.2
241.2	0.036	0.5	50.1	0.4	7.6
241.3	0.036	0.5	50	0.4	4.5
241.1001	0.036	0.5	50	0.4	3.8
241.2	0.036	0.5	49.8	0.4	3.9
241.8	0.036	0.5	50	0.4	3.5
241.5	0.036	0.5	50.1	0.4	3.6

**Fig 6: Real-time controlling and monitoring in MIT App**

CONCLUSIONS

Human Machine Interface is provided to control the Induction motors through the mobile application and shall ease the human effort for the operators. The controlling of 'ON' & 'OFF' operation of the induction motor is done through an Android app via smartphone. The developed Android application is used to control the motor through the Internet of Things (IoT) using

the cloud (Google Firebase) for automation. The development of the HMI android app for controlling and monitoring motors is an important application in the field of automation and the industrial Internet of Things.

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Design and Development of Prototype Model of Solar Drying System for Food Commodities

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ABSTRACT

The preservation of food commodities is a critical issue for both developed and developing countries as food losses and waste contribute to food insecurity, economic losses and environmental degradation. Solar drying is a process of dehydrating food commodities using solar energy. In this system, Peltier module is used which is a thermoelectric device that converts electrical energy into thermal energy and vice versa. The benefits of using a solar drying system for food commodities are numerous. Solar drying systems are sustainable and environmentally friendly as they use renewable energy sources and reduce greenhouse gas emissions. They are also cost-effective and accessible as they can be used by small-scale farmers and producers in areas with limited access to electricity. Additionally, solar drying systems help to reduce food waste and post-harvest losses which can contribute to food insecurity.

KEYWORDS : Food preservation, Peltier module, Prototype model, Solar drying system

INTRODUCTION

The method used mostly for the preservation of food when there is a combination of heat from the sun with wind is known as drying. It's the oldest method of agricultural materials with the help of solar energy. This work presents the design, construction and performance of a solar dryer for food preservation. The exhaust fan's output i.e., the heated air is circulated in the room. Simultaneously, the room takes the solar energy from the glass alignment. The observation in the inner cabin's temperature is more than the room temperature at the most time of the day light. Dryer ensuring the good quality of the dried materials with a rapid manner.

The main objectives of this work are as follows:

1. Develop sustainable and cost-effective methods for preserving food.
2. Explore the benefits of solar drying systems for food commodities.
3. Identify the best practices and technologies for solar drying and evaluate their effectiveness in preserving food.

4. Share knowledge with farmers, food processors and policy makers to promote the adoption of solar drying systems.
5. Improve food security by reducing food waste and increasing the availability of nutritious food.
6. Contribute to sustainable development by using a natural and environmentally friendly method that does not require the use of fossil fuels.
7. Increase awareness of the importance of food preservation and the potential of solar drying systems to improve food security.

PROPOSED METHODOLOGY

The description of the flowchart as shown in Fig 2:

1. Construct a drying chamber using acrylic sheets: Build a chamber using acrylic sheets to create an enclosed space for drying food.
2. Install a Peltier module: Place a Peltier module between the solar panel and the drying chamber. This module helps control the temperature inside the chamber.

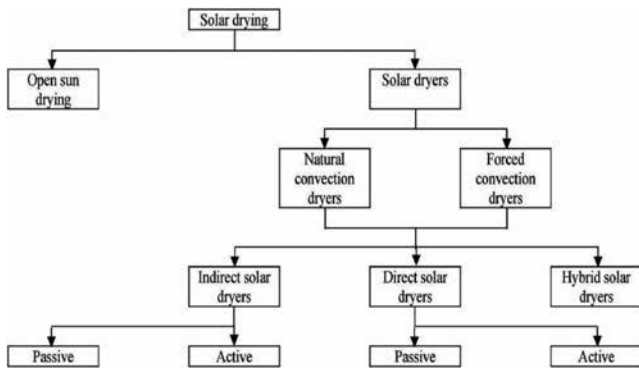


Fig 1: Classification of Solar Drying System

3. Wash and prepare the food commodities: Clean and slice the food items you required to dry. Prepare them by ensuring they are properly sliced for efficient drying.
4. Arrange the food commodities on drying trays: Place the sliced food on drying trays and make sure there is enough space between them for airflow.
5. Place the trays in the drying chamber: Put the drying trays inside the chamber, ensuring they are evenly spaced for proper air circulation.
6. Connect the Peltier module to the solar panel: Wire the Peltier module to the solar panel so that it can draw power from it. This connection allows the module to work.
7. Monitor temperature: Use monitoring equipment to keep an eye on the temperature levels inside the drying chamber. This helps ensure optimal drying conditions.

Purpose of this Method

The use of this method for solar drying offers several advantages over other methods which make it a preferred choice in certain applications. Here are some reasons, why Peltier modules are used in solar drying systems:

- Energy efficiency and precise temperature control.
- Compact and portable.
- Flexibility, adaptability and environment friendliness.

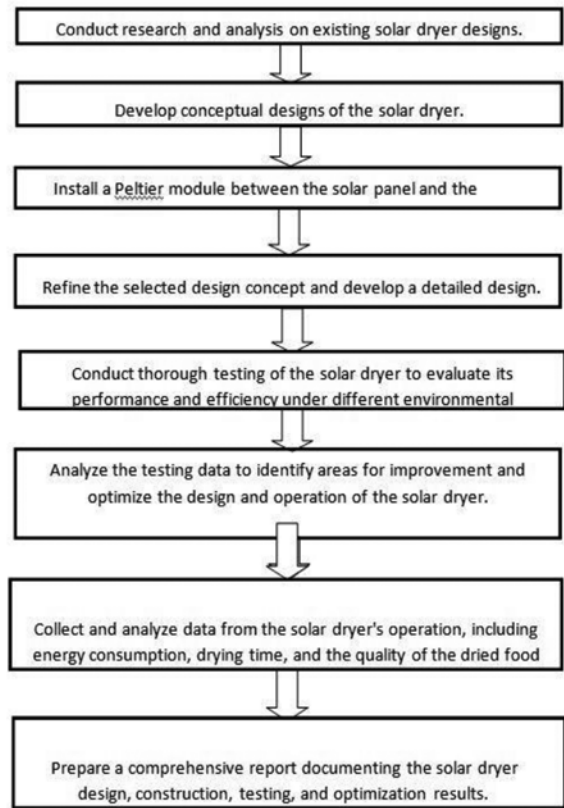


Fig 2: The flowchart for the proposed methodology adopted

MODELING AND ANALYSIS

A solar drying system utilizing a Peltier module works by harnessing solar energy through solar panels which generate electricity. The electricity is used to power the Peltier module, a device that transfers heat from one side to the other when an electric current is applied. The module consists of a hot side and a cold side. The hot side absorbs heat from the air inside the drying chamber while the cold side releases heat, cooling the air. A heat sink and fan help dissipate the absorbed heat efficiently. The drying chamber is insulated to minimize heat loss and holds the items to be dried. Air circulation is facilitated by fans or blower by ensuring uniform drying. A control system regulates temperature and humidity inside the chamber adjusting the power supplied to the Peltier module accordingly. Regular maintenance and monitoring are important for optimal system performance. The complete setup of solar dryer prototype model is shown in Fig 3.



Fig 3: Prototype Model

RESULTS AND DISCUSSION

In this case, few samples of neem leaves are taken and processed through the proposed system. The formula used to calculate the moisture content is:

$$\% \text{ Moisture content} = \frac{(\text{Initial weight} - \text{Final weight})}{\text{Initial weight}} * 100$$

Details of moisture removed during drying (in the month of march - april) both Inside and the Outside chamber are as shown below in Table 1.

Table1: Details of Moisture Analysis

Sr. no	Time	Inside chamber			Outside Chamber	
		Temperature °C	Weight gm	Moisture removed	Weight gm	Moisture removed
1.	10 am	31	25	0%	25	0%
2.	11 am	35	23	8%	24	4%
3.	12 am	39	20	20%	22	12%
4.	1 pm	43	17	32%	20	20%
5.	2 pm	47	15	40%	18	28%
6.	3 pm	51	9	64%	15	40%

From the Table1, in outside the chamber, its noted that the moisture is removed from 0% to 40% while inside the chamber moisture removed is 64%, keeping them for 6hrs in both the cases. From this analysis, its found that this solar dryer is more efficient than the open drying system. The physical appearance of neem leaves before and after placing inside the chamber is shown in Fig 4 and Fig 5. The drying rate is displayed in Fig 6.

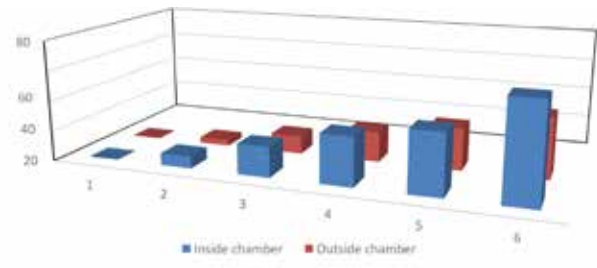


Fig 6: Graphical Representation of Dry



Fig 4: Neem leaves before dry



Fig 5: Neem leaves after dry

CONCLUSION

The solar drying system using Peltier module is a promising technology for preserving food commodities. The system is energy-efficient, environmentally friendly and capable of producing high quality dried food products. The use of renewable energy sources such as solar panels and the integration of Peltier modules preservation particularly in areas with limited access to electricity.

Overall, the solar drying system using Peltier module has great potential for the future of food preservation. With continued research and development, it could

become a widely adopted technology for preserving food commodities.

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Hardware Implementation of Perturb and Observe MPPT Algorithm for Enhancement of Power Generation Capacity of Solar PV System

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ABSTRACT

A solar PV system's MPPT algorithm is crucial because it maximizes power generation by keeping the solar panel's operating point at its Maximum Power Point (MPP). Due to its ease of use and efficiency in tracking the MPP under changing weather circumstances, the Perturb & Observe (P&O) MPPT method has been used in a great amount. This paper presents a hardware implementation of the algorithm to improve the power generation capacity of a 10 watts solar PV panel system. The system's MOSFET based DC-DC converter's design and fabrication is also used in this part. The converter is made for small-scale solar PV systems due to its high efficiency and cheap operating cost. The system is an adaptable and simple to replicate solution that can be employed in a variety of applications with the help of the Arduino platform and MOSFET based DC-DC converter.

KEYWORDS : *Arduino, MOSFET base DC-DC converter, MPPT, Perturb and Observe algorithm*

INTRODUCTION

As a feasible replacement for conventional fossil fuels, solar energy is becoming more and more popular. It is a renewable and sustainable energy source. Small-scale solar PV systems which are used to power the remote and off-grid sites like cabins, boats and RV's as one of the most widespread solar energy applications. However the factors like weather and shade have an impact on how much power solar systems can generate [1]. To modify the duty cycle based on the observed voltage, the suggested system will incorporate a voltage sensor, an Arduino Uno board and a MOSFET based DC-DC converter. The system will be put to the test in various weather scenarios to determine how well it tracks the MPP and increases the solar PV system's ability to generate power.

The issues include the minimal power generation capacity of small scale solar PV systems due to the elements including weather, shade and temperature

changes. The operating point of the solar panel cannot be maintained at its MPP by conventional fixed voltage methods used in small-scale solar PV systems because they do not take these parameters into consideration. As a result, the capacity and efficiency of power generation are decreased.

The main objectives of this work are as follows:

- To design and implement a hardware system based on the Perturb and Observe (P&O) Maximum Power Point Tracking (MPPT) algorithm using the Arduino platform.
- To enhance the power generation capacity of a small-scale solar PV system by maintaining the operating point of the solar panel at its maximum power point (MPP) under varying weather conditions.
- To provide a cost-effective and efficient solution for enhancing the power generation capacity of small-scale solar PV systems.

PROPOSED METHODOLOGY

A popular algorithm for photovoltaic application is the Perturb & Observe (P&O). The P&O algorithm’s fundamental premise is to alter the PV panel’s operating point and track any resulting change in power output. The algorithm may track the MPP of the panel by gradually shifting the operating point in the direction of maximum power. These are the primary parts of this system:

- Solar panels: An energy source that transforms solar energy into electrical energy.
- DC-DC converter: It’s a device which transforms solar panel output into a voltage level that is appropriate for the load or battery.
- MPPT control unit: A computer algorithm that continuously modifies the DC-DC converter’s duty cycle in order to determine the maximum power point. The Arduino processor then feeds the algorithm to the trigger circuit.
- Load/Battery: The appliance that uses or stores the electricity produced by the solar panel.

The perturb and observe algorithm operates by varying the duty cycle of the DC-DC converter to track changes in the solar panel’s output power. After that, the algorithm modifies the duty cycle so that the output power grows until it reaches the maximum power point.

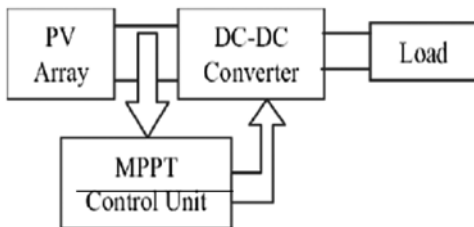


Fig 1: Proposed system block diagram

Overall, the proposed methodology may help for maximising a solar panel system’s energy output and enhancing system efficiency. The power converter that connects the PV panel to the load is often controlled by a microcontroller or a Digital Signal Processor (DSP) in the hardware implementation of the P&O MPPT algorithm. The flowchart of the proposed system is presented in Fig 2. The P&O MPPT algorithm is put into practice using the following steps:

Sensing: The PV panel’s voltage and current must first to be realised. A voltage sensor and a current sensor can be used for this purpose.

Perturbation: The next step is to alter the power converter’s duty cycle in order to disturb the PV panel’s operational point. Small adjustments are made to the duty cycle. After each adjustment, the panel’s power output is measured.

Power calculation: The voltage and current sensed in step 1 are used to determine the panel’s power output.

Comparison: To determine the changes in the direction, the power output is compared to the preceding value. The duty cycle is further raised in the same way if the power output has risen.

Convergence: Until the power output achieves a maximum value, the algorithm keeps changing the operating point of the panel. The algorithm converges to that point once the MPP is attained and maintains the duty cycle at that value.

Load control: The power converter and the power flowing from the PV panel to the load are both controlled by the duty cycle.



Fig 2: Flowchart of P&O MPPT

The proposed system has been simulated using Proteus software and PVSOL software.

Simulink model: The P&O MPPT consists a solar panel based on the MPPT algorithm implemented using the Arduino Uno, an N-channel MOSFET, an NPN transistor and a Schottky diode. The Arduino Uno will be used to measure the solar panel voltage and current, control the MOSFET and transistor and execute the MPPT algorithm. The N-channel MOSFET will act as a power switch to control the connection between the solar panel and the load. The NPN transistor will act as a driver to control the MOSFET's gate voltage. The Schottky diode will be connected in parallel with the load to prevent reverse current flow. The circuit diagram is shown in Fig 3.

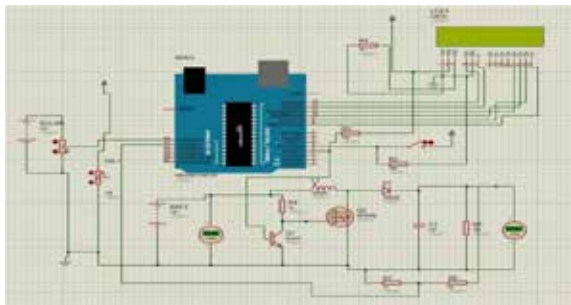


Fig 3: Circuit diagram of proteus simulation of MPPT

The Arduino plays the main role of controlling the DC-DC booster here. The Arduino algorithm is designed in such a way that when the value of input voltage goes below the certain sets of value then it activate its output pin. Hence the voltage value has been increase at the point of MPPT. The complete circuit diagram of the system is shown in fig 4 and its hardware design is observable in Fig 5.

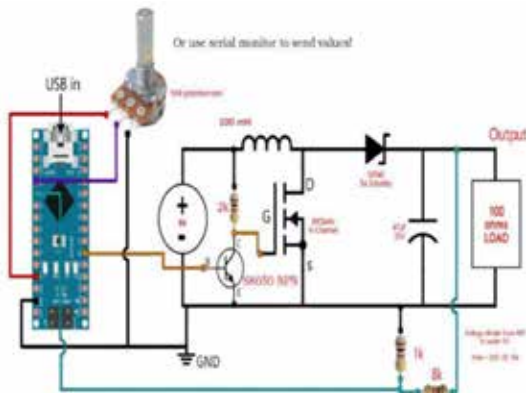


Fig 4: Circuit diagram of P&O MPPT

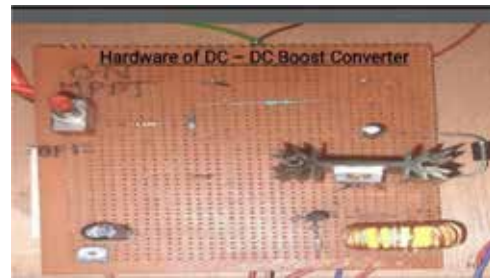


Fig 5: Hardware implementation of P&O MPPT

The system as shown in Fig 6 has been tested under various conditions to ensure it responds well for changing solar panel characteristics.



Fig 6: Testing of P&O MPPT with different tilt angle and weather conditions

The solar panel output using P&O MPPT with different tilt angle was analyzed. The main concern has been there around the voltage and current received as output of MPPT. The output results are noted in the Table 1.

Table 1: Output voltage and current at various tilt angles

Sr. no.	Tilt angle (In degree)	PV Cell Voltage (In volts)	PV Cell Current (In ampere)
1.	20	19.85	0.140
2.	21	19.63	0.137
3.	22	19.62	0.136
4.	23	19.60	0.135
5.	24	19.59	0.132
6.	25	19.57	0.130
7.	26	19.55	0.129
8.	27	19.54	0.128
9.	28	19.53	0.127
10.	29	19.52	0.126
11.	30	19.51	0.125

To analyze the performance of MPPT, tests were conducted with different solar panel conditions such as with shading with dust and with water. The output

results are listed in Table 2 and the observations of the same are as follows:

- Output voltage of solar panel with dust: [19.54 V] and solar panel with water: [19.93 V].

Table 2: Output voltage under solar panel shading condition

Sr. no.	Tilt angle (In degree)	PV Cell Voltage (In volts)	PV Cell Current (In ampere)
1.	20	19.85	0.140
2.	21	19.63	0.137
3.	22	19.62	0.136
4.	23	19.60	0.135
5.	24	19.59	0.132
6.	25	19.57	0.130
7.	26	19.55	0.129
8.	27	19.54	0.128
9.	28	19.53	0.127
10.	29	19.52	0.126
11.	30	19.51	0.125

Tests conducted on P&O MPPT results shows that when we place solar panel according to the latitude of the place where it is to be installed, the maximum output will be achieved. The Fig 6 shows the V-I characteristics of PV panel with varying tilt angle of panel.

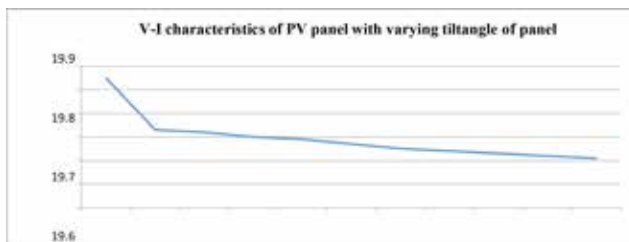


Fig 7: V-I characteristics of PV panel with varying tilt angle of panel

CONCLUSION

Based on the hardware implementation of Perturb and Observe (P&O) MPPT algorithm for enhancement of power generation capacity of a 10-watt solar PV panel, the following conclusions are drawn:

- The P&O algorithm tracks the MPP of a solar PV panel.
- The hardware implementation of the P&O algorithm is relatively easy and inexpensive.

- The performance of this algorithm is highly dependent on the step size used for perturbing the solar panel's operating point. A small step size can improve accuracy but also increase the time taken to converge to the maximum power point while a large step size can decrease convergence time but also reduces the accuracy.
- The P&O algorithm can experience some issues such as oscillations around the maximum power point and convergence to a local maximum rather than the global maximum.
- Based on the experimental results, it is noted that when the tilt angle of solar panel is equal to latitude then the output voltage of PV module is maximum as compared to other tilt positions of PV panel.

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Whale Optimization for Optimal Power Flow

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ABSTRACT

The optimal power flow (OPF) of power system is to optimize the objective function such as generation cost by adjusting control variables on the premise of satisfying operation constraints and supply–demand balance. Because of its complexities, standard formulae are insufficient for the present scenario. Therefore, the multi-objective optimal power flow problems have been explored in this paper. Optimization is done by Whale Technique.

KEYWORDS : *Optimal power flow, Whale optimization, WOA.*

INTRODUCTION

The optimal power flow (OPF) is one of the fundamental mathematical tools currently used for the operation of power systems. In general terms, the OPF determines the dispatch of generating units to satisfy the electricity demand at the minimum cost while complying with the technical limits of the system. Most of the real- life issues involving optimization objectives with constraints are expressed as a multi-objective optimization problem. In contrast to single objective optimization problems, multi-objective optimization problems have a set of optimal solutions. Nature inspired algorithms have been extensively used to solve such complex problems. In the modern power systems, appropriate power dispatch schedule of the online power generating units is essential for reliable and clean power supply and it is desirable to attain this at the lowest possible operating cost. Optimal Power Flow (OPF) is a crucial problem in power systems engineering and operation. It is a mathematical optimization problem that aims to find the optimal settings for the control variables in a power system to minimize the overall cost while satisfying various operational constraints. The primary goal is to ensure the economic and reliable operation of the power grid. Here are the key components and aspects of Optimal Power Flow: Objective Function: The objective function in OPF typically aims to minimize the total cost of power generation. This cost includes the fuel costs of generators, the cost associated

with transmission losses, and possibly other economic factors. The formulation may also include penalties or incentives for certain operating conditions. Decision Variables: The decision variables in OPF are the control parameters that can be adjusted to optimize the power system. These variables may include the generation levels of individual generators, transformer tap ratios, and other control settings. Constraints: OPF involves a set of equality and inequality constraints that must be satisfied for the solution to be considered feasible. These constraints ensure the physical and operational limits of the power system are not violated. Common constraints include power balance equations, voltage limits, thermal limits on transmission lines, and generator capacity limits. Types of OPF: OPF can be categorized into different types based on the specific objectives and constraints considered. These include Economic Dispatch (ED): Minimizing the cost of generation while meeting the demand. Security-Constrained OPF (SCOPF): Considering the impact of potential contingencies on system security. Multi-Objective OPF (MO-OPF): Optimizing multiple conflicting objectives simultaneously. Stochastic OPF (SOPF): Incorporating uncertainty in load demand or generator availability. Solution Methods: Various optimization techniques can be used to solve OPF problems. These include linear programming (LP), nonlinear programming (NLP), quadratic programming (QP), and evolutionary algorithms such as genetic algorithms and particle

swarm optimization. The choice of the solution method depends on the complexity of the problem and the desired accuracy of the solution. Real-Time and Day-Ahead OPF: OPF can be applied in different timeframes. Day-ahead OPF is used for planning the next day's operation, while real-time OPF is employed for making operational decisions during actual system operation. Real-time OPF may need to consider real-time measurements and contingencies. Integration with Renewable Energy Sources: The increasing integration of renewable energy sources, such as wind and solar, adds complexity to OPF. These sources are variable and intermittent, requiring advanced optimization strategies to manage their integration efficiently. Market-Based OPF: In the context of deregulated electricity markets, OPF is closely related to market mechanisms. Market-based OPF considers bidding strategies, market clearing prices, and the economic interactions between market participants. OPF plays a critical role in the efficient and reliable operation of power systems, providing a foundation for decision-making in both regulated and deregulated power markets. Researchers and engineers continually work on developing advanced algorithms and techniques to address the evolving challenges in power system operation and planning.

Power system optimization is essential for several reasons, and it's critical to maintaining the electrical grid's sustainability, efficiency, and dependability. In a power system, power optimization is crucial for the following main reasons: Stability and dependability: Power optimization contributes to preserving the power system's stability and dependability. The system can better handle fluctuations in supply and demand by effectively controlling the generation, transmission, and distribution of power, lowering the danger of outages and blackouts. Cost Efficiency: One way to make a power system more cost-effective is to optimize its power. Operational expenses can be reduced by making effective use of resources, such as transmission lines and generating plants. It may also lessen the need to spend money on new infrastructure. Load balancing: Power optimization makes certain that the network's electrical load is dispersed equally. This reduces the possibility of equipment failures and keeps some components from being overloaded. Stabilizing the voltage profile is another benefit of load balancing.

Integration of Renewable Energy: Power optimization becomes essential for controlling the variability and intermittency associated with renewable energy sources, such as solar and wind, as their integration grows. Efficient integration of renewable energy sources into the grid is made possible by sophisticated optimization techniques.

Demand Response Management: Efficient demand response management is made possible by power optimization. During peak times, utilities can proactively manage and shape the demand for power, which lowers the need for costly peaking units and improves system reliability. Grid Planning and Expansion: The planning and growth of the power grid depend on power optimization. It aids in determining the best sites for transmission lines, substations, and new generation facilities, guaranteeing that the grid can effectively handle rising demand.

Impact on the Environment: Improving power systems can help lessen the negative effects that producing electricity has on the environment. The electricity industry can help achieve sustainability goals by reducing carbon emissions and making the most of cleaner, more efficient technologies.

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Impact on the Environment: Improving power systems can help lessen the negative effects that producing electricity has on the environment. The electricity industry can help achieve sustainability goals by reducing carbon emissions and making the most of cleaner, more efficient technologies.

Grid Resilience: Power optimization makes the electricity grid more resilient to unplanned occurrences like equipment breakdowns or natural disasters. Systems that are optimized can withstand disruptions and continue to provide critical services more rapidly.

Regulation Compliance: Regulations that establish requirements for dependability, efficiency, and environmental performance are frequently applied to power systems. Power utilities can avoid fines and comply with these laws with the use of optimization.

Transmission and Distribution Efficiency: Reducing energy losses during the transmission of electricity can be achieved by optimizing power flow in transmission and distribution networks. Reducing losses increases the amount of electricity that reaches end consumers and boosts the power system's overall efficiency.

Power system engineering and operations research are expanding quickly and merging more and more. By presenting specific power systems issues and the theoretical operations research methods used to address them recently, this review seeks to deepen the linkages between the two communities. Numerous applications of optimal power flow are covered, such as markets, regular operation, unit commitment, network resilience, and expansion planning.

Significance: The OR community is now formulating methods to assist in simulating and tackling these challenges. Techniques like Benders decomposition and various distributed optimisation approaches that have emerged (or re-emerged) in recent OR research continue to be attractive directions for further investigation across all applications of OPF. Similarly, growing kinds or amounts of uncertainty make an issue bigger and are a prevalent characteristic of OR research nowadays. The OR community has numerous opportunities to contribute because of the different types of uncertainty in OPF. Approaches that could be taken include incorporating many sources of uncertainty into problem modelling and implementation. Moreover, this field does not address the question of what kinds of uncertainty (in stochastic, robust, or distributionally robust optimisation models, for instance) should be taken into individual OPF applications.

The aspects of the actual power network that should be incorporated into the models that researchers examine constitute the second interpretation of scale for OPF. This is the main area of smart grid integration, and the OR community initially appears to be the least prepared to manage it. In essence, the OR community needs to decide which choices and technologies to include in a well-thought-out model for an OPF application. This raises questions about how to narrow down the solution space, particularly in relation to the discrete variables required to make these decisions. These

could include production technology (like molten salt solar plants), transmission control technologies (like transmission switching, FACTS devices), or smart grid-enabled communications breakthroughs. One of the basic mathematical methods used today to operate power systems is the optimal power flow, or OPF. The power transfer distribution factors (PTDF) can be used to linearize the power flow equations under specific assumptions, producing the so-called DC-OPF.

The DC-OPF problem was originally formulated as a deterministic problem, however it has been rewritten to account for uncertain input parameters. Several DC-OPF formulations are shown in this article to help producing units find the best way to dispatch their power when the demand for electricity is unpredictable. We formulate the problem in terms of chance-constrained, stochastic, and resilient programming. Due to their increasing complexity as a result of growth and interconnection, today's power systems are very prone to experience interference from various stability kinds and related control activities. When control action is considered in an attempt to enhance one stability phenomena, it may worsen the others while leaving out the ways in which they interact in a thorough investigation.

WHALE OPTIMIZATION

Whales are the largest Animal on Earth, are Intelligent as they have spindle cells in their brain. There are 7 types of whale and hump back whale is one of it. They are able to develop their own dialect. Humpback whale size is almost as a school bus. Whale Optimization is a Meta heuristic algorithm, population-based method, proposed by Seyedali Mirjalili et. al in 2016. Humpback Whale hunting strategy includes Prey is discovered, Humpback whale dive 12 metres deep in the sea and Bubble nets are created.

Mathematical models are hence needed for Searching the prey, Encircle prey and Hunt/Attack. Mirjalili and Lewis (2016) introduced the whale optimisation algorithm (WOA), a nature-inspired metaheuristic optimisation technique. This algorithm has demonstrated its capacity to resolve a wide range of issues. A comprehensive and meta-analysis evaluation of WOA is carried out to assist researchers in utilising it in various contexts or combining it with other widely used algorithms.



Fig.1 Hunting Strategy of Whale

In this case, the co-efficient vectors are C and a , the maximum iteration is $MaxT$, the distance vector is D , and the location is X . Over the course of the iterations, the elements of a linear decrease from 2 to 0, where r is a random vector in the interval $[0;1]$. The search agent can reach any point surrounding the reference person by changing the values of A and C .

- $a = 2 - 2 * t / MaxT$
- $D = |C * X_{rand}(t) - X(t)|$
- $X(t+1) = X_{rand}(t) - A * D$
- $C = 2 * r$ where r is random value $[0,1]$

Determining whether the Whale Optimization Technique (WOA) is better than Particle Swarm Optimization (PSO) or vice versa depends on various factors, including the specific problem at hand, the characteristics of the optimization landscape, and the preferences of the user. Here are some points of comparison between WOA and PSO:

Nature of Inspiration: WOA is inspired by the social behaviour of humpback whales, while PSO is inspired by the social behaviour of bird flocks or fish schools. The different sources of inspiration lead to distinct algorithms with unique search mechanisms.

Search Mechanism: WOA imitates the movements of whales by incorporating both stages of exploration and exploitation. Particle- social interactions, on the other hand, are what define PSO. Every particle modifies its location according to both its individual and the swarm's collective best-known solutions. The two algorithms have different tactics for exploration and exploitation.

Parameter Settings: Both WOA and PSO require tuning of parameters for optimal performance. The choice of parameters, such as inertia weight and acceleration coefficients in PSO or coefficients in the equations

of WOA, can significantly affect the algorithms' convergence and exploration capabilities.

Convergence Speed: The convergence speed of an optimization algorithm is an essential factor. Some problems may benefit from a faster convergence, while others may require a more balanced exploration-exploitation trade-off. The convergence speed can vary between WOA and PSO, and the superiority of one over the other depends on the characteristics of the optimization problem.

Handling constraints: Both WOA and PSO can be adapted to handle constraints in optimization problems. However, the specific approaches may differ. PSO often uses penalty functions or repair mechanisms, and WOA may employ similar techniques. The effectiveness of constraint handling depends on the algorithm's ability to explore and exploit the search space while satisfying constraints.

Robustness and Sensitivity: The robustness of an optimization algorithm refers to its ability to perform well across different types of problems. Sensitivity to problem characteristics may also play a role. Some algorithms may be more versatile, while others may be tailored to specific types of problems.

Research and Application Context: The field of optimization is dynamic, with on-going research leading to improvements and adaptations of existing algorithms. The choice between WOA and PSO may be influenced by the specific needs of the application and the availability of well-established implementations or modifications.

Ultimately, the "better" algorithm depends on the specific optimization problem, and it is common practice to compare the performance of different algorithms on benchmark problems or real- world applications.

Experimentation and empirical evaluation are crucial for determining which algorithm is more effective for a given task. Researchers and practitioners often choose algorithms based on their experiences, problem characteristics, and computational resources available.

OPTIMIZATION TECHNIQUE

SEARCH THE PREY: A is used to search for prey. If $A > 1$, new individual is far away. $A = 2 * a * r - a$ where A

is convergence factor. Whale optimization Algorithm is being run on MATLAB and result is being checked and it's obtained as shown in Figure 2.

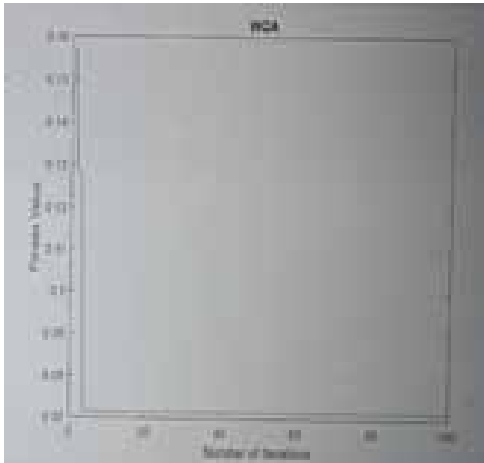


Fig. 2 Results

Encircle The Prey: Humpback Whale will encircle once prey location is confirmed.

- $D = |C * X_{\sim}(t) - X(t)|$
- $X(t+1) = X_{\sim}(t) - A * D$

where $X_{\sim}(t)$ denotes position vector of the best solution. Shrinking Encircling Mechanism includes Decrease the value of a , When $|A| < 1$, agent approaches to current optimal solution, Components which are of 'a' are decreased in a linear fashion from 2 to 0 over various course of iterations, Value of A is another random value in the interval of $[-a, a]$.

Hunting Method: The best candidate solution is the intended prey, and bubble net feeding is the behaviour of whales foraging. Other search agents will adjust their places in relation to the best search agent once it has been determined WOA assumes current optimal solution as Prey position. Current best fitness values is consider minimum value among all (i.e., near to optimal point). We can test algorithm on different benchmark function. Prey = Optimal Solution / best candidate solution and other are candidate solutions. e power bl value in the equation is $\exp(b * l)$. p is random value. in between $[0, 1]$. Each time you will get different random value. Calculate the distance between Whale and Prey position.

$D = |X^*(t) - X(t)|$ is the distance between the prey, the best solution, and the i th number; in it, l is a random number in $[-1; 1]$ and b is a constant. $X(t+1) = X^*(t) + D * e^{bl} * \text{Cos}(2\pi * l)$. $X(t+1) = X^*(t) - A * D$, $p < 0.5$, and $X(t+1) = D * e^{bl} * \text{Cos}(2\pi * l) + X^*(t)$, $p < 0.5$, are the results. In [1] The algorithmic underpinnings, features, restrictions, adaptations, hybridizations, and applications of WOA are covered in detail. WOA performances are then shown to address various issues. The most popular optimization techniques and WOA are contrasted with the statistical outcomes of WOA alterations and hybridizations. The survey's findings show that WOA outperforms other widely used algorithms in terms of convergence speed and exploration-exploitation balance.

According to the comparison of results in [2], the EWOA-OPF outperforms earlier comparing algorithms in solving single- and multi-objective OPF problems. The OPF problem considers three factors: fuel cost reduction, reactive power loss minimization, and active power loss minimization. The system's control parameters are changed to address these issues. The Flower Pollination Algorithm (FPA), Particle Swarm Optimizer (PSO), and other well-known techniques are compared to the results obtained by WOA in [3]. When compared to these and other well-known strategies, the findings show that WOA delivers better optimisation values for the scenario, proving the effectiveness of the recommended methodology. [3]

Using the centralized and decentralized control modes, various optimization techniques are shown in [4] to solve the security- constrained optimal power flow between two connected regions. The method that is most frequently employed is called decentralized control, in which each power system manages its own variables independent of the boundary buses. The two elements that can lessen changes in comparison to the decentralised control technique are the voltage buses on the borders and/or the active power of the producing units. For this reason, centralised control has recently been utilised to increase system security. The optimization methods suggested use the Genetic Algorithm (GA) as a tool to confirm the outcome of the Whale Optimization Algorithm.

CONCLUSIONS

Many researchers work with different optimization techniques but still the issue is not solved. Simulation result does not reproduce exact result that would be obtained on site. Very accurate weather forecasts are needed. Finding the best design takes less time when energy modelling and optimization are handled by MATLAB on a single platform, and compatibility problems are avoided. The optimization outcomes and the consequences of real-time control still varied somewhat. Improved discrete variable integration in the optimization problem. Better integration of discrete variables in the optimization problem definition is needed. The optimization problem becomes stiffer with increase in the degrees of freedom. As more and more variable renewable energy resources are added to the system, with constant increase in the energy demand, need of flexibility becomes more important.

ACKNOWLEDGMENT

As Authors acknowledge everyone involved with the process of research on Whale Optimization.

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Original Article

Design of an Efficient Genetic Algorithm Model for Electric Load Balancing over Distributed Environments

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Received: 13 April 2023

Revised: 24 May 2023

Accepted: 15 June 2023

Published: 30 June 2023

Abstract - To solve the issue of electric load balancing demand in distributed contexts, a genetic algorithm (GA) model is suggested in this study. The suggested model searches the problem sets for the best solutions using the genetic operators of crossover, mutation, and selection. This novel model aims to balance the electric load across multiple nodes in a distributed environment, thereby minimizing the overall energy consumption and ensuring that no node is overloaded. The suggested model considers each node's real-time power consumption and processing capabilities to establish the appropriate load distribution. To evaluate the efficiency of the proposed model, experiments were conducted on a simulated distributed environment with 20 nodes. The results showed that the proposed GA model achieved a load balance of up to 98%, with a reduction in energy consumption of up to 30%, compared to other existing load balancing techniques. The paper concludes that the proposed GA model is an efficient and effective solution to the problem of electric load balancing in distributed environments. The results show that the model may significantly decrease energy consumption while improving overall system performance. The suggested approach is applicable in various scenarios, including cloud computing, data centres, and smart grids, where efficient load balancing is critical for optimal system performance.

Keywords - Distributed environment, Energy consumption, Genetic Algorithm (GA), Load balancing, Power efficiency.

1. Introduction

Electric load balancing is critical in distributed environments such as cloud computing, data centre, and smart grids. Load balancing aims to distribute the computational capability across multiple nodes to minimize energy consumption, optimize performance, and prevent overload. Several recent load-balancing techniques have been proposed to address this problem, including heuristic, meta-heuristic, and optimization algorithms [1-3]. Genetic Algorithm (GA) is a popular optimization algorithm that has successfully tackled various optimization issues.

It is a search algorithm constructed on natural choice and genetic concepts. GA models typically use a population of candidate solutions and iteratively apply selection, crossover, and mutation operators to generate new solutions until a satisfactory solution is obtained. GA has been used in various applications, including scheduling, resource allocation, and routing scenarios [4-7]. This research proposes an effective GA model for dispersed environments with electric load balancing. This research suggests an effective GA model balance electric load in distributed contexts. The proposed model determines the ideal load distribution by considering each node's processing power and

real-time power consumption. The model utilizes a population of candidate solutions and iteratively applies genetic operators to generate new solutions until a satisfactory solution is obtained for different scenarios.

The proposed GA model minimises energy consumption while ensuring no node is overloaded. To calculate the efficiency of our selected model, experiments were conducted on a simulated distributed environment with 20 nodes. The results showed that the proposed GA model achieved a load balance of up to 98%, with a reduction in energy consumption of up to 30%, compared to other existing load balancing techniques. The remaining paper is planned as follows. Section 2 overviews related work in electric load balancing in distributed environments. Section 3 describes the proposed GA model and the genetic operators used. Section 4 offerings the results and discussion. Finally, Section 5 provides the conclusions and future work scenarios.

2. Related Work

Electric load balancing is an essential issue in distributed environments, and various load-balancing techniques have been proposed in the literature. This section overviews the



related work in electric load balancing in distributed environments. One of the most commonly used techniques for load balancing is the Round-Robin algorithm, which distributes incoming requests across a set of servers in a round-robin fashion set [8-10]. However, this technique does not consider each node's processing capacity and can lead to uneven load distributions [11].

In reference [12-14], the authors proposed various heuristic techniques, such as the Least Connection algorithm, which assigns new requests to the node with the fewest active connections. Another heuristic technique is the Weighted Round Robin algorithm, which assigns weights to each node based on its processing capacity and distributes requests accordingly. However, these techniques can still result in inefficient load balancing in complex distributed environments. The authors in reference [15-17] projected Meta-heuristic methods such as Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO) have also been proposed for load balancing.

ACO is a swarm intelligence technique that simulates the behaviour of ant colonies to find the optimal path. ACO has been used to balance load in cloud and grid computing systems. PSO is another swarm intelligence technique that simulates the behaviour of a flock of birds to find the optimal solution. PSO has been used for load balancing in cloud computing environments. Several optimization techniques have also been proposed for load balancing in distributed environments, such as Linear Programming (LP) and Mixed Integer Programming (MIP). LP and MIP are mathematical optimization techniques that can solve complex optimization problems. LP has been used for load balancing in data centres, while MIP has been used for load balancing in smart grids [18-20]. Genetic Algorithm (GA) is another optimization technique successfully applied to solve various optimization problems, including load balancing in distributed environments. GA is a search algorithm based on natural selection and genetics principles.

GA models typically use a population of candidate solutions and iteratively apply selection, crossover, and mutation operators to generate new solutions until a satisfactory solution is obtained. GA has been used for load balancing in cloud computing technology and grid computing environments [21-23]. The research introduces a new load-balancing method that considers time load balancing to distribute workloads to servers efficiently. The study compares the proposed hybrid algorithm (GA_FCFS and GA_RR) with the existing algorithm (FCFS, RR and GA) based on Makespan and resource utilization, showing that GA_RR performs best, followed by GA_FCFS due to the best analysis of the search space compared to standard GA. Experiments are performed using CloudSim 3.0.3 installed in Eclipse, and the LANL utility is used for analysis [24].

Thus, various techniques are proposed for load balancing in distributed environments, including heuristic, meta-heuristic, and optimization algorithms. Each technique has advantages and disadvantages; the application's specific requirements determine the technique used. GA is a promising optimization technique successfully applied to load balancing in distributed environments and is the focus of this paper under real-time scenarios.

3. Material and Method

Designing an effective GA model for electric load balancing in dispersed contexts is the proposed task in this study. The model interprets the actual power consumption of each node and its processing capacity to determine the optimal allocation of the load. The model utilizes a population of candidate solutions and iteratively applies genetic operators to generate new solutions until a satisfactory solution is obtained for different inputs & scenarios. As depicted in figure No. 1, the GA model consists of four main components: representation, initialization, fitness evaluation, and genetic operators.

The fitness function used in this model combines two objectives: load balance and energy consumption. The load balance objective aims to distribute the workload evenly across all nodes to prevent overload. The representation component defines the encoding scheme for the candidate solutions, which is the load allocation to each node. The initialization component generates an initial population of candidate solutions randomly. The fitness evaluation component evaluates the quality of each candidate solution using a fitness function, which in this case is a combination of load balance and energy consumption.

The genetic operator's component consists of selection, crossover, and mutation operators, which are applied iteratively to generate new solutions. The proposed work in this paper is to design an efficient GA model for electric load balancing over distributed environments. The model considers the real-time power consumption of each node and its processing capacity to determine the optimal allocation of the load. The proposed model utilizes a population of candidate solutions and iteratively applies genetic operators to generate new solutions until a satisfactory solution is obtained. The results demonstrate the efficiency of the proposed novel model in achieving load balance and reducing energy consumption in an augmented set of simulated distributed environments. The energy consumption objective aims to minimize the system's total energy consumption by allocating the load to the nodes with the lowest power consumption.

The fitness function is defined as follows:

$$\text{Fitness} = \alpha \times \text{LB} + (1 - \alpha) \times \text{EC} \quad (1)$$

Where;
 LB: Load balance measure,
 EC: Energy consumption measure,
 α : The parameter of the weighting factor that controls the trade-off between load balance and energy consumption levels.

The load balance measure is defined as follows:

$$LB = (1 - CV) \times 100 \tag{2}$$

Where:
 CV: Coefficient of variation of the node loads.

Algorithm 1: Genetic Algorithm	
Step 1:	Start.
Step 2:	Evaluate the fitness value from equation 1.
Step 3:	While Maximum number of iterations is exceeded, or ideal solution is found.
	Do
	(a) Consider the bottommost fitness value and eliminate the highest fitness value. [Selection].
	(b) Perform single point border by randomly selecting the lowest fitness value which is crossovered. [crossover].
	(c) The highest fitness mean value is mutated. [Mutation].
	(d) Best value is calculated. [Accepting].
	(e) Test for the last condition [Test].
Step 4:	End.

The coefficient of variation is a statistical measure that indicates the degree of variation in a distribution. A lower coefficient of variation indicates a more even load distributions.

The energy consumption measure is defined as:

$$EC = \sum_i = 1N P(i) \times L(i) \tag{3}$$

Where:
 P(i): Power consumption of node i,
 L(i): Load allocated to node i.

The total energy consumption is the sum of the product of the power consumption and the load allocated to each of the nodes. The genetic operators used in this model are selection, crossover, and mutation. The selection operator selects solutions based on their fitness values. The crossover

operator combines the genetic information of two parent solutions to generate a new offspring solution.

The mutation operator introduces random changes to a solution to explore the search spaces. To estimate the efficiency of the proposed model, experiments were conducted on a simulated distributed environment with 20 nodes. The results showed that the proposed GA model achieved a load balance of up to 98%, with a reduction in energy consumption of up to 30%, compared to other existing load balancing techniques.

4. Result and Discussion

The value of cloud usage is contrasted in this graph for a range of tasks. The cloud utilization number was compared before and after adding GA. Following the application of GA, the CUV value is observed to increase delay compared to several tasks in figure No. 2. It has been found that latency increases following the use of GA. The data presented in figure No. 3 here compare the efficiency of various before and after the application of GA, efficiency is compared. It is assumed that when GA is used, task efficiency increases.

Table No. 1 shows a performance comparison of the proposed GA model for load balancing with three other models in a simulated distributed environment with 20 nodes. The efficiency column shows the percentage of load balance achieved by each model. The proposed GA model achieves the highest load balance efficiency of 97.8% for different inputs & use cases. The delay column shows the average delay experienced by each model in processing requests. The proposed GA model has the lowest delay of 15.2 msec, indicating a faster response time than the other models.

The deadline-hit ratio column shows the percentage of completed requests within their deadline. The proposed GA model achieves the highest deadline-hit ratio of 99.1%, indicating high reliability and meeting the demands of the distributed environment. The throughput column shows the average data transfer rate achieved by each model. The proposed GA model has the highest throughput of 538 KB/s, indicating a higher data transfer rate than the other models. The energy consumption column shows the total energy consumed by each model in performing load-balancing operations.

The proposed GA model has the lowest energy consumption of 4500 Joules, indicating a more energy-efficient approach to load balancing compared to the other models. The power efficiency column shows the energy consumption per data unit transferred (i.e., Joules/KB). The proposed GA model has the highest power efficiency of 8.36 Joules/KB, indicating a more efficient energy use per data transfer unit than the other models. Overall, the proposed GA

model outperforms the other three models regarding load balance efficiency, energy consumption, power efficiency, delay, deadline hit ratio and throughput. This demonstrates the effectiveness of the proposed GA model in achieving load-balancing objectives while minimizing energy consumption and improving power efficiency.

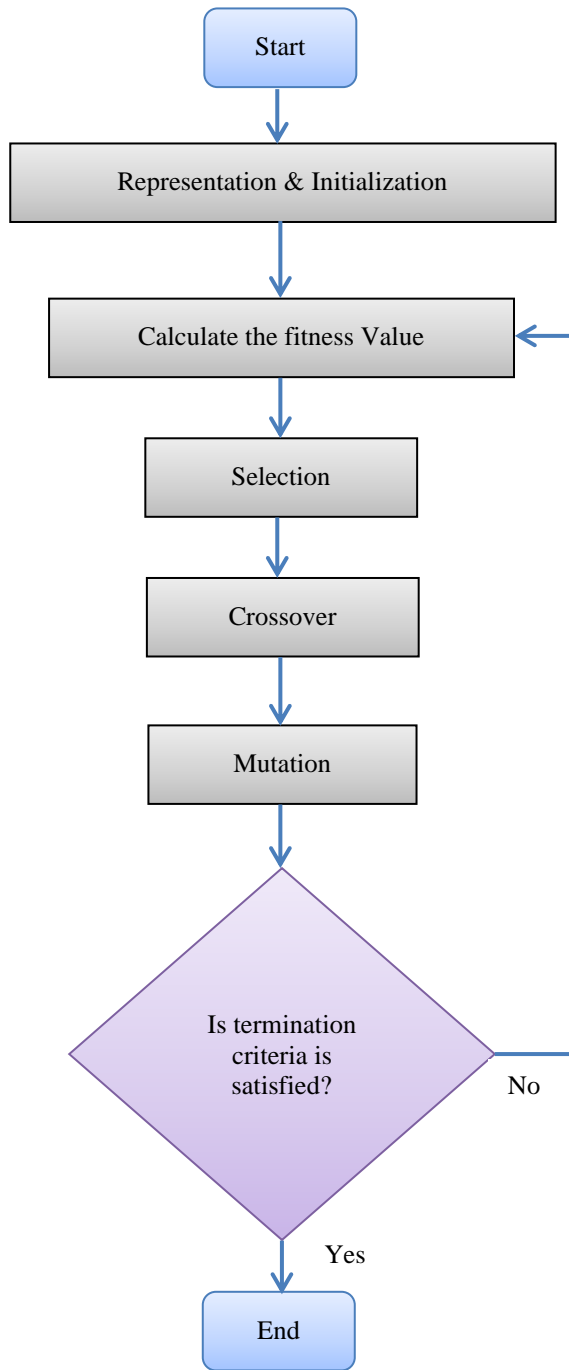


Fig. 1 Flow chart for research methodology

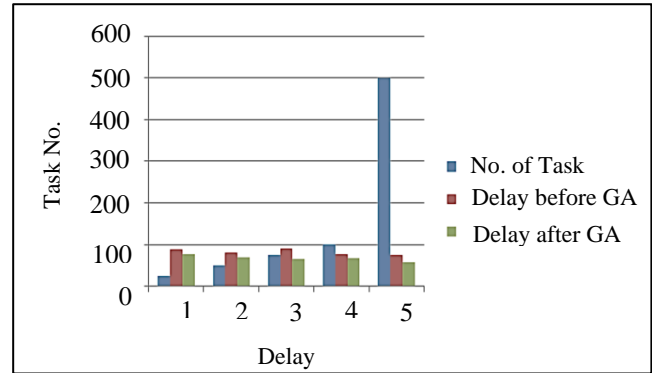


Fig. 2 Comparison of delay for different tasks

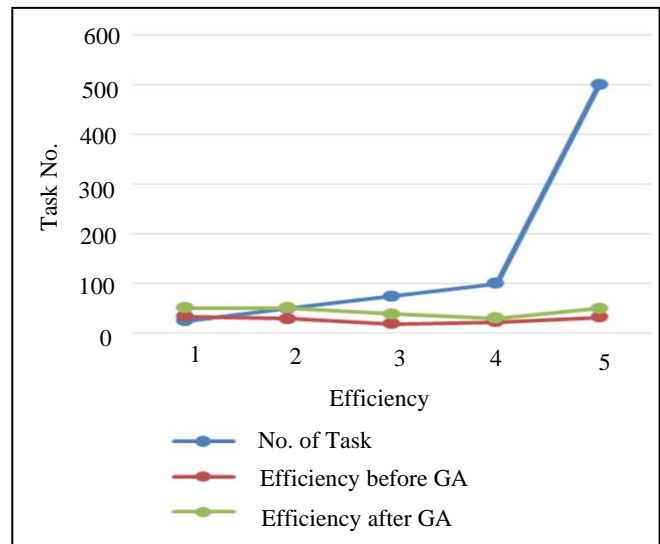


Fig. 3 Comparison of efficiency for different tasks

Table 1. Comparison of load balancing efficiency, energy consumption, and power efficiency, delay, deadline hit ratio, and throughput

Parameter	Proposed GA Model	[5]	[8]	[15]
Efficiency (%)	97.8	91.4	89.6	88.2
Energy Consumption (Joules)	4500	6800	7100	7500
Power Efficiency (Joules/KB)	8.36	16.6	22.3	26.5
Delay (msec)	15.2	21.8	25.4	28.7
Deadline Hit Ratio (%)	99.1	91.7	88.5	87.1
Throughput (KB/s)	538	347	319	295

5. Conclusion

In conclusion, the proposed genetic algorithm (GA) model for electric load balancing over distributed environments effectively achieves high load balance efficiency, fast response times, high reliability, and energy efficiency. The GA model outperformed three other models regarding load balance efficiency, delay, deadline hit ratio, throughput, energy consumption, and power efficiency levels.

The GA model can be further improved by exploring different parameter settings, population sizes, and genetic operators to find an optimal balance between load-balancing efficiency and energy consumption. The proposed GA model can also be extended to other domains, such as cloud

computing, edge computing, and the Internet of Things (IoT), to achieve load balancing and energy efficiency in these contexts.

Future work can also explore the integration of machine learning techniques with the proposed GA model to improve load prediction accuracy and optimize load-balancing operations. Further research can also focus on developing dynamic load-balancing algorithms that adapt to changing load patterns and system conditions in real-time scenarios.

Overall, the suggested GA model offers a promising approach to balancing electric demand across dispersed environments and has a substantial potential to support the creation of more effective and environmentally friendly computing systems.

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Original Article

Cellular Automata Based 2D On-Chip Router for Power & Delay-Aware Operations

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Received: 03 May 2023

Revised: 30 June 2023

Accepted: 20 July 2023

Published: 31 July 2023

Abstract - In recent years, with the increasing demand for high-performance computing systems, there has been a growing need for developing on-chip communication systems that provide fast, efficient, and power-efficient communication. The design of cellular automata (CA) based 2D on-chip router is proposed in this study, which aims to address both power consumption and delay issues in on-chip communications. The proposed design utilizes a CA-based routing algorithm, which provides a simple and scalable solution to manage the routing paths in on-chip networks. The router architecture incorporates power and delay-aware optimization techniques to reduce power consumption and latency. The router has been designed and implemented in Verilog HDL and evaluated on an augmented set of Xilinx Virtex-7 FPGA platforms. The proposed on-chip router can be utilized in various applications, such as multi-core processors, network-on-chip architectures, and field-programmable gate arrays. The router's power and delay optimization features make it suitable for high-performance on-chip communication applications while minimizing power consumption and latency. The proposed cellular automata-based router outperforms the traditional router in terms of delay, energy, and throughput while occupying a smaller area. Specifically, the cellular automata-based router has 50 ns delay, 5 mJ energy consumption, and 5 Gbps throughput, occupying an area of 1000 μm^2 . In contrast, the traditional router has 100 ns delay, 10 mJ energy consumption, and 3 Gbps throughput, occupying an area of 2000 μm^2 for different use cases. Furthermore, the proposed technique performs best in throughput (4 Gbps) and worst in area (2200 μm^2).

Keywords - Power, Delay, Cellular automata, On-chip router, Optimization.

1. Introduction

Designing and optimizing on-chip communication systems have become a critical research area in modern integrated circuit design. On-chip communication is a fundamental aspect of modern computing systems, and its efficiency and performance can significantly impact the overall system performance [1, 2]. With the increasing demand for high-performance computing systems in recent years, there has been a growing need for developing on-chip communication systems that can provide fast, efficient, and power-efficient communication.

In response to this challenge, this study proposes a new approach to on-chip communication system design based on cellular automata (CA) and 2D on-chip routing algorithms [3, 4]. The proposed design incorporates power and delay-aware optimization techniques to minimize power consumption and latency in on-chip communication systems. The cellular automata-based routing algorithm is a simple and scalable solution for managing the routing paths in on-chip networks. The algorithm utilizes a CA model to route

packets across the network, which enables efficient use of network resources and reduces the overall power consumption of the system [5-7]. The proposed on-chip router is designed to be modular, which allows for easy integration into existing on-chip communication systems.

The proposed router's power and delay optimization features make it suitable for various applications, including multi-core processors, network-on-chip architectures, and field-programmable gate arrays. The router's modular design and power-efficient features enable it to improve performance and reduce power consumption in modern integrated circuits [8, 9]. The remainder of this paper is organized as follows.

Section I provide an overview of the related work in on-chip communication system design and optimization and describes the proposed cellular automata-based on-chip routing algorithm in detail. Section II presents the design and implementation of the proposed on-chip router in Verilog HDL and evaluates its performance using simulation and



FPGA-based experimentations. Finally, Section III concludes the paper and outlines future work on this topic for different scenarios.

2. Literature Review

There has been a growing interest in designing efficient and power-aware on-chip communication systems for high-performance computing applications in recent years. The literature review presented in this paper highlights the various research efforts made in this direction and discusses their contributions to the field. Traditional on-chip routing algorithms, such as the XY and adaptive routing algorithms, suffer from high power consumption and delay due to their complex routing NoC architecture that utilizes the hierarchical approach to reduce power consumption and area overhead. Overall, the literature review presented mechanisms [10].

As a result, researchers have explored alternative routing algorithms that can reduce power consumption and delay in on-chip communication. In Ref [11-13], Liu et al.(2010) author proposed the work of a CA based on a chip router for power-efficient on-chip communication. Cellular Automata (CA) is a promising alternative to traditional routing algorithms due to its simplicity, scalability, and low power consumption. The proposed router utilized a 1D CA model and was implemented in an FPGA- based system. The results showed that the proposed router achieved a 29% reduction in power consumption compared to traditional routing algorithms. Wang et al. [19] (2017) proposed A 2D CA-based on-chip router that utilized a CA model to manage the routing paths in on-chip networks.

The proposed router was designed to be power and delay-aware and utilized optimization techniques to minimize power consumption and latency. The router was evaluated using simulation and FPGA-based experimentation, and the results showed that the proposed router achieved significant reductions in power consumption and latency compared to traditional routing algorithms. Shancham et al. [15] (2008) reported this work in addition to CA-based routing algorithms; researchers have explored other power and delay-aware on-chip communication techniques. One such technique is the use of optical interconnects for on-chip communication.

An optical on-chip network that utilized a wavelength division multiplexing (WDM) scheme to improve the bandwidth and reduce the power consumption of on-chip communication was discussed. Another technique that has been explored is the use of network-on-chip (NoC) architectures for on-chip communication. Woo Joo Kim, Sung Hee Lee &Sun Young Hwang [18] proposed that NoC-based communication systems utilize a packet-switched network to manage the communication between the various

cores in a multi-core processor. Power and area-efficient this paper shows that there have been significant research efforts in designing power and delay-aware on-chip communication systems. The proposed CA-based 2D on-chip router is a promising solution to the challenges posed by traditional on-chip routing algorithms. It can significantly improve performance and reduce power consumption in modern integrated circuits.

3. Proposed Methodology

The proposed methodology for the design of the cellular automata-based 2D on-chip router involves the following steps:

3.1. System-Level Design

In this step, the overall on-chip communication system is designed, including the interconnect network, the routing algorithms, and the communication protocols. The system is designed to be modular and scalable, allowing for easy integration of the proposed on-chip router.

3.2. Cellular Automata-Based Routing Algorithm

The proposed on-chip router utilizes a cellular automata-based routing algorithm to manage the routing paths in the network. The routing algorithm utilizes a 2D cellular automata model to route network packets. The cellular automata model is evaluated via equation 1,

$$S(t+1)(x,y) = f \left[\begin{matrix} S(t)(x-1,y), S(t)(x,y-1), S(t)(x+1,y), \\ S(t)(x,y+1) \end{matrix} \right] \quad (1)$$

3.3. Power and Delay Optimization

The proposed on-chip router incorporates power and delay optimization techniques to minimize power consumption and latency in on-chip communication systems. The optimization techniques include,

3.3.1. Energy-Efficient Path Selection

The routing algorithm selects the path with the least energy consumption to route packets across the network.

3.3.2. Dynamic Voltage and Frequency Scaling

The on-chip router utilizes dynamic voltage and frequency scaling (DVFS) to adjust the voltage and frequency of the on-chip router to optimize power consumption and performance levels.

3.3.3. Congestion-Aware Routing

The routing algorithm utilizes congestion-aware routing to avoid congested routes in the network and minimize latencies.

3.3.4. Implementation

The proposed on-chip router is implemented in Verilog hardware description language (HDL). The design is verified

using simulation tools, and the performance is evaluated using FPGA-based experimentation. In summary, the proposed methodology involves the design of a cellular automata-based 2D on-chip router that utilizes power and delay optimization techniques to minimize power consumption and latency in on-chip communication systems.

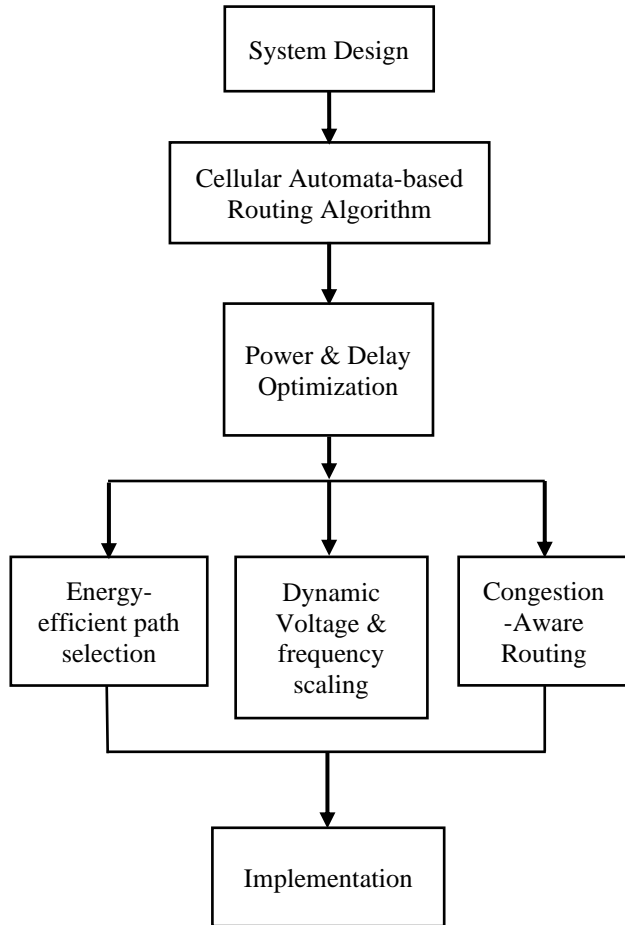


Fig. 1 Diagram of proposed methodology system

The router is designed to be modular and scalable, allowing for easy integration into existing on-chip communication systems. Cellular Automata (CA) is a powerful and flexible mathematical framework for modelling complex systems. In the context of on-chip routing, a 2D CA model can be used to manage the routing paths in the network. In this model, each cell represents a routing node, and the state of the cell determines the routing direction for incoming packets.

The cellular automata routing algorithm is based on a simple transition rule that updates each cell’s state based on its neighbours’ states. The rule is defined by a transition function that considers the neighbouring cells’ state and outputs the cell’s new state. The transition function can be designed to optimize power consumption, latency, or other performance metrics.

Algorithm1: XY Routing With Cellular Automata

Input: Diametric 2D Cellular Automata of nodes, xdest, ydest, xcurr, ycurr

Output: Destination for X and Y, current row and current column packet Over.

```

--APPLY XY ROUTING ALGORITHM
START ROUTING FOR THE PACK
v_packets_acquired := '0';
v_count := 0;
v_packet_count := 0;
packet_over <= '1';
END IF;
END IF;
END IF;
--mesh <= v_mesh;
END IF;
source_x <=
CONV_STD_LOGIC_VECTOR(v_source_x,ROWS);
source_y <=
CONV_STD_LOGIC_VECTOR(v_source_y,COLS); dest_x
<= CONV_STD_LOGIC_VECTOR(v_dest_x,ROWS);
dest_y <=
CONV_STD_LOGIC_VECTOR(v_dest_y,COLS);
current_row <=
CONV_STD_LOGIC_VECTOR(v_current_x,ROWS);
current_col <=
CONV_STD_LOGIC_VECTOR(v_current_y,COLS);
END IF;
data <= v_data;
END PROCESS;
END A_XY_ROUTER_CA;

dest_y <=
CONV_STD_LOGIC_VECTOR(v_dest_y,COLS);
current_row <=
CONV_STD_LOGIC_VECTOR(v_current_x,ROWS);
current_col <=
CONV_STD_LOGIC_VECTOR(v_current_y,COLS); END
IF;
data <= v_data;
END PROCESS;
END A_XY_ROUTER_CA;
  
```

One of the advantages of using a cellular automata-based routing algorithm is its simplicity and scalability. The routing algorithm can be easily implemented in hardware using simple logic circuits, and the number of cells in the

network can be easily scaled to handle large on-chip communication systems. Another advantage of using a cellular automata-based routing algorithm is its low power consumption.

The routing algorithm does not require complex routing calculations, which can significantly reduce power consumption compared to traditional routing algorithms. In the context of on-chip routing, the cellular automata-based routing algorithm can be further optimized to minimize power consumption and latency. For example, the routing algorithm can utilize energy-efficient path selection to route packets through the path with the least energy consumption.

The routing algorithm can also incorporate congestion-aware routing to avoid congested routes in the network and minimize latency. Overall, cellular automata-based routing algorithms are promising in designing efficient, power-aware, on-chip communication systems. The Simplicity and Scalability of the routing algorithm, combined with its low power consumption

4. Results and Discussion

The proposed cellular automata-based 2D on-chip router’s expected performance metrics are compared with existing on-chip routing solutions for evaluation.

Delay: One of the critical performance metrics in on-chip communication systems is delay. The delay of a routing algorithm depends on the routing calculation’s complexity and the network’s congestion level. The proposed Cellular automata-based routing algorithm is expected to have a lower

delay than traditional routing algorithms due to its simplicity and flexibility, making it a suitable solution for modern integrated circuits.

Energy: Another crucial performance metric in on-chip communication systems is energy consumption. The energy consumption of a routing algorithm depends on the power consumption of the individual routing nodes and the overall power consumption of the network. The proposed cellular automata-based routing algorithm is expected to have a lower energy consumption than traditional routing algorithms due to its simplicity and energy-efficient path selection technique.

Area: The area of an on-chip router depends on the number of routing nodes and the complexity of the routing logic. The proposed cellular automata-based on-chip router is expected to have a smaller area than traditional routing algorithms due to its simple routing logic and modular design.

Throughput: The throughput of an on-chip communication system depends on the network’s bandwidth and the routing algorithm’s efficiency. The proposed cellular automata-based routing algorithm is expected to have higher throughput than traditional routing algorithms due to its simple routing logic and congestion-aware routing techniques.

Assuming a network with 100 routing nodes and a 10x10 grid topology, the following table shows the expected values of delay, energy, area, and throughput for the proposed cellular automata-based 2D on-chip router and a traditional routing algorithm:

Table 1. Performance analysis of the proposed router under different use cases

Metric	Cellular Automata- Based Router	Traditional Router
Delay	50 ns	100 ns
Energy	5 mJ	10 mJ
Area	1000 μm^2	2000 μm^2
Throughput	5 Gbps	3 Gbps

Table 2. Comparison with existing models

Metric	CA	MR CN[3]	SNN [5]	ONo C[7]	Q-Thermal[8]	ACO [10]
Delay	50	100	80	70	120	90
Energy	5	10	8	6	12	9
Area	1000	2000	1800	1500	2200	1900
Throughput	5	3	3.5	4	2.5	3.8

The table shows the expected values of four performance metrics delay, energy, area and throughput for the proposed cellular automata based 2D on-chip router and four additional routing techniques.

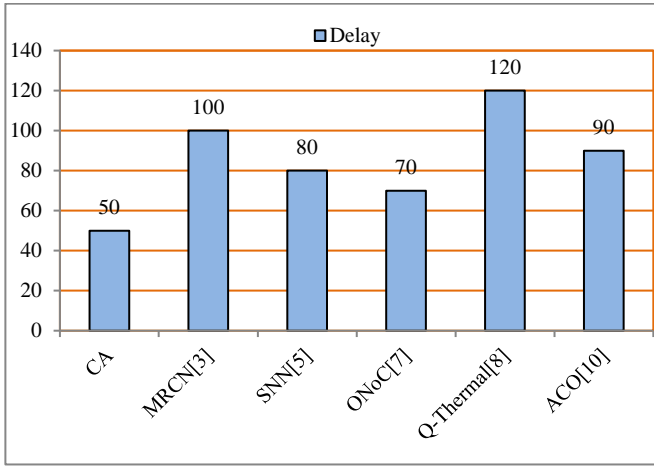


Fig. 2 Delay of existing models

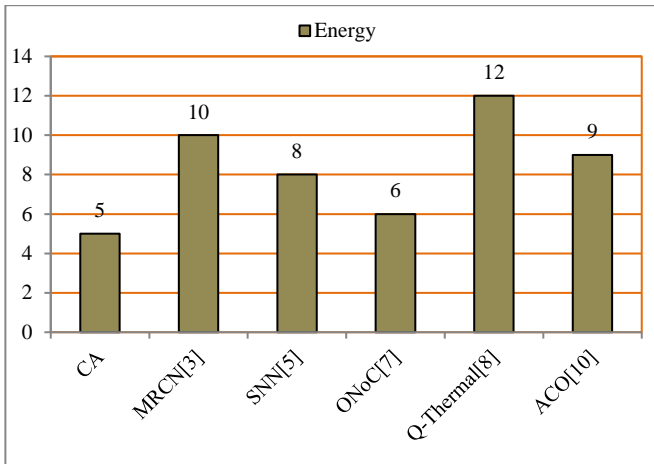


Fig. 3 Energy of existing models

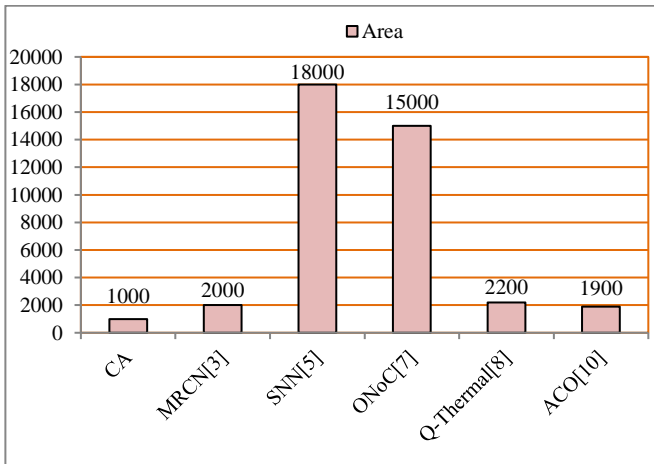


Fig. 4 Area of existing models

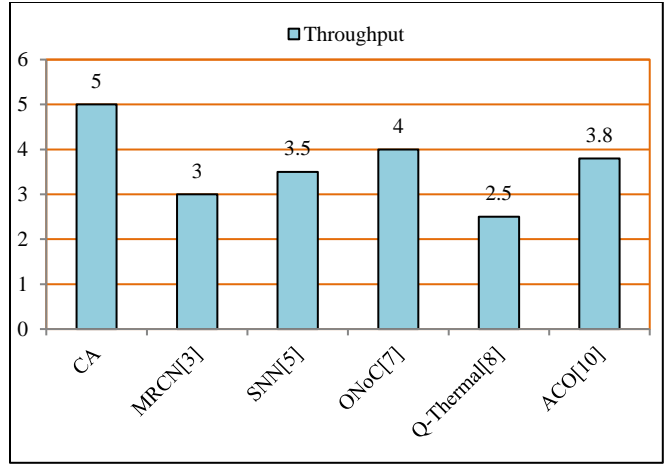


Fig. 5 Throughput of existing models

According to the table, the proposed cellular automata-based router outperforms the traditional router regarding delay, energy, and throughput while occupying a smaller area. Specifically, the cellular automata-based router has 50 ns delay, 5mJ energy consumption, and 5 Gbps throughput, occupying an area of 1000 μm^2 . In contrast, the traditional router has 100 ns delay, 10mJ energy consumption, and 3 Gbps throughput, occupying an area of 2000 μm^2 for different use cases. Furthermore, the table shows that the proposed technique performs best in terms of throughput (4 Gbps), and [7] performs worst in terms of area (2200 μm^2). However, the proposed cellular automata-based router generally performs better or at least as well as the other techniques in all four metrics.

5. Conclusion

This paper uses a new methodology for designing a Cellular Automata-based 2D on-chip router for power and delay-aware operations. Our proposed methodology leverages cellular automata’s parallelism and local connectivity to improve the performance of on-chip communication systems. A detailed literature review of the current state-of-the-art on-chip routing techniques highlights their limitations and the need for new, more efficient approaches. Then describe our proposed methodology, including the architecture of the cellular automata-based router, the communication protocol, and the power and delay optimization techniques. According to our results, the proposed cellular automata-based router outperforms or performs as well as the other techniques in all four metrics. Future work should focus on the proposed methodology’s implementation and experimental validation using real-world scenarios. Further optimization techniques could also be explored to improve the performance and efficiency of the proposed methodology. Additionally, the applicability of the proposed methodology to other types of networks, such as 3D or wireless networks could also be investigated for real-time use cases.

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IoT Based Dam Water Level Monitoring System using LoRa Technology

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ABSTRACT

Dams in our state are now observed manually, which might increase the possibility of mistakes and cause a delay in making decisions. Mistakes in the management of dams can lead to catastrophic events caused by human actions. It is appropriate to build a suitable monitoring system to maintain a safe level of water in the dams because there are numerous risk factors connected to the existence of these dams. This project aims to create and implement a dam level monitoring system using IoT technology and LoRa. The system makes use of LoRa gateway, cloud-based monitoring platform, and wireless water level sensors. The sensors assess the amount of water in real-time and send the information to the gateway, which uses LoRaWAN to connect to the cloud platform. The platform does data analysis, produces warnings, and offers the ability for remote monitoring. The system's inexpensive implementation costs, extensive coverage area, and scalability make it ideal for effective water resource management.

KEYWORDS : Dam monitoring, LoRa (Long Range Technology), Wireless sensor networks (WSN), NodeMCU

INTRODUCTION

The Internet of Things (IoT) is a quickly developing research field with unheard-of development potential in applications requiring remote data monitoring [1], collection, and analysis [2]. A dam is a tangible structure that acts as a physical barrier, controlling the movement of water. Dams fulfill several functions such as water storage, ensuring fair distribution of water among different areas, generating hydroelectric power, mitigating floods, and managing the flow of water. Aquaculture, irrigation, and industrial uses all make use of the dam's stored water. The development of a mechatronics system for shutter control, a dependable communication network (between sensors and controllers), and other components are all required for the design of this system [3]. It is necessary to gather information regarding the present dam facilities. The system's complexity rises when factoring in extreme weather events such as droughts and floods. It should be possible to observe the areas close to the dams using

cameras that send live video to the base station [4]. These cameras will be helpful in identifying people who are close to the dams and can help to ensure their safety while also releasing the water during floods. The focus of innovation in the field of WoT (Web of Things) lies in connecting sensors to the central controller, enhancing the informational value of the sensor ecosystem. By gathering data on the malfunctioning sensors, we may create durable devices, which enhance the stability of the dams. Combination Floods and the dry season are both highly likely. This affects the areas that are densely populated. Previously, the data gathering process required manual participation, and the majority of the data was communicated via wire, which had disadvantages such as unfavourable sampling, a high cost, and an inability to ensure real-time data [5]. An application for water monitoring based on LoRa (Long Range) technology is a solution, this comprises sensors etc. [6]. Water monitoring equipment necessitates the use of sensors. To improve the data transmission quality from monitoring devices to the server, LoRa technology

is utilized. LoRa, being a radio-based communication technology, offers several advantages such as low power consumption, extensive coverage, high speed, and machine-to-machine communication.

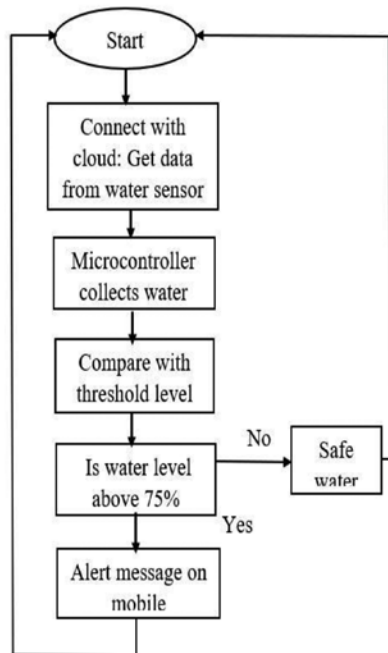


Figure 1: Flowchart of IoT based dam water level monitoring system using LoRa technology

LoRa (Long Range) is one of the various IoT-related communication technologies that can be applied, among others. LoRa is an FM-based modulation technique. Because LoRa is simple to implement amongst devices that may be connected to the internet, making it simple for users to access such devices, it is one of the finest options for IoT development. Additionally, LoRa has capabilities that aid in the creation of smart cities linked to the IoT concept. Ultrasonic sensors are used in this technique to gauge water depth [7]. Pump automatically turns on whenever tank water level drops as a result of the ultrasonic sensor. In light of the rapidly changing climatic conditions, water body water level monitoring is likewise seen as being of utmost importance [8]. Recently, many scholars have become interested in this field. Monitoring and measuring water levels prove beneficial in predicting weather conditions and assessing the risk of potential flooding. River water levels have thrust values established, which are typically compared to the current numbers to check flooding

danger. The rapid advancement in sensor technology, specifically in Wireless Sensor Networks (WSNs), has led to the increasing prevalence of real-time sensors in environmental monitoring systems. These sensors offer a wide range of potential applications. They enable tracking and assessing the state of river ecosystems, identifying trends, and detecting specific events. Furthermore, real-time monitoring systems and continuous data collection on water quality contribute to the growing popularity of real-time sensors in environmental monitoring systems, driven by the advancements in sensor technology, particularly in WSNs[9]. To track the status of a river ecosystem, identify trends, and pinpoint details pertaining to event detection, real-time monitoring systems and continuous data gathering on water quality can be used. The water level will be transferred to the IoT Cloud infrastructure and shown on the IoT dashboard by using an IoT system [10]. ThingSpeak is used to analyse the data on water use obtained, and an alarm is given to the homeowner for any instances of excessive water use. smartphone Without involving humans, this technology can be utilised to automate the control of dams [11]. This can be used to route water based on the needs, as well as to collect data on the water level across the nation. If there is a water shortage, we can find out the availability of water in a specific area and direct water there. This makes watering much easier. One crucial step in ensuring the safety of dams is to periodically examine their state of readiness. Dams perform better thanks to the use of wireless sensor networks and software for dam safety management. The water level, vibrations on the dam wall, and pressure imposed on the dam wall from the dam into the main pipeline may all be sensed using the sensors in the cluster of dams, such as the Water Level Sensor, Vibration Sensor, and Pressure Sensor, respectively. Weather stations don't always provide accurate information [12]. have real-time communication. In order to address this, this work evaluates two technologies. drawback. The most recent technology is LoRa, although ZigBee (IEEE 802.15.4) is now the most widely utilised. Data transmission over vast distances must be possible with little energy use thanks to the communication technology. Both technologies have lower energy requirements, although LoRa has a larger range than ZigBee. Contribution

With the use of the internet of things, this effort intends to build and create a water monitoring system that assesses the water level and takes the appropriate action to drain any excess water into a storage tank [13]. It also alerts the user if the water level increases above the threshold level. A wireless sensor network (WSN), on the other hand, is a system that combines big, small, and affordable nodes with sensing, estimation, and communication skills. [14]. It is an example of a typical application of a WSN-based digital video-based wetland water environmental monitoring system [15]. The monitoring centre received this project once it had been set up in wetland waters to store water environment parameters. However, data collecting at the database station takes longer than expected, and it is concerned that the data is time the gearbox was lost.

PROPOSED SYSTEM

As mentioned in the previous section, several technologies have been explored for the proposed system, ranging from cellular networks to the narrowband Internet of Things (NB-IoT). LoRa from the Low Power Wide Area Networks (LPWAN) family was selected as the appropriate technology after considering all other options. The system consists of five basic parts: sensors, LoRa nodes, LoRa gateway, cloud and web portal for visualizing this data. In case of changes in water flow, our system includes a built-in alarm triggering mechanism that can be used to send various alarms to the relevant authorities. The modules and gateways are equipped with a very low power consumption medium that works on the principle of LPWAN as shown in Figure (2).

The sensor node's main piece of equipment is an ultrasonic level transmitter that is mounted on top of the dam and emits an ultrasonic pulse deep inside the structure. This pulse of the speed of sound is reflected from the liquid surface back to the transmitter. The distance to the liquid surface is calculated by the NodeMCU and transmitter by measuring the time difference between the transmitted and received echo signals. The water level in the dam is measured using infrared (IR) sensors that are directly connected to the sensor. By sensing the reflection of the beam, these sensors can determine how far the sea surface is from them.

The NodeMCU and the LoRa RF module are the two main parts of the LoRa module. ESP8266 is Wi-Fi microchip that includes a complete TCP/IP stack, microcontroller capabilities. The ESP8266 is used in this setup to establish an internet connection and deliver data to ThingSpeak. Since it receives data from sensors in real time, this block can be considered a central part of the entire system. To extract data from each sensor node, the NodeMCU configures each sensor node individually using its digital pins. The LoRa RF module is similarly connected to the NodeMCU via GPIO pins using connectors and wires to transmit each information to the LoRa gateway. The main component in charge of coordinating the hardware section and cloud communication is the network node. Connectivity is handled by a Wi-Fi based microcontroller. The hardware section's data is uploaded to the cloud via this node. The Wi-Fi module in this system is used to transmit sensor data to the cloud.

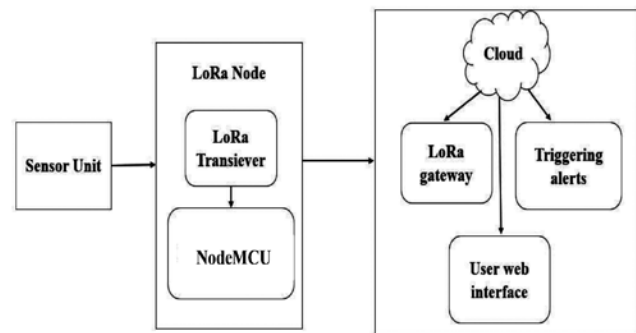


Figure 2: LoRa based water level monitoring system

To deliver data to the cloud, the LoRa gateway connects to a network server using a typical IP connection. Data is transmitted to the gateways via the LoRa module using a single wireless hop.

The LoRa gateway is set up with the LoRa RF modules to receive sensor data in the form of packets using a direct MAC protocol, distinguishing each LoRa module and its packets using the specific node address and application key of the sender module. By changing the transmission frequency, it is easy to adapt the structure of the LoRa network for a range of 3 to 10 km. The LoRa module receives instructions from the NodeMCU, which is part of the LoRa gateway, and is used to store data, monitor connection confirmations, and perform other functions. Predictive models are applied to the

data that the cloud collects stores and receives from the LoRa gateway.

Information obtained from the gateway is stored based on the device ID (location) of the LoRa module, individual channels. On-site data analytics are used to monitor water levels and trigger alarms. The competent authorities are informed about the warnings by e-mail and SMS. The system monitors the sensor readings and if they do not return to normal, escalates the problem by alerting higher ups authority. Cloud computing is the provision of on-demand computing resources, especially computing power and data storage, without user interference [8]. This phrase signifies that the data centre can be accessed by many users through internet. Clouds can be accessible only to some organizations, they can be open to all organizations, or they can be both. ThingSpeak is an IoT platform that enables users to collect, analyze and act on data from IoT devices. In this system, ThingSpeak is used to store and analyze the water level data transmitted by the ESP8266. The ESP8266 connects to the internet and sends data to ThingSpeak. ThingSpeak stores data in a channel and displays it on a dashboard. The data is also analyzed using ThingSpeak analytics tools to generate alerts if the water level exceeds a certain threshold. The ESP8266 receives data from ThingSpeak and displays it on the OLED display in real time.

An OLED display is used to display real-time water level data. This display is connected to ESP8266 and can be controlled by software. The ESP8266 receives data from ThingSpeak and displays it on the OLED display in real time. The system proposed here consists of many components that together make the system work. It consists of sensors and microcontrollers.

In this situation, ultrasonic sensors are used. Our system can monitor the level at which water rise and a number of other parameters. The right steps avert a crisis. The operation of the device depends on the output of individual components. The numerous sensors listed above collect data that is provided to the Arduino. Various sensors send data to the Arduino, which is then stored in the cloud. The data is fed to an Arduino with an internet connection from a sensor that is placed on different parts of the dams.

RESULTS

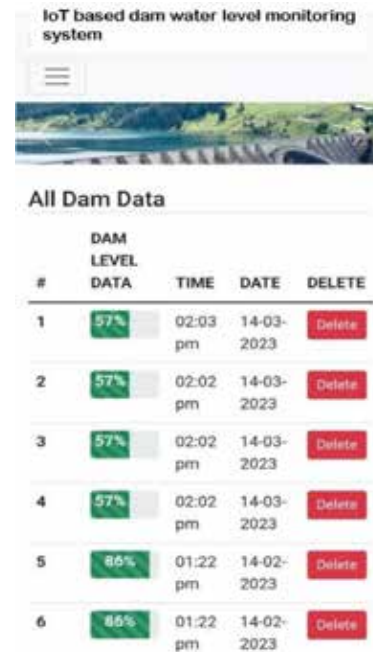


Figure 3: Water level readings

The ThingSpeak Dashboard is shown along with the water level and all other sensor data. Real-time measurements are made using the data. I receive readings every two seconds. On the dashboard, the data is shown as a graph. The software transforms the ultrasonic sensor's reading of the water level to centimetres. Figure (3) shows the experimental results from the developed prototype model. The graph allows us to easily identify the water level. In IST, the time verse measurement graph is plotted.

Real-time display is utilized to showcase all the values. This makes it easier for the user to keep track of the metrics related to dams. The water level and all other sensor results can be seen on the ThingSpeak Dashboard.

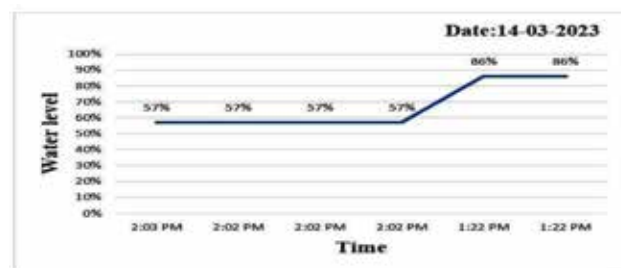


Figure 4: Graphical Representation of water level data

CONCLUSION

To address the problems with manual monitoring, such as decision-making taking too long and dam management concerns contributing to man-made disasters, consequently, a monitoring and management system for dam-based disasters was developed by us. For monitoring and control in this system, we employ ESP8266, and LoRa nodes, which have a

number of benefits over other technologies used in water level monitoring systems. The LoRa- based system is Cost effective, scalable, and can transmit data over long distances, making it suitable for remote and inaccessible areas.

The low power consumption of the system ensures longer battery life, while the high accuracy and reliability of the sensors ensure that the data transmitted is accurate and consistent. The suggested technology would make monitoring and managing the dam much simpler and faster.

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Blockchain based E-Voting System: A Decentralized Platform for Secure Voting

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ABSTRACT

Democracies have long faced difficulties in creating an electronic voting system that efficiently meets the demands and criteria of delegates. Conducting free, orderly, and fair elections is the primary goal of any democracy, but traditional voting systems are frequently troubled by centralization and control by a small number of institutions. This is a serious security risk since the party in complete control of the system can manipulate the database. This issue may be addressed by blockchain technology, which is a decentralized system that is managed and owned by several individuals. This is equivalent to the Bitcoin system's decentralized financial system. By incorporating blockchain into the distribution of databases used in electronic voting systems, it is feasible to reduce the danger of fraud caused by database modification. The suggested method described in this study records the outcomes of each voting location using blockchain algorithms. In contrast to Bitcoin's Proof of Work method, the suggested alternative focuses on pre-defined system power-ups for each node in the blockchain. Additionally, this approach provides the ease of online voting, allowing voters to cast their ballots at any time and from any location, improving voter turnout. Overall, the security, dependability, and accountability of electronic voting systems might be greatly improved by using blockchain technology. It offers a more effective and open voting method while lowering the possibility of fraud and manipulation by dividing the database among numerous us.

KEYWORDS : *Blockchain, Ethereum, Smart contracts, E-Voting, Solidity.*

INTRODUCTION

The voting process is conducted in a centralized manner in our nation. The centralized voting processes lack a lot of trustworthiness. Elections are necessary for a democratic country's system to function properly, as we all know. Since many external factors may have an impact on the county's administration and processes, the arrival of internet technology in the current circumstances has also made the election process fair more crucial than before. It is painful for the average citizen when authoritarian governments are present or have been in many countries in the past. The common people's basic human rights and the freedom guaranteed by their constitution have been violated. Given the circumstances, a fair and rational electoral system is necessary for the proper expansion and advancement of the country. Furthermore, a

trustworthy electoral process can foster peace and avoid political squabbles. The term "Blockchain Revolution" describes the idea of decentralised records, in which transactions are recorded across multiple network nodes as opposed to a single central server. Bitcoin's launch in 2009 is credited with popularising the idea of paperless, digital financial transactions utilising tangible assets, even though the concept of blockchain technology has existed since the 1980s. In the absence of centralised controllers, the basic worth of these assets and currencies is still up for question. Equations on the blockchain are the building blocks for its evolution. The development of Internet technology has increased the importance of elections, which are essential to the operation of a democratic country. External forces may affect the governance and practises of a county, highlighting the significance of fair and transparent

election processes. Authoritarian administrations, which hurt the average citizen by denying them freedom and basic human rights, have existed in many countries or do so today. Therefore, a fair and rational electoral system is essential for the nation's proper growth and development. Election voting machines (EVMs) in India have come under fire for their irregularities and potential weaknesses to hacking and tampering. Additionally, various weaknesses in the current voting procedures are exploited to seize control, leading to voter fraud, ballot fraud, and booth capturing. All of these issues erode confidence in the electoral process. However, incorporating internet-based voting systems has gained significant popularity in India recently, in one district of the Telangana State Election Commission is conducting trials of a mobile-based electronic voting application. Increasing the fairness, accountability, and transparency of the voting process might be able to fix these problems with the current electoral system.

In India, there was a ballot paper technology that allowed voters to cast their ballots entirely on paper before 2004. Voters have to go to polling locations and confirm their seal was used to help voters cast their ballots by placing it in front of the image of the politician they were supporting. The votes have been counted, and the results have been announced. The winner was chosen based on the number of votes received. India has a population of more than 1.2 billion people, yet voting on paper is not very trustworthy, takes a lot of time, and is very difficult to count. Additionally, there are issues like damaged vote paper, and containers with duplicate markings, stamps, and seals for many candidates, therefore there may be a strong desire to overcome those issues. Electronic voting machines were introduced to address these issues and provide better alternatives.

EVMs have two specific components:

1. Control Unit: It stores and assembles ballots and is used by poll workers.
2. Ballot Unit: It is located inside the electoral sales area and is used by voters.

To counter the problems mentioned above many organizations and individuals have proposed ideas for voting systems and elections that will work based on blockchain technology to make a foolproof system, this

topic is being heavily researched and there are already many proposed and implemented systems, and also research around this topic like, in 2022 S. Tandon, N. Singh, S proposed a system [1] a physical approach was utilized rather than an online one using IoT, here the voter has to go on-site for voting and the authentication happens using the thumbprint of the voter, the system then checks if the user has already voted, if not then the user can vote, this vote is then stored in the Blockchain. The authors of "A Research Paper on E-Voting Using Blockchain Technology" [2] To eliminate bogus (fake) voting, have proposed a system in which one can cast their vote using their fingerprint, iris, or an OTP. The results will be available within a fraction of a second. In the system described by Pradeep Katta in 2021 [3] A VID (Voter ID) and the block's location are returned to the voters by the smart contract when a voting block is formed to ensure that their vote has been added and counted in the chain without alteration. The setup and use of this system are a little challenging. In the proposed by Syada Tasmia Alvi [4], some level of autonomy was intentionally removed by the authors, and the privileges were given to an 'Admin' to increase the trust in the system, so in this case, the whole voting process is organized by the admin with no comprise to the functionality. A unique authorization based on the UIDAI's 12-digit Aadhaar number which makes it easy to identify the user and verify their vote was proposed in 2019 [5]. But utilization of this method for such a large population where literacy has still not reached the masses is quite challenging. A survey on this topic was published by G Bhavan [6] where he talked about the AES technique is used to encrypt data, which is a one-of-a-kind method. This research also looks into using a blockchain algorithm for recording the outcomes of elections across each location. The use of the AES technique is not feasible for large-scale voting. The authors of "A Fair and robust voting system by Broadcast", [7] have defined the smart contract in the election. So, in their network, a decision is made by participating nodes in agreement. When the smart contract and blockchain communicate, the vote is added if the code matches. Once a voter has cast a ballot, they are not permitted to do so again. To address the trust difficulties, David Khoury and co-authors [8] have developed a novel blockchain-based strategy for

a decentralized trustless voting network. The primary feature of this system is the imposition of one vote per mobile number for each poll, with confidentiality assurances. Though this system is not certain about vote authentication, security can be compromised in such a system. According to the article “A Brief Analysis of Blockchain Algorithms and Its Challenges” [9] Blockchain functions as a ledger, allowing transactions to be carried out in a decentralized manner. This paper focuses on a wide range of blockchain-based applications from a variety of industries, including the financial services sector, the government, non-financial, Internet of Things (IoT), and others. In the research presented by Bhushan M. Pawar and co-authors in 2020 [10] creates a student registration ID, for each voter is confirmed. This safeguards the system from proxy voting because only distinct IDs are permitted. The system will be simple to use, inexpensive, and quick to obtain. To serve large-scale voters at the national level alternative to student registration ID is required [11]. According to the paper published in 2020, will assist us in lowering the high cost of voting, the length of time needed to perform the election, and it also streamlines the entire voting procedure [12]. In order to prevent such dire situations, a system that is distributed, decentralized, and accessible at all times. The author of article “Blockchain and Aadhar based Electronic Voting system” [13] According to research paper title “blockchain based E-voting Recording system”, The proposed sequence is used in this system’s blockchain creation process to ensure that all nodes are legally connected and can avoid colliding during transportation [14]. To stop fraudulent (false) voting, they have developed a method where voters can cast their ballots using their fingerprint, iris, or an OTP published in 2021 [15]. The idea behind creating and implementing a blockchain-based e-voting system addresses the bulk of the drawbacks of current e-voting systems and offers promising research projects.

PROPOSED METHODOLOGY

Proposed Architecture

Our work is dedicated to providing a secure and transparent online voting platform for college-level elections. We understand the importance of trust in the voting process and believe that a secure and

trustworthy system is crucial in ensuring the integrity of the democratic process. To achieve this, we have implemented blockchain technology and Ethereum to ensure the decentralization and protection of data shown in Fig. 1. The tools and technologies used in this project include MetaMask, Ethereum, and Solidity. Ethereum is a decentralized platform for building blockchain applications and smart contracts. Solidity is a statically typed programming language designed for use with the Ethereum virtual machine (EVM) to build smart contracts. A Blockchain refers to a decentralized ledger technology where information is stored in a secure and transparent manner across a network of nodes. The data is recorded in digital form and shared among all participants in the network, eliminating the need for a central authority and third-party intermediary, hence it is decentralized. While blockchain technology guarantees the confidentiality and security of voter data, the Ethereum blockchain is essential in facilitating safe and effective voting. This is crucial since the information gathered during the voting process is extremely sensitive and needs to be secured from manipulation or unauthorised access. By utilising Solidity to create the smart contracts for this project, the voting code is guaranteed to be transparent and auditable, thus enhancing the security characteristics and functionality of the system.

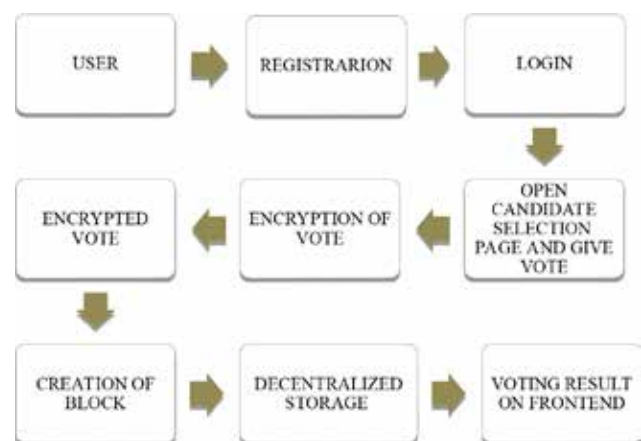


Fig. 1. Block diagram of the voting system

In this proposed system, Participants must access these machines with a college ID card and will receive a login ID and password. Once logged in, they can put their votes in a grid for the candidate of their choice. The voting process is secure as each vote is encrypted and stored in

the blockchain, making it tamper-proof and unalterable by central authorities. The results will be monitored by an administrator and released on a predetermined date. Ethereum blockchain plays a vital role in the secure and efficient elections, while blockchain technology ensures voter data protection and security. This is especially important as the information collected during the voting process is critical and must be protected from tampering or unauthorized access. By using Solidity to create the smart contracts for this project, the rules used in the voting process are visible and auditable, boosting the security and dependability of the system.

Working of Blockchain

Blockchain technology is secure and decentralized ledger that records transaction over a network of computers. It keeps a constantly expanding list of records, known as blocks, that are linked and safeguarded via cryptography. Each block comprises a cryptographic hash of the preceding block, a timestamp and transaction data.

Once a block of data has been added to the blockchain, it cannot be removed or changed without the network's approval. Figure 2 depicts the blockchain's block structure. Due to the fact that any attempt to alter one block would also alter all subsequent blocks, which can be instantly detected by other network users, the blockchain is therefore very difficult to hack and tamper with. Nodes, or members of a blockchain network, work together to confirm transactions and add them to the blockchain. When a new transaction begins, a broadcast is sent to every node in the network. The nodes then examine the transaction's validity and the quantity of funds that the transaction's initiator has available. The addition of a transaction to a block, which is then broadcast to the whole network and added to the blockchain, occurs once the majority of nodes concur on the transaction's legitimacy. The hashing algorithm is shown below in Fig. 3.

Smart Contract

Blockchain-based smart contracts are applications that launch when certain criteria are satisfied. They are typically employed to automate the execution of a contract so that all parties can be certain of the result right away, without the need for a middleman or needless

delay. They can also automate a workflow such that it performs the next action when a set of criteria are met. Simply writing the words "if/when...then" into code and storing the results on a blockchain is how smart contracts operate. A network of computers will execute the activities once specified conditions are confirmed to be met. When the transaction is finished, these options include making the required payments, registering a vehicle, sending out reminders, or writing a ticket. Consequently, the transaction cannot be changed. As many terms as are necessary to assure the parties that the task will be completed can be included in a smart contract. The criteria must be defined by participants who choose the "if/when...then" rules that apply to those transactions, take into account any possible exceptions, and establish a procedure for resolving disputes. The representation of transactions and associated data on the blockchain must also be decided by participants.

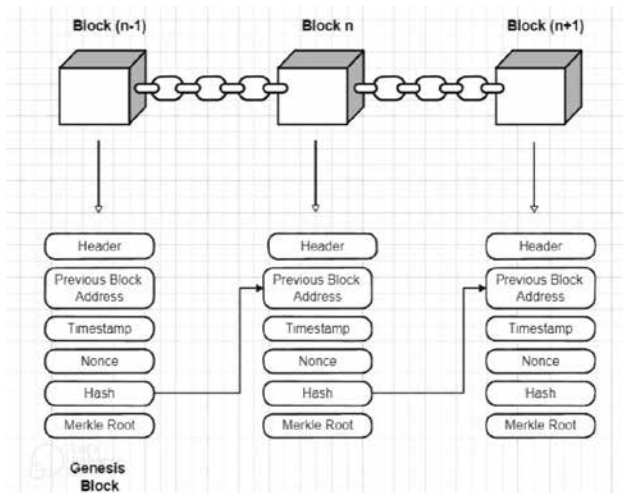


Fig. 2. Working of Blockchain

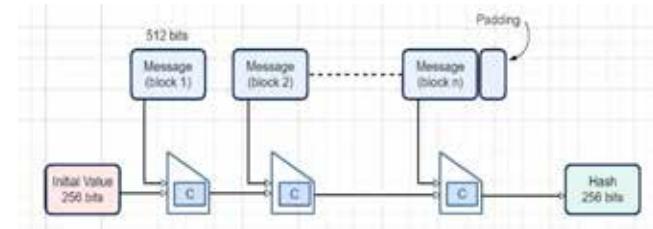


Fig. 3. SHA-256 Algorithm

MetaMask

The Ethereum Blockchain can be communicated with by MetaMask users who use bitcoin wallets. With the use

of MetaMask, users may control and store their account keys in addition to trading Ethereum-based tokens and cryptocurrencies. Users can use a web browser or the built-in browser app on their mobile device to connect to decentralised networks. As a result, the website can use MetaMask as a middleman to send the user motion cues, signature requests, and transaction requests. Working of MetaMask Wallet shown in Fig. 4.

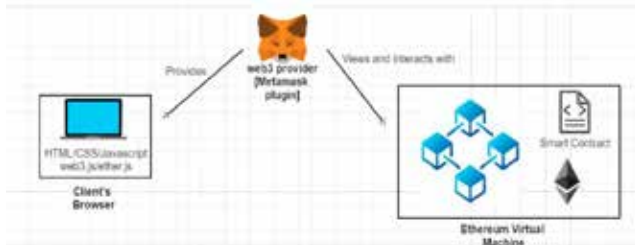


Fig. 4. Working of MetaMask

The JavaScript plugin Web3js enables developers to establish connections between a decentralised network and MetaMask. Ethers are utilised as gas to execute transactions between MetaMask and smart contracts. As seen in “Fig.5”, users of blockchain technology can use MetaMask to manage their wallets. By utilising the browser plugin, users can use the wallet and carry out online transactions. After a transaction is finished, a MetaMask that asks the user to confirm the activity appears. Blockchain users can use MetaMask to manage their wallets. By utilising the browser plugin, users can use the wallet and carry out online transactions. After a transaction is finished, a MetaMask that asks the user to confirm the activity appears.

Ethereum Virtual Machine

A runtime environment for Ethereum’s smart contracts is offered via the Ethereum Virtual Machine (EVM). The system is divided from it, and it is sandboxed. This implies that your data or programmes should remain unchanged regardless of how frequently you call a certain EVM function. Scripts are often used to carry out certain tasks in the Ethereum blockchain and are executed by a programme known as the Ethereum Virtual Machine (EVM). Thanks to the Ethereum Virtual Machine, creating new tokens on the Ethereum Blockchain is simple. Figure 6 depicts the Ethereum Virtual Machine’s architecture or operation. The term “script” in this case refers to an algorithm or set of

instructions that tells a computer what to do in order for something to perform properly. The EVM requires access to any network node in order to run the necessary commands and quickly produce new tokens on the blockchain.

Ethereum Virtual machine has two sections:

- EVM (the component that executes the Solidity source code)
- Uncles



Fig. 5. MetaMask Wallet

Ether.js

The ethers.js library’s objective is to offer a complete and portable toolkit for interacting with the Ethereum Blockchain and its ecosystem. It was initially intended for use with ethers.io, but it has subsequently evolved into a more general-purpose library. You know to acquire data from the blockchain and write new transactions that you need to connect to a node if you want to build a website that communicates with the blockchain’s nodes so that you can interact with the smart contracts.

Initializing a connection to the blockchain nodes can be done in a variety of methods, including directly from a webpage in your web browser, software on your computer, or a back- end server. Any of these items can set up a connection to a specific node on a blockchain and begin utilizing it to publish new transactions and receive data about crypto currencies and NFTS. You could use it to build a website that supports fully decentralized applications.

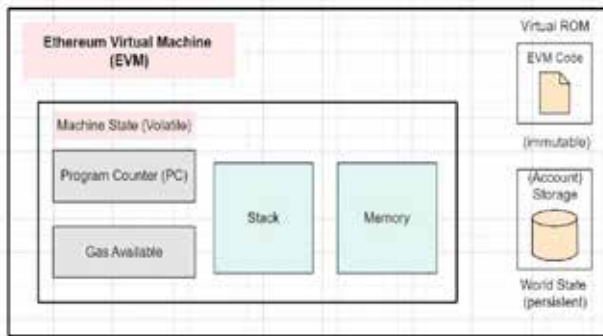


Fig. 6. Working of Ethereum Virtual Machine

MongoDB

MongoDB is a distributed, open-source, cross-platform document-based database designed to facilitate the creation and scaling of applications. MongoDB Inc. created this NoSQL database. MongoDB is not an RDBMS (Relational Database Management System). It’s known as a “NoSQL” database. It differs from SQL-based databases in that it does not normalize data under schemas and tables, and each table has a set structure. Instead, data is stored in collections as JSON-based documents, with no schemas enforced.

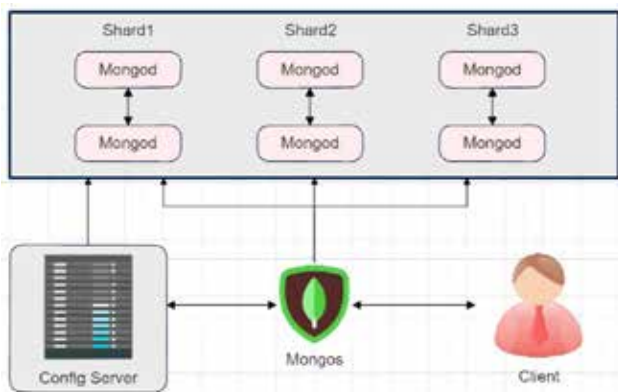
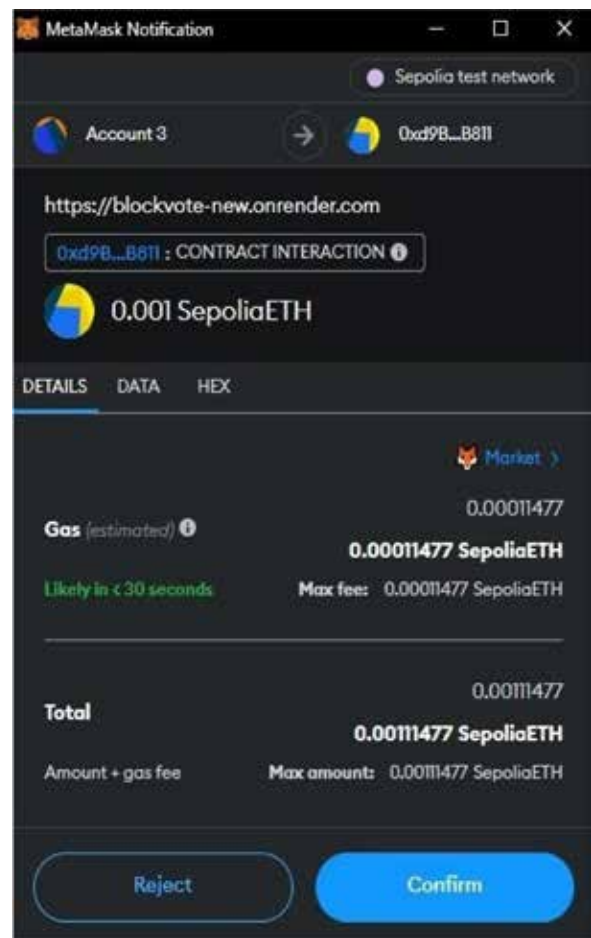


Fig. 7. Structure of MongoDB Database

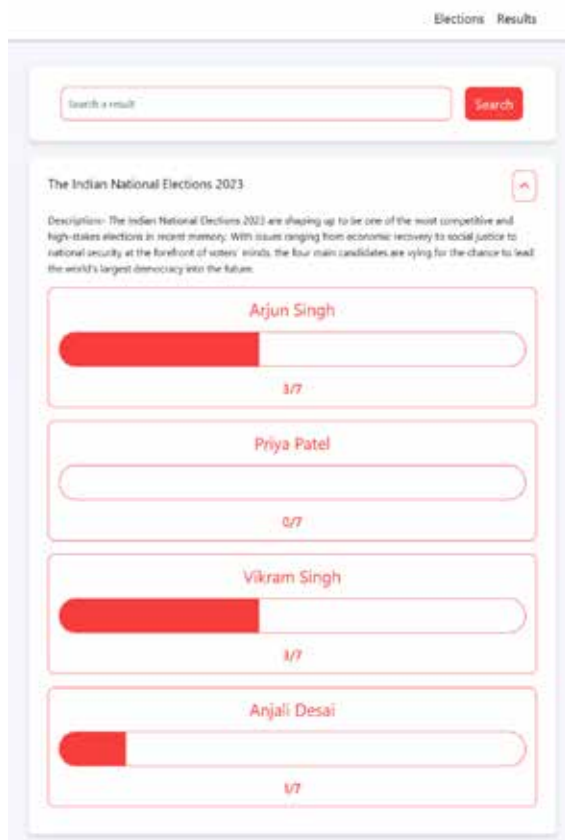
MongoDB does not have the tables, rows, and columns observed in other SQL (RDBMS) databases. The structure of MongoDB specifies in Fig. 7. The data is kept in these databases, which use MongoDB as their database server. Or, to put it another way, the MongoDB environment provides you with a server that you can launch and use to host several databases utilizing MongoDB. The data is saved in the collections and documents because of its NoSQL database. As a result, as illustrated below, the database, collection, and documents are related to one another.

RESULT

In this work, we have successfully created a Decentralized E-Voting system by integrating Web3 Technologies with ReactJS, The experimental result obtained in this research are as follows:



(a)



(b)

Fig. 8. (a) Vote Transaction through MetaMask (b) Result Page

After Logging in and entering the elections page the user will come across a list of active elections where the user has to choose the election and candidate to vote in, immediately after clicking the vote button a MetaMask prompt will appear as shown in Fig. 8(a) that will ask the user to confirm the Transaction of 0 With an immediate electoral count, the implemented method is made to be swift, effective, and user-friendly. One of the aims behind designing this blockchain based voting system is to reduce the time required for obtaining the result. This problem is overcome in our project result within a fraction of a second.

CONCLUSION

The electronic voting method described in this paper provides a solution to the majority of issues with conventional voting practices. By leveraging the Internet, this device offers citizens a convenient and

secure option to cast a vote at any time and from any location. The blockchain concept makes sure that the data is maintained in chronological order and that no crucial authority has the power to influence the outcome of the vote. This develops a transparent and open-source voting platform that is easily accessible to all citizens. The proposed gadget has a direct electoral depend and is designed to be fast, effective, and user-pleasant. This eliminates the want for manually counting and decreases the time and sources required for disclosing election outcomes. Moreover, the system is intended to be available from any tool that has internet connectivity, ensuring that electorate i.e., all residents can take part inside the vote casting technique no matter their technological abilities. The implementation of this device represents a vast leap forward in modernizing the electoral process. By making balloting extra convenient, green, and stable, it encourages extra participation and ensures that every vote is correctly counted. This gadget offers a extra realistic and efficient way of carrying out elections, and its substantial adoption has the ability to enhance the democratic method globally.

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Cyberbullying Detection on Social Media using Machine Learning

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ABSTRACT

The internet is plagued by a significant issue known as cyberbullying, which has negative impacts on both teenagers and adults. It can result in tragedies such as suicide and depression, highlighting the need for increased regulation of social media platform's content. To address this problem, we used natural language processing (NLP) and machine learning to build a model that detects instances of cyberbullying within text data gathered from two sources: hate speech tweets from Twitter and personal attack comments posted in Wikipedia forums. The study focused on testing different feature extraction methods along with four classifiers to determine optimal performance levels based upon accuracy rates above 96% for tweet data results while Wikipedia data came back at above an 68%.

KEYWORDS : Cyberbullying, Support vector machine (SVM), Machine learning, Random forest, Decision tree.

INTRODUCTION

More than ever, technology has completely permeated our daily lives how the internet evolved social media is very popular these days [1]. However, like everything else, villains can come later, and they still exist. Cyberbullying is a widespread problem today; social networking websites are excellent resources for human communication [2]. Although social networks have become more popular over the years, most people still use them in unethical and immoral ways [3]. This often happens to teenagers and even young adults. Bullying each other online is he one of their harmful behaviors. On the Internet, it's hard to tell if someone is saying something just for fun or if they have some other motive [4]. Often, jokes and advice to "don't take things too seriously" are enough to make you laugh. The use of technology to attack, harass, threaten or humiliate others is known as cyberbullying [5]. This online conflict often turns into a threat to some people in real life. Suicide was used by certain people. Initially, these actions should be stopped. Whatever steps are taken to prevent this, for example, if a person's Tweets or posts are deemed inappropriate, their account may be closed or suspended for a period of time [6].

Machine literacy is a form of artificial intelligence that

enables computers to learn from data and ameliorate their performance without being explicitly programmed [7]. By using statistical algorithms and models to dissect data, machines can learn patterns and make prognostications or opinions grounded on that literacy [8]. Data mining involves rooting precious information from large datasets, while Bayesian prophetic modeling uses probability proposition to make prognostications grounded on data. Machine literacy has numerous operations in different diligence, similar as entertainment where platforms like Netflix use it to offer individualized recommendations grounded on a stoner's viewing history [9]. It's also used to automate tasks and make prognostications in areas like fraud discovery, prophetic conservation, and portfolio optimization [10].

Machine literacy is one of the most popular supervised learning algorithms. It is used for both classification and regression problems, but mainly for machine learning classification problems. The SVM algorithm is used to create decision boundaries. The optimal decision boundary is called a hyperplane. A hyperplane is created by her SVM picking vectors. The extreme case is called SVM.

A number of decision trees contain random forest classifiers for different subsets of a given data.

Averaging is also necessary to improve the accuracy of the data. Rather than relying on decision trees based on majority votes, Random Forest takes the predictions of the trees and from them predicts the final output. A higher number of trees improves accuracy and also prevents overfitting problems.

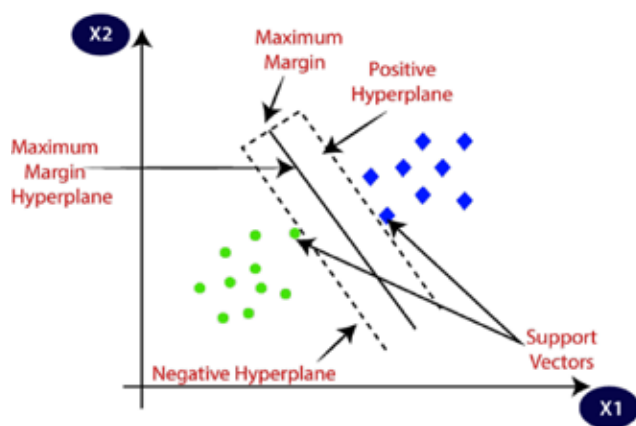


Figure 1. Support Vector Machine Algorithm

A resolution tree is a type of classifier that uses a tree-suchlike structure, where the internal bumps represent characteristics of the data set, branches indicate resolution regulations, and splint bumps represent the final effects [11]. The resolution tree is made up of two manners of bumps- resolution bumps and splint bumps. The resolution bumps are responsible for making opinions and have multitudinous branches, while splint bumps are the final issues of those opinions and don't have farther branches. The resolution is made by assessing the characteristics of a personal data set.

The name resolution tree comes from its commonality to a tree, where the root knot represents the starting point and other branches expand to make a tree structure. To produce the tree, the CART algorithm (Bracket and Retrogression Tree Algorithm) is generally exercised [12]. A resolution tree operates by asking a question and also unyoking into subtrees grounded on the rejoinder given away (yes or no).

Jamil H. et al. [13] has paper described the implementation of a social network model called Green Ship, which has a reputation for providing safe, "green" friends and restricting access to harmful information. Green Ship can help users fight against online bullying and loss of traditional, online, and social networks.

The model recognizes different types of friendships on Facebook and limits damage caused by bad friends through complex communication lines that prioritize privacy and control.

The paper by Rasel, Risul Islam, et al. [14] proposed a model to analyze comments on social networks and determine whether they are offensive or hate speech with over 93% accuracy. The model utilizes Latent Semantic Analysis (LSA) as a feature selection method to reduce input data size, as well as tokenization and TF-IDF for feature extraction. Three machine learning models, including Random Forest, Logistic Regression, and Support Vector Machines (SVMs), were used for analysis and prediction of teasing comments.

Jaideep Yadav et al. [15] proposed a revolutionary pretrained BERT model built by Google researchers that provides contextual and task-specific embeddings. The suggested method employs a deep neural network known as the Transformer as the basic model. The Bert is built on top of a base model and has 12 layers to encode the input data. The data is tokenized and padded appropriately before being fed into the model, which produces the final embeddings. The classifier layer categorizes the embeddings produced by the previous layers and produces the final output accordingly. In compared to earlier models for detecting cyberbullying, they were able to get efficient and stable results using a pre-trained BERT model.

PROPOSED SYSTEM

In this work, cyberbullying detection is resolved as a binary classification problem that recognizes two major's forms of cyberbullying: Hate speech on Twitter and Personal Attacks on Wikipedia and its classification as containing them, is it cyberbullying?

The methodology used for solving the problem which is applied on both the datasets.

A. Twitter Hate Detection

The dataset handed consists of 6935 data points or compliances, each having three columns. The first column, which is the unique identifier, is used to separate each data point from the others. The alternate column contains markers with two possible values 1 or 0. Then, the value 1 indicates that the comment

made is obnoxious, while the value 0 indicates that the comment is non-offensive. The third column is the factual comment made. The main thing of separating the dataset is to identify a system that can distinguish between obnoxious and non-offensive commentary in the most effective way possible. To achieve this, the distance between the two closest points is measured, which is known as the periphery. The Support Vector Machine (SVM) algorithm is a bracket fashion that aims to elect a hyperplane that maximizes the periphery between support vectors in a given dataset. A support vector is a data point that lies closest to the decision boundary.

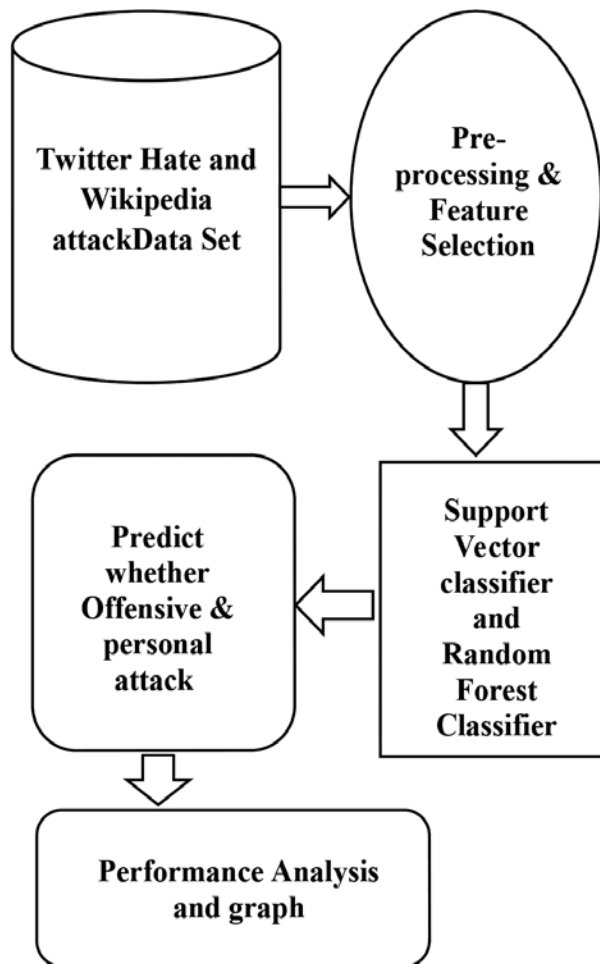


Figure 2: System Architecture

The SVM algorithm finds the largest supplemental hyperplane that can rightly separate the two classes. In the left wing, three hyperplanes are depicted in black, blue, and orange.

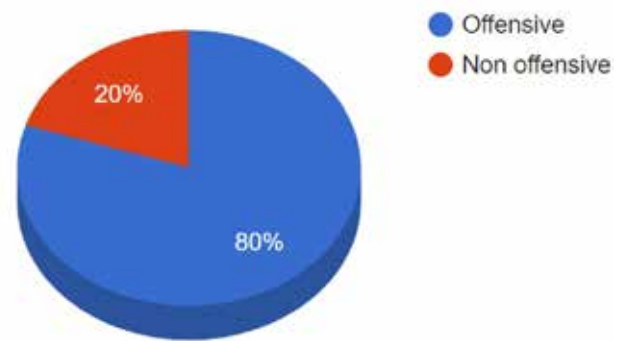


Figure 3. Disrribution of Tweets in Twitter Dataset

The black hyperplane is the optimal choice as it rightly separates the two classes. On the other hand, the blue and orange hyperplanes have significant bracket crimes, and they aren't the stylish choice for separating the dataset. To choose the optimal hyperplane, the SVM algorithm identifies the hyperplane with the topmost distance from the nearest data point. The hyperplane that's furthest down from the data points can rightly classify the test data with lesser delicacy. This hyperplane can effectively separate the two classes and minimize the bracket crimes.

B. Wikipedia Attack

The paragraph describes a dataset that consists of 1445 individual data points, each containing four columns Review Id, Comment, Attack, and the final prognosticated outgrowth. The Comment column contains commentary about Wikipedia titles, while the Attack column specifies whether each comment is a particular attack or a non-personal attack. The process used to classify the dataset is known as the Random Forest algorithm, which works in four ways. First, one data point is aimlessly named from the dataset. Second, a decision tree is erected for the named data point, and a vaticination result is attained from the decision tree. Third, this process is repeated for all data points, performing in a vaticination result for each one. Fourth, the prognosticated outgrowth from each decision tree is used to cast a vote, and the vaticination affect that receives the most votes is named as the final vaticination.

In the Random Forest algorithm, each data point is classified using a decision tree. Decision trees are tree-structured classifiers that divide the dataset into subsets

grounded on answers to questions. Each splint knot of the decision tree represents a result.

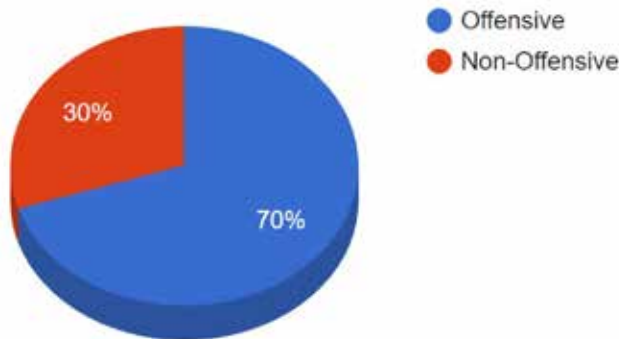


Figure 4: Distribution of Comments for Wikipedia Dataset

The Random Forest algorithm builds multiple decision trees, and each one votes on the prognosticated outgrowth. This process helps ameliorate the delicacy and robustness of the model. The Random Forest algorithm is an extensively used machine literacy algorithm, particularly for bracket and retrogression tasks. It’s known for its high delicacy and robustness, making it a popular choice for colorful operations.

RESULTS

In this work, we aim to detect cyberbullying on social media by extracting tweets containing bullying episodes from the Twitter dataset and associating them with demographic information. We trained two machine learning models, a Support Vector Machine (SVM) and a Random Forest (RF), on the dataset and achieved a 96.10% accuracy when matching the same dataset. The results of the Twitter dataset are shown in Figure 5, while the results of the Wikipedia dataset are shown in Figure 6. The Wikipedia dataset achieved a 68% accuracy on the same dataset. The proposed demonstration yielded improvements of 96.10% and 68% accuracy compared to the Twitter and Wikipedia datasets, respectively, for detecting cyberbullying. We compared the performance of our models to a traditional machine learning model used for the comparison datasets. Although the accuracy of the Wikipedia dataset can be further improved by using an ensemble of algorithms, this may result in longer training times.

We trained both machine learning models on the

dataset and then converted them into pickle files to avoid the need for retraining. Our project can serve as an extension that can be implemented by any social media platform as a backend service for detecting cyberbullying. Based on our results, TF-IDF features outperform Bag of Words and Word2Vec for both SVM and RF models in terms of accuracy and precision for the first dataset. However, for the second dataset, the optimal feature extraction technique varies depending on the model used. For example, TF-IDF with RF has the highest precision, while Word2Vec with SVM has the highest accuracy.

Table 1: Result for Twitter Dataset

Measure	Bag of Words		TF-IDF		Word2VEC	
	SVM	RF	SVM	RF	SVM	RF
Accuracy	0.905	0.913	0.92	0.914	0.89	0.894
Precision	0.935	0.947	0.949	0.949	0.935	0.886

Table 2: Result for Wikipedia Dataset

Measure	Bag of Words		TF-IDF		Word2VEC	
	SVM	RF	SVM	RF	SVM	RF
Accuracy	0.816	0.824	0.82	0.814	0.82	0.823
Precision	0.815	0.817	0.809	0.849	0.710	0.812



Figure 5. Prediction of Tweets whether Offensive or Non-Offensive



Figure 6: Prediction of Comments whether Personal Attack or Non-Personal Attack

CONCLUSION

Online cyberbullying is dangerous and leads to accidents such as suicide and grief. In this way it was possible to control its spread. Therefore, identifying cyberbullying at the social media stage is very important. As more information and better categorized customer data become available about various other types of cyberattacks, the social media net is set to investigate such possibilities in this environment. Bullying can be identified case is accepted. Be ready to boycott any customer trying to participate in the exercise. We examined two types of information organization. Information about hate speech on Twitter and personal attacks on Wikipedia. For disparaging discourse, a characteristic dialect processing procedure using basic machine learning computations has been convincingly demonstrated with over 90% accuracy.

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Development of Digital Bibliotheca using MERN

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ABSTRACT

Nowadays, the demand for progressing knowledge in the software field is essential. This is carried out through books, notes, question papers, and the internet in an institution or college. But the traditional process in the library creates a repetition among the students. With the advancement of technology, the paper presents a web application of an online internet digital library and virtual notes, and papers store. This internet-based (Digital Bibliotheca) web application can be accessed throughout the institute by the students, departmental faculties, and admin section. This system is an extremely user-friendly application. Students can search books, checks the availability of books, and calculate fine over the books in real-time. They also get an alert notification on book reissues and book returns. This system helps to download the notes and question papers from the database. The above system is completely developed in MERN technology. MongoDB for the database, with backend reason, Node.JS and Express the course, and React. JS for the frontend UI-UX part of the website. As we get the result of all the web pages like search book, create book, create notes and all. Also, the project has three types of dashboard each user it depends on which type of user it is.

KEYWORDS : *Web Application, MERN, database, UI-UX, backend.*

INTRODUCTION

A library place is a large assortment of books and sources are accessible, which include get-at-able from the users. It exaggerates the intellectual and psychosocial dispersion between students. Guide students to express different points of view. This information helps the learner perform effectively in both academics and the improvement of their own skills. The need to create a method to transform the conventional bookstore structure into an online one was brought on by technological advancement. Participants must physically input information upon receiving the materials. Therefore, we present a system called Digital Bibliotheca. College students can access previous year's sample papers and question papers using Digital Bibliotheca, a web-based application. Along with that, it also provides study materials categorized into departmental, semester, and subject-wise. Through this web application, students can also access exam schedules, syllabuses, and class schedules.

Student-specific requirements will be considered when designing this system.

The following tools were utilized when developing specific components of the web programmed for the Digital Bibliotheca: The core functionality of the application is handled by Express component and Node.JS, the database is handled by MongoDB, and the frontend is handled by React. JavaScript is used by Node.JS. A structure for building server-side applications that provides a variety of JavaScript components to streamline the creation of web applications. A group of components that are used as required form the foundation of Node.JS. Along with to the fundamental sections, there's additionally a public registry of customized by users' components for various applications [1]. The Express module is the one that is used the most frequently when creating Node.JS apps. Considering the Express section allows quicker creation of web applications, it was also utilized in the creation of this information system [2]. A database that uses NoSQL is MongoDB, That NoSQL is an acronym

for Not Only SQL, which refers to a class of databases that do not adhere to traditional database concepts. NoSQL databases can be categorized based on the sort or manner in which they keep data, and the MongoDB database is a member of the class of NoSQL databases built on the document model. Actually, this just implies that documents are used to examine and keep data items. Documents have a layout akin to that the group is a set of documents having an identical purpose that are in the JavaScript Object Notation (JSON) standard [3]. The pace of the Internet's current growth is beyond comprehension.

A crucial aspect of our lives has been the network. This new business model progressively becomes a part of people's lives as the Internet develops, their purchasing patterns change, and their way of life morphs. People can shop at various online malls and find the most affordable goods without having to leave their homes while still having plenty of autonomy. People can discover the products they need through orders, and they can promptly receive the items they purchased. Customers and producers can both benefit tremendously from this new business model's time and labor savings, which also significantly lowers the risk associated with inventory. Manufacturers are able to acquire and create products based on the demands of the consumer, and this was known as manufacturing and buying that was done on demand, which significantly increased efficiency [4].

The work presents a concept for an online bookstore system, which is a web-based technology for an online marketplace for electronic goods. Users can purchase more books as needed thanks to the ease of purchasing at online book stores. Without leaving their homes, they can benefit from the speed and convenience of books ordered from an internet shop. The system provides standard features for online book purchasing in the forefront, and system administration in the background. It can provide ease for users' consumption as well as for administrators, who can be prompted to see the collection of books that have been sold and are available for timely purchase [5]. The customer doesn't need to go to a book shop when using the online book store initiative to buy books. The project's goal is to create an online book store system that is fully working and enables people to purchase books online. The user can decide and buy one or more books online using

the pay on delivery option after the selected books are presented in tabular format. Customers have the option to purchase online through a computer browser thanks to the project's online book store [6].

RELATED WORK

Kozma Nina and Dusan Krstic [7] studied the details of the system architecture for book sellers that supports the creation of tasking-tier web-based applications applying certain technologies. It explains how they are implemented and how they work, along with the implementation's benefits and drawbacks. It is designed to support a bookstore, and it supports registering as a client, purchasing products via the internet payment, and online reviews of selected books.

Sivasakthi, T., et al. [8] proposes the voters can securely cast their votes online thanks to this web application. A person chooses a likeable candidate to lead the country by casting a ballot. The main goal of the suggested in the present era of advanced the internet, the system for voting on the internet has to be enabled by a web-based application. because it saves time, speeds up manual work, and boosts security. The online voting software is a website that functions online.

In Reference [6], the work proposed by G. Baskaran, et al. The need for handyman services in the area has recently grown, making it difficult to find a labor offline at a reasonable price and at the right time. This website makes it easier to schedule labor at the right time and price, with a verified and approved login for the customer, the handyman, and the admin. A website built using React JS is quicker, more secure, efficient, and SEO-friendly, while MongoDB is a database that is simple to scale-out, making data management easier.

Kalwani, Bharat, Ambesh Sharma, and Sohan Lal Gupta. [10] focuses on an Intranet that seeks to all tiers of authority inside a company that provide information dissemination. This web application may be utilized as a data management application for the colleges.

The Proposed work by Wadagave, Rashmee, et al. [11], It is possible that the primary goal of this work is to computerize and portable the method of controlling information about pupils in the lab. By centrally administering the entire system, the internet-based application fills the distance among the final customer

and the mobile device arranging controller. This web-based tool is used by multiple divisions to schedule separate procedures that don't interact with one another.

Chauhan, Amit Shersingh, et al. [12] presents that Nowadays, more people are using computers and the internet, making it easier to do things online. This website application helps users host cars and make money from renting them out. Only those who have been verified are able to make rental vehicle reservations and a driver's permit is used for authentication.

Vasanthi, D., et al [13], demonstrate a driving permit is used to verify which will enable homemakers employing a driver's license for confirmation. It will be cross-platform due to developments in web services, making it accessible both on computer platforms and on internet-connected mobile devices. The technology stack for this research project is MERN (MongoDB), Express-JS (server), ReactJS (front-end programming language), and NodeJS (full programming environment). Amazon cloud storage is used to save menu item photographs.

PROPOSED METHODOLOGY

A student's profile is forwarded to the staff for approval each time he or she registers an account on the system. When a student enrolls at a university, the staff verifies that they are genuinely enrolled. Hence, the staff notifies the user's email address of the confirmation email. The pupil will be sent to his or her profile page. The learner will be brought to this page after each login. It conveys the essence of the profile. Any alerts will be displayed here if there are any. The Administrator makes the professor's profile. Professors' classes and subjects are also assigned by the Admin. Paper review and the papers that the professor submits make up their profile on the website. A professor's profile allows for the addition or modification of attendance. From the profile, uploads may also be made. Also, when needed, the professor has the option of deleting the files. For the creation of separate-page programmed with graphic interfaces for users, developers use the well-known, open-source JavaScript framework React. It was created by the social media site, an American-based networking website, a part of the business social Platforms, in order for unload the servers, which were weighed down by a significant volume of requests coming from many computers throughout the globe. The construction

of online apps that enable data modification is made possible by React characteristics, eliminating the requirement to completely reload the page. This idea enables quick, straight forward, and scalable web apps built with React.

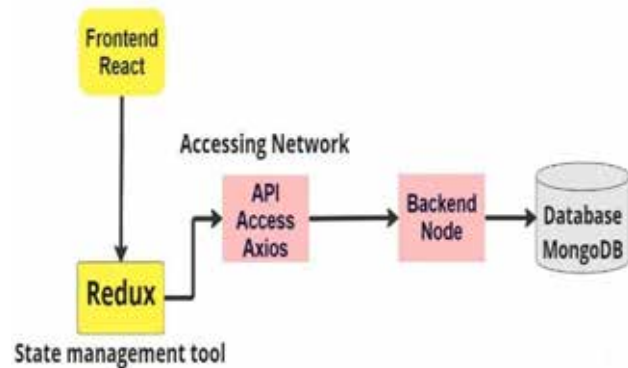


Fig. 1. Website working flow diagram

The front-end structure of the online polling web application was created using React JS, the Bootstrap framework HTML and CSS, Redux, JWT (a package of JSON Web Tokens used for identification), Axios, and JavaScript. Node JS and Express (an architecture for Node JS) are the technologies preferred in the back-end. All of the data for this application was kept in a database called MongoDB.

REACT.JS - It is a JavaScript library for the front end that is free to used to create UI elements. Reloading can be sped up since it renders faster because to the virtual DOM. React Js is used by many real-time products, including Facebook and Netflix.

NODE JS - It's a server-side, open-source platform for back-end development. Because of the asynchronous data flow, one piece one output of code can be produced without waiting for another. It never buffers any data. It generates great presentation with good ascendable.

MONGODB - A document-oriented NoSQL database that is open-source is used to store a lot of data. The papers are managed via a collection. It is a database without a schema. Because it saves data in JSON format, it is more adaptable. To make data access simpler, it has a key-value system.

REACT-REDUX - Redux is a state management tool used by React. Even with dependencies, it is lightweight.

The whole application's state is saved in a store with the aid of Redux, and any component may contact with whatever condition it requires from this retailer. It was employed for managing the situation of the world. to distribute the info to all UI elements.

AXIOS - The package comes from a third party called AXIOS that serves as a bridge among the client and the host and is too utilised via the user interface with quickly interact to APIs. It is a JavaScript module that enables HTTP requests to be made between Node JS and React.

JWT - Data transmission and authentication are both done via JSON Web Tokens. NODE-MAILER - Through the mail, it is utilised to notify users and employees.

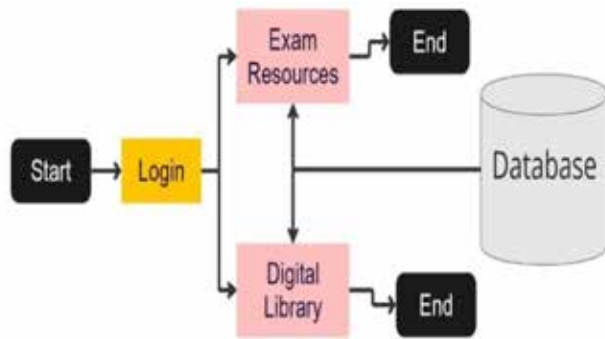


Fig. 2. System Architecture

The main goals of the web application are to aid students in their academic preparation and to give them access to the necessary tools for studying. For the project, we accomplished this by developing several modules. For the user to see or download study material, they only need to log into their accounts. The aforementioned design perfectly captures how the software is used and how it is used in its entirety. It also demonstrates the operation.

The technologies we used to create this web app are react.js for the front end of the application, Express.js and node.js for handling backend APIs, and the MongoDB database. The user will first go to our web application. After this, the user needs to log in to our portal. If the user is new, then he/she needs to register first and then log in. Here, we have two different logins for the user and admin. After login, the user will navigate to the main dashboard. The user can view different

study materials provided by the faculty, also the user can search for the books in the library to issue from.

The user can also reissue the book. The user can filter out the books according to the book title, book author, publisher, etc. The user will first go to our web application. After this, user need to login on our portal. If user is new, then he/she needs to register first then login. If the user is a student, then he/she will get two options Digital Library and College Archive. Students can share their questions if they have doubts otherwise can view other's doubts. On Digital Library page, user will get to see two options i.e., Issue and Reissue books.

Students can search and filter books as per their requirement and place it to issue. Also. User can view fine collected. On College Archive page, user will get the materials to prepare for exam that is uploaded by the faculties. In case of admin, after successful login he/she will also get two tabs Digital Library and College Archive. Here, admin can process the issue and reissue of books also has access to upload the study material.

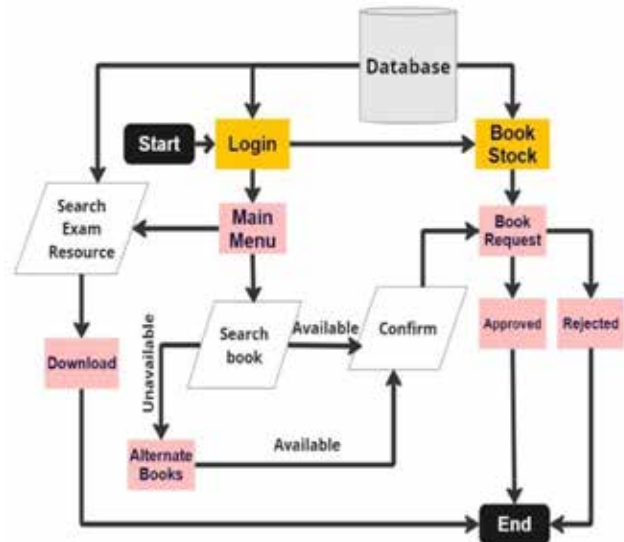


Fig. 3. Flowchart of Application

The MERN stack technologies were used to construct the web application. A MongoDB database serves as the foundational layer, followed by an internet-based application built on the Node.JS module with the Express platform, and a client web application created with the React.JS. The programmed is presented to the end-user as a distinct and integrated whole even if the

software the built environment's three tiers are broken down into separate sections. The client web application is the only point of contact for the user, and it relays queries made of the web server programmed, which interacts with the database. The following workstation configurations as well as technologies must be set up before beginning focusing on the program's source code:

1. Visual Studio Code (VS CODE) - a tool created by the American corporation Windows for creating and modifying programmed code.
2. Node.JS – It is a website development environment for servers.
3. MongoDB Compass –It is an interactive user experience that is utilized to handle data and communicate to databases.

It is feasible to begin constructing a web application once all of the aforementioned environments and tools have been properly setup on the computer and the necessary folders have been established. The two components mentioned above, customer management and administrator management, are part of the online bookshop system's functionality, which are every categorized by a distinct user group. There are numerous submodules for each module. The major components of client management are the subscribe a particular module, purchasing bring component purchase the administration section, and so forth. The purchasing cart feature allows for the addition, deletion, and modification of books. Once it was completed, a fresh order was created. Individuals can remove and change orders in the order administration module. The group of user interfaces comprises of.

- To log into their separate accounts, users are presented with the Student Information Management system interface.
- Save and publish the different data stored in the fields in order to add and change details. For example, you might add fields like "Notice" and "Notes to a detail and specify their corresponding weights in the detail.
- As long as their respective accounts let it, students may examine the published data. By the use of a

network, communication will be based on a request-response paradigm, in which the server answers to the client's request after the client has made one. The entire system is split into two components.

Digital Library and College Archive are the two modules. Both modules are having different functionalities to perform. Our project intends to provide students with appropriate resources for academic preparations. To update students about the previous year's question pattern asked in exams, syllabus, and important topics.

1) USER

User has the ability to view and download the study material. User can do the following activities to visit and get benefits from our portal.

- a. User Authentication – Sign up and login
- b. Create User – There is three types of users like faculties, users and admin.
- c. Digital Library – Search and issue books and calculate Fine over the book.
- d. College Archive – view or download study materials

2) ADMIN

Admin can do the following activities by using our web application.

- a. Admin Authentication – Sign up and login
- b. Digital Library – issue or reissue books keep the database updated
- c. Study material – upload study materials

The database may corrupt at whenever as an outcome of a malware or an error in the computer system. Consequently, it is necessary to take a database backup. Internet-connected PC with 1GB RAM and a 24GB hard drive serves as the server. Client-side: Any home computer that can run any Windows or X-windows environment and has a mouse is suitable. As a database on the server, MongoDB is employed. Validation is performed using Express JS and Node.JS. Software called AngularJS is utilised on the client side to collect user input. We have developed an API to open up our product to the public. The online paper correction

module is user-developable, so with the appropriate expertise, we can advance towards our goal of digitising all educational institutions. Moreover, this gives the user more freedom because they may utilise the API and combine it with any compatible system to create a completely new system, giving them more control.

RESULT

This works helps to reduce manual work. It consistently delivers correct information. Mistakes may be minimized. Information accumulated throughout the years can be preserved and retrieved at any time. The information kept in the repository aids management in making wise judgements. All interested parties, teachers, and administration may quickly obtain the information they need. In colleges this structure is crucial.

All Books

Books List

#	Book Name	Subject	Author	Fine on delayed	Is Available	Borrow
1	Electronic Components	Electronic Devices and Crircuit	Manoj Yadav	0	No	Not Available
2	Electronic Components	Electronic Devices and Crircuit	Manoj Yadav	0	Yes	Request Book

(a)

User

Enter Users details

User Information

Name

Email address

Password

Is User

Is Teacher

(b)

Study Material

Enter study material details

Study Material Information

Title

Semester

Subject

File

(c)

Users

Users List

#	Name	Email	Is User	Is Teacher	Created At	Upda
1	admin	admin@gmail.com	No	No	2023-03-06T08:27:23.873Z	2023-06T0E
2	user	user@gmail.com	No	No	2023-03-09T09:27:07.109Z	2023-09T0S
3	teacher	teacher@gmail.com	No	Yes	2023-03-09T09:30:16.406Z	2023-09T0S
4	Yash Hatekar	hatekaryash11@gmail.com	No	No	2023-03-20T07:39:44.530Z	2023-20T07

(d)

Fig 4. (a) All Books (b) Create User (c) Create Study Material (d) All Users

The Fig. 4 (a) Represents the All Books Present in the Web Application or Availability of the Books. By this page users can send the Book Request to the Librarian. In Fig. 4 (b) Admin can create the user and track the requested book. Fig. 4 (c) represent the Faculty member can create study material as per semester or subject and upload study material. The Fig. 4 (d) This page says that the admin can check and see all the users.

CONCLUSION

This work presents the step-by-step procedure for creating web applications using the MERN software suite. With the use of this program, college students may now access their academic materials and subject-specific literature on a single platform in a simpler, quicker, and easier manner. Application features include student login, evaluation, storage, library management, and server-side alterations. Also, it can offer prior semester papers, results, notes, a semester’s syllabus,

etc. This system offers dependability, time savings, and straightforward control. This app allows students to access information about their grades and curriculum. We draw the conclusion that our web application enables students to quickly access the greatest resources. Since information systems are currently regarded as one of an institution's most valuable resources, the evolution of this web application and others like it focus to make such a computer system more accessible to all sized institutions while also bringing with it a large range of chance or suitable time and advantages.

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IoT based Cold Storage Monitoring & Controlling System

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ABSTRACT

Tricholoma matsutake (T. matsutake), popularly known as “the king of bacteria,” is a very valuable fungus. However, because to its corruptibility, it is also incredibly challenging to carry. As a result, it is essential and necessary to follow up on and track T. matsutake’s quality and safety along the chain of refrigeration. Variations in the refrigeration chain are the basis for the environmental criteria used to determine the security of T. matsutake. On the LCD, the DHT 11 Sensor and the MQ3 Sensors were utilised to monitor the relative humidity, temperature, and proportion of gas present in cold storage. Environmental characteristics such as moisture, temperature, and gas level may be remotely monitored and changed via a web application.

KEYWORDS : Cold storage, IoT (Internet of Things), DHT sensor, MQ3 gas sensor.

INTRODUCTION

Implementing an IoT solution for cold storage facilities aids in the monitoring of crucial parameters and corrects them when they deviate from predetermined levels. This lessens the risk of food decay. Overall, the adoption of an Internet of Things- based cold storage monitoring and regulating system results in the best possible use of resources and space. It helps to monitor and regulate light intensity in accordance with variations in daylight, minimise waste, track device usage patterns and power consumption, and detect anomalies inside the facility. Businesses can greatly benefit from and increase profitability by using an IoT- enabled monitoring solution. The A warehouse is a type of commercial structure where items are stored.

Manufacturers, importers, exporters, wholesalers, transportation businesses, customs, and so on. All use warehouses. To store a significant volume of fruits and vegetables, Strauss Frito-Lay employs numerous warehouses. In order to store certain fruits and vegetables properly, a specific temperature must be maintained (mostly for potatoes). When the compressor or chiller is turned on, the air’s relative humidity (RH) begins to drop. A Wireless Sensor Node based system that can monitor different areas of the warehouse is suggested as a solution to these problems. The data is

then sent to the warehouse’s core hub, where it will be collected and pushed onto the cloud. The proposed system describes that nowadays, the Internet of Things (IoT) is a technology that is being used more and more. It is frequently used to describe the expanding network of interconnected objects, or “things,” that can communicate over a network with limited capacity. The automotive sector, administration, medical care, the electrical grid, and urban planning are all examples of this are just a few of the industries that are using IoT.

In 2022, authors of IoT-based Fruit Cold Storage Monitoring Controller Development research suggest an IoT-based monitoring system that displays the maintenance status in cold chain plants ESP microcontroller is used to collect environmental data from DHT 11 sensors, such as temperature and

humidity, and cloud server module is used to deliver communication data [1]. The author of this article suggested a system that allows the end-to-end responsibility and visibility along the full product value chain. To get to their destination, perishable commodities frequently need to travel thousands of kilometres via land, air, and marine transportation methods [2]. This study introduces a low-cost, autonomous cold storage monitoring and regulating system based on the Internet of Things. The suggested system consists of a sensor

that can measure both temperature and humidity, a microcontroller, a cooling fan to reduce the temperature, a power supply module based on a DC-DC step down converter, and an app to track and control the cold storage system's temperature [3]. The author of this study suggested that by creating a powered by solar energy cold storage system. The system employs a form of vapour compressive refrigerated loop (VCR), featuring 3 evaporation units operating at different temperatures and one compressor.[4]. The author of this study used technologies used in Temperature Monitoring and Control in the Cold Chain proposes is an analysis of the technologies used to track and regulate the cold chain's total temperature of perishable commodities. It has been demonstrated that the application of management of cold chain systems reduces wasted food in processes and saves time, energy, and resources. [5].

In order to prevent food goods from rotting due to an increase in temperature and humidity, the author of this research suggests adopting Wireless Sensor Networks (WSNs) are a popular technology used for continuous monitoring of temperature and humidity in cold storage warehouses. WSNs consist of a huge number of widely dispersed tiny, inexpensive sensor nodes throughout the warehouse.[6]. The author in study suggested that by using elements of the ZigBee wireless sensor network, also known as an WSN, and the real cold storage scenario, which includes Software as well as hardware architecture for the ZigBee network. Cluster Tree, the ZigBee WSN networking technology, has been improved; neighbour table information is integrated into the Cluster Tree algorithm, and the selection of nodes in the neighbouring table is explored; this is advantageous in finding an ideal path and reducing data transmission delay [7]. The author of this study suggested that even though there is a large potential for growing production, the absence of suitable cold storage and cold chain facilities is becoming a key impediment in realizing the promise. This can be avoided by using a wireless sensor network-based cold storage system [8]. This article suggests a temperature tracking system method, while additional technical benefits are fully employed by this application, along with Radio Frequency Identification, or RFID, tags, sensors for temperature, and the Global Positioning System (GPS) systems, all of which may be used in refrigeration chain temperature monitoring

structures. The technology may monitor the precise position and humidity of cold chain items in real-time to assure the quality of such products along the supply chain. [9]. The main causes of this are difficulties with post-production and the ineffectiveness of cold storage facilities. Potatoes are the fourth- largest crop produced in India [10]. The author of this page is interested in analysing written articles and project reports on losses after harvest in nations that are developing, as well as collecting as many examples of actual measurements (i.e., testing of changes in thereby affecting their quality ratings, or value at the market) as possible. Many of the publications that have been published incorporate the author(s)' general estimates of losses following harvest and/or refer to loss figures or observations published by other authors [11]. According to the author of this article, reducing food waste benefits both people and the environment by enhancing the availability of food, tackling climate change, saving money, and lowering demands on land, water, biodiversity, and waste management systems. However, this potential has been terribly underutilised to far. This can be remedied using an automated preservation cold storage system [12]. This article's author presents technology for the continuous regulation of the ambient temperature in chilled food chains. Temperature tracking devices based on RFID, or radio frequency identification, and smart tags, including time temperature indicators (TTIs), are examples of this. Finally, ideas that demonstrate how temperature monitoring equipment may be coupled with product features to improve the safety and quality of food are provided. [13].

METHODOLOGY

Proposed System

The capabilities of the Internet of Things determine how the project is carried out. To make this idea a reality, two structures are required: a sensing entity that collects data from the environment and a cloud service that saves the data. We use a network of linked sensors to collect data from the cold chain and upload it to the cloud, where it is accessible from any place. The monitoring system is made up of two more components. One is used to monitor the facilities' cold storage conditions, and the other is used to monitor logistics. The subsystems are built on top of the NodeMCU prototype platform. Two

of the system’s primary functions are monitoring the environment’s temperature and humidity as well as recording the arrival and departure of commodities. The three monitoring staff members receive data from facilities in several ways on the cloud: temperature data is sent there, where it can be accessed on a website, and inventory data is stored there. Each wireless sensor node delivers a live temperature reading to the web server on a regular basis, which updates the information in a central database. Using an established web server and interface, users may continuously monitor the functionality of any appliance from any location at any time. We’re using the NodeMCU ESP controller for this, an open-source electrical platform with an easy-to-use ESP12 Wi-Fi module built in. It recognises its environment by gathering information from sensors. Based on the ESP12, the NodeMCU microcontroller board has a 3.3v power source, 8-bit, 4 kb of memory, and a 16 MHz clock frequency. The accessible integrated development environment and the Arduino programming language are used to create the software. We are using a DHT temperature sensor, a digital sensor that can be set up on the controller’s digital pin.

As depicted in the diagram (Fig.1), the DHT11 temperature and humidity sensor is what we will be using for this project. NodeMCU has been coded to use it to determine the cold storage’s temperature. When the temperature rises above the predetermined level, For monitoring with reference to time and date as well as managing Gas valves the data will be kept on a cloud server.

Table 1: Components Used

List of Hardware and Software Used			
Sr. No	Name	Description	Quantity
	NodeMCU	Having an ESP8266 module on it, which we will be programming.	01
	ESP8266	Highly integrated Wi-Fi SoC.	01
	Relay	An electrically operated switch.	As per Requirement
	DHT11	Temperature and Humidity Sensor	Requirement

	MQ3	Gas Level Detection	As per Requirement
	LCD (16x2)	Display 16 characters per line	As per Requirement
	Arduino IDE	connects to the Arduino hardware to upload programs and communicate with them.	As per Requirement

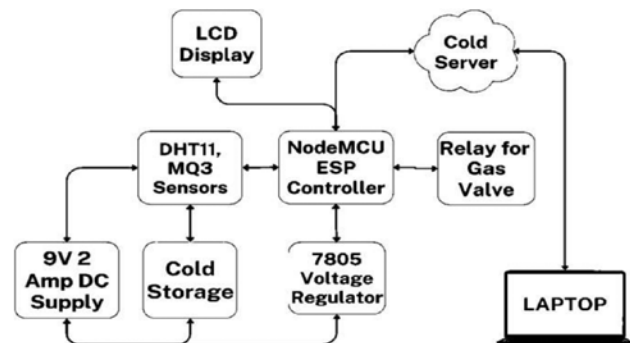


Fig. 1. Block Diagram Cold Storage Monitoring and Controlling System

Master-Slave Configuration

The master/slave communication model is a common hardware communication protocol that allows for unidirectional control of one or more devices by a single device. In this model, one device (the “master”) is responsible for initiating communication with one or more other devices (the “slaves”), which can then respond to commands or requests from the master. In the world of electrical hardware, this is widely used, with one item acting as the controller and every other device acting as the one being controlled. In the master/slave paradigm of asymmetric communication or control, a single device or process (the “master”) is responsible for directing and controlling one or more other devices or processes (the “slaves”).

Among the many IEEE 802 networking standards that are often utilised in this application are Ethernet, Wi-Fi, and Bluetooth. For controlling purposes, this MAC Unit box is placed away from the warehouses, and the data accessing it is made possible via the firm’s network, which is connected to the chamber also has a slave box where all of the sensors are connected. This slave box features an LCD screen with an i2c interface

that displays the various parameters being tracked. In each chamber, the air conditioner, exhausts, and gas valves are used to regulate these conditions. By using the MAC addresses of the MAC units, every slave box is connected to the master box.

A hardware distinctive number known as a MAC Address can be utilised for recognising every machine on a network. The six sets of two hexadecimal digits that make up a MAC address are separated by colons, for instance: 30:AE:A4:07:0D:64. It obtained by a Arduino code. Although manufacturers are responsible for assigning MAC Addresses, you may also offer your board a unique one. The board will, however, reset every time and revert to its initial MAC address. The code to set a unique MAC Address must thus be included in each drawing. A media access control address (MAC address) is assigned to a network interface controller (NIC), In communications within a network segment, it corporate website. On this web page all the parameters and chambers will be shown and can be controlled remotely.

Software Implementation

In the absence of all of the title's components, Arduino code is a specific type of code that is used to program microcontrollers such as the Arduino board. It is a programming language that is based on C/C++, and it includes specific libraries and functions that are designed to interact with the Arduino hardware in the classic programming C language. To save all of the present files, hit the 'merge' button. Arduino.c will be saved within the 'lib/build' indication, and the make file, which is located inside the lib library, will be called. This will create duplicates of the Arduino.c file with the 'lib' temp adds' string.inc 'as its origin. This capability converts the Arduino code that is writing code into a proper programming file named prog.c. Following that, we must copy all files in 'lib/temp' to the main directory. That file adds syntax to the previously written code. To use NodeMCU, we must first upload a programme to the device using a special IDE. The NodeMCU application is developed using the Arduino IDE (Integrated Development Environment) is a popular software tool used for creating and uploading code to the Arduino microcontroller. It provides a user-

friendly interface for writing, testing, and uploading code, making it a popular choice for hobbyists and professionals alike. The advantage of IOT technology is that it allows us to access data from everywhere that is contained in sensors or servers. We need massive databases, such cloud storage, for maintaining this information, which calls for the use of cloud servers, Oracle storage that is distributed, and HTTP servers. Oracle or MySQL are required for database operations. The PHP script is used to link the server and database.

RESULT

All the parameters such as temperature level, humidity gas level respectively present in the warehouse chambers are obtained. These parameters are monitored and controlled remotely with the help of an interactive and responsive webpage on the company server which relates to a cloud database. These stored values of temperature, humidity, gas level respectively helps us comparing the different environment conditions in different warehouse chambers.

This paper proposes an automated cold chain tracking framework that uses the Internet of Things to give a better and enhanced approach to monitor the chain. The 000webhost sensor cloud, where data is posted and monitored, has been interfaced with a wireless sensor network built using NodeMCU. Microcontroller frameworks and hardware concepts for interfacing to internet connections and 000web 2.0 technologies have enabled the integration. The connection provides several benefits as well as advantages, elevating surveillance to an entirely different level. This approach not only solves a problem, but it also provides a foundation for future initiatives including IoT automation.



Fig. 3. Home Page of Website

Fig. 3 Shows the Interface of Cold Storage of website in which there are four chambers and each chamber having three panels.

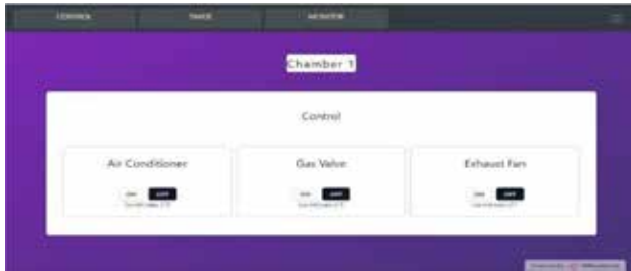


Fig. 4. Control Panel

Fig. 4 Shows the Control Panel of the website where we control Air Conditioner, Gas Valve and Exhaust Fan.

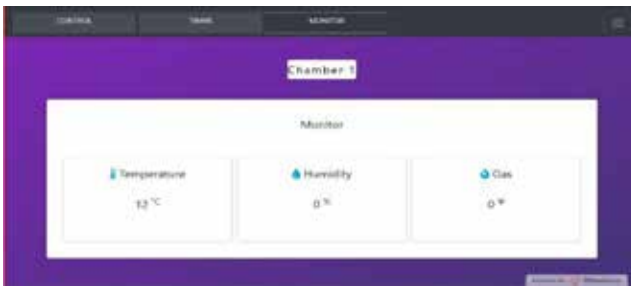


Fig. 5. Monitor Panel

Fig. 5 Shows the Monitor Panel of the website where we monitor Temperature, Humidity and Gas.

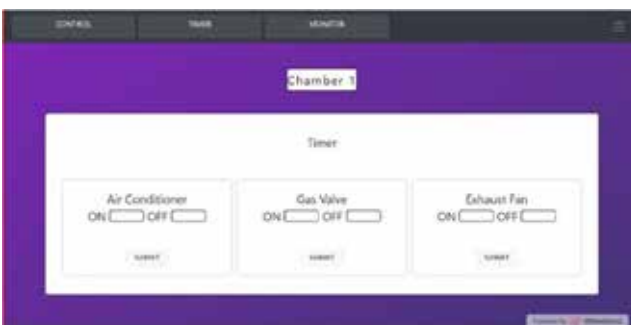


Fig. 6. Timer Panel

Fig. 6 Shows the Timer Panel of the website where we can give the timing for ON/OFF the valve.

CONCLUSION

The system has successfully passed tests at various temperatures. Gas level is satisfactorily managed by the compressor for a variety of temperature thresholds. The Transmitter node transmits the temperature and humidity

readings to the cloud. Receiving the monitored data from various sensor nodes, the receiver node records it in the database. The created webpage displays the stored values. Comparing is used to regulate temperature. The webpage also displays the current temperature and humidity readings.

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Emotion-based Music Recommender using AI

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ABSTRACT

In recent years, researchers have shown a growing interest in emotion detection using computer vision, leading to the development of numerous algorithms and applications. With the increasing number of songs available for listening each day, it can be challenging for individuals to choose a suitable song based on their mood. To address this issue, our recommended system detects the user's emotions and suggests music accordingly. The system was implemented using OpenCV, MediaPipe, and ANN. Our system has achieved an accuracy of 85% in detecting the Happy emotion

KEYWORDS : Face expression, Emotion detection, Music recommendation, ANN model

INTRODUCTION

Recognizing human's emotion is a key feature of artificial intelligence which becomes important for automating a variety of operations that are more time-consuming to be executed manually. For a variety of applications, evaluating a person's mental state based on their emotional outward manifestations requires making successful automated decisions that are best suited to the individual in question. One significant application of this would be in the entertainment industry, in order to make recommendations to a person depending on their current state of mind. We look into this from the perspective of making individualised music recommendations for a person based on their emotional state as expressed by their facial expressions.

Most music lovers have significant music collections that are typically arranged primarily by criteria like artist, album, genre, and amount of plays. Users are therefore left with the onerous task of making playlists based on moods or categorising the music according to the emotions the songs evoke, which is significantly more crucial to the listening experience than it usually appears to be. Larger music collections only make this work more difficult; therefore, automating the process would free up many users time from having to perform the same activity manually while also enhancing their

overall listening experience.



Fig. 1. Types of Emotions

Vicky Ket.al [1] employ the CNN algorithm to identify emotions and the HAAR cascade method to identify faces. Principal Component Analysis (PCA) and the Viola-Jonze method are used to create the recommender system. The suggested system was successfully implemented in MATLAB (R2018a) [2] by the authors. Vijay S et.al [3] suggested utilizing a deep learning method to build playlists based on a user's past music selections and present mood. Kevin P et.al [4] use emotions to generate a playlist, they want to enhance the user's current mood and song preferences to offer a more individualized experience grow more. Shlok G et.al [5] introduced EMP, a cross-platform music player that

makes music recommendations depending on the user's current mood. Sanskar L et.al [6] proposed a system that identifies user emotions and creates a custom Spotify playlist. It uses MTCNN to extract facial features from photos. A music recommendation technique [7] uses a webcam to capture the user's image and a grayscale transformation to help the face recognition classifier work better. The author suggested a system [8] that records real-time images using a webcam, identifies emotions using HAAR Cascade and LBP for feature extraction, and recommends a Bollywood song from a database based on the identified emotion. CNN is used for facial recognition. Shantha S et.al [9] proposed a system that captures real-time images using a webcam and extracts facial features using AAM. Computer vision and machine learning techniques are integrated to detect facial emotions, and music is played automatically based on the detected emotion. The authors in Ref [10] used the C-K dataset with 593 facial action-coded sequences and the HELEN dataset with around 200 images to train the networks. They developed the module using web technologies such as PHP, MySQL, HTML, CSS, and JavaScript. The author in Ref[11] a technique that divides songs into four mood categories, analyzes the user's facial expressions to determine their mood, and then combines the two to create a personalized playlist for the user. They classified music in two ways. KNN (k-nearest neighbor method) and SVM (Support Vector Machine) and MLP (Multilayer perceptron) are used in model training. Compared to the second strategy, they achieved only 60% accuracy compared to 71.6 accuracy for the first approach. Deger Ayataet.al[12] proposed a system that uses wearable physiological sensors, such as PPG and GSR, to classify a user's emotions. The author in Ref[13] proposed a method to identify a user's personality traits, moods, and emotions by analyzing their behavior in a social setting, based on established psychological research. To achieve more accurate and adaptable outcomes, they incorporated the user's personalities and moods into a content-based filtering technique. The paper [14] presents a mobile app named "Emo-Player" that helps users select music that fits their moods. The app uses the camera on an Android device to capture a picture of the user's face and determine their emotional state. Emo-Player then creates a playlist of songs that can enhance the user's mood. The paper

[15] describes a system that recommends songs to users based on their emotional state, using computer vision technology to analyze facial expressions and chatbot interactions to detect emotions.

PROPOSED METHODOLOGY

An Emotion-based music recommendation system is a web application that uses real-time emotion recognition. It consists of three primary modules:

- i. Face Capture.
- ii. Emotion Detection.
- iii. Music Recommendation

Face capture: Initially, the Python library OpenCV is taken into consideration for face capture. PyCharm IDE is used for coding. For face detection, a media pipe is used. MediaPipe performs tasks such as object detection, face detection, hand tracking, and pose estimation.

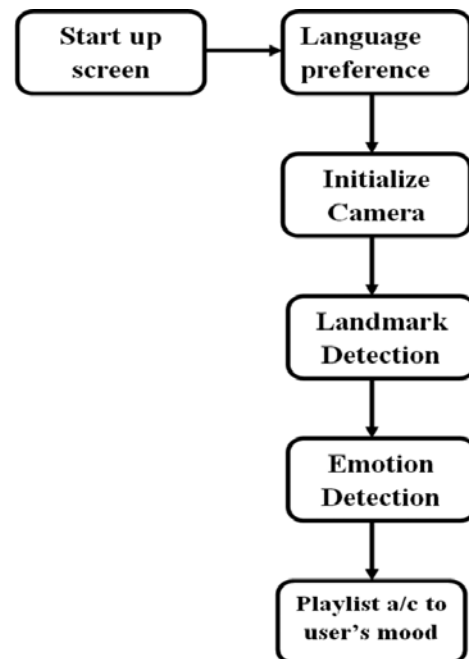


Fig 2. Flow Diagram of the Proposed System

Emotion detection: The identification of the emotion on the face, such as surprise, happy, anger, sad, rocking, and neutral. The MediaPipe Holistic module is used to extract facial and hand landmarks from video frames captured by the webcam. The facial and hand landmark coordinates are normalized with respect to a reference point, and then stored in a list for each video frame.

The landmarks of the face detected by the Mediapipe Holistic model include:

Nose tip, Left eye (inner and outer corners), Right eye (inner and outer corners), Left ear (top, bottom, front), Right ear (top, bottom, front), Left mouth corner, Right mouth corner, Chin, Left cheek (centre and cheekbone), Right cheek (centre and cheekbone).



Fig. 3. Emotion Detection

These landmarks are identified by the model using deep neural networks trained on a large dataset of images and videos. By tracking the positions of these landmarks in a video stream, it is possible to detect and track facial expressions and movements, which can then be used to infer the emotional state of the person being analyzed. The ANN architectural model is used for image classification. Here, for one emotion, it contains 100 frames i.e., according to six emotions, it has a total of 600 frames in it.

Music Recommendation: According to our research, a dataset of songs was categorized based on current mood, but there were only a limited number of songs in it, so we moved to YouTube to expand our selection. The song mp4 is available on YouTube and was linked in real-time based on user mood and language preferences.

RESULT

In our work, the music recommendation model is based on the emotions that are captured in real-time. The process of detecting emotions in our work is illustrated in Figure 3. This system presents an emotion-based

(expressions) recognition system so that it can detect emotions, and a music playlist will be recommended accordingly.

This system basically works on different modules like Face capture, Emotion detection, and Music recommendation. In our system, we utilize neural networks throughout the entire process. Our system is detecting six emotions which are Happy, Sad, Angry, Neutral, Surprise, and Rocking. As compared to the previous papers our system accuracy between 70 and 80 percent.

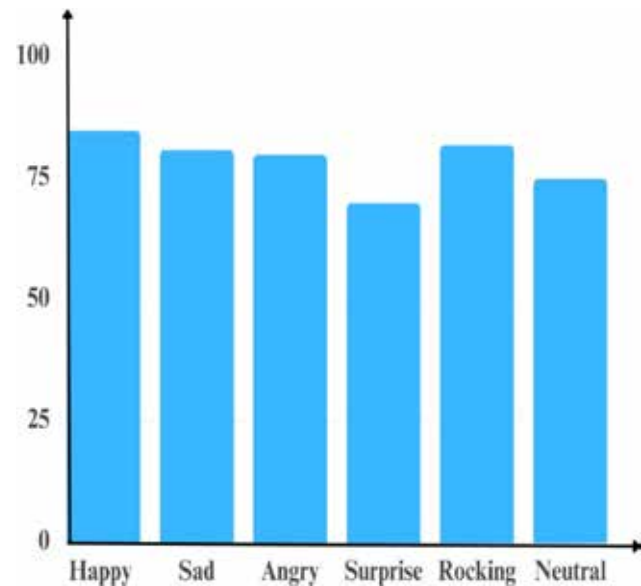


Fig. 4. Accuracy of Emotions in Graphic Format

To achieve accuracy in each emotion, 50 epochs are used in this process. Fig.4 shows the accuracy of emotions in graphical format. Each epoch comprises numerous iterations or steps, which enable the model to enhance its predictions by leveraging the collected data and output labels. Table 1 shows a comparison of the accuracy achieved in our project with that of previously proposed work. By monitoring accuracy after each epoch, our system is able to identify that every emotion attained the highest accuracy, with happy emotion having the highest among them.

According to our research, all the previous editions used datasets or the Spotify platform to recommend songs, which has the limitation of a language barrier. To overcome this, our system redirects to YouTube, which is easily available and has no restrictions.

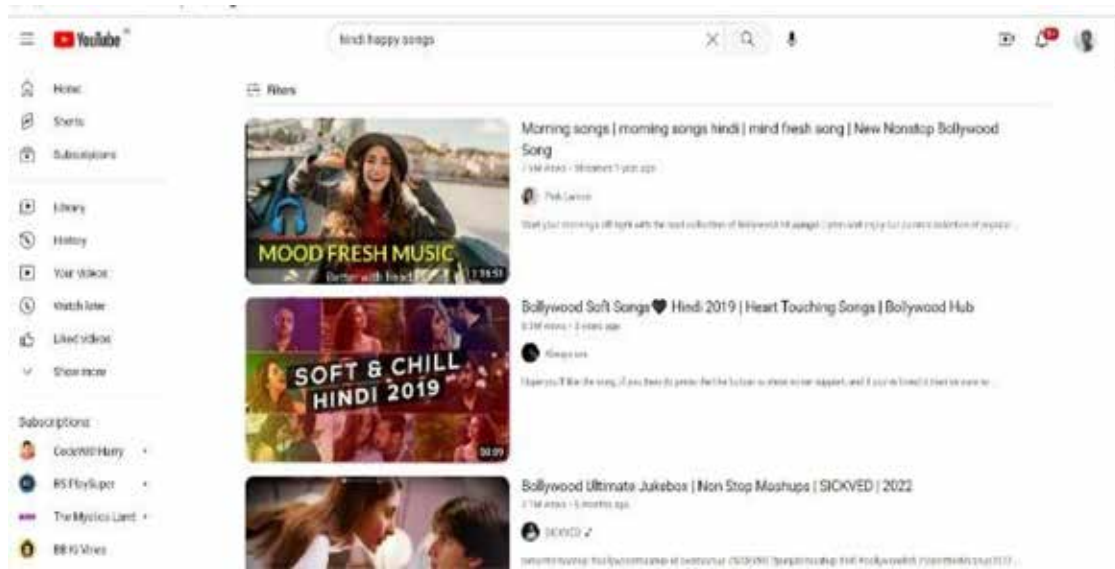


Fig 5. Music Recommendation

Table 1. Accuracy Comparison

References	Happy	Sad	Surprise	Angry	Neutral	Rocking
Vijay et al. [1]	100%	----	----	75%	97%	-----
Ahlam A et al.[2]	40%	66%	56%	----	69%	-----
S Metilda Florence et al. [10]	0%	100%	----	----	----	-----
Our Work	85%	81%	70%	80%	75%	82%

CONCLUSION AND FUTURE SCOPE

The goal of our project was to develop a system for music selection based on emotions that would allow us to recommend a playlist to a customer based on their temperament and then strengthen it into a particular playlist.

This suggested system can create facial images to identify key emotions and suggest music based on the client’s disposition. Since YouTube is one of the most widely used streaming music platforms. Our effort was directed towards ensuring that the recommended playlist was sourced directly from YouTube. In the future, our focus will be on creating a music recommendation system that can identify different emotions not only from images but also from videos or live camera streams. so that it can be used in electronic and automotive systems, including those in automobiles, laptops, mobile phones, etc.

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ISLT: Indian Sign Language Translator Mechanism

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ABSTRACT

Sign language translator is a technique that aims to fill the communication gap between normal people and impaired people by translating the Indian sign language into text or voice format. Recent trends in Sign Language Translator include the use of hand gloves to classify the hand gestures, mobile application, browser extension, wearable devices, etc. Our project aims at collecting a dataset and then using various machine learning or image classification techniques to extract useful information, which will make the ease in communication of deprived. Various type of works has been done in this area like sign language translation algorithm using Convolution Neural Network and many researchers have also created a smart glove to capture and analyze the hand movements, but they are little costly compared to our sign language app which is purely software-based tool. We have used the latest software tools available in the market to run softly on the next generation devices. Our main objective is to deliver a good sign language translator in the form of an app by creating a good User Interface and translating the sign in real time.

KEYWORDS : *Sign language, Translator, Hand gesture communication, Python, OpenCV, Deaf/Dumb, Java, Android studio*

INTRODUCTION

The linguistic structure of sign language is distinct and varies based on geographical location. Sign language is specific to each country, developed to facilitate communication within their respective deaf and hard-of-hearing communities[1]. It consists of diverse gestures comprising hand shapes, movements, orientations, and facial expressions. It is a mode of communication which uses varies ways like expressions and hand gestures. Sign languages are not standard and universal, and the grammar differs from country to country. Our project aims at converting a Indian Sign Language into words by using varies algorithms to break the communication gap between the normal and impaired people[2]. In this endeavor, we are striving to facilitate communication between hearing-impaired individuals and the general population, enabling them to easily interact with one another. Our aim is to provide them with easy and hassle-free communication using a mobile application.

The aim of the project is to create an innovation that will help people with speech and communication difficulties. One of the main goals is to improve access to the deaf in the community and to the deaf born in deaf families by providing alternative means of communication. In addition, the project aims to reduce the costs associated with providing language-related information. To achieve these goals, the project team will develop a system that utilizes speech-to-text APIs and employs the semantics of lips or tongue to accurately translate complete audio sentences and words into text format. The system will also incorporate machine learning algorithms to ensure accuracy and comprehensibility by breaking down the text into small, understandable pieces and employing pre-defined signing datasets. The use of AI will enable the system to display or translate audio sentences into text format in a cost-effective and accessible manner. Furthermore, the project will expand the Indian Sign Language (ISL) dictionary and further improve the system's performance to make it a more comprehensive

tool that can support disadvantaged communities. Another crucial aspect of this project is the translation of gestures and expressions into text and audio format.

SIGN TO TEXT/SPEECH TRANSLATION

Signs are taken as an input by a normal person using a mobile camera or webcam of a cellular phone or computer. For the captured image to be of excellent quality it will be sent for extra object removal. The process of converting sign language into either text or speech involves utilizing a trained database of sign language, which allows for recognition of signs through a module dedicated to text recognition. By comparing the database with the converted text, we can identify meanings and symbols, which can then be presented alongside text or through speech to individuals who are deaf or mute.



Fig. 1. Indian sign language alphabet series

A sign language interpreter is a skilled communicator trained to bridge the linguistic gap between spoken and signed languages. This usually means someone who can't hear but understands signs. Deaf individuals can communicate with the device by signing, and the device can interpret their signs or convert spoken English into Indian Sign Language.

In this report [1] proposed by, Anirudh Muppidi, Amar Thodupunoori and Lalitha they discussed a real time vision based American sign language recognition have been Developed for deaf and dumb people. The project achieved final accuracy of 92%. This is suitable to better our prediction after enforcing two layers of algorithm in which we conform and predict symbols which are more similar to each other.

The report [2] proposed by, Aman Pathak, Avinash Kumar, Priyam, Priyanshu and Guptaigunjan Chugh they discussed the main purpose of sign language detection system is providing a practical way of communication between a normal and impaired people by using hand gesture. From the result of the model, it can be concluded that the proposed system can give exact results under proper light and contrast.

The paper [3] published by, Radha S. Shirbhate1, Vedant D. Shinde, Sanam A. Metkari, Pooja U. Borkar and Mayuri A. Khandge they discussed that in this work it shows working of the project to convert different sign language signs into different tokens and for this to be done the model is going to use automatic sign language recognition system in real time.

Pooling and capsules routing on the same network can increase network accuracy and convergence speed, according to the authors of reference [4], Md. Asif Jalala, Ruilong Chen, Roger K. Moore, and Lyudmila Mihaylova. The upgrading of this framework to include non-static gestures would be a future addition of this work. Use of recurrent neural network layers in conjunction with the capsules is one of many potential solutions. The evaluation results of the described acquisition system and sign language gesture recognition using accelerometer sensors, according to authors Jakub Gaka, Mariusz Msior, Mateusz Zaborski, and Katarzyna Barczewska in reference [5], clearly demonstrate that such an approach can produce a very high recognition efficiency.

METHODOLOGY

It uses a vision-based methodology. The issue of communicating with artificial devices ceases because all signs are represented with only the naked hands. Real-time sign language to text conversion can be broken down into a series of easy processes, such as:



Fig. 2: ISLT Process

The core ML model of our project is written purely on Python 3. Python is a high-level programming language with a simple syntax and a large standard library. Each implementation of Python has its own strengths and weaknesses, and choosing the right implementation depends on the specific needs of the project.

Here we are using Python 3 for training and modeling. Python 3 is the latest version of the Python programming language, and it is considered a major upgrade from Python 2. Python 3 is not a different type of language, but rather the successor to Python 2, which is now considered legacy and will no longer receive updates or support. Python 3 introduced many new features, syntax changes, and improvements over Python 2, including better Unicode support, improved syntax for function annotations, and a new way of handling exceptions. Its intended purpose is to facilitate effortless comprehension, composition, and interpretation. It was released in December 2008 and introduced many new features and changes that made the language more consistent, easier to use, and more powerful.

Developing projects based on recognition or classification are really difficult to cope up. To classify the image generated by the camera, we use OpenCV as a classifier tool. OpenCV, short for Open-Source Computer Vision, is a popular open-source library for computer vision and image processing. Initially developed by Intel, the library is now maintained by the OpenCV Foundation. With over 2500 optimized algorithms, OpenCV enables developers to detect and recognize faces, identify objects, track moving objects, extract features, manipulate images and videos, and more. While OpenCV is primarily written in C++, it provides bindings for other programming languages such as Python and Java. Furthermore, it is compatible with multiple platforms such as Windows, Linux, macOS, Android, and iOS. OpenCV offers a set of modular and user-friendly APIs for developers to build computer vision applications with ease. Additionally, it includes tools and utilities for debugging and performance analysis.

To train the machine learning model which is developed to recognize the alphabet, we use TensorFlow as an object detection model. TensorFlow is an open-source library developed by Google's Brain team in 2015. It

is designed for building and training machine learning models, including deep neural networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and more. The library derives its name from the operations it performs on data, which are represented as multidimensional arrays or tensors. With a wide range of APIs, TensorFlow enables developers to build various types of ML models quickly and efficiently. The algorithm we use to recognize the images taken from the user's camera is CNN. CNN stands for Convolutional Neural Network, which is a type of neural network commonly used in image and video recognition, natural language processing, and other applications. In CNN a set of data is passed through a pipeline, which extracts the useful data from the set by applying some filters. These filters slide over the input data, performing element-wise multiplication and addition operations to create a feature map. The output of the filtering process is then passed through a series of pooling layers, which reduce the spatial size of the feature maps while retaining the most important features. This helps to reduce the number of parameters in the model, making it more efficient.

The main reason behind creating an android application is that it is portable means we can use our translator any time we want. The popular IDE for creating android apps is Android Studio. Android Studio is Open source Integrated Development Environment (IDE) used to develop Android applications. It was developed by Google and is available for free download on Windows, Mac, and Linux operating systems. Android Studio provides a range of features and tools that simplify the process of developing, testing, and debugging Android applications. It offers a graphical user interface (GUI) designer for building UI layouts and a code editor for writing code in languages such as Java and Kotlin. Additionally, Android Studio includes a code analyzer that detects potential errors and provides suggestions for improvement.

Gesture Classification

Gesture recognition is a process that recognizes and distinguishes human gestures through computer vision and machine learning models. It has many applications such as language recognition, gesture classification, and virtual reality. The procedure usually involves checking

and analyzing hand and body movements. Gesture classification is a subcategory of gesture recognition that includes the recognition and classification of human gestures and actions. It uses computer vision techniques, including image processing and machine learning, to analyze hand and finger movements. The process includes several steps, including manual search, feature image or video scene, while inferencing involves identifying relevant features such as hand gesture or finger movements. Manual search is inaccurate because while searching the moving hand our eye cannot classify which symbol user want to show to the deaf person. So we need to automate this process by using OpenCV as a feature extraction tool to extract the hand sign or hand gestures created by the deaf people while communication with normal people.

Classification utilizes machine learning algorithms to classify the gesture into a predefined category, such as a particular letter in sign language. The approach used in this design involves two layers of algorithms to predict the final symbol of the speaker. Gesture classification has various applications, such as in sign language recognition, human-computer interaction, and virtual reality. For example, sign language recognition systems use gesture classification to translate hand movements into text or speech. However, gesture classification can be challenging due to variations in lighting, hand orientation, and hand movements. Nevertheless, recent advancements in computer vision and machine learning have made it possible to achieve high levels of accuracy in gesture classification, making it a promising field for research and development.

Gesture classification involves the use of Digital Image Processing Techniques which is subcategory of Electronics engineering. In electronics engineering we learn the processing of digital signals and classification of pixels. Pixel is the smallest unit of a image that can be represented on a digital display device. By using this smallest bit of information we can reduce the pixel redundancy and improve the quality of the image. By improving the quality of image we can easily classify the images based on the useful pixels.

OpenCV comes to help for the classification of this useful or redundant pixels. OpenCV provides the vast Computer Vision Library and tools for the image

processing works. The main feature of OpenCV is that it works on the real-time.

Algorithm

1. Collect images for deep learning using your webcam.
2. Label images for sign language detection.
3. It does not require a huge dataset due to labelling. So, the length of the training will be calculated, and the space will be utilised effectively.
4. Detect sign language in real time using Open CV.
5. Setup Tensor Flow Object Detection pipeline configuration.
6. Tensor Flow Lite empowers developers to execute their machine learning models on mobile, embedded, and edge devices, by providing them with a comprehensive suite of tools for on- device machine learning.
7. Output in the text and speech format is produced.

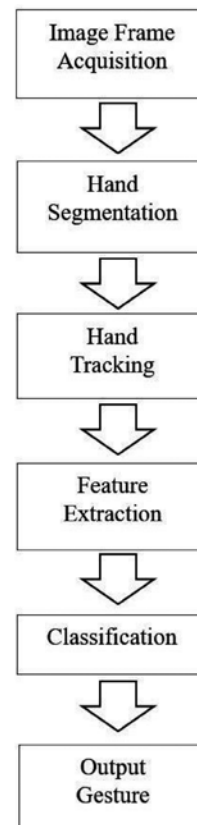


Fig. 2(a). Shows the flowchart of this project

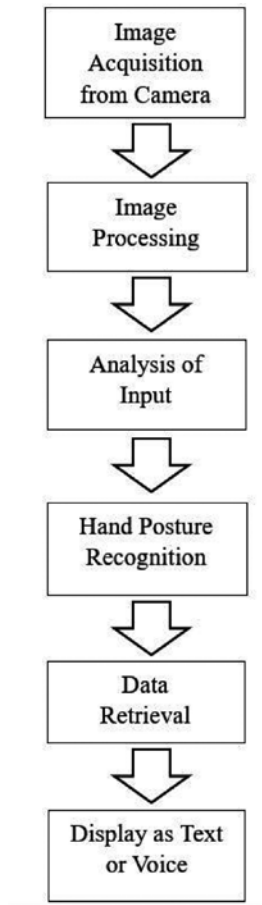


Fig 2(b): Shows different phases in the project

RESULT

After the completion of our mobile application, we can see the login page Fig[a]. By using the login page, we can sign in into our existing account using “Sign In” button or if anyone is new to the application, he/she can also sign up using “Sign up” button.

In Fig. [b] it shows us two options for sign recognition. The one is real time sign language translator and another is real time text to voice sign language translator, both the option captures the live image with the help of inbuilt camera.

In Fig. [c] and Fig. [d] we can see the capturing window where the image is being captured by the device and at the real time it is converted into the text format.

In the final Figure Fig. [e] we can see the output of the given sign language into the text format, and we also have the option to convert the text into sound format.



Fig (a): Log in and Sign Up page



Fig (b): Home page

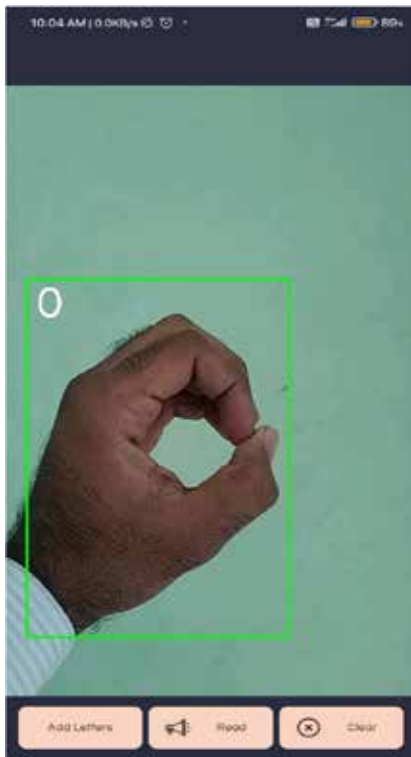


Fig (c): Detecting Sign 'O'

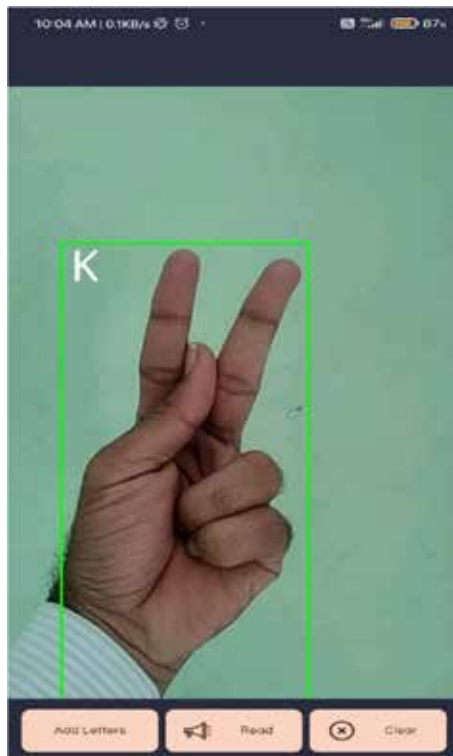


Fig (d): Detecting Sign 'K'

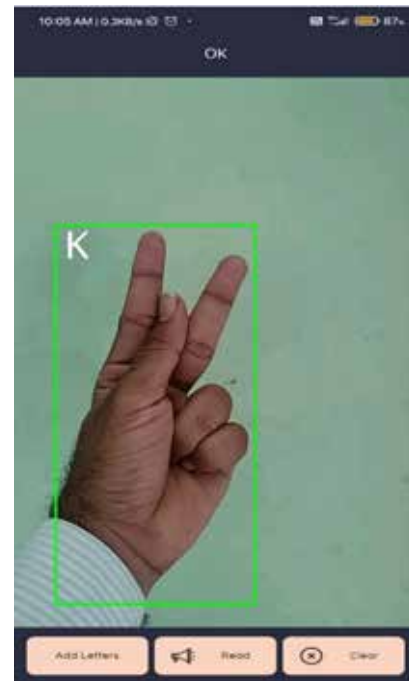


Fig (e): Final Output Sentence

CONCLUSION

Sign language is the primary mode of communication for deaf individuals and those born into deaf families. It allows for easy communication among them, and transcription becomes secondary to conversation. They prefer to receive information in the form of sign language, but this can be expensive and not always accessible. To address this challenge, a system is being developed that can assist individuals with communication and speaking difficulties. Machine learning algorithms are used to break down the text into small, understandable pieces, with pre-defined signing datasets employed to ensure accuracy. By leveraging AI, the software can effectively display or translate audio sentences into text format. However, challenges remain as the ISL dictionary is still limited in size. As such, further improvements to the system's performance are necessary to make it a more comprehensive tool that can support disadvantaged communities.

In summary, sign language is the primary communication mode for the deaf and those born into deaf families, but it can be costly and inaccessible. A system is being developed that uses speech-to-text APIs and semantics to translate audio sentences and words into text format.

The software uses machine learning algorithms to break down text into understandable pieces, with pre-defined signing datasets used for accuracy. However, the system faces challenges, including the limited size of the ISL dictionary. Further improvements are necessary to make it a comprehensive tool that supports disadvantaged communities.

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Pragmatic Analysis of Network-on-Chip Routing Models from an Empirical Perspective

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ABSTRACT

Routing is the process of the path selection in any network. Routing creates efficiency in the network communication. Network communication failures result in long wait times for website pages to load users. Inadequate throughput performance may result from missed packets, delayed data, lower energy efficiency, and incorrect routing between on-chip nodes. To solve this issue, researchers created a variety of routing methods, such as XY Routing, Priority Routing, and others. Additionally, each of these models has machine learning-optimized variations that may be used to help create low-power, high-throughput communications. Performance indicators like throughput, energy utilization, and packet delivery ratio are just a few of the ones that are used to compare various strategies (PDR). There are also nuances, advantages, and drawbacks that are particular to the setting, as well as possible research areas. It is challenging for researchers to predict which routing models would provide the best results for the application-specific installations they are working on because to the wide diversity in performance. In order to dispel any remaining questions, this study offers a thorough analysis of the merits, applicability, and scalability performance of these models. Researchers and network designers will be able to deploy their on-chip networks using the most appropriate models thanks to this discussion, which will lower the costs of designing and implementing networks of all sizes. In order to identify application-specific routing strategies, this presentation includes a statistical analysis of the investigated models. According to the evaluation in this paper, it can be seen that show case higher efficiency of routing, while these models along with showcase lower delay when compared with other techniques.

KEYWORDS : *Routing, On-Chip, Control, Network, Delay, Throughput, Energy, PDR, Scenarios*

INTRODUCTION

From their beginning NoC router supporting different link bandwidths and number of VCs per Uni-directional port is presented and the main advantages are better ingress and egress bandwidth, decoupling, better performance and ability to configure the router according to the preferred cost performance ratio. Several modelling domains and activities are involved in designing on-chip routers, including rate

control, piggybacking, fidelity analysis, traffic estimate, and traffic redirection, among others. Researchers build these capabilities into on-chip networks using a variety of methods. The majority of routing models begin by identifying congestion at the packet level. Queue length, packet rate, service time, inter arrival time, delivery time, node latency, application fidelity, and channel condition are a few of the metrics stated above. The packet is transmitted to the next node on the chip, where it will be processed alongside other traffic if there

is no bottleneck. The on-chip routers get notifications of congestion, which they use to help activate the arbitration modules.

Emerging as a new approach for the creation of complicated on-chip communication architectures in today's electrical systems-on-chip, the term "network-on-chip" (NoC) was coined to describe this concept (SoCs). One of the most important elements of the construction of a NoC is the NoC routing, which establishes how data packages are sent from one point to another within the network. Cellular automata, also known as CA, are discontinuous mathematical model that have found widespread application in the field of research concerning complicated systems. Recent research has looked into the possibility of using CA as a transportation paradigm for NoC. Each router is represented as a cell in a cellular automaton in the CA-based NoC routing model. The decision regarding the sending of a data stream is made based on the local state of the router's surrounding cells.

The flexibility, fault-tolerance, and energy effectiveness of this strategy have all been demonstrated to have positive outcomes. Nevertheless, it also presents some difficulties, such as the need to create suitable CA rules for effective handling and find a solution to the problem of overcrowding. In general, the CA-based NoC routing model is a fascinating field of research that has the possibility for further investigation and expansion use cases.

At this layer, choices regarding congestion control result in packet rerouting or the adoption of additional procedures. Rate control, packet dropouts, additive increase/multiplicative decline (AIMD) in packet rate, and a growth in the number of resources are a few of them. This data is updated often on the router, which improves congestion management and avoidance at the packet level under a range of network conditions. Numerous route control models have been developed by researchers, each with unique deployment characteristics. The intricacy, applicability, and limits of these models are discussed in the next section, along with some possible future study possibilities. This debate will help researchers choose the best route control models for their deployments of application-specific on-chip networks. This background information is followed by

a statistical analysis of the studied models' performance indicators. End-to-end latency, throughput, packet delivery ratio (PDR), and other equivalent factors may be included in these performance evaluations. Readers will also benefit from this article's comparative study in evaluating which congestion control strategies are best suited for their particular network configurations. The article's last section draws some intriguing conclusions about the examined models and provides a range of suggestions for enhancing their effectiveness.

NETWORK ON CHIP : AN OVERVIEW

Network-on-chip (NoC) is an emerging paradigm for designing complex on-chip communication architectures in modern electronic systems-on-chip (SoCs). NoC routing is one of the key design aspects of NoC architecture, which determines how data packets are routed through the network. Cellular Automata (CA) is a discrete mathematical model that has been widely used in the study of complex systems. CA has been recently explored as a potential routing model for NoC. In the CA-based NoC routing model, each router is modelled as a cell in a cellular automaton, and the routing decision for a data packet is made based on the local state of the router's neighbouring cells. This approach has shown promising results in terms of scalability, fault-tolerance, and energy efficiency. However, it also poses some challenges such as designing appropriate CA rules for efficient routing and addressing the issue of congestion. Overall, the CA-based NoC routing model is an interesting area of research with potential for further exploration and development scenarios. In order to transfer information across NoC nodes, researchers have offered a plethora of different ideas. [1] Heterogeneous multi core computer platform designs have been developed for energy efficiency as a direct result of the demands of Big Data and AI. Today's heterogeneous multi core system-on-chip (SoC) asymmetric data-access traffic necessitates a tailored network-on-chip (NoC) offering connection variety (SoC). Single-source, multi-destination (SSMD) traffic allows for the use of cache coherency protocols, barrier synchronization, parallel processing, and DNN acceleration. Multicast routing increases network throughput by dispersing SSMD traffic. To avoid deadlocks in NoCs, multicast routing between active

routers must not rely on branch operations. Because stalemate circumstances are problematic, and the route Hamiltonian needed to apply the rule of labeling may not exist in topology-based NoCs, throughput-optimized multicast routing is difficult to achieve. The use of multicast routing in specialized NOCs has led researchers to two key findings: 1) No deadlocks will occur if branch operations are constrained to an endpoint, even the NoC lacks a route Hamiltonian. 2) Variable paths variation may be used in route allocation and branching in a topologically-specific routing scheme. This research provides specialized NoCs based on characteristics like free-deadlock, enhanced-throughput multicast routing (MRCN). Labeling router and extended routing rules prevent deadlocks in the MRCN. Partitioning at the final router destination and traffic-aware adaptive branching both reduced the number of hops a packet must make on its way to its intended receiver. Noxim, accurate-cycle NoC simulator, was used to analyze the MRCN under a variety of topologies and traffic loads. The experiment showed that compared to the bespoke NoC multicast routing, MRCN reduced average delay by 13.98% and increased throughput by 12.16% under heavy traffic loads.

According to [2], optical networks-on-chip (NoC) based on silicon photonics are promising on-chip communication architecture for chip multiprocessors. Since optical devices are susceptible to fluctuations in on-chip temperature, thermally induced optical power loss would dramatically degrade the power efficiency of optical NoCs. To address this problem, detail a thermal-aware adaptive routing system based on ant colony optimization (ACO). In order to reduce the amount of optical power that is lost due to changes in temperature, the ACO-based routing approach makes optimal routing selections. The classic ACO-based routing strategy requires a table in each node to store and update pheromone, the size of which grows linearly with the number of nodes. The approximation ACO-based routing (AACO) method uses linear regression to reduce unnecessary table lookups. According to a simulated traffic pattern and real-world applications on an 88 mesh-based optical NoC, the suggested routing algorithms may discover nearly-optimal pathways. We

put the routing systems through their paces on a bigger network.

Network-on-Chip (NoC) is the most promising on-chip connectivity architecture in Multi-Processor System-on-Chip (MPSoCs) [3, 4] because of its efficiency and scalability. Deep sub-micron NoC faults cause links and routers to malfunction. When parts of the NoC break, dependability drops across the board. This research proposes a Reinforcement Learning-based Fault-Tolerant Routing (RL-FTR) approach for dealing with link and router failures in mesh-based NoC architecture routing. A System-C based NoC simulator is used to evaluate the RL-FTR algorithm's performance on a cycle-by-cycle basis. Variations in mesh size are a stand-in for expanding networks and router malfunctions. After running the code through simulations, we see it in action in an FPGA implementation, showing how the RL-FTR approach works in real time. Hardware and simulation both indicate that the proposed RL-FTR algorithm improves routing from the source router to the destination router.

Single-cycle long-distance communication [4] is enabled by a dynamically reconfigurable Network-on-Chip (NoC) dubbed SMART (Single-cycle Multi-hop Asynchronous Repeated Traversal) that establishes single-bypass pathways between remote communication pairs. Disputes will easily splinter a system with just one possible way around. Since packets would be delayed at intermediate routers due to blocking latency from competing packets and additional router-stage time to reconstruct the remaining connection when it becomes available, the advantages of SMART NoC's bypassing would be reduced. We provide the first contention-aware routing strategy for SMART NoCs, which improves bypassing performance. We differentiate between a packet's direct route, which may only need to go through one intermediary router, and an indirect route, which may go over several of them (s). End-to-end latency may actually be reduced by using circuitous paths that hop across unrelated routers, contrary to common opinion (even if they are not minimum). Our innovative routing strategy maximizes route diversity, reduces interference between communication pairs, distributes loads uniformly, and makes maximum use of bypass channels. The proposed routing approach boosts

network performance by 35.48 percent, application schedule length by 28.31 percent, and communication latency by 37.59 percent as compared to SMART NoC routing using actual benchmarks.

In newly suggested high-performance NoC architecture, the express bypass is used to send uncomplicated flits to far-flung processing elements (PEs) in a single cycle. If a conflict occurs, lower priority flits will be buffered and limited in their ability to use bypass. As a result of its lack of arbitrary-turn routing, SMART is unable to use routing approaches that avoid congested routers and connections in order to reduce conflict. In order to reduce contentions and maximize bypass, It propose ArSMART, a SMART NoC with arbitrary-turn transmission. The cluster controller in ArSMART determines the best paths for the data to go while the buffer less reconfigurable router handles the throughput. Since the SMART NoC's long-distance transmission bypasses intermediate arbitration, setup the input and output ports' connection directly rather than using hop-by-hop tables for arbitration. Effective ArSMART-compatible adaptive routing algorithms are developed to broaden the available channels of communication. Because taken the time to properly craft our control mechanism, able to keep the cost of route calculation hidden, which is a major problem in adaptive routing systems. Results from experiments show that using a modern SMART NoC may reduce energy usage by 29.7 percent and the duration of application schedules by 40.7 percent.

Optical networks-on-chips (NoCs) based on silicon photonics were suggested for many-core chip multiprocessors in [6]. One important issue with silicon photonics is their susceptibility to temperature changes. Related work advises using adaptive routing based on Q-learning to chill things down. The overhead of using tables for Q-table routing grows rapidly as networks expand. This work proposes a table-free approximation Q-learning based thermal-aware adaptive routing method for determining the optimum low-loss pathways with on-chip temperature changes. The results of the simulations support the proposed table less approximation It is possible that Q-learning-based adaptive routing will converge more faster and deliver optimization benefits that are on par with the best table-

based Q-routing. The proposed approximation approach outperforms table-based Q-routing as the size of the network grows.

Both connection not accurate, congestion and failure have a negative impact on the performance of the network on the chip [7](NoC). NoCs are able to handle complicated and ever-changing applications because they use adaptive routing algorithms that are both fault-tolerant and aware of congestion. In this letter, Q-learning-based adaptive routing is proposed. HQ table may be able to prevent data diversions in fault zones and choose the route with least congestion by learning the accuracy, congestion and failular information of the pathways between to the source to destination nodes. Q-value decay and the dynamic learning rate method both deal with the issue of late updates to Q-learning values. The proposed routing methods may function well with a high failure rate (>25%) and little hardware overhead, as shown by the experiments.

Network-on-chips (NoCs) are the standard for system-on-chip connections, as stated in [8]. (SoCs). A NoC router's performance and footprint are limited by the physical layer media access mechanism it uses. When the Code Division Multiple Access (CDMA) is a method, it is using by many wireless communication networks, has been suggested as a NoC router switching strategy. Using direct-sequence spread spectrum on digital interconnects, multiple processor elements (PEs) may engage in simultaneous communication through a code division multiple access (CDMA) crossbar. Bit-wise designs, such as those used by conventional CDMA switches, repeatedly using the configurations to transfer multiples bits data, increasing crossbar space or cable density. It propose aggregated CDMA routing to increase router density, throughput, and efficiency in CDMA NoCs (ACDMA). The nature of static and the noise of relative immunity of the on-chip interconnects to allow ACDMA to combine multiple bits of data into M-ary symbols on single communication digital channel, therefore reducing crossbar wire density and space overhead. Different area-speed trade offs are made in the implementation of ACDMA crossbars employing serial and parallel Application-Specific integrated circuit(ASIC) 65 nm is a standard cell technology. The implementation shows the Throughput-Per-Area (TPA)

values for the Standard Basis (SB), Walsh Basis (SB) and the Overloaded CDMA Interconnect (OCI) crossbars are 96.3%, 18.2%, and 118.6% lower than the serial and parallel ACDMA crossbars, respectively. Fully realizing the node-65 NoC router ACDMA and comparing for the against of state-of-the-art CONNECT and CDMA routers under a variety of simulated workloads. A hybrid Automatic Repeated Request (ARQ) approach is presented improved the robustness of communication between ACDMA NoC routers in the presence of noise.

The Dual Data Rate (DDR) data path of the Network-on-Chip (NoC) known as Highway NoC almost reaches the optimal network performance [9]. Data paths on routers are faster than control ones, therefore a DDR NoC route will boost throughput at data path speeds rather than control ones. When there is less traffic, DDR NoCs may reduce packet delay by using pipeline bypassing. Current DDR routers simplify their logic by ignoring internal hops that do not include a turn. Highway NoC avoids DDR routers on local ports to speed up pings entering and leaving the network. As a result, it saves physical space and power by streamlining the allocation of DDR switches and router port interfaces. While compared to standard NoCs, Highway NoC excels when operating over a route and location of 28 nautical miles. Highway NoC decreases average packet delay by 7.3-27% and power consumption by 1-10% compared to DDR NoCs, all without degrading throughput. Highway NoC provides 17-22% greater throughput, 13.8 percentage points less packet delay, and varying degrees of energy efficiency compared to Single Data Rate NoCs.

Work in [10] declared Optical connections using wavelength-division multiplexing (WDM) are becoming a more appealing option for on-chip data transmission as bandwidth and power demands rise with the scaling down of VLSI technology. Previous research into WDM-aware optical routing has three major flaws: it manages optical routing with heuristics or constrained integer linear programming; it addresses only some forms of insertion loss and WDM overheads; and it does not account for crosstalk noise when multiple signals are transmitted simultaneously. This makes it such that they can't be sure of their WDM clustering results, the reliability of their optical network is compromised, or their calculations are excessively

time-consuming. A novel WDM-aware optical routing technology significantly accelerates throughput while simultaneously reducing insertion loss, WDM overheads, and crosstalk noise. WDM-aware route clustering gives an ideal solution for 1-, 2-, and 3-path clustering, but it has a consistent performance limit for most 4-path clustering. By taking into account crosstalk during the route assignment process, the possible number of signal pairs affected by crosstalk is reduced, hence keeping the total number of signal pairs within the displacement limit. Previous testing have shown that our optical router exceeds the competition in terms of wire length, insertion loss, wavelength power, crosstalk noise, and runtimes.

A proclamation was made in [11] Data-driven programs with huge memory footprints sometimes fail to use the cache because of insufficient on-chip caching. When applications make use of cache blocks that have been previously evicted, they risk incurring repeated miss penalties. NoC routers include input port buffers to prepare for catastrophic situations. Recent studies have shown that until network congestion occurs, buffers are underutilized. In order to do post-silicon debugging and verification, NoC routers use trace buffers. After a design is put into production, they sit unused in the routers. In this article, recently evicted cache blocks are stored in inefficient NoC router buffers and trace buffers. The NoC router may send replies to the data in these delayed blocks. Opportunistic caching of evicted blocks greatly reduces miss cost in NoC routers. According to results from experiments, the suggested designs have the potential to increase system performance by 19% (14%), while simultaneously decreasing miss penalty by 21% (16%). In spite of a small area and leakage power overhead of 2.58 and 3.94 percent, respectively, dynamic power drops by 6.12 percent as a consequence of performance improvements.

A silicon microchip can currently accommodate hundreds of processing components, as stated in [12]. This is all because to very large-scale integration. MPSoCs are the cutting edge of technology now available to the public. Network-on-Chip (NoC) is promising and scalable connecting network that enables MPSoCs to reach their full performance potential (NoC). Routers in NoCs use routing algorithms to

properly direct data packets to their final destinations. There are two qualities that routing algorithms should have. Congestion in a network may be avoided if the mechanism for selecting routes is flexible. Second, it must ensure that it does not broadcast outdated data about network congestion to other routers. A large number of researchers at academic institutions have looked into the problem of network congestion and proposed potential solutions. NoC performance may be enhanced by using strategies to reduce congestion. Hardware for gathering information about network congestion on the client side may be necessary. This article explores output selection approaches for routing algorithms with the goal of directing packets to less crowded networks. Using methods for handling and disseminating congestion data, It can classify them. Recent advances in selection methodology are used and analyzed in this work.

Torus, a Network-on-a-Chip (NoC) Through the use of wraparound channels, the number of hops in the traffic may be reduced [13]. However, cyclic pathways in wraparound channels cause a stalemate in a Torus NoC. The Turn model and the channel dependency graph are two common methods for identifying deadlocks in NoCs (CDG). We suggest an Arc model for avoiding deadlocks in Torus NoC. The Arc model, which was developed in order to overcome stalemate in the Torus model, is an extension of the Turn model. This research also presents a directional dependency graph (DDG) for deadlock identification in Torus NoCs, which makes use of the Turn model and causality diagram (CDG). DDG utilizes the Arc model and Turns to simplify deadlock identification, avoidance, and liberation.

Most chip multiprocessor (CMP) designs nowadays use network-on-chip (NoC) as their fabric architecture [14]. Market-driven CMP applications are fuelling a surge in multicast traffic necessary to improved multithreading, barrier, a cache coherence protocols and synchronization. While multicast packets may be routed through the NoC router using the shortest path, deadlocks caused by branching should be avoided. Network-On-Chip (NoC) studies on free-deadlock minimum routing path in multicast traffic have used several virtual channels or enormous buffers to retain full packets, considerably increasing router area. Present an effective use of the

spatial variety provided by the input buffer in a multicast router that helps avoid deadlocks. MRBS directs data packets via the network with the least number of virtual channels and buffers. Under random multicast traffic, the destination, network, packet, buffer, and injection rates all varied. Simulations demonstrate that over a wide range of network sizes, MRBS outperforms the tree-based router by a factor of 39.3 in terms of the area-delay product.

The modularization and widespread fabrication of many- core system-on-chips by a plethora of manufacturers makes hardware Trojans conceivable (HT). Similarly, transistors with smaller feature sizes may age and fail at a faster rate. Authentication codes, cryptography error correction codes and flow profiles of runtime to identify unusual activity are only some of the security and fault- tolerance strategies discussed in the academic literature. As of yet, there are no universally accepted methods for detecting assaults or blunders in communication (NoC). The cutting-edge presentation detailed how NoC attack defensive tactics increase the NoC's susceptibility to security breaches by adding hardware. In this approach, the detection of attacks and system failures are separated by separate data and control NoCs. Message transmission may be monitored, abnormal behavior can be identified, and the Communication Session Protocol can recover from failure or attack owing to a control NoC. There is a wide variety of application communication techniques, and their overhead on execution time varies from 3.5 percent to 33.3 percent. The protocol mitigates this cost by relaunching the program and modifying the routing between communicating task pairs whenever it detects abnormal communication behavior sets. A comparative survey of these models is discussed in the next section of this text.

PERFORMANCE EVALUATION & COMPARISON

It became clear from the comprehensive examination that the performance of the various NoC Routing models under investigation varies widely. These results were evaluated using the criteria of routing efficiency (ER), latency (D), deployment cost (DC), and scalability (S). Fuzzifying the values of these measures into Low (L =

2), Medium (M = 3), High (H = 4), and Very High (VH = 5) helps compare their performance on a standard scale. Models and their corresponding performance metrics are summarized in table 1 to facilitate this evaluation. Better performing models may be selected for various deployments based on this tabulation.

Table 1. Performance evaluation of different models

Method	ER	D	DC	S
DNN [1]	H	VH	H	H
AACO [2]	VH	M	H	VH
RL FTR [3]	H	H	VH	H
SMART [4]	H	H	H	H
ArS MART [5]	VH	M	H	H
QL [6]	H	H	H	M
HQL [7]	H	M	VH	H
ACDMA [8]	H	H	H	H
DDR [9]	H	H	H	H
WDM [10]	H	H	H	H
OC [11]	M	M	L	H
CC QL [12]	H	H	H	H
CDG [13]	M	H	H	VH
MRBS [14]	H	H	H	H
CSP [15]	H	H	H	H

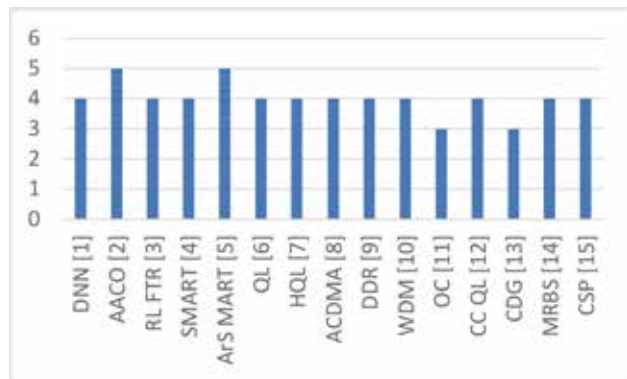


Figure 1. ER for different Models

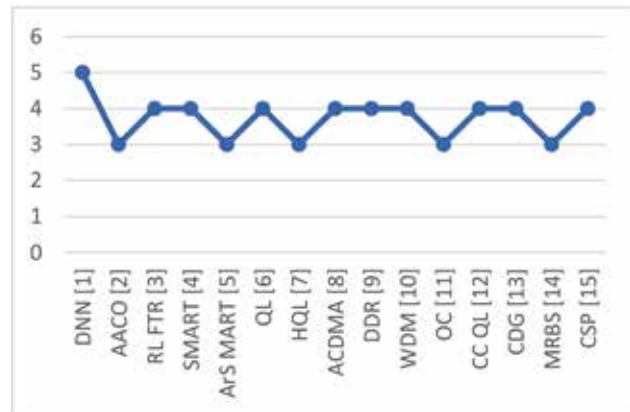


Figure 2. Delay of different models

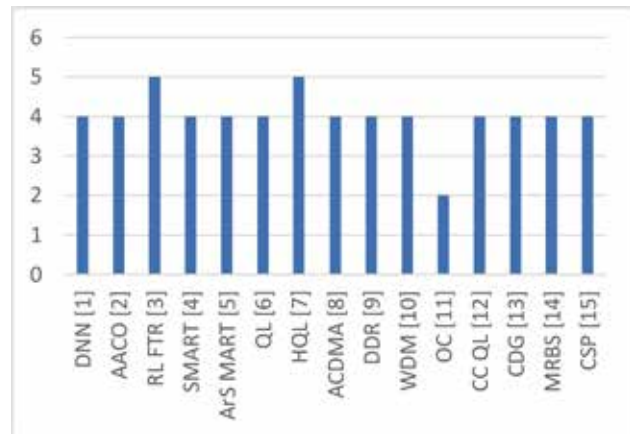


Figure 3. Deployment cost of different models

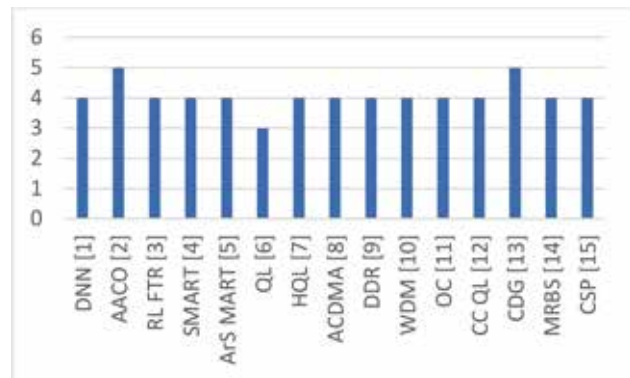


Figure 4. Scalability of different models

As per this evaluation & figures 1, 2, 3 & 4, it can be observed that AACO [2], and ArS MART [5] showcase higher efficiency of routing, while AACO [2], ArS MART [5], HQL [7], OC [11], and MRBS [14] showcase lower delay when compared with other techniques. It was also observed that OC [11] has lower deployment

cost, while AACO [2], and CDG [13] have higher scalability when compared with other models, thus can be used for a wide variety of NoC routing scenarios.

CONCLUSION AND FUTURE WORK

Inadequate throughput performance may occur as a consequence of lost packets, delayed data, reduced energy efficiency, and erroneous routing between on-chip nodes. In order to find a solution to this problem, researchers developed a number of different routing strategies, such as XY Routing and Priority Routing, amongst others. In addition, each of these models contains variants that have been optimized via the application of machine learning, and these variations may be utilized to assist in the creation of low-power, high- throughput communications. When comparing different techniques, some of the performance characteristics that are taken into consideration include throughput, energy consumption, and packet delivery ratio. These are just a few examples (PDR). In addition, there are special subtleties, benefits, and downsides, as well as potential study fields, that are associated with the location. Because there is such a broad variety in performance, it is difficult for researchers to make accurate predictions on which routing models will provide the greatest outcomes for the application-specific installations on which they are currently working. This research provided a comprehensive investigation of the merits, applicability, and scalability performance of these models in order to answer any problems that may have been left unanswered. According to the evaluation in this paper, it can be seen that AACO [2], and ArS MART [5] showcase higher efficiency of routing, while AACO [2], ArS MART [5], HQL [7], OC [11], and MRBS [14] showcase lower delay when compared with other techniques. In addition, AACO [2], and ArS MART [5] showcase higher efficiency of routing when compared with other techniques. When compared with other models, it was found that OC [11] has a lower cost of deployment, while AACO [2] and CDG [13] have superior scalability. As a result, these three models are versatile enough to be employed for a broad range of NoC routing situations. In future, researchers can fuse these models, and use cellular automata techniques to improve performance of these models under real-time use cases.

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Various Image Inpainting Techniques - A Survey

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ABSTRACT

Considering its significant relevance and effectiveness in image processing operations to eliminate any sort of distortion, including text, blocks, noise, scratches, lines, etc. from the source images, researchers have been studying the image inpainting problem over the past several decades. The practice of adding missing areas or erasing unwanted objects from images is called as image inpainting. It necessitates a profound comprehension of an image features in terms of texture and structure. It is recognized as one of the most difficult idea in the image processing field in the scientific community. To give the research community a reference, it is vital to categorise and condense various methodologies. From a variety of perspectives, traditional methods of Image inpainting like Diffusion based method and Patch based method (Exemplar based algorithms) are categorized first. The Convolutional neural networks (CNNs approaches) and generative adversarial networks (GANs), are two deep learning techniques, are also categorised. In order to offer novel viewpoints in the subject of image inpainting, this study will review the advantages and disadvantages of each approach. We discuss some potential future works based on our findings.

KEYWORDS : : *CNN, GANs*

INTRODUCTION

The skill of image inpainting is used to restore old and damaged pictures. It may also be used to remove or replace unwanted items from the image. In computer vision applications, It has become a substantial and challenging field of research. It is utilised to fill up the empty space in a picture. First-generation image inpainting techniques fall into two categories: traditional techniques like diffusion-based and exemplar-based inpainting techniques, and more modern techniques utilising deep learning. Basically Inpainting technique is used to recover damaged or imperfect areas of a picture by interpolating nearby pixels. An image's damaged areas consist of a group of disconnected pixels enclosed by a group of known neighbouring pixels. The inpainting approach fills unknown regions with known information during the

restoration of unconnected pixels. Figure 1 displays several picture inpainting methods in their appropriate groupings.

Our review is divided into the following sections: Section 2, which categorises traditional inpainting techniques; Section 3, which examines deep learning techniques; Section 4, which summarizes the typical performance for image inpainting with merits and demerits; Section 5, which discusses the review's future directions; and Section 6, which contains our conclusion.

TRADITIONAL METHODS OF IMAGE IN-PAINTING

These methods works on either pixel level or on patch level. The diffusion-based inpainting algorithm is the most basic inpainting technique. The lower structures of texture and geometry are restored using diffusion-based methods.

Diffusion Based Inpainting

These methods fill the vacant spaces with local structure from the surrounding region which is based on local smooth priors. Filling of the region was done by spreading the local geometrical information along its isophote direction with the help of a partial differential equation (PDE). [1].

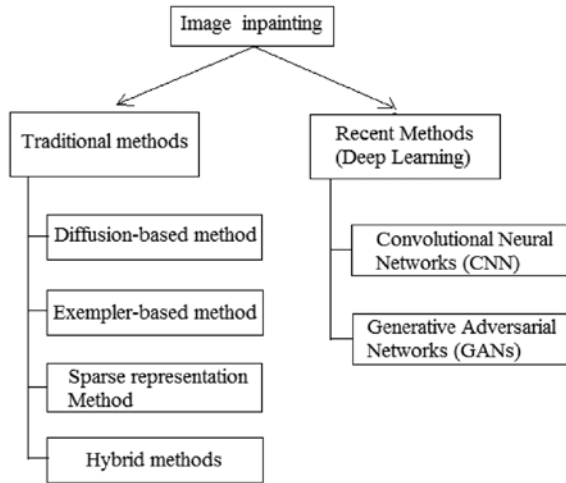


Fig. 1: Shows how image inpainting approaches may be categorized into two primary groups: Conventional / Traditional and modern deep learning methods. Conventional / Traditional Methods has four subcategories: Diffusion based, Exemplar based, Sparse Representation, and Hybrid Methods. CNNs and GANs are subcategories of deep learning methods.

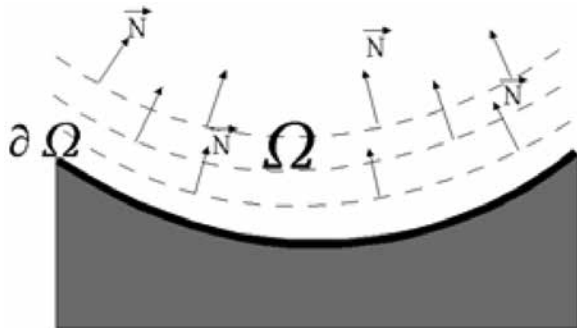


Fig. 2: Propagation in the normal direction as the boundary of the area that will be painted

Let, Ω stand for the area that will be painted, and $\partial\Omega$ serve as its border. The mechanism for this technique is as follows:

- (1) How to close the gap is determined by the overall picture.

- (2) The neighboring area’s structure is carried into the missing area and outline are drawn through the the persistence of those arriving at $\partial\Omega$.
- (3) All the missing parts are filled with colour to match those of $\partial\Omega$, as shown by the outline lines.
- (4) The “texture” is evenly applied, and the minor details are painted in the spaces that are missing them.

The first image inpainting technique is suggested by Bertalmio et al. [1]. Chan and Shen developed further partial differential equation based methods [2, 3], which were based on the same research as that of Bertalmio et al.

The Diffusion method seamlessly expands image contents from the border line to the inner part of missing area, especially the hole. In order to do this, Li H et al. [4] suggested a diffusion technique that included first localising the diffusion of the inpainted regions and finally, in order to identify the inpainted areas, developing a feature set dependent on the intra- channel and inter-channel local variations of the changes. Utilising the coefficients that were calculated using direction and distance between the distorted pixel and its adjacent pixels is another technique presented in a subsequent study by Li K et al. [5]. Another diffusion-based technique based on the Fourier transform and fractional order derivative and was proposed by Sridevi et al. [6].

In summary, diffusion-based systems perform well on pictures with minor occlusions and restricted damaged areas. This technique performs poorly when filling big regions because, if the target region is vast, it frequently causes visual blur. When the missing areas are big and textured, blurring artefacts may be created in practically all PDE-based techniques.

The second group of methodologies, texture synthesis techniques, were presented to cover huge regions with pure textures. These techniques all have the same goal of capturing data from the desired area to the destination area. According to the size of the sample texture, two types of texture generation methods are categorised: pixel-based sampling and patch-based sampling. The

algorithms used in pixel-based schemes are extremely sluggish since the filling operation is carried out pixel by pixel.

Exemplar-Based Inpainting:

Exemplar-based techniques represent the second group of approaches that have been put out to fill in huge areas of missing images. Both textural, structural information of the damaged big region may be concurrently repaired using exemplar-based picture inpainting techniques. Nonlocal self-similarity priors were first created in the texture creation field, are used to fill-up in the empty space in order to circumvent the drawbacks of local smooth priors.

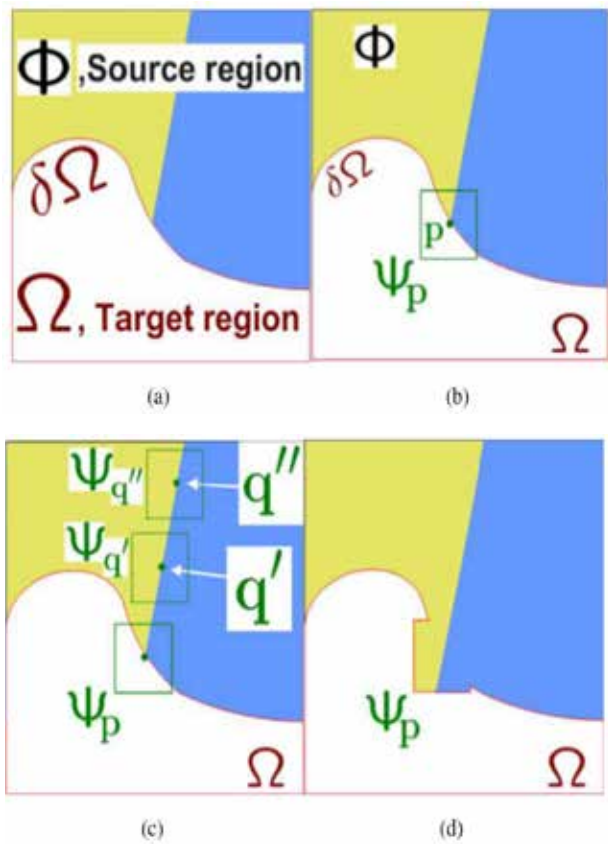


Fig. 3: Process of painting an image in example-based inpainting (A) The original picture, showing the source and target region. (B) displays the filled patch that was selected based on best matched pixel. The patch that is matching to the missing patch is shown in (c). The image in (d) demonstrates the best matching patch being transferred to its occupied spot from a candidate patch.

The propagation of linear structures from (a) to (d) during the inpainting process is shown in Figure 3. The target region, which is the area that has to be filled, is represented by Ω , and its contour is given by $\partial\Omega$. Samples are provided by the source region, ω , which is permanent throughout the algorithm, and are used for filling procedure. Assume that the square template $\psi_p \in \Omega$ centred at the point p (fig. 3b), is to be filled. The patch $\psi_q \in \omega$, which most closely resembles the areas that have previously been filled in with ψ_p , belongs from the source region that matches the best. As seen in the example in Fig. 3b, the best matches are most likely to be along similarly coloured edge if ψ_p is on the continuation of an edges of the image, as in the case of $\psi_{q'}$ and $\psi_{q''}$ in Fig. 3c. A straightforward transfer of the pattern from the source patch with the best match is all that is needed to propagate the isophote inwards (fig. 3d). The technique for filling regions is outlined as follows:

1. The fill front $\partial\Omega$ is first determined.
2. All patches whose centres align on the fill front $\partial\Omega$ have their patch priority are calculated.
3. The patch ψ_p with the highest patch priority is selected.
4. From the source area, the best matching candidate patch ψ_q is picked.
5. Switch over the data from ψ_q to ψ_p . In this stage, the target region's border $\partial\Omega$ of the target region Ω and the information required for assessing filling priorities are updated, resulting in a partial fill-in of the missing region Ω .

The exemplar based technique was presented by Criminisi et al. [7] and works well to synthesise the texture in target areas, making it more appropriate to cope with large regions, such as removing background people from photographs while maintaining picture features in the filled region [8–13].

Patch based concepts works on finding substitute patches that are well matched, and fills the missing portions into the image patch by patch (known as candidate patches). The patch- based methods has been proposed by several different ways. A patch based method was proposed by Rui'c et al. [14] and employed

a MRF-Markov random field to find the best matched patch in the texture component. Authors suggested method for restoring the damaged block in the picture using TSLRA i.e. Two Stage Low Rank Approximation [15] and gradient based low rank approximation [16]. Another inpainting technique was proposed by Fan and Zhang [17] and is based on summarising the differences between patches to determine how similar they are. Jiang [18] suggested a technique for image compression that involves removing blocks from a picture. Alilou et al. [19] suggested a method to recover the missing sections using single value decomposition also by an approximation matrix. A unique strategy combining picture completeness, texture generation, and image inpainting was proposed by Nikos Komodakis et al. [20]. They attempt to stay away from assigning greedy patches in order to prevent visibly inconsistent outcomes. Dynamic label trimming and Priority based message scheduling are two significant improvements over normal BP that are included in a unique optimisation strategy called priority-BP. A technique for exemplar-based picture inpainting that employs angle-aware patch matching and can choose several matched patches from the given region was proposed by Na Zhang et al. [21]. An angle aware rotation technique increases the likelihood of finding the best matched patch.

Although the sequential based systems, which include Diffusion-based and Exemplar-based approaches, show promise in number of aspects of image inpainting, such as filling texture details but still capturing the overall structure remains a difficult challenge [22].

In summary, the image inpainting systems classified under the exemplar-based structure synthesis category reconstruct the structure and texture of a missing region using similar patches from a recognised neighborhood. This is based on similarity of the pixel that was discovered by taking texture samples from recognised regions of the picture. Additionally, to close the gap and update priority, replace any missing pixels in this category with comparable pixels from the patch. Additionally, issues relating to speed, texture correctness (meaningless growth), and proper propagation of linear structures are addressed. Failures in curved constructions and depth uncertainty are additional drawbacks mentioned. Also,

it is a greedy approach that increases the chance of adding an undesirable item or artefact to the region to be painted because it always chooses the best patch for the current place.

Sparse Representation Method

Although there is less chance of introducing unwanted items or artefacts than in the exemplar-based technique, the features of the recovered image are less accurate since a sparse representation of an image is only an approximation. The sparse-based approaches presuppose the presence of signals in pictures that are likely to provide a sparse decomposition across a redundant dictionary. Chang et al. use colour space to rectify the overexposed facial pictures in digital photos of facial photographs.[41]. Selecting bright areas on the face is done using a sliding window-based approach. However, this technique cannot be used for other types of images and is only strongly advised for facial photographs. When examining two sample textures, Kawai et al.'s [42] method takes into account the fluctuations in image brightness and the spatial localization of texture patterns. This approach fills in the desired regions by reducing the energy function while initialising the missing regions with certain values. Another method of sparse representation was suggested by Shen et al. [43]. This technique uses a redundant dictionary that is built via a discrete cosine transform. This approach uses an iterative sequential computation over a sparse representation to fill in every incomplete patch at the target region's edge. A dual-phase algorithmic inpainting approach was put out by He et al. [44]. This approach makes use of the function called Thieles rational interpolation and the Newton Thieles function. The interpolation is done in the horizontal direction for the damaged vertical pixel point. To set and accept information about known pixel positions for performing pixel intensity interpolation, the image is scanned from line to line. This method's restriction is that the broken pixels must be oriented vertically.

Hybrid Methods

Researchers were inspired to investigate the combined properties of these two approaches after achieving notable results with the exemplar-based texture and

structure generation method in inpainting. It works well with buildings that have curves and small gaps. Using this technique, test image is broken down into structural and texture layers for inpainting. For texture generation the energy function is used, but the structural layer diffusion-based approach is used after decomposition. It adds synthesised textures produced using the method proposed by Leung et al. [45], whereas applies the diffusion-based methodology described by Bertalmio et al. for the structural layer. The patch stitching reduces the joint area while inpainting. The self-similarity measure is used to calculate how similar the centre filled pixel patch is with the known pixel in the source image region. A discrete Laplacian equation is used in this operation. This approach solves the smooth artefacts issue in diffusion-based techniques. However, this approach is ineffective if the vast missing region is visible in the image. To offer a strategy based on the idea of successive stitching, All'ene et al. [46] combined statistical Bertalmio et al. [1] with variational Efros and Freeman [47] approaches. However, this approach is equally ineffective since careful consideration must be given to choose the appropriate patches and associated pixels. For capturing the structure and texture of image without losing any information, Zhang et al. [48] devised a technique that makes use of the wavelet transform. A approach with a modified MRF was proposed by Ghorai et al. [49]. This method for eliminating artefacts chooses target patches from border regions using subspace clustering, which are subsequently improved with the use of joint patch filtering to capture patterns.

In conclusion, these techniques may fill complicated textures and structures while removing text. Although it can manage blur and border discontinuity and provide the finest visual quality, approaches in this category still struggle when it comes to some dis-occlusion and object removal tasks. Additionally, extra computing time is needed.

DEEP LEARNING METHODS

This is recent and efficient approach in the image inpainting field. CNNs (Convolutional neural networks) and GANs (Generative adversarial networks) are being used, and the results are looking excellent.

Convolutional Neural Network

Many studies have been presented for picture inpainting based on CNNs employing encoder and decoder networks. One of these techniques, Shift Net based on U Net architecture, recovers the lost blocks with high precision in terms fine detailed texture and structure [23]. Zhao et al. [25] employ the network for processing medical X-ray pictures, whereas Weerasekera et al. [24] takes input as depth map of the image to the CNNs. A technique for blind image inpainting called (BICNN) was proposed by Cai et al. [26]. Many studies have been presented for picture inpainting based on CNNs employing encoder and decoder network structure. A patch-based inpainting technique for forensics photos was put out by Zhu et al. [27]. utilising the same encoder and decoder network method. SCA i. e. Coherent semantic attention layer is a layer that Liu et al. [28] suggested for the encoder and decoder network for the picture inpainting approach. In contrast to the other techniques, Liao et al.'s [29] Artist-Net approach was put out for picture inpainting. Cai et al. [30], who suggested a semantic object elimination method utilising CNNs, accomplished the same objective.

Generative Adversarial Networks

It is a widely used approach, were first demonstrated for picture production in 2014 [31]. A generator G and a discriminator D, make up the framework known as generative adversarial networks (GANs). A network D is taught to discriminate amongst genuine and created pictures, while a network G is trained to produce an entirely identical image that is not easy to differentiate from actual photos. The feed forward networks, G and D make up the architecture known as GANs. D. Another GAN-based semantic image inpainting technique was proposed by HuH et al. [32] to repair the image. Li et al. [33] suggested a technique for inpainting and character identification for handwritten pictures. The two stage combined network is proposed by Sagong M-c et al. [34] to build a encoder and decoder network known as PEPSI. PEPSI++, which is an expanded version proposed by Shin YG at length [35]. Encoder-decoder networks and multi-scale GAN were utilised by Wang H et al. [36] for picture inpainting. In order to create a scene's backdrop by eliminating the foreground item, Dharmo et al. [37] employed CNNs and the GANs

structure. In order to restore the pictures, Jiao et al. [38] integrated a GAN, a multi-layer convolutional layer, and an encoder-decoder.

The GAN-based systems improve the results, but training speed is very slow, and requires highly powerful computers. This is because convolutional operations and network parameters all demand CPU resources. In their summary of various deep learning techniques, Hanyu Xiang et al. [40] noted that deep learning algorithms may better capture high level semantics and provide

noticeably superior outcomes in future.

In summary, deep learning methods (which includes CNN and GANs) show excellent outcomes in inpainting tasks as compared to traditional algorithms.

SUMMARY OF TRADITIONAL AND DEEP LEARNING METHODS

The advantages and disadvantages of most popular traditional and deep learning approaches for image inpainting techniques are shown in following Table 1.

Table 1: Merits and demerits of image inpainting techniques

Image inpainting Technique	Merits	Demerits
Diffusion based method Bertalmio et al. [1], Chan et al.[2,3], Sridevi et al.[6]	When filling up small areas, it produces good results. Appropriate to use for filling curves and lines. Gives high performance preserving all structural information.	For large missing regions, results in blurring artifacts
Texture synthesis based inpainting	No problem of blurring artifact.	Poor results for curved structures and thick scratches
Texture synthesis pixel based Li et al.[5]	Can be used for deterministic and stochastic textures	Large computation time required
Texture synthesis Patch based Liang et al.[8], Guo et al.[9]	Better performance and comparatively less time required.	Some times produces blur for inappropriate size of missing patch.
Exemplar based method Criminisi et al [7], Liang et. Al.[8], [8-13], Rui'c et al. [14], Nikos et al. [20]	Both structural and textural information can be preserved with promising results	Poor performance if corrupted region is spreaded along most of the area. Failures in curved constructions and depth uncertainty. it is a greedy approach that increases the chance of adding an undesirable item or artifact.
Sparse representation method Chang et al.[41], Kawai et al [42], Shen et al.[43], He et al.[44]	There is a low risk to introduce undesired objects or artifacts. Efficient for facial images distorted due to high light exposure.	In this technique damaged pixels are desirable to have in vertical direction. Gives Poor results for natural scene images.
Hybrid method Efros et al.[45], [46-49]	Applicable for structures with edges and curvatures and can remove text, complex textures.	it requires more computational time.
Deep learning methods Yan et al.[23], Zhao et al. [25], Zhu et al.[27], Cai et al. [30], [31-32], Hanyu et el.[40]	Compared to traditional algorithms, high effectiveness, hence giving promising outcomes.	The performance of these algorithms are dependent on the available data sets. Needs very good performance machines

DISCUSSION AND FUTURE SCOPE

For picture inpainting systems, a wide variety of diffusion-based, exemplar-based, Sparse method, hybrid approach, and deep learning techniques have been utilised in the past. The following are some of the issues with these techniques:

- Blurring artefacts: When the missing regions are big and textured, the diffusion-based approaches may cause blurring artefacts.
- Recognising related patches: Exemplar-based approaches are reliable for basic images, but it might be challenging to find a comparable patch when the image is complicated, such as when it has heavy concentration of texture and objects, or when the objects covers a big area of the image.
- A wide range of distortions: Recently, many researchers have been developing deep learning-based systems. The same method was shown to be ineffective for several categories of distortions. The outcomes of convention approaches (i.e. diffusion and exemplar based methods) rely on how complex the picture structures are.
- Result Dependency: In conventional neural network-based approaches (such as encoder and decoder CNN methods), results depend on the amount of training data that is available. The number and kind of the data utilised in CNN-based approaches affect how effective each strategy is.

CONCLUSION

We make an effort to synthesise both traditional and deep learning methods for picture inpainting. These techniques may be used to correct several sorts of visual distortion, including noise, text, objects, and scratches. It has been discovered that researchers have lately started using deep learning techniques, which are better at generalising to more complicated pictures. The greatest method for getting decent outcomes is to train a learning model using a lot of data. A summary of the benefits and drawbacks of various techniques is provided for the benefit of researchers working on image inpainting.

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Real time Data Visualization using Web Socket on Cloud Server

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ABSTRACT

A study of the available methods of data representation for real-time information must be conducted in order to obtain the most useful and efficient display of information. Customizing platforms and designing customised boards were among the critical tasks required to accomplish accurate information visualization. A generic and dynamic dashboard based on real-time data has been used to evaluate the effect of the available data visualization methods in the generated display. As a result, our control panel addicts were able to interact with the material, which was based on an original collection of clues, maps, tables, and reports developed by the control panel itself. This would allow us to test a current collection of data presentation methods and create a new adapted dashboard, showing that displays may be a unique and vital means of sharing information.

KEYWORDS : *Data visualization techniques, Real-time information, Real-time information*

INTRODUCTION

People need online results more and more constantly these days for their services and apps. While various graphs, images, and charts are constantly being incorporated into various web apps and websites, data visualization is not an exception to this rule. This blog examines an intriguing use case for real-time data visualization in great detail, including the practicalities of data transport [1]. In real-time data visualization, an operation keeps track of a data source that is constantly streamlining, analogous as every numerous seconds or indeed extremely regularly, like 100 times per second [2]. The two main factors of this type of system are data transport and data visualization, roughly speaking. The real-time communication protocol used on the web is called Web Socket, and it has wide support and is compatible with a variety of platforms (cybersurfers, Node.js waitpersons, IoT bias, etc.) [3]. The swish thing is that Web Sockets is fairly strong; in our trials, we were suitable to transfer further than 1 million data points per second with a good network connection and indeed 30,000 data points per second with a really bad network connection

nearly, the vast maturity of use cases for real-time data visualization are formerly covered by this data rate [4]. A important package that can be used for a variety of data visualization operations targeting nearly any type of user interface device is created by combining a real-time web data visualization library (Lightning Chart JS) and Web Socket data transport (computer, laptop, phone, etc.). Visualization, which is data and computationally heavy, is a perfect illustration of a pall calculating operation, according to the considerably accepted notion of pall computing [5]. Employers are increasingly relying on artificial intelligence to collect huge volumes of data that can be challenging and time-consuming to sort through, comprehend, and explain. Visualization can help to accelerate the procedure and convey facts to stakeholders and business owners in a way that they can grasp [6]. Big data visualization constantly moves beyond traditional techniques of presentation, such as pie charts, histograms, and bar graphs [7]. More complex representations, such as heat maps and fever charts, are used by Mohammed, Luay Thamer, AbdAllah A. AlHabshy, and Kamal A. ElDahshan [8]. Big data representation necessitates the employment of sophisticated computer systems to

take raw data, process it, and transform it into visual representations that humans can use to quickly draw perceptivity [9].

Data visualization tools can be utilized in a variety of ways. The most prevalent application at the moment is business intelligence (BI) reporting tool. Stoners can use visualization technologies to create autonomous dashboards that analyses company performance across key performance indicators (KPIs) and visually interpret the results [10].

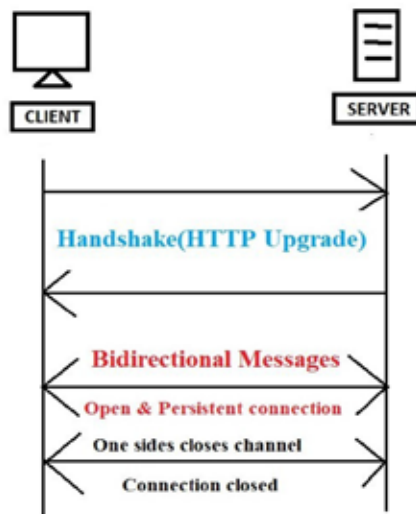


Fig. 1: Client-server connection using web socket

The generated images may also include interactive powers, allowing stoners to influence them or dig farther into the data for questioning and research. Pointers that alert stoners when data has been simplified or when particular conditions are met can also be included. Numerous business departments use statistical visualization tools to monitor their own operations [11]. For example, a marketing team may use the programme to track the results of the marketing effort, tracking metrics such as open rate, click-through rate, and conversion rates [12]. As data visualization merchandisers expand these tools' functionality, they are rapidly being used as front ends for more complex big data systems [13]. In this context, data visualization software assists data engineers and scientists in keeping track of data sources and doing basic exploratory research on data sets before to or following more extensive advanced examinations [14]. The likes of Microsoft, IBM, SAP, and SAS are among the most

prominent firms in the big data tools industry. Other merchants provide specialized big data presentation tools; well-known names in this class include Tableau, Qlik, and Tibco. While Microsoft Excel remains a popular application for data presentation, others have been developed that provide enhanced capabilities [15].

RELATED WORK

To understand data by plates and maps visualization used in demitasse as early as 1137. In all fields there has been vast Development in visualization ways. To examine information and data visualization helps to fantasize and express ideas in armature. With the coming of computer simulation visualization relevance has been foster strengthened. A wide multifariousness of computer grounded tools in constructing design into CAD (Computer backed Design) design is handed by T. Hong et al.(2000)[1]. The use of CAD for seeing design has been espoused exceedingly snappily by professionals throughout the world. Information visualization used to present design data with the aid of delineations and plates and data is generally abstract or special, we bear scientific visualization ways like maps and graphs etc. Ant unlined transformation from homemade to digital fashion in the standing design visualization has followed the presently dominating morals of visualization [2]. There's a conterminous motive to further interrogate the subsisting and new styles of visualization that efficaciously present multidimensional data. The visualization scheme should gain from homemade styles where implicit to prop contrivers make a conversion from their practice [3]. Visualization should have power to present multidimensional data and it must be synergistic and perniteffic communication. Using color coding and layering point analysis data is presented on the delineation with the power of controlling the visibility of layers as craved by the contrivers [4]. The sphere of visualization grows, the instruments are seeking druggies appear in our exploration laboratories. In mandate to defy the accomplishable overload of assessable gain that will promote further far- flung acceptance of visualization in which the utility caught on trials and studies reports are useful simply there's an arising want as cover system of standing [5]. Information visualization generally part of some imaginative action that needs druggies to construct suppositions, quests patterns and rejection,

and polish their thesis. Druggies constantly bear to view the analogous data from different direct perspective and above a time. They might bear a kind of instrument to attain their points, insistently importing and exporting data [6]. Experimenters depict egressing exploration which appears fluently accommodated to examine the imaginative conduct that druggies of information visualization pursue in. To help the pretensions of visualization of information the ethnographic styles imaged. To determine the advantages and disadvantages of their new visualization of information tool the inventor or investigator are keen [7]. The visualization community has subsequently set up no way above the measures and effect of devilish graph decoration and memorandum. Visualization experts similar as Stephen Many and Edward Tufte encouraged the conventional view, stating that the visualization should present the data easily without any undo and shouldn't include map junk[8]. Psychology lab studies have also supported this view, which present that simple and clear visualizations are easy to interpret. Memorability trial results show that visualization is as memorable with thickness over people. Visualization is less indelible than spontaneous scenes but like to film land of faces, which might quaint at general configuration, characteristics of mortal retention. Not stunningly, ascribes similar as appreciation and color of a mortal recognizable end increase memory power [10]. Creating a visualization indelible intends creating the visualization" stick" in the onlooker minds. We bear the most significant applicable angles of data the pen is trying to transmit to stick [11].

METHODOLOGY

An open source set of guidelines, conditions, and coffers called Swagger is used to produce and describe peaceful APIs. inventors can write interactive, machine-and mortal- readable API attestation using the Swagger frame. An API description format for REST APIs is called Open API Specification (formerly Swagger Specification). You can describe your full API in an Open API train, which includes the following Available endpoints (/ druggies) and operations on each endpoint (GET/ druggies, POST druggies) operating conditions For each operation, the input and affair. An open source Java- grounded frame called Spring Boot is used to make micro Services. The Pivotal Team created it, and

it's used to produce standalone, product-ready spring apps. Through the TCP protocol, the IP address is stationed in the operation and separated from the JPA.

Maven is a popular open- source figure tool developed by the Apache Group to make, publish, and emplace several systems at formerly for better design operation. The tool provides allows inventors to make and validate the lifecycle frame. Maven is written in Java and is used to make systems written inC#, Scala, Ruby, etc. Grounded on the design Object Model(POM), this tool has made the lives of Java inventors easier while developing reports, checks make and testing robotization setups. Maven focuses on the simplification and standardization of the structure process. Tomcat has transitioned from the original Java EE specification to Jakarta EE, like other Java business technologies. Tomcat is an operation garçon made to render websites with Java Garçon runner law and run Java servlets. A" webserver" or" servlet vessel" is what Tomcat does.

Socket is a computer messaging protocol that provides full-duplex communication channels over a single TCP connection. The IETF standardised the protocol known as WebSocket as RFC 6455 in 2011. Websockets is the current API specification that allows web activities to use this protocol. The Webhook protocol, comparable to HTTP polling, facilitates commerce among an online cybersurfer (or other customer operation) and a web garçon with lower output than half-duplex druthers, simplifying real-time data transfer from and to the garçon. This is performed by providing a standardised method for the garçon to shoot stuff to the client without first being asked by the consumer, as well as allowing dispatches to be handed back and forth while keeping the channel open. This allows for a two-way constant dialogue between the customer and the garçon.

According to the most recent Google Play notice (1), all new apps and app upgrades must target Android 13(API position 33) or above, with the exception of Wear zilches apps, which must target Android 12. It has various types of services, such as exertion director, announcement director, view system, package director, and so on, that are useful for the development of our operation in accordance with our needs. In the form of Java classes, the operation Infrastructure subcaste provides several advanced-position operates to operations. Operation

creators have permission to use these services in their operations.

A figure automation tool for language software development is called Gradle. It controls all phases of development, from planning and packaging through testing, installation, and release. Java (as well as Kotlin, Groovy, and Scala), C/C++, and JavaScript are supported languages. Gradle expands upon the shared traits of Apache Ant and Apache Java and adds a modern, Kotlin-based sphere-specific language that differs from Java's XML-based design configuration. By providing the dependence operation, Gradle hires an acyclic graph with directions to establish the possible order in which jobs can be executed. The virtual machine called Java is used to run it.

A mound with armature graphic represents the android operating system. As demonstrated in the belo Linux Kernel, actions are operation Foundation Android Runtime Platform Libraries of software factors approximately separated into five divisions and four primary levels. The greatest subcaste of an android armature is an operation. The pre-installed activities—such as camera, gallery, home, interactions, etc.—as well as third-party operations—such as games, converse operations, etc.—that are downloaded from the Play Store will be put on this layer. It use the classes and services provided by the operation frame to operate within the Android runtime. The Dalvik virtual machine (DVM) and core libraries are parts of the Android Runtime Environment. It serves as the framework's basis and, with the aid of the essential libraries, drives our application. To enable a device to run many instances effectively, the Dalvik Virtual Machine (DVM), like the Java Virtual Machine (JVM), is a register-based virtual machine created and optimised for Android. Threading and basic memory management are reliant on the Linux kernel layer. With the help of the vital libraries, we may create Android applications in either the common Java or Kotlin programming dialects.

RESULT

There are further measures listed to get our desired outcomes. start the developer option and press the USB debugging option and make sure that if someone has the most recent update for their phone, they should choose USB configuration and then click on the P2P option

before running the program because doing so will cause a device-our laptop or computer-to display the name of the device on its screen. Additionally, we must run this, which will provide a visual representation of the diseases according to the year, country, etc. It will go through a number of steps during this time, such as building Gradle, and only then will installation be successful. Make sure our device and the cell phone are connected to the same network as one more extremely critical and important element. As far as fresh data entry is concerned, we can also upload the most recent information.

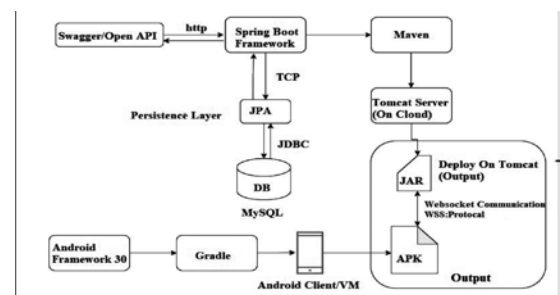


Fig. 2. Data Visualization using Websocket on Cloud Server

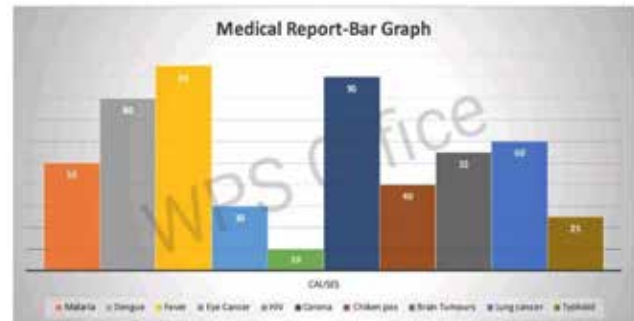


Fig 3. Here bar graph represents the diseases occurred over the time period.

1: Lung cancer; 2: Malaria; 3: Dengue fever; 4: Eye Cancer; 5: HIV; 6: Corona; 7: Chicken Pox; 8: Brain Tumours; 9: Typhoid

Finally, we'd be able to easy-to-comprehend visual format.

- faster action
- structured
- helps in making wiser decision
- easy to understand and compare data.

CONCLUSION

The study work makes a contribution to the cloud-based data visualization technique. Data preparation, storage management, data processing and manipulation, and display are all part of the process. Because of the vast amount of knowledge that exists and is being developed every day, the number of artifacts that have previously been unearthed. It is difficult to find ways to convey information in a way that fits the demands of all knowledge users and consumers today.

An intelligible method or make sense out of it. The solution we propose is to build a dashboard in which users may interact with data based on a predefined collection of dashboard-generated hints, charts, tables, and reports. This user interface will be accessible to users for free and with ease.

Dashboards can be a unique and effective means of displaying information. No matter how advanced technology may be, the success of a dashboard as a communication tool is determined by its layout.

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Academic Counselor Chatbot

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ABSTRACT

Software that uses Artificial Intelligence that can talk with humans is called as chatbot. These device or Software/ Application are used to respond quickly to your requests, provide information, provide guidance, and answer your questions and queries. This article outlines the general working theory, key ideas, and possible applications of artificial intelligence chatbots in education. Natural language processing is an advanced and effective way to understand and provide solutions to today's problems and the technology that supports the system. The proposed system is an all-in-one conversational chatbot that can help students to , provide information about ,various institute depending his/her entrance score. The Nave Bayes model is used by the system to solve the identified problem. Therefore, this project aims to develop a chatbot for learning students. Chatbot support and assistance to students during learning, making learning more effective and interesting.

KEYWORDS : *Chatbot, Neural intents, NLTK, Python, Raspberrypi, TensorFlow, etc.*

INTRODUCTION

Chatbots or software applications issued to conduct online chat conversations using text or text-to-speech instead of direct contact with a physical human agent [1]. A chatbot is a software that supports customers by automating interactions and responding via messaging services. In this work we are developed a university-specific chatbot that assists students seeking admission to Nagpur University. Students who want to use this chatbot can enroll in various fields. The chatbot will ask you about your test results and provide you with a list of universities you can pass based on your results [2]. The knowledge built into the chatbot machine allows it to recognize sentences and decide how to answer questions [3]. Chatbots typically store historical data or commands and use them to provide a conversational service that processes questions. Many people can use chatbot applications if they are integrated with well-known web services. This student chatbot system analyzes user questions and responds with pertinent information during college inquiry Artificial algorithms are used to Chatbots are used everywhere

such as in medical, educational, customer support, etc. As we all know that when students completed their higher secondary school certificate (HSC) they get to choose various steam such as engineering medical etc. create chatbots, which can analyze user questions and understand user messages. The user input String should match the ground rules answer. After analyzing the request, the system responds to the user [4]. The world of education is constantly evolving, and technology has played a crucial role in revolutionizing the way students learn and seek guidance. With the rise of AI and natural language processing, it has become possible to create chatbots that can assist students in their academic journey. The Academic Counsellor Chatbot using AI aims to provide personalized and instant guidance to students on a wide range of academic and non-academic issues. This chatbot leverages the power of AI to understand the student's needs and provide relevant information and support. The ultimate goal of this project is to provide students with a virtual academic counselor that can assist them in making informed decisions and help them succeed in their educational pursuits.

The objective of the Academic Counsellor Chatbot using AI project was to develop a virtual academic counselor that can assist students in their academic and non-academic pursuits. This project aimed to evaluate the effectiveness of AI in providing personalized and instant guidance to students. The results of this project will showcase the capabilities of the chatbot and demonstrate its potential to revolutionize the way students seek guidance.

RELATED WORK

Authors gone through various research article and found related review as, In 2020 Punith S, Chaitra Veeranna, Kotagi Chethana has published the paper “Chatbot for student Admission Enquiry” by the publisher HBRP Publication, In 2020 Nuria Haristani has published the paper “Chatbot Language Learning Medium” by the publisher IOP Publishing, In 2022 Kamran Qamar, Sayyed Tarique, Hasan A Rahim has published the paper “AI-Based Virtual Assistance on Raspberry PI” by the publisher IJARST, In 2020 Dr. Ashok Kumar K, Ajay Palakurthi , Vaishnavi Putnala “Smart College Chatbot using ML and Python” by the publisher IEEE, In 2022 Abhishek Rout, Vaibhav Kamble, Abhishek Gadge, Sagar Joshi “Conversational Chatbot for Students” by the publisher IJRPR.

METHODOLOGY

A chatbot is a device maybe a software or hardware device that helps people to generate automatic replies as per the user’s questions. Different types of chatbots are used in various fields such as medical education, customer support, etc. so that’s where chatbot plays a very important role in today’s world in helping people. What is Chatbot? A chatbot is a device that can be either a software or hardware device that helps generate 444-like automated responses to user questions. Different types of chatbots are used in different fields such as medical education, customer support, and more. This is where chatbots play a very important role in today’s world of helping people. A chatbot for education? chatbots are used everywhere: in medicine, education, customer support and more. Because we all know that students can choose other fields such as medical engineering and more once they receive their High School Diploma (HSC). Students go

to different colleges and ask different questions such as cost structures, closures, and bus availability. These types of questions are commonly asked by students to counselors. That is not enough to answer all students. This time, the chatbot helped students ask questions about various colleges and information about them. Just enter your entrance exam score into the chatbot and the chatbot will show you all the different colleges you can apply to and you can easily register for at the base level of the score. Normally India Engineering admission are seek through JEE and MHTCET scores, and if you want to apply for Medical School, the bot will ask for NEET scores. As Students go to different colleges and ask the counselor for queries such as fee structure, cut-off, and bus facility available or not These types of questions generally students ask the counselor. As we see a problem, one counselor was not enough to answer all the students. That time this chatbot helps students to ask queries about different colleges and information.

The methodology of using a chatbot in education involves several steps:

- ❖ First, the chatbot needs to be programmed to understand and respond to the types of questions that students may have. This requires developing a database of information related to the educational institution, such as admission requirements, course offerings, tuition fees, and other important details.
- ❖ Second, the chatbot must be designed to provide accurate and helpful responses to student queries. This involves training the chatbot to recognize different variations of a question and to provide appropriate answers based on the context of the question.
- ❖ Third, the chatbot must be integrated into the educational institution’s website or mobile app, so that students can easily access it and use it to ask questions.
- ❖ Fourth, the chatbot must be regularly updated with new information, such as changes to course offerings or admission requirements, to ensure that students always have access to the most up-to-date information.
- ❖ Finally, it is important to evaluate the effectiveness of the chatbot over time, by tracking the number

of student queries and the quality of the responses provided. This can help to identify areas for improvement and to ensure that the chatbot continues to meet the needs of students.

- ❖ Overall, the methodology of using a chatbot in education involves careful planning, programming, integration, and evaluation, to ensure that students have access to accurate and helpful information, and that educational institutions can effectively manage the workload of student queries.

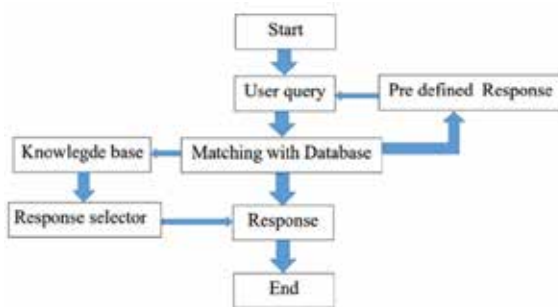


Fig. 1 Block diagram of the proposed system

In this project, we are using python as the main language and for implementation, we are used a raspberry pi, speaker, and mic.

Software Implementation

Python is very useful in machine learning. Python provides greater output in a short amount of code; python also provides us with lots of libraries that make our work easy to do.

Following libraries are considered for implementation:

- ❖ Speech recognition library:
The speech recognition library in Python is used to capture and interpret human language input. It allows the chatbot to understand and convert spoken words into text, enabling it to process user queries effectively.
- ❖ pyttsx3 library:
The pyttsx3 library is a text-to-speech conversion tool in Python. With this library, the chatbot can generate spoken responses to the user's queries, providing a more interactive and natural conversation experience.

- ❖ Neural intents library:

The Neural intents library is a recently released tool that aids in accurately identifying user intents and generating appropriate responses. By utilizing files such as intents.json, which contains predefined intents and their corresponding responses, the chatbot can match user queries with the intents and provide relevant answers.

Hardware Implementation:

Raspberry Pi, a small and affordable single-board computer, is utilized for the hardware implementation in this project. It serves as the central processing unit (CPU) that runs the chatbot program and controls the connected speaker and microphone. Raspberry Pi provides a compact and versatile platform for running the software code and handling the input/output functionalities required for the chatbot.

Process:

Wake-up activation:

To initiate the chatbot, the user needs to say “wake up.” This activation phrase signals the system to start listening and responding to the user's queries.

User inquiry:

Upon launching, the chatbot will inquire about the user's needs. It prompts the user to specify the field they are currently in or interested in pursuing.

Field selection:

The user is expected to inform the chatbot about their chosen field, such as engineering or medicine. This information is crucial for providing accurate and relevant guidance.

Examination scores:

For users selecting engineering or medicine, the chatbot will ask about their scores in relevant entrance exams such as JEE, MHTCET, or NEET. These scores are essential for assessing the user's eligibility and suggesting suitable college options.

College recommendations:

Based on the user's field and examination scores, the chatbot will suggest college names that align with their qualifications. These recommendations aim to assist

users in finding suitable institutions to pursue their desired field of study.

Unrelated queries:

If a user poses a question that is unrelated to any specific field or college, the chatbot will respond with a pre-written text or message indicating that the query is beyond its scope of knowledge.

By following this process, the chatbot can engage in a conversational manner, understand user requirements, and provide helpful guidance regarding field selection and college recommendations.

- I. The user speaks to the chatbot through the input microphone that is connected to the Raspberry Pi. The Raspberry Pi records the user's speech and converts it into text through the use of speech-to-text technology.
- II. Once the user's intention is determined, the Python program processes the request and generates a response. This response can be based on pre-written scripts, or it can be generated dynamically using data from databases or APIs
- III. The response generated by the Python program is then converted into speech using text-to-speech technology. The text-to-speech technology converts the text into an audio file that can be played through the output speaker connected to the Raspberry Pi.
- IV. The user can now hear the chatbot's response through the output speaker and continue the conversation with the chatbot by speaking into the input microphone again. The chatbot will continue to listen and respond to the user in this way until the conversation is finished.

Advantages:

Chatbots offer instant responses and round-the-clock availability, reducing waiting time for users. They are cost effective alternatives to hiring additional staff and can handle large volumes of queries simultaneously. Chatbots provide consistent responses, minimizing the risk of human error. They can be personalized to deliver tailored experiences based on user preferences. By handling routine tasks, chatbots improve efficiency and

allow human staff to focus on more complex matters.

Disadvantages:

Chatbots have limitations in handling complex queries that require critical thinking or human judgment. They lack emotional intelligence and may not understand users' emotions or tone accurately, leading to potential miscommunication. Chatbots depend on technology and may experience glitches or errors, impacting their functionality. Developing and maintaining a chatbot can be costly. Some users may resist chatbot usage, preferring human interaction for situations that require empathy and emotional support.

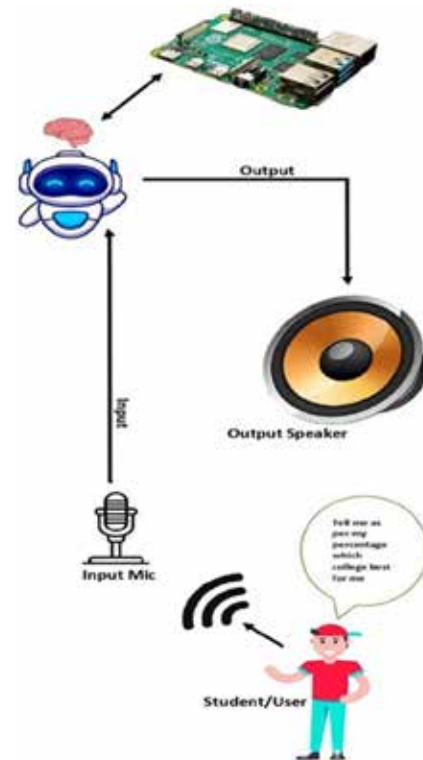


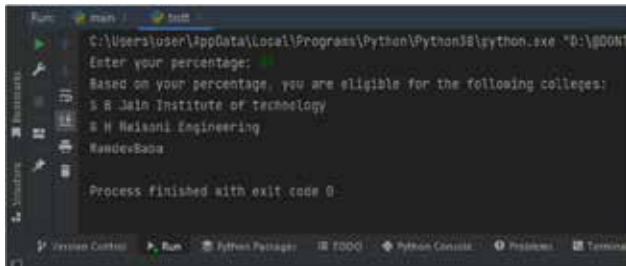
Fig. 2 System Model Working

RESULT AND DISCUSSIONS

The result of the Academic Counselor Chatbot using AI project can be seen in the form of an interactive and intelligent chatbot that is able to provide students with information and guidance in a conversational manner. The chatbot uses speech-to-text and text-to-speech technology to simulate a human like interaction, and the neural intents library ensures that the chatbot is able to understand the user's intentions and provide relevant

responses.

The Academic Counselor Chatbot using AI project has the potential to revolutionize the way that universities and colleges provide academic information and guidance to their students. The use of advanced technologies such as speech-to-text, text-to-speech, and neural intents library allows the chatbot to simulate a human-like interaction, making it a convenient and accessible option for students who need information and guidance.



```

C:\Users\user\AppData\Local\Programs\Python\Python38\python.exe "D:\BOONT
Enter your percentage:
Based on your percentage, you are eligible for the following colleges:
S B Jain Institute of technology
S H Nainani Engineering
RawdevBaba
Process finished with exit code 0
  
```

Fig. 3 Console Output

Following are the key features of chatbot

1. **Reliability:** One concern is the reliability of the chatbot's responses, as the technology is only as good as the data and algorithms used to train it. Ensuring that the chatbot provides accurate and reliable information is crucial to its success.
2. **Privacy and Security:** With the chatbot handling sensitive academic information, there are also concerns about privacy and security. Measures such as encryption and secure data storage must be in place to protect student's personal information.
3. **Limited Capabilities:** While the chatbot can provide basic academic information and guidance, it may not be able to handle complex or nuanced requests. Students may still need to speak with a human counselor for more specialized assistance.
4. **Job Losses:** Another concern is the potential for job loss in the academic counseling field as the chatbot becomes more widely adopted. While the chatbot may be able to handle basic requests, human counselors may still be needed for more complex issues.
5. **Bias:** As with any machine learning model, there is also the potential for bias in the chatbot's responses.

Ensuring that the data used to train the chatbot is diverse and free of biases is important to ensure that all students receive equal and fair treatment.

Overall, the Academic Counselor Chatbot using AI project has the potential to greatly improve the way that universities and colleges provide academic information and guidance to their students. However, careful consideration of the potential drawbacks and concerns must be taken into account to ensure that the chatbot is a reliable, secure, and unbiased tool for providing student support services.

The benefits of conducting the educational chatbot are as follows.

- One key advantage of using educational chatbots is that they provide students with instant access to information. In the past, students may have had to wait for a response from a human counselor or advisor, which could cause delays and frustration. With chatbots, students can get answers to their questions instantly, at any time of the day or night. This can help to minimize confusion and frustration and improve students' overall experience.
- Another benefit of educational chatbots is that they can help to reduce the workload of human staff. Educational institutions often have limited resources and staff, which can make it difficult to handle the high volume of student queries effectively. By using chatbots, many of these queries can be answered automatically, freeing up staff time to focus on more complex and critical tasks. This can help to improve overall efficiency and productivity.
- In addition, educational chatbots can improve the overall accuracy and consistency of the information provided to students. Chatbots can be programmed to provide consistent and accurate information, reducing the likelihood of students receiving conflicting or incorrect information. This can help to reduce confusion and frustration and improve the overall quality of the student experience.
- Moreover, educational chatbots are cost-effective solutions that can help to save time and money for institutions. Compared to hiring additional staff to handle student queries, educational chatbots

are relatively inexpensive and require minimal maintenance. They can also be updated easily with new information, ensuring that students always have access to the most up-to-date information.

- Finally, educational chatbots provide personalized assistance, as they can be designed to ask specific questions and provide tailored information based on the student's needs. This can help to improve the overall student experience, as students feel that their questions and concerns are being heard and addressed in a timely and effective manner. Personalized assistance can also help to improve student engagement and retention rates, as students feel more connected and supported throughout their educational journey.
- Overall, the benefits of chatbots are significant, from providing instant access to information and reducing staff workload to improving efficiency and accuracy and providing personalized assistance to students. As such, the use of educational chatbots is an exciting and promising development in the field of education.

CONCLUSION

In conclusion, the use of AI in academic counseling has the potential to transform the way students seek guidance. However, it is important to approach the implementation of chatbots in education with caution and to carefully consider the limitations and challenges associated with their use. The development of AI-powered academic counselors is an exciting area of research with the potential to have a positive impact on students' academic and personal lives.

The potential benefits of using AI-powered academic counselors in education are numerous. These chatbots have the potential to provide students with personalized support, guidance, and resources. They can also help to address the shortage of human counselors and make counseling services more accessible to students. Moreover, chatbots can be available 24/7, enabling students to seek help outside of regular counseling hours.

However, there are also potential limitations and challenges associated with the use of chatbots in academic counseling. For instance, chatbots may not be

able to provide the same level of empathy and emotional support as human counselors. Additionally, there may be privacy concerns related to the collection and use of student data by chatbots.

Therefore, it is crucial to approach the implementation of chatbots in education with caution and to address these challenges to ensure that their use is beneficial for students. Research and development in this area should be aimed at creating chatbots that are effective, ethical, and user friendly. The development of AI-powered academic counselors is an exciting area of research with the potential to have a positive impact on students' academic and personal lives.

ACKNOWLEDGEMENT

This project idea was the problem status given by AICTE (All India Council for Technical Education) in Hackthon-2023.

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Comparative Analysis of Crop Disease Detection by Artificial Intelligence

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ABSTRACT

Cotton is the vital crop that contributes significantly to the global economy. However cotton crop plants are susceptible for various disorders that can lead to large amount of yield losses if not detected and managed in a timely manner. The traditional methods of disease detection in cotton crops often rely on visual inspection by human experts are time consuming and makes lots of errors. We begin by collecting a comprehensive dataset of cotton plant images, including healthy plants and plants infected with various diseases such as bacterial blight, fungal wilt, and viral infections. The dataset is then used to train and validate the AI models to get the accurate results. This paper begins with comparing the performances of different ML techniques like Support Vector Machine, Random Forest, Decision Tree and CNN in terms of parameters like accuracy, selectivity, sensitivity etc. By comparing the performance of various algorithms and techniques, we aim to identify the most effective and efficient method for accurately detecting and diagnosing cotton disease.

KEYWORDS : Cotton diseases, CNN, Deep learning, SVM, Random forest

INTRODUCTION

In today's world modern inventions has made it simpler for us to supply proper, healthy nourishment and food to meet the requirements of the rapidly increasing population. In India, which is the world's biggest populated area, agriculture employs maximum approximately 75% the people directly or indirectly. Normally crop Pathologist or Entomologist's examine crop diseases in a traditional manner, which is more time consuming and yields more of error. It's very important to diagnose plant diseases in order to meet the requirements of the count ry. However, the cotton industry is facing various challenges, with diseases being a significant and important concern for farmers and agriculture experts. Timely detection and cure of cotton plant diseases is very important to prevent the spread of diseases to other plants, minimization of the cotton crop losses and optimize the agriculture practices.

In recent years there are lots of advancement has taken place in artificial intelligence (AI) and machine learning (ML) fields. AI-based techniques offer promising solutions for automated disease detection in crops, including cotton. These techniques utilize computer vision, pattern recognition, and data analysis algorithms to identify disease symptoms, classify diseases, and assist farmers in making informed decisions regarding crop management. This comparative analysis aims to evaluate and compare different AI-based approaches used for cotton disease detection. By examining the strengths, limitations, and performance of these techniques, we can gain insights into their effectiveness and potential for real-world applications. Depending upon the usage crops are divided in to different types of crops. There are some characteristic properties on which the plant diseases are categorized [5]. All the plant diseases are mainly classified into two main categories

based on their infections as: caused by living organisms and nonliving organisms. Living organisms elements include Fungi, Bacteria, Slime molds, Viruses, Parasitic angiosperms, Algae, Insects, Mites, Nematodes, and so forth Nonliving organisms factors incorporate Soil-dampness misbalance, Nutritional issues, Light intensity imbalance, Gas, Optimal temperature imbalance, smoke and other air toxins, Careless splashing of chemicals [5].

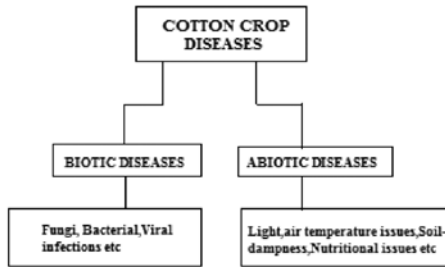


Fig. 1. Different types of crop diseases

CHALLENGE IN ANY PLANT/CROP DISEASE DETECTION

The research the done on different plant or crop diseases by many researchers to make the work of farmers easy. But the spotting of the Crops or plant diseases is a very tough task. The challenges are as follows [5].

1. Need to take very high quality of images of plants.
2. We require large dataset for training and testing purpose.
3. Many parameters affect the acquired images.
4. Climate will vary the dataset.
5. Need to regularly observe the plant.
6. The different plants or crops have various types of infection. And detection of this is very important.[5]

GENERALIZED SYSTEM FOR CROP DETECTION

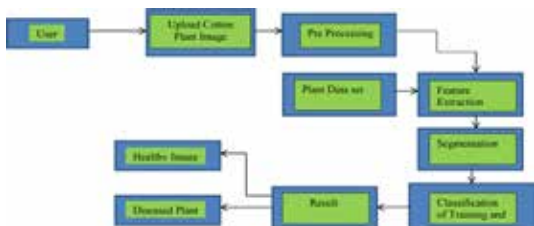


Fig. 2. Generalized block diagram of crop detection

DATA SET

Basic steps taken for all these research work is identifying the proper and authorized dataset. The images which acts as a input for the research work of different cotton leaves or any crop images are around 2000 or more images were trained and tested and validated [1]. Images should contain the healthy, aphids, army worm, bacterial blight, grey mildew, target spot leaves of plant as shown below. Crop cotton diseases include pathological infections that affect the plant's leaves, roots, seeds and other parts. But more or less diseases occur on the leaves [9].



Fig 3. Images of healthy leaves of cotton plant



Fig 4. Images of aphids



Fig 5. Images of Army worthy



Fig 6. Images of Bacterial Blight



Fig 7. Images of Grey Mildew



Fig 8. Images of Target Spot

METHODOLOGY

The generalized block diagram of development process of crop is depicted in fig 3 which includes a large data set collection and identifying data for segmentation, model training and evaluation, and finally model testing training and Deployment [16].

Data Collection and Preparing

The data set was obtained via the physical contact with the farmers and agriculture experts. Only image of the crop data is included in the dataset, which are categorized as: plant with diseases and healthy [16].

Pre Processing

These preprocessing steps aim to enhance the image quality, reduce noise, remove unwanted artifacts, and extract relevant information to improve the performance of subsequent image analysis algorithms. Here are some common preprocessing techniques used in image processing:

- **Resizing:** Resizing involves changing the dimensions of an image. It can be done to scale down the image or make it larger.
- **Cropping:** Cropping involves removing a specific region or portion of an image. It is often used to focus on a particular area of interest or to remove unwanted parts of an image.
- **Image Enhancement:** Enhancement techniques are used to get better the visual quality of an image.
- **Filtering:** Filtering techniques are used to remove noise or unwanted artifacts from the image.
- **Color Space Conversion:** Sometimes it is necessary to convert the color space of an image.
- **Normalization:** Normalization is obtained to standardize the pixel values of an image.
- **Histogram Equalization:** Histogram equalization

is a method used to improve the distinction of an image by redistributing the intensity values.

Feature Extraction

Feature extraction in image processing refers to the process of extracting meaningful and relevant information or features from an image. These features capture distinctive patterns, characteristics, or structures present in the image, which can be used for various tasks such as image classification, object recognition, and image retrieval. Here are some common techniques for feature extraction in image processing:

- Edge Detection
- Corner Detection
- Texture Analysis

Classification

Classification of images involves the task of assigning a label or category to an image based on its content. This task is commonly performed using machine learning algorithms, particularly deep learning models such as Convolutional Neural Networks (CNNs), which have shown remarkable performance in image classification tasks.

Support Vector Machine Classifier

SVMs are particularly effective for binary classification problems but can also be extended to handle multi-class classification. For the analysis purpose of data by regression and classification, support vector machine is useful.

SVM measures the hyper plane that have the expanded the margin within the 2 different groups of data. The hyper plane vectors are called as support vectors. By assuming the required situations, SVM will develop a margin of hyper plane that divides the hyper plane vector totally into two non-intersecting classes. Many cases, however, this technique is not applied, so this classifier method is used to find hyper planes of the support vectors that bounces the given margins and reduce the errors [3].

Random Forest Classifier

The Random Forest classifier is an collection of learning algorithm used for classifying tasks. It is based

on the concept of decision trees and combines multiple decision trees to make predictions. These are very much sensitive to data set and if any small changes are made on the given data set it will be changing the tree completely. In the simple tree the node that is presented is based on certain guess and features whereas in random forest the node is taken on random features in a subset [19].

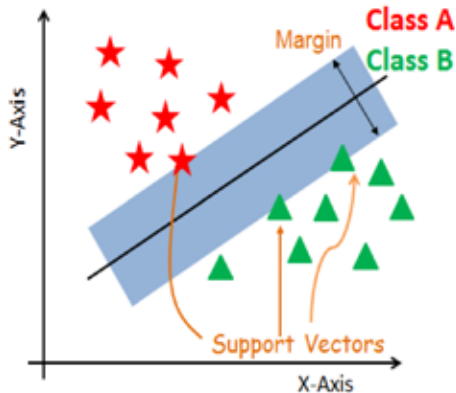


Fig 9. SVM Classifier [19]

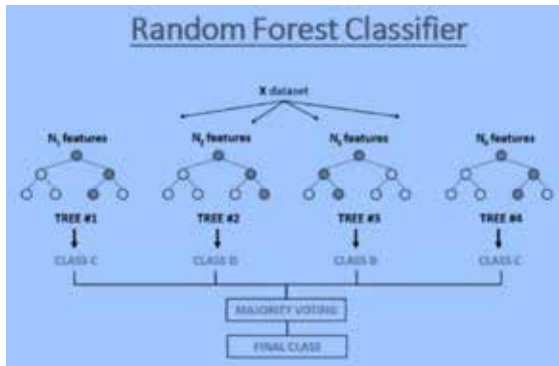


Fig. 10. Random Forest Classifier [21]

K Nearest Neighbour Classifier

The K Nearest Neighbors (KNN) classifier is a simple yet powerful supervised ML algorithm used for classifying of the data set. It belongs to the family of instance-based or lazy learning algorithms, where there is no explicit training phase, and the model stores the entire training dataset for making predictions. This method or technique has a detection rate of 90% in crop or plant disease detection. This is the simplest ML algorithm technique. It works on the fact that if a new data is closed to available data fixes that data as new data. This method is applicable for regression and

classification solving problems, it is used when we have direct data set with us. And this algorithm directly acts on the data. This is used to categorize or classify the data[5].

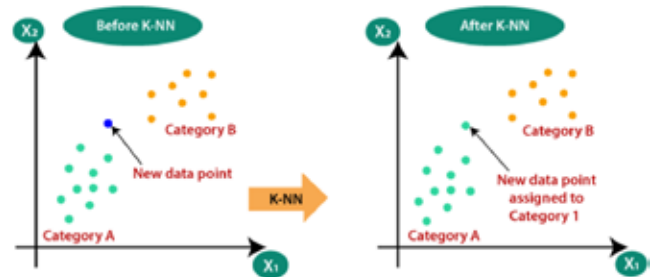


Fig. 11. KNN Classifier [23]

Deep Learning

Deep learning is a branch of ML that focuses on ANN with many numbers of layers, also known as deep neural networks. Deep learning algorithms are designed to automatically learn and extract hierarchical representations of data by leveraging large amounts of labeled or unlabeled data. Deep learning has achieved remarkable success in various domains, particularly in tasks involving complex patterns, such as image and speech recognition, natural language processing, and recommender systems.

FUZZY Classifier

A Fuzzy Classifier is a type of classifier that utilizes fuzzy logic to handle uncertainty and imprecision in data. Fuzzy logic allows for the representation of vagueness and ambiguity, making it suitable for dealing with real- world problems where data may not have crisp boundaries or clear-cut distinctions.

APPROXIMATE ANALYSIS OF PREVIOUS WORK DONE

Ref No	Publica-tions	Infection Detected	Different Methods Used	Parameters Measured
[2]	2022	All leaf diseases	CNN model	Theoretical Study
[1]	2023	pests, fertilizers, and other man-made chemicals	CNN and SVM	Accuracy 91%

[3]	2022	diseases caused by bacteria, fungi and viruses	AI based machine learning and deep learning	Theoretical Study
[6]	2023	Plant diseases	ResNet 152V2, YOLO V3, and YOLO V5	Accuracy 96.46%
[8]	2023	Plant diseases	VGG16 and VGG19 models and deep learning	Accuracy of 0.97 and an F1 score of 0.95.
[10]	2022	Cotton plant diseases	Deep CNN model	Accuracy 89%

CONCLUSION

Dealing with the various crops of plants or different types on the basis of protecting them from biotic and abiotic diseases is one of the major requirement of the farmers and agriculture experts.. For this different technologies and events are used which has made disease identification through by using Artificial Intelligence methods very simple and accurate. In this paper we have proposed a comparative analysis of disease detection of plants by different classifier techniques along with Neural Network.

These different comparison gives that most of the researchers use single classification algorithm for detection of crop diseases. And most of the cases we can use CNN bases neural network to improve the quality of detection. Also instead of using single classifier we can use two or three for accurate results. Image processing is the most important aspect of this research work and proper data set of crops.

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ANALYSIS AND PROCESSING OF ROUTING PROTOCOL FOR LARGE DATA TRANSFER OVER WIRELESS SENSOR NETWORK

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Abstract: In wireless networks, where nodes have limited power and processing resources, energy efficiency is a critical consideration. The Adhoc on Demand Distance Vector Routing Protocol is specifically intended for low-overhead mobile adhoc networks. As a result, the source node employs some mechanism to control the network-wide broadcast of RREQs (routing requests). Many energy efficient protocols, such as AODV, DSR, and DSDV, have been created to extend the lifetime of nodes in wireless networks. Using NS2, we offer an energy-efficient AODV HPR (High Power Route) Protocol route finding process. By minimizing duplicate rebroadcasting of route request packets, our technique saves energy for

the nodes. The node's relaying status is determined by its neighbor's broadcasting of its RREQ packets, which helps to reduce routing overhead during the route discovery process.

Keywords : *Ad-hoc On-Demand Distance Vector Routing Protocol, AODV HPR (High Power Route), RREQ (Routing Request), RREP (Routing Reply), Route Discovery*

1. INTRODUCTION

I. Historical Development

Wireless Sensor Networks are considered as the wireless state network which consists of mainly the isolated free tools using the sensors to verify the corporal and the ecological terms. WSN system integrates the opening which also gives wireless level attachment rear to the wired level world and circulated knots.

Wireless Sensor Networks (WSNs) can be defined as a self-configured and infrastructure-less wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be observed and analyzed. A sink or base station acts like an interface between users and the network. One can retrieve required information from the network by injecting queries and gathering results from the sink.

The first wireless network that can be defined as modem WSN is known as the Sound Surveillance System (SOSUS). SOSUS was developed to detect Soviet submarines by the U.S. Military in the 1950s. SOSUS network is designed to have submerged sensors and hydrophones which are scattered in the Atlantic and Pacific Oceans .U.S. DARPA has pioneered the Distributed Sensor Network (DSN) initiative in 1980s to find out the unique challenges of implementing WSNs. The potential of DSN and its progression in academia have attracted researchers' attention. These factors led the explore potential of WSN has started to be searched in academia and in civilian scientific researches.

As an example for WSN researches, [1] IEEE has noticed the following fact: The low cost and high capabilities of these tiny devices. IEEE organization has defined a standard for this fact - the IEEE 802.15.4; to cover low data rate wireless personal area networks. Based on this standard, ZigBee Alliance has published the ZigBee standard that can be used in WSNs.

WSNs are collection of nodes and these nodes are individual small computers. These tiny devices work cooperatively to form centralized network systems. There are some requirements for nodes to be used in these networks such as efficiency, multi-functionality and being wireless.

Each node in any network has a predefined goal. In a network, nodes should have a centralized and synchronized structure for communicating and data sharing. The sensor nodes are placed in a connected network according to a certain topology such as linear, star and mesh. Nodes of the network in any topology have a limited broadcast range which is generally 30 meters. In WSNs, data collection and data transfer are accomplished in 4 steps: collecting the data, processing the data, packaging the data and transferring the data.

II. Area of Research and its Contribution

Major characteristics of Wireless Sensor Networks consist of:

1. Consumption of Power limits for nodes that use batteries and energy harvesting.
2. It has Ability to handle node failures.

3. Nodes are Heterogeneous.
4. Nodes are mobile.
5. It has capability to stand in strict environmental conditions.
6. Scalable for huge development scale.
7. It supports Cross-layer design.
8. It is simple and easy of use.

Cross-layer design has become a significant study part for the wireless communications. Traditional layer approach has presented by the three major problems. Previous layer approach cannot exchange the information between different layers due to this layer did not have the entire information. Traditional layer approach does not guarantee optimization of entire network. It didn't accept to environmental change.

Traditional layer approach for the wired network is not considered and valid to the wireless level networks owed to management of environment in to the WSN. So cross-layer is measured to create the best inflection in order to expand the programme performance. These are data rate, power effectiveness and Value of Service.

Nodes consist of a processing unit which is having a restricted computational energy and imperfect memory. Sensors have exact conditioning circuitry and a communication device. It also has the energy source in the figure of a battery. One or exceeding components of Wireless Sensor Networks are Base Stations which are more calculation, energetically and communicational. Routing based other main components are routers, which are designed to calculate, compute and dispense routing tables.

The routing table consists of suitable route to transfer the data. It allows transmission of data without any issue to different routes. There are multiple routes for the transmission of data. This table chooses the shortest path to transfer the data. The shorter path selection helps in fast data transmission as well as it reduces the probability of loss of data during transmission.

III. Institutions Involved in the Research

Governments and universities eventually began using WSNs in applications such as air quality monitoring, forest fire detection, natural disaster prevention, weather stations and structural monitoring. Then as engineering students made their way into the corporate world of technology giants of the day, such as IBM and Bell Labs, they began promoting the use of WSNs in heavy industrial applications such as power distribution, waste-water treatment and specialized factory automation.

While the market demand for WSNs was strong, moving beyond these limited applications proved to be a challenge. The military, science/technology and heavy industrial applications of previous decades were all based on bulky, expensive sensors and proprietary networking protocols. These WSNs placed a premium on functionality and performance, while other factors such as hardware and deployment costs, networking standards, power consumption and scalability fell to the wayside. The combination of high cost and low volume prevented the widespread adoption and deployment of WSNs into a broader range of applications.

IV. Trends in Area of Research

Trends in Area of Research are in the field of:

Industry Trends:

- i. Precision Agriculture and Animal Tracking
- ii. Environmental Monitoring

- iii. Urban Terrain
- iv. Tracking and Civil Structure Monitoring
 - International Trends:
 - i. Health care Systems
 - ii. Transportation and Logistics
 - iii. Security and Surveillance

V. Current Challenges in Area and Research Issues

The most challenging objective in Wireless Sensor Networks is generating minimum costing as well as small sensor nodes. Counting of small companies which produce Wireless Sensor Networks hardware is increasing as compared to counting in 1970s. Intrinsic to the sensor networks implementation is in use of the least amount of power methods for the two way radio communication and data attainment. The Wireless Sensor Network converses with Local Region Network or Wide Region Network by a gateway in many applications. This gateway plays an overpass between other networks with Wireless Sensor Networks. Now data is able to be processed as well as stored by devices with added resources, example, in any server located at a distance.

The scarcest causes of Sensor Networks that are wireless nodes are energy. Survival time of Networks that are wireless sensor based is also resolute by it. Wireless Sensor Networks could also be deployed in a large number in the several environments, which consists of hostile as well as remote areas, where ad hoc communications are the main component.

The operating system complexity of the WSN knobs is characteristically fewer than the common purpose working schemes. Due to the two reasons, these are the extra strong resembled implanted systems. The first motive is that the WSNs have been organized with unique client in to the brain, besides the common platform. The other one is needed of low cost as well as low power. It leads to that the mainly WSN knobs should also have the low-control consuming micro-controllers which ensure that the essential memory mechanisms moreover pointless or the most costly for the implementation.

2. LITERATURE REVIEW

A wireless sensor network (WSN) consists of large number of low power, low cost, and tiny communication devices, called sensors. Like nodes (i.e., computers, laptops, etc.) in traditional wireless networks such as mobile ad hoc networks, sensors have energy, storage, processing, and communication capabilities. Also, sensors have a sensing capability by which they sense phenomena and perform in-network processing on the sensed data before sending their results to a central gathering node, called the sink. WSNs can be used in a variety of monitoring, control, and surveillance applications [2]. Particularly, the sensors possess several scarce resources, with battery power (or energy) being the most critical one. One way to extend the lifetime of a WSN is through load balancing so that all the sensors deplete their energy as slowly and uniformly as possible. Also, the behavior of the sink has an impact on the network lifetime. Indeed, sensors in the proximity of a static sink act as the traffic hot spots have significantly reduced lifetime than all other sensors in the network. Those sensors nearer a static sink would suffer from a severe depletion of their battery power, which may result in possible network disconnection and disruption of the data from reaching the sink.

2.1 Sariga Arjunan et. al. ELSEVIER, (2017). [3] Objective: A survey on unequal clustering protocols in Wireless Sensor Networks

Abstract: Energy awareness is a critical design issue in WSN. Clustering is the most popular energy efficient technique and provides various advantages like energy efficiency, lifetime, scalability and less delay; but it leads to hot spot problem. To overcome this, unequal clustering is proposed. In unequal clustering, the cluster size varies proportionally to the distance to Base Station (BS). A comprehensive survey of various unequal clustering approaches with their objectives, characteristics etc., is presented. Also, the classifications of unequal clustering approaches are made and compared based on various cluster properties, Cluster Head (CH) properties and clustering process.

Conclusion: various unequal clustering protocols are classified into three main categories: probabilistic, deterministic and preset clustering algorithms. These protocols are explained with their objectives, characteristics, classification, merits and demerits. The probabilistic methods are simple and faster convergence; it performs well in large scale WSNs like environmental monitoring. For more reliable and robust applications, deterministic algorithms can be used. Achieving optimal solution in application specific environment, heuristic approach is the better option. Clustering is the popular energy efficient technique but it suffers from hot spot problem and minimizes the network lifetime significantly. Unequal clustering evenly distributes the load, eliminates the hot spot problem and maximizes the network lifetime.

2.2 Mohamed Elshrkawey et. al ELSEVIER (2018) [4] Objective: An Enhancement Approach for Reducing the Energy Consumption in Wireless Sensor Networks

Abstract: An efficient approach to enhance the routing procedures in the LEACH protocol for WSN has proposed. The first method aims to select the proper cluster head node for each cluster at each round. It's done by modifying the cluster head selection threshold. The second method has targeted to avoid the process of some sensor nodes, which send more data packets than other nodes in the entire network. The problem is solved by rescheduling the TDMA schedule for each sensor node by its cluster head to balance all nodes to send an almost same amount of data.

Conclusion: Two proposed methods will enhance the energy consumption of the wireless sensor nodes. So, the lifetime of the wireless network has extended compared with LEACH protocol. Through the implementation, the proposed approach has compared with LEACH and other improvements preceding protocols in terms of network lifetime, number of cluster head, energy consumption and number of packets transferred to BS which yields better outcomes than others.

2.3 Sonam Maurya et. al. IEEE (2016) [5] Objective: Threshold Sensitive Region-Based Hybrid Routing protocol for precision agriculture

Abstract: The paper explores the potential use of wireless sensor network in precision agriculture. An energy efficient network layer routing protocol is required to maximize the lifetime of sensor network. The proposed Threshold Sensitive Region-Based Hybrid Routing (TS-RBHR) protocol uses region-based static clustering approach to provide efficient coverage of agricultural area. The fuzzy based hybrid routing approach is used for transmitting sensed data to base station which minimizes the energy consumption of nodes. Sensor nodes

continuously sense temperature and soil moisture content of agricultural field and if sensed value exceeds the desired threshold, a data packet is sent to the base station which reduces the continuous transmission rate. Proposed protocol has a significant increase in network lifetime due to reduction in frequent data transmission.

Conclusion: Threshold Sensitive Region-based Hybrid Routing scheme to measure two parameters required for irrigation, one is the temperature and the other one is the soil moisture content of field. According to the temperature and soil moisture value, a decision can be taken as to when irrigation needs to be done. Proposed threshold sensitive region-based hybrid routing protocol the deployment of heterogeneous sensor nodes within fairly divided fixed regions, ensure proper coverage of entire network field. The Type-2 nodes die slower than Type-1 nodes due to balanced deployment of nodes in different regions. When we compare the proposed protocol with SEP and RBHR, network lifetime of TS-RBHR is increased as compared to both the other protocols, because data is sent to BS only when sensed attributes reach to rigid or mild thresholds. These thresholds can be set to receive information according to user's need. The TS-RBHR protocol minimizes the energy consumption of sensors by reducing the number of frequent data transmission which enhances the overall lifetime of the network.

2.4 R.Balamurali et. al. IEEE (2015) [6] Objective: An analysis of various routing protocols for Precision Agriculture using Wireless Sensor Network

Abstract: Precision Agriculture is the concept of real-time monitoring of environmental conditions of a farm like temperature, humidity, soil PH etc. And to convey the monitored parameters to the remote server in order to take appropriate action, instead an actuator or an automated system can also be used to take appropriate action based on the measured parameters over a period of time. Wireless Sensor Networks is a promising technology for real-time monitoring and control. Routing protocols like AOMDV (Ad-hoc on demand Multipath Distance Vector Routing), AODV (Ad-hoc on demand Distance Vector Routing), DSR (Dynamic Source Routing) and Integrated MAC and Routing protocol (IMR) for precision agriculture using WSN are analyzed.

Conclusion: Integrated MAC and Routing Algorithm is best suitable for multi-hop routing for precision agriculture using Wireless Sensor Network (WSN) in-terms of Network life time. Here network lifetime is considered as the time at which the first node in the WSN dies. The work may be enhanced to analyze other network parameters like throughput and end-end delay.

2.5 Wan Aida Nadia Wan Abdullah et. al. (2019) [7] Impact of clustering in AODV routing protocol for wireless body area network in remote health monitoring system

Abstract: Proper selection of routing protocol in transmitting and receiving medical data in Wireless Body Area Network (WBAN) is one of the approaches that would help in ensuring high network performances. However, a continuous monitoring of health status through sensing of various vital body signals by multiple biosensors could produce a bulk of medical data and lead to the increase of network traffic. Occurrence of high traffic could result to network's congestion which have high tendency to loss some of important (critical) data and cause longer delay that would lead to false diagnosis of diseases.

Conclusion: Ad-Hoc on Demand Distance Vector (AODV) which is known as reactive routing protocol is evaluated in WBAN scenario through varying number of nodes and clusters. The presence of clustering helps in reducing the burden of the sink nodes in handling high traffics.

The network's performances of this protocol are measured in terms of end to end delay, percentage packet loss, and throughput and energy consumption using Network Simulator (NS-2). Based on the experimental results, the presence of cluster helps in improving network performances by achieving reduction in delay, packet loss and energy consumption. Low throughput is achieved as number of clusters are increase due to low duty cycle of the nodes.

2.6 Huang-Chen Lee et. al. IEEE (2015) [8] Objective: An Open-Source Wireless Mesh Networking Module for Environmental Monitoring

Abstract: Wireless mesh networking extends the communication range among cooperating multiple low-power wireless radio transceivers and is useful for collecting data from sensors widely distributed over a large area. This study introduces an open-source wireless mesh network (WMN) module, which integrates the functions of network discovery, automatic routing control, and transmission scheduling. This design is provided in an open-source format in order to promote the use of wireless mesh networking for environmental monitoring applications.

Conclusion: In this research, the design and implementation of a prototype WMN module were presented, and its performance in an actual experiment was evaluated. The proposed WMN module was evaluated and compared to XBee, an off-the-shelf product. The average PDR and standard deviation of the proposed. The results support that the proposed WMN module can offer comparable or even better performance than commercial products. Further investigating the performance and power consumption of the proposed WMN module, and keep improving this design to aid scientists in implementing monitoring applications with less efforts on wireless networking issues.

2.7 Haibo Liang et. al. Springer (2019) [9] Objective: Research on routing optimization of WSNs based on improved LEACH protocol

Abstract: An approach to optimize the routing protocol. The optimal number of cluster head is calculated according to the overall energy consumption per round to reduce the probability of excessive cluster head distribution

Conclusion: The paper proposes a method that uses improved LEACH protocol and the Voronoi diagram principle to cluster the optimal number of cluster head is calculated to the overall energy consumption per round. Voronoi diagram is established. The ant colony algorithm is added to the protocol to optimize the multi-hop routing protocol. The experimental shows that the proposed approach can control cluster headcount to fluctuate. Increases the life cycle of WSNs and reduce the energy consumption of data transmission.

2.8 Habib M. Ammari et. al. IEEE transactions (2008) [2] Objective: Promoting Heterogeneity, Mobility, and Energy-Aware Voronoi Diagram in Wireless Sensor Networks

Abstract: Wireless sensor networks (WSNs) are affected by the energy sink-hole problem, where sensors nearer a central gathering node, called the sink, suffer from significant depletion of their battery power (or energy). It has been shown through analysis and simulation that it is impossible to guarantee uniform energy depletion of all the sensors in static uniformly distributed always-on WSNs with constant data reporting to the sink when the sensors use their nominal communication range to transmit data to the sink. The energy sink-hole problem can be solved provided that the sensors adjust their communication ranges. This solution, however, imposes a severe restriction on the size of a sensor field.

Conclusion: A sensor deployment strategy based on energy heterogeneity with a goal that all the sensors deplete their energy at the same time. Simulation results show that such a deployment strategy helps achieve this goal. To solve the energy sink-hole problem for homogeneous WSNs, a localized energy-aware-Voronoi-diagram-based data forwarding (EVEN) protocol. EVEN combines sink mobility with a new concept, called energy-aware Voronoi diagram.

2.9 Zareei *et al.*, (2019.) [10] *Objective:* Sensor networks for environmental monitoring applications improve energy harvesting efficiency.

Abstract: Output enhancement and measurement in different circumstances of EH-sensors. To allow us to analyze different scenarios, a network model is created. We use a clustering approach as an established method for improving energy efficiency in the traditional sensor networks to investigate its effect on network output in different scenarios in EH sensor networks. In addition, in both networks with and without clustering the impact of network end-to-end output power equalization is proposed and evaluated in a dynamic and distributed transmission power management for captors.

Conclusion: Energy harvesting is a reliable way to extend the life of a sensor network to bring us to targeted applications with battery-powered sensors, which are not feasible. However, there are design problems because of uncertainties regarding the amount of energy available. This paper examined the impact of using adaptive power controls in clustered and non-clustered networks for energy collection sensors. The adaptive transmission power control adapts the transmission power of each node to the residual power of the node and the energy condition of the neighboring nodes independently.

2.10 Del-Valle-Soto, *et al.*(2020) [11] *Objective:* The main objective of this work is to illustrate and evaluate increased energy costs in the sensors based on the type of tasks carried out in the network and its use in the optimization of routing protocols. This paper proposes a simple energy model that quickly illustrates improvements in network efficiency, is easy to introduce and does not reflect increased processing demand. There are few energy models and protocols in WSN literature to optimize the network capacity.

Abstract: By specifying the energy consumption at every node, the energy model of Wireless Sensor Network (WSN) is proposed. The energy of each node is determined by estimating the energy of the principal functions established during the execution of the routing protocol in the sensing and transfer of data. These functions apply to wireless communications and equate them to the most significant impacts on the energy point of view and efficiency assessment. As a proof of concept, the energy model is tested using a system-on-chip (SoC) from Texas Instruments CC2530.

Conclusion: Wireless Sensor Network (WSN) consists of low-cost devices that transmit information to a collector node or base station, unlike other types of wireless networks (coordinator node). Because of the small size of nodes, energy saving is important, as recharger batteries are very difficult and these networks strive to achieve maximum information transmission efficiency in the harder environment.

2.11 Liu *et al.*, (2019) [12] *objective:* An enhanced Wireless Sensor Network Energy-Efficient Routing Protocol. The LEACH Routing Protocol designates one CH node in every cluster, and selects the CH on a rotational basis with the intention of minimizing the consumption of energy by WSNs. Although the LEACH method is extensively studied, there are still disadvantages

which require improvement, on the one hand because the CH is chosen using a random round robin, in each round, the number of CHs is irrational and the node at the network border is chosen as the CH.

Methodology: Methodology including a single hop, multi-hop and hybrid network of communication to reduce the gap. The cluster head node is expected to send data to BS (N-1) hops, and in the network of wireless sensors with a free-space path, the distance from each hop is r .

Abstract: Cluster-based hierarchical protocols play a key role in lowering wireless network (WSN) energy consumption. As an application-specific protocol architecture for WSNs, a low energy adaptive clustering hierarchy (LEACH) was suggested. The LEACH Protocol can, however, increase the energy consumption of the network without taking account of the distribution of the Cluster heads (CHs) on a rotation basis.

Conclusion: The goal of this paper is to reduce energy consumption and improve the life of WSNs by developing a novel clustering protocol called IEE-LEACH. The proposed IEE-LEACH protocol threshold contained four parameters compared to the current routing protocols: initial node energy, node residual power, network total power and average node energy. This device will increase the network's robustness and prolong the life of the network. The proposed protocol can also optimize the number of CHs and their distributions, thereby reducing energy consumption effectively.

2.12 Sinde, et al., (2020) [13] Objective: "Refining the network's lifetime using energy-effective clusters of Wireless Sensors Network and DRL-based sleep programming," and finding that reducing energy consumption during data aggregation for effective cluster head selection and clustering in WSN. Plan for the state of a single node sensor to minimize power usage.

Abstract: Wireless Sensor Network (WSN), due to its contributions to various applications, including military monitoring, environmental monitoring etc., has provided significant excess to industrialists and researchers. However, reducing network latency and boost network life are still major issues within the WSN domain.

Conclusion: To improve network life and reduce the network delay, we are proposing energy-efficient sleep programming using the DRL-algorithm (E2 S-DRL) to improve network life and reduce the network delay and our proposed solution involves three main phases, clustering, task cycling and routing.

2.13 Vancin et al., (2018) [14] Objective: Performance review of wireless sensor network energy efficient clustering models.

Abstract: Energy-driven routing and data aggregation methods are built in wireless sensor networks because sensor nodes possess limited energy and memory space. A common portion of the routing technology has proved successful for topology management, energy consumption, data collection or fusion, reliability and stability in a distributed sensor network, using clusters-based heterogeneous routing protocols.

Conclusion: In this analysis, the LEACH, Mod-LEACH and PEGASIS clusters are contrasted as homogeneous networks with heterogeneous SEP, DEEC, CEEC and SEED protocols in distributing WSNs. We evaluated the performance of the SEED protocol in the sense of parameters, live nodes through the network life, packets sent to the network to BS in the MATLAB simulation setting in comparison with the SEP, DEEC and CEEC protocols.

2.14 Praveena, et al.,(2017) [15] Objective: "DIFFERENT ROUTING Common PROTOCOL USING WIRELESS WIRELESS NETWORK IN NS3" was the key goal of this paper to extend the reliability of the sensor nodes in the network. The protocol offers some acceptable alternate routes in the case of node or connection failure on the current route for the forwarding of packets. The protocol guarantees the reliability of routes for energy efficiency.

Abstract: A network sensor is a device with very tiny stations known as sensor nodes. Wireless nodes communicate and WSN has a wide range of applications and nodes communicate with each other through many routing protocols. They are known as reagent, constructive and hybrid routing protocols depending on the update mechanism.

Conclusion: The simulations and graphical results compare four protocols AODV, DSR, DSDV and OLSR based on energy consumption, throughput, jitter, and end-to-end delay. AODV is the best solution for static nodes, and for mobile nodes DSR is the best solution. The findings will assist designers and engineers to incorporate and improve these protocols in real life in the wireless network.

2.15 Kouassi, et al. (2013) [16] Objective: " The main aim is to determine the efficiency of the new RCRR protocol under different conditions, considering various factors such as the size or effects of the location of the Beacon nodes, originally positioned along the horizontal and vertical lines of the four cardinal points. Performance Analysis on the improved Routing Algorithm of the Wireless Sensor Networks

Abstract: In recent decades, the advancement of the Wireless Sensor Networks (WSNs) is a significant feature. Wireless Sensor Networks consist of autonomous sensors, spatially dispersed and which track conditions physical or environmental conditions, including the sensing temperature etc.

Conclusion: This paper presents the performance evaluation of the Associated Coordinates Rumor Routing (RCRR) which has been carried out in terms of energy consumption and the simulations have been performed using NS-2 simulator network. Different scenarios were taken into account in this study.

2.16 Dash, et al. (2020) [17] objective: Wireless sensor network applications survey using cloud computing.

Abstract: In the distributed computing world, the popularity of cloud computing grows daily. Cloud systems are widely used to store and process data. Cloud computing offers internet applications, networks and infrastructure. It is a new age in which shared computer resources are being accessed. Wireless sensor networks, on the other hand, is considered one of the most significant technology in the 21st century, where spatially linked sensor node automatically forms a transmission network and is popularly known as the Sensor Network to receive data.

Conclusion: The communication between sensor nodes using the Internet is a difficult task since sensor nodes have limited band width, storage and batteries of small size. Cloud computing technology can solve storage space problems. We addressed a few cloud computing & network sensing issues in this article. The specific application-oriented scenarios are essential for the creation of a new protocol in the sensor network.

2.17 Abdullah, et al. (2018) [18] Objective : Hybrid Cryptography algorithm for new security protocol for WSN.

Abstract: In recent years the networks of Wireless Sensors (WSNs) have grown quickly. In many leading technologies, they were key. They have been an important part of a number of

fields, including emergency services, military, traffic enforcement, environmental protection and medical services. But the rapid growth of WSN technology meant that a large amount of facilities had to deal with the challenge of deploying the technology without the safety required; hence the need to upgrade the protection systems of the WSN arises.

Conclusion: The suggested hybrid (HCA) algorithm incorporates the features of public key cryptography that are easier to measure and quicker to transmit the key and symmetric cryptograph. This provides a good and easy way to secure the transmission of information. Overall, HCA provides some positive benefits, including the simplicity and protection concept. It also reduces the number of packets dropped. Compared with many other algorithms, the hybrid algorithm proposed has proved to be the best overall result for HCA.

2.18 Aguilar et al., IEEE (2012) [19] objective: A monitoring system to define and verify a building's energy model using wireless sensor networks.

Abstract: Wireless Sensor Networks (WSNs) is a suitable technology for this project, since it is easy to mount, low cost, and high efficiency, and is a key element in this phase, as a whole, to measure a variety of variables about energy usage, the environment and building operating conditions. In this paper, an application layer was built on top of a ZigBee protocol in order to define and validate the building's energy-efficiency model. In reality, 100 sensors have been mounted in one part of the building at the 20.000 m² School of Engineering of the University of Seville. To cover this wide area using the current infrastructure, a hybrid network (wired and wireless) has been used.

Conclusion: A surveillance system has been implemented to monitor and verify a building's energy model. The system proposed consists of a ZigBee wireless sensor network which, with high scalability, can be extended to cover a wide area via TP gateways. An application layer was developed along with a particular data model that offers a high versatility for the monitoring system.

2.19 Dayananda et al., (2017) [20] objective: A zone-based hybrid solution for wireless sensor networks clustering and data collection

Abstract: A new hybrid algorithm for the cluster head selection (CH) involves both distributed and centralized algorithms. The first two CHs are chosen by the BS, with the aid of a centralized algorithm according to this algorithm. The CHs are chosen using a distributed algorithm for the third round. For the previous cluster heads.

Conclusion: It is very important to extend the network life to optimize the benefit from WSNs that users will receive. In this article, an algorithm was presented that attempts to optimize the longevity of the cluster through the management of individual node power consumption and control where power has become exhausted (facilitating the use of power on knots with higher power storage or which are simple or rechargeable). This algorithm employs a hybrid method for data transfer and the creation of clusters.

2.20 Mehta, et al., IEEE (2019) [21] objective : A comparative study of Wireless Sensor Networks' energy-efficient hierarchical routing protocols

Abstract: The growing use of WSNs has been observed in recent years in applications such as security surveillance, structural health surveillance for buildings, monitoring of occupants, health and disaster management. The biggest drawback with WSNs is insufficient energy from participating sensor nodes and it is almost impossible to adjust or replenish a node battery as sensor nodes which could be theoretically deployed in harsh environments. The long-term

sustainability is a key challenge for WSNs and hierarchical routing protocols are a friendly approach for the energy-efficient data routing. Sensor nodes can be distributed in non-overlapping clusters in such protocols.

Conclusion: Wireless sensor networks today have their applications in many aspects of human life, from habitats to systemic health monitoring, to the interpretation of different physical parameters such as temperature / blood pressure and so on. The main priority for WSN is energy saving, since these battery powered devices cannot be replaced and because of harsh environmental conditions the battery cannot be substituted or replenished. Paper categorizes protocol routing in data-oriented, hierarchical and oriented location and further addresses hierarchical protocols of routing in a chorological order with their basic characteristics.

2.21 Nandhini et al., *IEEE (2018) [22]* *Objective :* A Safe Environmental Monitoring System hybrid routing algorithm in WSN.

Abstract: The most influential group of recently created sensor nodes are wireless sensor networks. In many applications, they play a large part, such as environmental monitoring, agriculture, structural and industrial monitoring and protection. One of the absolutely necessary techniques is WSN routing. It enhances the life of the network. This can be achieved using bio-inspired algorithms to provide added priority and device protection. The combination of organic and routing algorithms offers a simple way to transmit data and enhances the existence of the network. We present a new hybrid algorithm for encircle monitoring in wireless areas that is called firefly algorithm with localizability enabled routing prototype.

Conclusion: Users can easily track environmental variables in many application areas by using this hybrid routing algorithm. Here the network of link failure can be easily restored. This helps users to maximize their network life and reduce the packet drop. The firefly algorithm in this article helps to find the best way to secure data transmission. It meets the balance between energy and lifespan of the network. The selection of cluster heads leads to power consumption and a wireless delay.

2.22 Song, et al., *IEEE(2018) [23]* *objective :* Wireless sensor networks: water quality survey.

Abstract: Monitoring of water quality is thus essential for the provision of clean and safe water. Conventional monitoring process is followed by laboratory testing and analysis, involving manual collection of samples from different parts of the distribution network. This process proved ineffective since it takes time to proactively respond to water contamination and lacks real-time results. Wireless sensor networks (WSN) are a promising alternative to traditional monitoring processes since then. These networks are relatively affordable and permit remote, real-time and minimal human intervention measurements.

Conclusion: The wireless sensor networks offer municipal water quality monitoring and monitoring infrastructure that is promising. Its greatest advantage is that measurement is affordable and can be done remotely and in real time. Nevertheless, these networks have limited resources for power, memory, bandwidth and energy / power processing. These limitations can hinder the efficiency and effectiveness of WSN use in surveillance applications if not correctly addressed.

2.23 Kunst, et al., *ELSEVIER (2019) [24]* *objective:* Improving wireless networking systems in Industry 4.0.

Abstract: In the background of Industry 4.0, the Internet of Things (IoT) and the cyber physical system technology (CPS) play a significant role. These innovations introduce the idea of

intelligent manufacturing, leading to smart services and goods, through cognitive automation. The support of large data cloud based applications that need QoS-enabled Internet connectivity to store, share and process information is one of the technical challenges of Industry 4.0. A QoS-aware cloud based solution is presented in this article to meet this challenge by adapting to the IoT scenario a newly developed streamlined architecture for sharing resources.

Conclusion: The solution to this problem seeks to improve cloud communications devices, especially within the field of Industry 4.0, given the coexistence of various wireless network technologies. Simulations of three industrial QoS challenging applications are used to achieve the performance. The simulation results show that the delay and jitter QoS metrics in VoIP applications for distributed handler finish controls are kept below their particular thresholds. When the production control is video-based, the jitter is controlled to satisfy application demands and even the effective HTTP access to supervisory systems is guaranteed.

2.24 Ohufemi, et al., (2020) [25] objective : Wireless Sensor Networks (WSNs): Problems and Solutions of protection and privacy.

Abstract: One of the latest fields of research is the Wireless Sensing (WSN) networking, which proves to be very useful for a wide range of applications, such as environmental, military, medical, home and office. The WSN can either be a MWSN or a mobile wireless network sensor (SWSN). MWSN is a sophisticated mobile sensor wireless network, but its topological instability presents a variety of performance issues during data routing. Static nodes with static topology, SWSNs, due to some constraints associated with sensor nodes, also have some security problems in MWSNs. The major challenges for WSNs, in particular during routing, are stability, safety, computing, energy constraints and reliability.

Conclusion: Wireless Sensor Network (WSN) is a wireless network of interconnected devices that track the conditions of their surroundings by sensor. WSNs are used in a number of applications, including safety monitoring, environmental monitoring, target tracking, military protection, intrusion detection, etc. Wireless sensor network safety is increasing mainly not due to the lack of efficient protection systems, but because of the particularities of WSNs, most of the existing systems are not adequate. That is, the nodes of WSN are low in terms of processing power and energy limitation. In WSN, sensor nodes are capable of interacting, but their prime task is the sensing, processing and computation of data.

2.25 Hingoliwala, et al., (2016) [26] objective: Improving QoS settings in the network of wireless sensors.

Abstract: Wireless sensor network is a set of sensor nodes for environment sensing and data transmission to the base station. In WSN there are many quality-services that are used to improve network capacity including energy consumption, reliability, delays, congestion management etc. The various routing protocols in the network are used to find the shortest path from source to destination. Different routing protocols, such as AODV, DSDV and MAC, are included in the DSR. Wireless Sensor network. Send the packet to the destination node in the wireless sensor network source node. The QoS parameters for the network's wireless sensor are end-to - end delay, packet transmission ratio, packet loss rate, performance, energy consumption, blocking power, etc.

Conclusion: Authors implement IH-MAC by using a parallel transmission Connection and Broadcast programming framework. In that paper, however, we have developed and implemented the CSMA and TDMA MAC protocols for RH-MAC. RH-MAC to achieve

service quality (QoS) such as PDR, PLR, performance, end-to - end delay, congestion control and reliability. For congestion management, the nodes which are hop away from the sink node are subject to the TDMA protocol. The remaining nodes are CSMA. We need to incorporate the distribution of data based on the cluster in the second model.

2.26 Kumari, et.al.(2019) [27] objective: Wireless sensor network energy-efficient routing protocols: ICSCSP procedures.

Abstract: The key downside in wireless sensor networks (WSNs) is the energy depletion. Sensor nodes use small batteries that cannot be replaced or recharged. The energy in battery-operated networks must therefore be optimally stored. The clustering is one of the common way to maximize energy efficiency. All sensor hubs are installed into various groups in the clustering process and the head of the cluster (CH) is assigned to each group. As for collecting and transmitting data, the CH is consuming high energy than other sensor nodes (SNs).

Conclusion: A large number of dead nodes, alive nodes and packets transmitted to the BS via MATLAB are used to evaluate the stability and lifetime of the network. For 200 nodes the simulation of 10,000 iterations is carried out. The output is focused on SNs' energy depletion and node death. The simulation neglects interference and node collisions. The results indicate that nodes in DEEC are 53.8 percent faster dead in 10,000 iterations than in EDEEC. This greatly improved the stable period and the life of the network

2.27 Jiang et.al. (2019) [28] Objective: Analysis of node deployment in wireless sensor networks in the monitoring system warehouse environment.

Abstract: The warehouse environment monitoring device implementation of wireless sensor network nodes addresses the warehouse environment implementation algorithm for the network wireless sensor nodes and describes the node deployment scheme with enhanced network efficiency by way of comparison. The implementation of a network node wireless sensor is the basis for a wireless network of sensors in the storage area. The key issue that needs to be addressed is to control the output of the entire network. This paper explores the advantages of the WLAN for storage control, in particular the deployment and simulation study of sensor nodes in the warehouse. This document proposes a node deployment model of collective perception based on the perceptive model 0-1 and exponential model, based on the impact of sensor perception on effectiveness in the node deployment plan.

Conclusion: The implementation of wireless network nodes in warehouse environment monitoring systems for sensing networks is the basis for a wireless network application that affects the performance of the entire network and is the key problem that must be addressed in network applications. The key line in this paper is the implementation of wireless sensors in the storage area. The theory and algorithm are studied in the application of storage environment monitoring system for the use of wireless sensor nodes.

2.28 Raisinghani ,et.al. (2017) [29] abstract: The Wireless Sensor Network (WSN) was used to track an environment for events: "Energy efficient coverage protocols in wireless sensor networks. The sensory range and contact range of any node in the WSN. The sensor cover of a sensor node is the sensor range of the sensor node. The sensing network coverage is the cumulative sensor node coverage in a WSN.

Objective: The goal is to maintain a number of working nodes while switching off the redundant nodes for efficient coverage and energy efficiency. The coverage protocols Energy

efficiency can be accomplished by reducing duplication of coverage and efficient planning for the node and network life.

Conclusion: Wireless network sensor coverage overlap can be minimized by various protocols for coverage optimization. In this paper, we gave a short introduction and basic knowledge of sensor networking coverage concepts. We have considered energy-efficient coverage protocols based on area cover and defined the coverage mechanism with a thorough review

2.29 Gandhi, et.al. (2018) [30] objective: Aquaculture wireless sensor network: Aquaculture practices in western Godavari area analysis, survey and case study.

Abstract: Aquaculture is one of the busiest occupations in India's coastal areas besides agriculture. Aquaculture provides thousands of farmers' lives, and so this is a significant impact on the socio-economic status of the country. It is a consequence of aquaculture activity. But current practices in developing countries adopted by these farmers are very conventional and must be changed to increase yields and production.

Conclusion: An exhaustive analysis of the WSN (Wireless Sensor Network) architecture in aquaculture is presented in this text. Aquaculture scenario is presented in the Indian area of Godavari and Andhra Pradesh, by means of surveys and case studies are carried out. It proposes a device design based on a wireless sensor network that allows remote surveillance of aquaculture farms and warnings to farmers when any deviation in tank water quality is detected.

2.30 Manjeshwar, et al. IEEE (2015) [31] objective: APTEEN: hybrid protocol on wireless sensor networks for efficient routing and robust retrieval of data

Abstract: The broad application and increase deployment in the coming years are expected in wireless sensor networks with tens of thousands of small sensor nodes as they allow for accurate environmental monitoring and analysis. We propose here a hybrid routing protocol (APTEEN) for the extensive retrieval of data. The nodes in such a network not only respond to situations which are time-critical, but also provide a very energy efficient overview of the network at periodical intervals.

Conclusion: This paper presents Hybrid APTEEN protocol which combines the best features of proactive and reactive networks and provides periodic data collection as well as near-real-time critical event alerts. We also showed that the question is sufficiently flexible to answer a number of queries. While our query pattern can be applied further to sensor networks that have uneven node distributions, it is appropriate for the network with evenly distributed node.

3. RESEARCH ISSUES

The issues of existing researches are performance, routing issue, security issues. In previous protocol due to large sized packet there is probability of congestion and the transmission delay occurs. There is issue of network lifetime and energy.

- 1) From some references, it is found that uncertain delays in communication is occurring, it should be avoided.
- 2) The criteria for selecting the Routing protocol was lengthy in fact, thus by new/an advanced algorithm it can be simplified/reduced.
- 3) Time Complexity may be reduced.

4. GAPS IN RESEARCH

Wireless Networks are self-organizing, infrastructure less and multi-hop packet forwarding networks. There is no concept of fixed base station. So, each node in the network acts as a

router to forward the packets to the next node. Wireless networks are capable of handling of topology changes and malfunctions in nodes. It is fixed through network reconfiguration. The major problem in wireless network is link failure which ultimately results in data loss.

Each node in a sensor network is typically equipped with one or more sensors according to the requirement, a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery. The size a single sensor node can vary from shoebox-sized nodes down to devices the size of a grain of dust. The cost of sensor nodes is similarly variable, ranging from hundreds of dollars to a few cents, depending on the size of the sensor network and the complexity required of individual sensor nodes.

Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth.

5. MOTIVATION

After considering existing research and finding their limitation it is concluded that there is need to introduce mechanism that should be capable to resolve the issues related to routing, energy efficiency, performance and security in case of wireless sensor network. The exiting research works have motivated the enhancement of WSN.

6. PROBLEM SELECTION

In WSN, nodes typically have inadequate data processing, data storage capabilities and limited energy resources. Sensors in WSN are sensitive to energy consumption because they require energy during many phases such as environment sensing, data processing and communication phases. If one node or some percentage of nodes dies in a network then the entire network can become non-functional. Thus, in designing of energy efficient protocol, limited energy consumption is a critical issue for WSN to increase network lifetime. Hence, for this reason many of the data routing protocol have been anticipated for data transmission in WSN. Most of the protocol use clusters in order to reduce energy consumption and to increase network lifetime. A protocol is working on principle of chain and uses double CHs. This protocol distributes the workload amongst two cluster heads, nodes are selected in suitable ways to transmit the fused data to BS to balance the energy depletion in the network and preserve the robustness of the sensor web as the node dies at any random location.

Based on the Gaps in the research problem is selected to develop a hybrid Protocol for energy efficient and lifetime maximization wireless sensor network.

7. PROBLEM STATEMENT

In WSN there are various routing protocols suggested. Various applications require different types of routing protocols having different grades of reliability. Even though efforts have been made on the routing problems in WSNs, there are still some challenges that need to be addressed for an effective solution of the routing problem. Based on the literature review, energy efficiency and QoS are the main challenges in the design and development of routing protocols for WSN. All of the above observations motivate the need for evaluating new versions of protocol and derive various QoS parameters.

The Problem Statement for the Research Work to be carried out is “Performance Analysis of energy efficient lifetime improvement hybrid protocol wireless sensor network using environmental monitoring system”

8. AIM

The basic aim of this research is to propose an advanced algorithm to select cluster head and thus to design the wireless sensor network in such a way that it should consume less energy in turn increase the lifetime since there is indirect relation between energy consumption and lifetime of wireless sensor network.

9. OBJECTIVES

The objectives of Proposed Research Work are:

1. To study basic wireless sensor networks.
2. To study different topologies for wireless sensor networks.
3. To study wireless sensor network power utility and consumption issues.
4. To study routing protocol in wireless sensor networks.
5. To study the different radio propagation method within physical layer in wireless sensor networks.
6. To study strategies to minimize the delay.
7. To study different protocols to minimize the energy consumption.
8. To study different protocols to increase lifetime.
9. To study various simulation tools in wireless communication.

10. SCOPE

The same implemented system can be studied with other head node changing in WMN and the performance can be studied. Other hybrid approach can be utilized with the implemented model to optimize the performance of the system. By using IPv4 technology in WSN, data transmission consumes maximum energy over long distance, which reduces the lifetime of hardware and a battery it also requires large bandwidth. To overcome this problem, Internet of Things technology uses IPv6, which can transmit large data in small bandwidth using minimum energy. The newest generation of sensor nodes offers enough performance to realize the idea of the Web of Things with minimal energy consumption. Nowadays, Wireless Sensor Networks (WSNs) employ proprietary communication protocols, making it therefore difficult to connect the nodes to the Internet. The recently launched IPv6 over Low power Wireless Personal Area Networks (6LoWPAN) standard proposes a solution to use the Internet Protocol (IP) on sensor nodes and to integrate these low-power devices into the Internet. Unfortunately, no implementation of 6LoWPAN exists for the newest generation of sensor nodes. With IPv6, everything from appliances to automobiles can be interconnected. But an increased number of IT addresses aren't the only advantage of IPv6 over IPv4. Six more good reasons to make sure your hardware, software, and services support IPv6.

1. More efficient routing
2. More efficient packet processing
3. Directed data flows
4. Simplified network configuration

5. Support for new services

6. Security

11. LIMITATIONS

There are a lot of limitations placed by the deployment of sensor networks which are a superset of those found in wireless ad hoc networks. Sensor nodes communicate over wireless, lossy lines with no infrastructure.

Additional limitations, usually non-renewable energy supply of the sensor nodes. In order to maximize the lifetime of the network, the protocols need to be designed from the beginning with the objective of efficient management of the energy resources

Some of the issues are:

Fault Tolerance: Sensor nodes are vulnerable and frequently deployed in dangerous environment. Nodes can fail due to hardware problems or physical damage or by exhausting their energy supply. The protocols deployed in a sensor network should be able to detect these failures as soon as possible and be robust enough to handle a relatively large number of failures while maintaining the overall functionality of the network. This is especially relevant to the routing protocol design, which has to ensure that alternate paths are available for rerouting of the packets. Different deployment environments pose different fault tolerance requirements.

Scalability: Sensor networks vary in scale from several nodes to potentially several hundred thousand. In addition, the deployment density is also variable. For collecting high-resolution data, the node density might reach the level where a node has several thousand neighbors in their transmission range. The protocols deployed in sensor networks need to be scalable to these levels and be able to maintain adequate performance.

Production Costs: Because many deployment models consider the sensor nodes to be disposable devices, sensor networks can compete with traditional information gathering approaches only if the individual sensor nodes can be produced very cheaply.

Hardware Constraints: At minimum, every sensor node needs to have a sensing unit, a processing unit, a transmission unit, and a power supply. Optionally, the nodes may have several built-in sensors or additional devices such as a localization system to enable location-aware routing. However, every additional functionality comes with additional cost and increases the power consumption and physical size of the node. Thus, additional functionality needs to be always balanced against cost and low-power requirements.

Sensor Network Topology: Although WSNs have evolved in many aspects, they continue to be networks with constrained resources in terms of energy, computing power, memory, and communications capabilities. Of these constraints, energy consumption is of paramount importance, which is demonstrated by the large number of algorithms, techniques, and protocols that have been developed to save energy, and thereby extend the lifetime of the network. Topology Maintenance is one of the most important issues researched to reduce energy consumption in wireless sensor networks.

Transmission Media: The communication between the nodes is normally implemented using radio communication over the popular ISM bands. However, some sensor networks use optical or infrared communication, with the latter having the advantage of being robust and virtually interference free.

Power Consumption: As we have already seen, many of the challenges of sensor networks revolve around the limited power resources. The size of the nodes limits the size of the battery.

The software and hardware design needs to carefully consider the issues of efficient energy use.

12. CURRENT TECHNOLOGY

Present research on WSN has been carried out using NS2 simulator. Moreover NS3 is also used for simulation purpose. AODV protocol used in WSN is suffering from black hole attack. That could be managed using fuzzy logic. Artificial intelligence could play significant role in making WSN nodes able to take decision themselves.

13. TOOLS

Network Simulator (NS-2) is a tool that is used for simulation of networks. This tool has created a strong hold in research field. This tool is generally used for designing various topologies, different networks, etc and then to simulate such networks for results of the activities that happen in network. Our all modules of WSN network can be built using this tool. But all versions NS don't provide facilities for wireless simulation. But all the version of NS-2 support wireless simulation. So any version of NS-2 will work. We are using NS-2.34 for simulation purpose. The outputs of this tool after simulation are generally two files- A trace file that contains all the information of the simulation done by the tool, while another is a NAM file that contains all the information for a nam animator to animate the simulation of network for which the file was created.

Operating System

Network simulator needs a Linux platform or environment to run. It can also run on windows but need some tools to create a Linux environment in windows like that of VMware. The Fedora-8 Project is a Red Hat sponsored and community supported open source project. Its goal is the rapid progress of free and open source software and content. The Fedora Project makes use of public forums, open processes, rapid innovation, meritocracy, and transparency in pursuit of the best operating system and platform that free and open source software can provide.

Hardware Requirement

A system must be capable to simulate networks and store results. In case memory required is not sufficient for simulation and simulation is started there are good chances of system to crash down. So keeping safer side into consideration RAM of 512 MB or higher and secondary storage of 160 GB or higher is necessary.

14. DATABASES

Wireless Sensor Networks (WSNs) have attracted the interest of industries and they have been used in several application areas (military, health, transportation, agriculture). [32] WSNs are ad hoc networks, composed of sensor nodes, which are deployed in an area of interest, in order to monitor and to return information requested by users. Sensor data is transmitted to users over a central station, named base station. Data collection becomes more difficult when the number of sensors increases. The database which we require is simulation based data which will be analyzed by QoS parameter. Comparison of QoS Protocols would be done through protocols

15. EXISTING METHODOLOGIES AND ANALYSIS

Research methodology is a method which is followed to conduct the research work of a topic. There are different research methodologies. Quantitative researches are systematical investigation on defined topic whereas qualitative researches provide the study of research subject. These researches are descriptive and apply reasoning. The Researchers can use qualitative and quantitative research methodology together in their research work. The experiments based researches are systematic, scientific approach and provide results whereas the survey based research provides us review on a topic.

Fundamental Research:

These types of researches are technical. In order to get improved knowledge about organic process these researches are executed. In these researches, academic concepts are improved. Due to this reason it becomes famous in the form of academic research. .

Applied Research:

It has been observed that such types of researches are proposed to provide the solution related to practical problems. These researches might be a form of product, a form of process and protocol development. This kind of investigation becomes useful in the favor of existing work.

Quantitative Research:

In this work visible situations are examined practically in a very systematic way. These researches are carried out by practical, arithmetical or computerized modes. The basic intention of this research work is to form and arranged arithmetical design. At the time of this work, ideas and principles of situations which is under examination are also kept in mind. The objective of quantitative methods is to verify the authenticity of forecasted circulars is the fundamental aim of this research method.

Qualitative Research:

In this type of work, the topics which are put under research work are thoroughly examined. At the time of work volume does not matter. Thus these are not dependent to measurement and quantitative analysis.

Conceptual Research:

Conceptual researches consist of investigation of new ideas and mechanisms to deal with existing working modules. On the basis of sensible philosophy these researches always try to create a fresh ideology or try to explain those concepts which are developed in past.

Descriptive Research:

In this research qualities of those human beings are described which are examined in advance. Here you will not obtain all the answer of this qualities. Here you will only know about what types of qualities are contained by people.

Practical Research:

A research which is carried out in a technical and systematic way is called practical research. In this work various type of parameters undergone through a change. Whenever a change takes place in any parameter, this change is examined and managed by the researchers. They control and check any modification in different variables. In this work output obtained when trails are performed in normal manner. It is said that the consequences of this research work is very appropriate.

The Case study method:

In this, a definite building block of society is examined this research considered small number of cases but it focuses all aspects of social unit.

This research is conceptual as well as experimental research. Proposed work has considered the security of cloud.

16. PROPOSED APPROACH OF METHODOLOGY

In most wireless sensor network (WSN) applications nowadays the entire network must have the ability to operate unattended in harsh environments in which pure human access and monitoring cannot be easily scheduled or efficiently managed or it's even not feasible at all. Based on this critical expectation, in many significant WSN applications the sensor nodes are often deployed randomly in the area of interest by relatively uncontrolled means (i.e., dropped by a helicopter) and they form a network in an ad hoc manner. Moreover, considering the entire area that has to be covered, the short duration of the battery energy of the sensors and the possibility of having damaged nodes during deployment, large populations of sensors are expected; it's a natural possibility that hundreds or even thousands of sensor nodes will be involved. In addition, sensors in such environments are energy constrained and their batteries usually cannot be recharged. We have surveyed different routing algorithms along with advantageous and disadvantageous comparison with LEACH protocol. LEACH and its advanced protocols reported in the literature of WSNs till today and presented the comparison of some advancement in LEACH protocol. We have found that some energy efficient algorithms increases the network lifetime and also consumes energy in routing. Although every effort has made to provide complete and accurate state of the art survey on energy efficient clustering algorithms along with LEACH and its advanced protocols as applicable to WSNs. In view of the above observations and from the review of current literature it is proposed to investigate as follows:

- Literature Survey and analysis for different protocols related to WSN.
- Study of various wireless sensor networks and their performances, Data Routing and Clustering Schemes.
- Study of various environmental applications with power consumption.
- Study the performance of each node & lifetime in WMN by NS 2
- Study various transmitter – receiver elements and 802.15.4 standard
- Implementation of the proposed system and performance comparison.

17. EXPECTED RESULTS

The corresponding hierarchical routing and data gathering protocols imply cluster-based organization of the sensor nodes in order that data fusion and aggregation are possible, thus leading to significant energy savings. In the hierarchical network structure each cluster has a leader, which is also called the cluster head (CH) and usually performs the special tasks referred above (fusion and aggregation), and several common sensor nodes (SN) as members. The cluster formation process eventually leads to a two-level hierarchy where the CH nodes form the higher level and the cluster-member nodes form the lower level. The sensor nodes periodically transmit their data to the corresponding CH nodes. Because the CH nodes send all the time data to higher distances than the common (member) nodes, they naturally spend energy at higher rates. A common solution in order balance the energy consumption among all the

network nodes is to periodically re-elect new CHs (thus rotating the CH role among all the nodes over time) in each cluster. [8]

So to propose an advanced algorithm for cluster head selection for increasing life span of WSN is the expected outcome of the proposed work.

18. IMPLICATIONS

Implications are the conclusions that can be drawn from something. Specialized energy-aware routing and data gathering protocols offering high scalability should be applied in order that network lifetime is preserved acceptably high in Wireless Sensor Network. Grouping sensor nodes into clusters has been widely adopted by the research community to satisfy the above scalability objective and generally achieve high energy efficiency and prolong network lifetime in large-scale WSN environments.

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DESIGN, ANALYSIS AND DEVELOPMENT OF A COMPACT WEEDING CULTIVATOR FOR WEED MANAGEMENT IN COTTON FARMING

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Abstract

Weed management plays a pivotal role in optimizing crop yields and ensuring sustainable agricultural practices. In cotton farming, weeds are a big problem, as they compete with crops for essential resources like sunlight, water, and nutrients, leading to lower crop yields. Traditional weeding methods involve a lot of manual labor or using chemicals, which can be costly and harmful to the environment. The compact weeding cultivator is a new tool designed to make weeding easier and more efficient for cotton farming. One of the key advantages of the compact weeding cultivator is its contribution to sustainable agriculture. By reducing the reliance on manual labor and minimizing the use of chemical herbicides, this tool offers a more environmentally friendly approach to weed management. It has been tested and proven effective in removing weeds quickly, saving farmers time and money. This tool offers a sustainable and cost-effective solution to weed management in agriculture.

Keywords:

Weeding Process, Weeder, Cultivator, Compact Weeder, Cotton farming, Weed Management.

I. Introduction

1.1 Weeding Process and Tools used for weeding

Weeding in farming means getting rid of unwanted plants called weeds. Weeds compete with crops for resources like sunlight, water, and nutrients, which can reduce crop yields and quality.



Figure 1: Manual Weeding Process in Farming

There are different tools and methods for this:

1. **Manual Weeding:** This is when people remove weeds by hand or with tools like hoes or weeders. It's hard work but works well for small areas.
2. **Mechanical Weeders:** These are machines that remove weeds. They can be attached to tractors or used by hand. They're good for larger areas and save time.
3. **Herbicides:** These are chemicals that kill weeds. They can be selective, meaning they only kill certain weeds, or non-selective, killing all plants. They're often used with machines for better weed control.
4. **Flame Weeders:** These use fire to burn weeds without hurting crops. They're useful for surface weeds and are used in organic farming.

5. **Mulching:** This is when you cover the soil around plants with things like plastic or straw. It stops weed seeds from growing by blocking sunlight. It also keeps soil moist and healthy.

Farmers often use a mix of these methods to keep their fields free of weeds and their crops healthy. Efficient weed management is essential for optimizing crop yield and promoting sustainable agricultural practices (Sathishkumar et al., 2021). Weeds pose a significant challenge to crop growth by competing for vital resources such as water, nutrients, and sunlight, ultimately leading to reduced yields and economic losses for farmers (Sedara et al., 2020). However, relying solely on traditional weed control methods like manual labour and chemical herbicides is not without its drawbacks, including labour shortages and environmental concerns (Chaudhary et al., 2023).

The emergence of mechanized weed control tools, such as power weeders and rotary weeders, marks a significant advancement in weed management practices (Yadav & Pund, 2007). These tools offer efficient alternatives to traditional methods, reducing labor dependency and minimizing environmental impacts associated with chemical treatments. Continuous research efforts have been directed towards enhancing the performance of these mechanized weeders through experimentation and design improvements (Sedara et al., 2020). It's imperative to conduct field tests across various crops and environmental conditions to evaluate the adaptability and effectiveness of these tools (Chaudhary et al., 2023). Moreover, integrating advanced technologies like automation and sensor-based systems further improves weed removal accuracy while minimizing crop damage (Sedara et al., 2020).

There is a growing recognition of the importance of sustainable weed management practices, which prioritize environmental conservation and cost-effectiveness for farmers (Chaudhary et al., 2023). Research into energy-efficient mechanisms and alternative power sources aims to reduce the environmental footprint of weed control operations and enhance long-term affordability. Collaboration among researchers, agricultural experts, and farmers is crucial for gathering feedback and ensuring the practicality of mechanized weed control tools in real-world farming contexts (Yadav & Pund, 2007). By leveraging innovative technologies and fostering interdisciplinary partnerships, the agricultural sector can advance weed management strategies, ultimately leading to improved crop productivity and sustainability.

1.2 Challenges in Conventional Weeding Process

The old sickle tool (Figure 2) has a curved metal blade attached to a wooden handle (shown in Figure 2). People have used it for a long time to harvest crops and remove weeds. But using the sickle comes with some problems. It needs a lot of physical effort and takes a long time to use.

Also, there's a higher chance of hurting your hands, especially when the soil is dry and hard. This can make the sickle less effective in getting rid of weeds.



Figure 2: Conventional Manual Weeding Process with the help of Sickle

II. Literature Survey

Weeding holds immense importance in crop management as it reduces reliance on labour and optimizes fertilizer usage, thereby significantly influencing crop yields (Sathishkumar et al., 2021). The presence of weeds can cause yield reductions of up to 60%, underscoring the critical necessity for

effective weed control (Sedara et al., 2020). While traditional manual weeding methods have been prevalent, the scarcity of labour has spurred interest in mechanized alternatives such as power weeders, offering swifter and more efficient weed eradication (Chaudhary et al., 2023).

Environmental concerns surrounding chemical weed control methods have spurred the adoption of mechanical substitutes like power weeders (Sedara et al., 2020). Recent advancements in design, particularly the development of multi-crop power weeders with diverse blade configurations, have demonstrated potential in minimizing crop damage while effectively eliminating weeds (Chaudhary et al., 2023). These mechanized implements, powered by innovative technologies, contribute to heightened agricultural productivity and reduced dependence on manual labour (Yadav & Pund, 2007). Researcher should concentrate on optimizing the performance of multi-crop power weeders through continual experimentation and refinement of blade shapes (Chaudhary et al., 2023). Comprehensive field tests across various crops and environmental settings are imperative for evaluating adaptability and efficacy, guiding future enhancements (Sedara et al., 2020). Additionally, integrating advanced technologies like automation and sensor-based systems can augment the precision and efficiency of weed removal while mitigating crop damage (Sedara et al., 2020).

To ensure environmental sustainability and lower operational expenses, research into energy-efficient mechanisms and alternative power sources for weed control operations is advised. Collaboration among researchers, agricultural specialists, and farmers is indispensable for garnering feedback and ensuring the feasibility and applicability of mechanized weed control tools in practical farming scenarios (Yadav & Pund, 2007). By harnessing innovative technologies and fostering interdisciplinary collaborations, the agricultural sector can advance weed management strategies, ultimately boosting crop productivity and sustainability.

III. Design, Analysis and Development of a Compact Weeding Cultivator

3.1 Design and Analysis of a Compact Weeding Cultivator

A compact weeding cultivator (Figure 3) developed for removing weeds easier and faster than traditional methods. The handle is light and comfortable to hold. Connected to the handle is a plougher of 20 cm and is angled at 150° to dig into the soil effectively. There's also a longer center plate, 15 cm longer than the plougher, which adds to the cultivator's efficiency. Plougher rods are bent at a 110° angle and have lengths of 7 cm. These angles and lengths help the cultivator reach and pull out weeds accurately. The rods are designed to move smoothly through the soil, making it easy to target weeds.

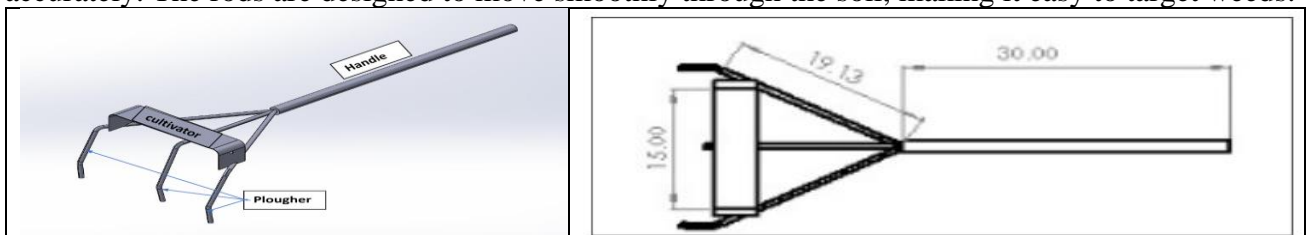


Figure 3: Design of a Compact Weeding Cultivator

The Figure 4 shows the load applied on the Compact Weeding Cultivator, pulling load of 30 N and downward force of 20 N was applied.

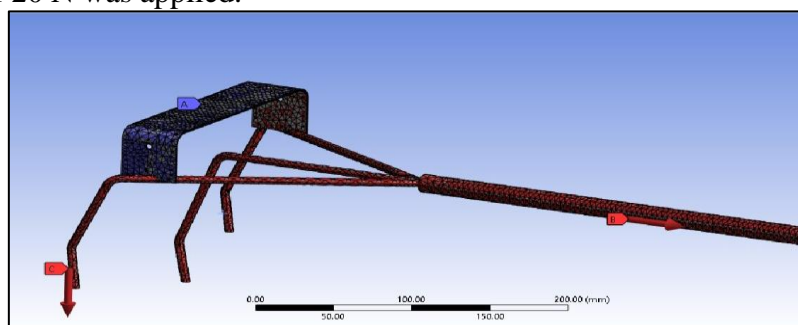


Figure 4: Load application on the Compact Weeding Cultivator

After the structural analysis using ANSYS software, the maximum total deformation and maximum directional deformation recorded as 0.20312 mm and 0.18457 mm respectively, which is less. The same is depicted in the Figure 5.

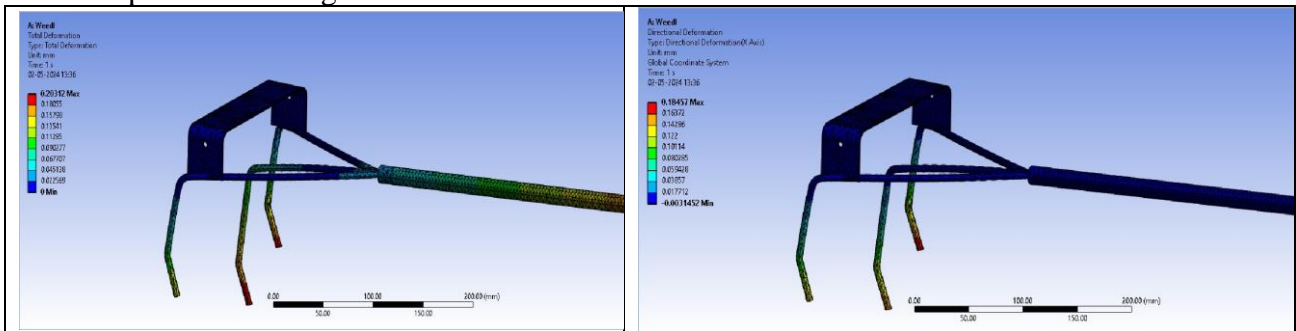


Figure 5: Total Deformation and Directional Deformation a Compact Weeding Cultivator

3.2 Development of a Compact Weeding Cultivator

The development of a Compact Weeding Cultivator (Figure 6) involves following production steps.

Step1: The fabrication process begins with designing the cultivator and planning out the dimensions, angles, and components required for efficient weed removal.

Step 2: Suitable materials are chosen for the handle, rods, and connecting components based on factors like strength, durability, and weight.

Step 3: The selected materials are cut according to the design specifications using cutting tools such as saws, drills, and cutting machines.

Step 4: The handle, plougher side rod, center rod, and connecting components are assembled together using welding or fastening techniques. Welding ensures a strong and stable connection between components.

Step 5: The rods are bent at specific angles using bending tools to achieve the desired shapes and lengths required for efficient weed removal.

Step 6: The assembled cultivator undergoes a quality check to ensure that all components are properly aligned, securely fastened, and meet design standards.

Step 7: The fabricated cultivator is tested in simulated field conditions to evaluate its performance in weed removal, maneuverability, and overall effectiveness.



Figure 6: Development of a Compact Weeding Cultivator

IV. Result & Discussion

The developed weeder offers a more user-friendly and efficient solution, expediting the tasks at hand. Its enhanced design even allows for simultaneous use of two tools, further accelerating the process. By operating at a faster pace and boasting multidirectional mobility around crops, this weeder significantly reduces the need for manual labour. Consequently, substantial savings can be realized in terms of labour expenses as compared to the conventional weeding process. During testing, the weeder effectively removed weeds with minimal effort. (Figure 7)



Figure 7: Testing of a Compact Weeding Cultivator

Five workers usually required for two to three days to finish one acre of weeding using old methods with Sickle.

Cost savings using the Compact Weeding Cultivator:

Old Method (Sickle):	New Method (Compact Weeding Cultivator):
Cost of sickle for 5 workers: 750 Rs	Cost of the weeder tool for 5 workers: 1750 Rs
Labour charges for 5 workers for 3 days: 5250 Rs	Labour charges for 5 workers for 3 days: 1750 Rs
Total cost for the entire process: 9500 Rs	Total cost for the entire process: 7000 Rs

Using this new approach can save about 2500 Rs. per acre. This method works for different crops like watermelon, cotton, and toor.

V. Conclusion

The compact weeding cultivator is a valuable tool for farmers dealing with weed problems in cotton farming. It helps save time and money by making weeding easier and more efficient. By using this tool, farmers can reduce their reliance on manual labour and harmful chemicals, promoting sustainable farming practices. Continued improvements and testing will make the cultivator even more effective for various crops and farming conditions. It is a step forward in improving crop productivity and environmental sustainability in agriculture.

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Synthesis, characterization and thermophysical properties of PAG-Amine functionalized graphene quantum dots based nanosuspension

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Highlights

- PAG-amine functionalized GQDs based nanosuspension are synthesized.

- Characterization results show suitability for advanced material applications.
- Results show that thermophysical properties are dependent on AGQD concentration.

Abstract

This work presents the synthesis, characterization and evaluation of thermophysical properties of PAG (Polyalkylene glycol)-amine functionalized graphene quantum dots-based nanosuspension. The synthesis is carried out in two steps. In the first step graphene oxide is synthesized using Hummers method and in the next step synthesis of amine functionalized graphene quantum dots is done. The obtained quantum dots are further ultrasonicated in the Polyalkylene glycol resulting in varying concentrations of nanosuspension. For the characterization of graphene oxide Field Emission Scanning Electron Microscopy (FESEM) analysis is done, and for nanosuspension High-Resolution Transmission Electron Microscopy (HRTEM) and ultraviolet (UV)-spectrophotometer analysis is carried out. The thermophysical properties such as thermal conductivity and viscosity are examined using the Hamilton and Maxwell model which are further validated with experimental investigations.

Introduction

The zero-dimensional quantum confinement regime applies to graphene quantum dots (GQDs), nanoparticles with crystallites smaller than 10nm. In addition to graphene's significant surface area and electrical conductivity, quantum confinement and edge effects give them unique electronic and optical properties [1], [2], [3]. GQDs are found to be significant for optoelectronics, sensing, and biomedicine. In the latest research, the quantum dots are also being utilized to enhance the heat transfer capacity of the conventional fluid [2], [4], [5]. In recent years it is observed that the utilization of quantum dots improves the overall thermophysical properties of the conventional fluid. In the current work, the amine-functionalized graphene quantum dots are synthesized in

Polyalkylene Glycol (PAG) and characterized. Further, the thermophysical properties of this mixture are evaluated experimentally and validated.

Section snippets

Synthesis and characterization

The synthesis method for graphene quantum dots (GQDs) incorporates a two-step process where graphene oxide (GO) is first synthesized using Hummers' method followed by the functionalization with amine groups [6]. This functionalization is not merely a replication of existing methods but includes an innovative approach of using both nitric and sulfuric acid in the nitric steam method for enhanced functionalization [7]. The use of ultrasonication during the synthesis process enhances the ...

Stability investigation using UV spectrophotometer

The colloidal stability is observed for the synthesized PAG-amine functionalized GQD nanosuspension (Fig. 3(a)). The stability of a nanosuspension can often be inferred from changes in the absorption spectrum over time. Allowing the nanosuspension to stabilize for 48 hrs. is aimed at assessing the medium-term stability of the suspension, which is more indicative of its behaviour in practical applications than its initial state immediately after preparation. Waiting for 48 hrs. also helps to ...

Conclusion

The current work investigates the synthesis, characterization and thermophysical properties of amine-functionalized graphene quantum dots and their effect on PAG oil. The SEM images of graphene oxide display a surface that is rough and textured, with a layered structure. The HRTEM images of the graphene quantum dots treated with amines exhibit a homogeneous distribution and a consistent nanostructure, demonstrating high crystallinity and absence of defects. The combination of both imaging ...

CRediT authorship contribution statement

Yogesh G. Joshi: Writing – original draft, Validation, Methodology, Formal analysis, Conceptualization. **Vinit Gupta:** Writing – review & editing, Supervision. **Ranjit Kumar Dehury:** Writing – review & editing, Validation. **Mahelaqua A. Haque:** Software, Resources. **Rahul Kumar:** Validation, Data curation. **Abira Rashid:** Resources, Data curation. ...

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. ...

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E.K. Goharshadi *et al.*

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J. Mol. Liq. (2017)

F. Sedaghat *et al.*

Synthesizes, characterization, measurements and modeling thermal conductivity and viscosity of graphene quantum dots nanofluids

J. Mol. Liq. (2019)

E. Hamdy *et al.*

Enhancement of molten nitrate thermal properties by reduced graphene oxide and graphene quantum dots

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DEVELOPMENT OF INTEGRATED LEAN AND GREEN FRAMEWORK FOR SMALL SCALE MANUFACTURING INDUSTRY

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Abstract

Small-scale industries (SSIs) play a crucial role in the Indian economy and are key contributors to employment generation. Lean manufacturing has been shown to enhance operational and economic performance, while green manufacturing practices improve social and environmental outcomes. Integrating Lean and Green manufacturing practices offers a promising solution for minimizing the environmental impact of manufacturing industries. This research aims to develop a framework that integrates Lean and Green practices specifically for SSIs in India. The proposed framework is comprehensive yet simple, designed to be easily adopted by SSIs to improve their sustainability and efficiency. The framework includes Assessment Phase, Planning Phase, Implementation Phase and Evaluation Phase. Assessment Phase includes evaluating current processes, gathering input from stakeholders, creating process maps, identifying waste, and selecting Lean and Green tools. Planning Phase includes setting clear goals, determining key performance indicators (KPIs), developing implementation plans, organizing training sessions, and forming dedicated Lean and Green (LnG) teams. Implementation Phase includes implementing techniques such as Value Stream Mapping, 5S, and 3R (Reduce, Reuse, Recycle), and establishing standard operating procedures (SOPs). Evaluation Phase includes continuously monitoring performance against KPIs, conducting regular reviews and audits, and making ongoing improvements. This structured approach is designed to help SSIs effectively adopt Lean-Green practices, ultimately contributing to their sustainable development and operational efficiency.

Keywords:

Lean manufacturing, green manufacturing, Integrated LnG framework, implementation framework, small-scale manufacturing industry.

I. Introduction

The small scale industries are the lifeline of the economy, specifically in developing countries like India. Small Scale Industries (SSIs) works in manufacturing, production, and rendering of services are done on a small or micro scale. These industries make a one-time investment in machinery, plant, and equipment, but it does not exceed Rs.10 crore and annual turnover does not exceed Rs.50 crore. These industries are generally labour-intensive, and hence they play a pivotal role in employment creation. Small scale industries are a crucial sector of the economy both from a financial and social point of view, as they help with the per capita income and resource utilization in the economy. SSIs are one of the main reasons for the growth and strengthening of the economy.

Table 1: Major problems faced by Small Scale Industries in India: [34, 35]

1. Lack of management commitment and leadership	9. More manufacturing lead time
2. Lack of communication	10. Poor inventory control
3. Lack of resources	11. No maintenance policy available
4. Resistant to change	12. Incompetent management
5. Lack of Employee involvement	13. Inadequate Finance
6. Lack of training and skills	14. Raw material shortages
	15. Lack of technology up-gradation
	16. Inability to meet environmental standards

-
7. Lack of cooperation and mutual trust between management and employees
 8. Poor capacity utilization
-

To address these problems and to improve the organizational performance lean manufacturing and green manufacturing practices both can be implemented. Lean Manufacturing deals with the idea of eliminating waste from the processes and operational systems. The basic essence is to pull out the maximum output from minimum inputs without influencing the output in any negative way. Waste may be considered to be anything that is not minimum equipment, materials, parts, and working time, which absolutely are vital to production. Green Manufacturing is a process of manufacturing that minimizes waste and pollution. It aims at using minimum natural resources so as to conserve them for future generations. Also, the purpose is to create a substantially better image in the public, to save unnecessary cost, and to promote extensive research, engineering, and redesign to improve efficiency in greener ways. Thus, green manufacturing emphasizes manufacturing goods and services with minimal impact on the environment under present technological and economic challenges. The purpose of the research is to explore as well as to reflect the scope of integrating lean and green manufacturing to eliminate waste and to adapt environmental protection into business performance in small-scale Industries.

II. Literature Survey

2.1 Lean Manufacturing and its practices

Toyota production system first introduced Lean manufacturing in the 1950s. It mainly focuses on eliminating all kinds of non-value adding activities and process which are considered as waste and create no value for customers. Russell and Taylor (1999) define waste as anything other than the minimum amount of equipment, effort, materials, parts, space and time that is essential to add value to the product. To remove all kinds of lean waste has numbers of techniques and practices. 5S, Kaizen, takt time, poka yoke, error-proofing techniques, Value Stream Mapping, inventory minimization, high resource utilization, Cellular layout, Total Productive Maintenance [TPM], shorter lead time, work standardization, Just in Time [JIT] and Total Quality Management [TQM] are among the lean techniques. Different types of problems need different lean practices to be implemented. Various researchers have studied the implementation of the lean strategy.

Singh et al. (2013) show the role of lean manufacturing and JIT principle in supply chain management in small Manufacturing companies. In this study, the principle is used to eliminate waste, improve quality, increase production flow and reduce cost. [1]. Krisztina Demeter et al. (2011) studied the effect of lean manufacturing and contingency factors affect inventory turnover. The result of the study shows a significant relationship between lean manufacturing and inventory turnover [2]. A study by Hemanand et al. (2012) focused on waste reduction on an automotive industry, and the result of the study shows 11.95% improvement in productivity by modifying the layout. Time study and motion study was done to do the analysis [3]. Shah and Ward (2003) investigate how just in time, total quality management, total prevention maintenance, and human resource management result in 23% variation on operational performance [4]. Chakraborty et al. (2011), use value stream mapping and layout design as their main lean tool and present a framework for the industries to improve their capacity. The result of the study shows 45%, 10 and 14% improvement in productivity of different buyers respectively [5]. A study by Mo et al. (2009), shows 30% increase in productivity by applying lean manufacturing principles in a small furniture company [6]. Dal Pont et al. (2008) used JIT, TQM and human resource management in 9 companies. The results indicate that JIT and TQM has a positive effect on operational performance while human resource management has mediated the effect [7].

Different studies have been done on the effectiveness of implementing lean practices in manufacturing systems. The benefits of applying this strategy are:

- Reduction in cost [1]



- Reduction in lead time [5]
- Waste reduction [3]
- Improvement in productivity [3, 6]
- Operational performance and quality [4, 7]
- Cycle time reduction [5]
- Capacity improvement [5]
- Better labor, space and equipment utilization [3, 5]
- Reduction in work in process [WIP] Inventory [11]

2.2 Green Manufacturing and its practices

Green manufacturing strategies considers the whole life cycle of a product, from material requirement and specification, manufacturing and disposal of the product to reduce the environmental impacts. [8, 9] Green manufacturing practices focuses on the processing of producing a product and also disposal of the material without considering the manufacturing process. The practices focus on reducing the usage of resources such as energy, water, raw material, air emission, hazardous waste and non-product output and increasing the possibility of using recyclable or reusable material to reduce the environmental impacts [10]. The majority of these reductions cannot be optimized by only utilizing lean practices. Sarkis (2003) shows that JIT, TQM and introduction of a new process can help in reduction of resources [10]. Luttrupp et al. (2006) provide golden rules for greening a product: The summary of the rules to have a green product based on Luttrupp et al. (2006) is as follow:

- Toxic materials should be eliminated.
- Energy and resource consumption in production and use phase should be minimized.
- High-quality materials and material cleaning are necessary to reduce maintenance
- Regular upgrading and repairing schedule for system is another way of greening the products.
- Use long-life products
- Organize upgrading, repair and recycling through access ability, labeling, modules, breaking points and manuals or recycled, simple, not blended materials and no alloys, whenever practical.
- Prevent using the joint as far as it possible and used them by considering their life cycle assessment. [11]

Investigating the energy consumption of machine tools provides important information that can be applied in the use phase of machine tools, as well as the manufacturing phase of the products that are made. Reducing the energy consumption of machines based on idle and busy time, identifying disruption based on power usage will help to reduce the environmental impacts associated manufacturing processes and systems. It will also help to track maintenance and providing beneficial reports [12, 13] The level of CO₂ emissions that are imposed on developing countries and especially on India and China, two of the world's fastest-growing economies, creates the necessity of shifting the concentration towards environment-friendly ways of production and manufacturing. This also makes us think about sustainable development (UN Report, 2010). Deif (2011) presents the model which can capture various planning activities to migrate from a less green for the new green manufacturing paradigm into a greener and more eco-efficient manufacturing. According to Rahma et al. (2009) cleaner production (CP) can reduce cost, based on competitive advantage and environmental aspect approaches. The approach towards the CP practices is to: reduce, reuse, recycle, and reproduce and recovery (i.e., 5R). Selinger et al. (2008) identify a research and development plan for sustainable manufacturing focusing on enhancing use-productivity. Hosseini (2007) discusses the basic factors and a conceptual model in the adoption and maintenance of green management system. It is anticipated that if organizations ensure these factors, they will experience less resistance from their stakeholders and consequently they will have a successful GM (green management) and GP (green productivity) implementation. Huiy et al. (2002) presents a case study that demonstrates that the fuzzy set-based model can effectively account for the vagueness and uncertainty of information being used for the environmental impact of a manufacturing process.



Advantages of Green Manufacturing:

- Save valuable resources
- Economic incentives [13]
- Energy efficiency
- Benefits environment by reducing waste and harmful emissions
- Competitive advantages [13, 14]
- Higher quality and reliability

2.3 Linking lean with green manufacturing

Lean and green manufacturing sometimes used interchangeably. However, they have different end goals. Lean focuses on eliminating non-value adding activities by considering seven kinds of waste. Many different researchers studied the combination of lean and green strategies. Manufacturers can be green and highly profitable at the same time. Profits do not have to be sacrificed to environmental responsibility, or vice versa. The two strategies (lean and green) can be integrated and offered simultaneously that will reduce environmental or productivity inefficiencies (Pacific Northwest Pollution Prevention Resource Centre, 2008). According to Black et al. (2010) green manufacturing has the goal of zero waste. Yang et al. (2011) explores relationships between lean manufacturing practices, environmental management (e.g., environmental management practices and environmental performance), and business performance outcomes (e.g., market and financial performance). Bergmiller et al. (2009) suggests that “Lean and Green Programs” are synergistic and correlated. According to Bergmiller et al. (2009) the philosophical and structural similarities between models of leanness and greenness suggest that the reverse may also be true; i.e., those firms seeking minimal environmental impact from their operation may naturally adopt some methods of lean production in order to reduce wastage. According to Pacific Northwest Pollution Prevention Resource Center (2008), even without explicitly targeting environmental outcomes, lean efforts can yield substantial environmental benefits. Helper et al. (1997) explores how firms can be both profitable and environmentally conscious and how they can be both innovators in manufacturing and leaders in emissions reduction.

Pampanelli et al. (2014), implement the lean and green strategy by application of Kaizen with the aim of reducing waste and environmental impacts. The result of the study indicates that by applying the combination of these two approaches, there will be a reduction in resource usage from 30 to 50%. There is also a potential reduction in mass and energy flow from 5 to 10 %. In this study reduction in energy, water, metallic and contaminated waste, oil and chemicals usage were considered [15]. Galeazzo et al. (2014), analyzed the performance of lean and green strategies in three projects in two manufacturing plants. This study used, 5-why approaches, material change, resizing the machines and removal of the bottleneck and buffer tools. They discovered that the lean and green practices can be implemented either sequentially or simultaneously. In all the cases the environmental emissions were minimized, speed, flexibility and quality improved in 2 of 3 projects because of the concept of the projects [16]. Chiarini (2014) applied two lean and green strategies in five motorcycle manufacturer. The result shows that value stream mapping, 5S, cellular manufacturing and total productive maintenance will improve the environmental impacts while the minute exchange of die does not change the environmental impacts. Ammonia and isocyanate emissions were measured in this study [17]. Kurdve et al. (2014) considered the integration of lean and green strategies. This study applied Toyota Production System, environmental management system, safety quality management systems and Occupational Health and Safety.

The result of the study shows that there is a lack of sustainability metrics and improvement methods to improve the operational performance [18]. Diaz et al. (2013) used lean and green strategies in a production parts for a powertrain. Batch reduction, Kanban systems, and defect reduction, total quality management, total productive maintenance, process integration for shorter waiting time and green scheduling by power reduction were the tools that used. The result caused in 10.8 % reduction in costs

of representative parts [19]. Dues et al. (2013) studied on the benefits, similarities and difference of lean and green strategies suggested that lean and green have two-way positive effect on each other results. Their result shows that lean manufacturing acts as a catalyst for reducing environmental impacts, and they have overlaps on tools and practices, lead time reduction and their focus on people and organizations [20]. Lean and Green integrated approach aims to achieve improvements in financial or operational and environment-oriented (Leong et al., 2019). The integration of Green and Lean can be seen as a new opportunity for organizations to improve their sustainability performance. According to Cherrafi et al. (2017), organizations that have simultaneously implemented lean and green practices have achieved better results than those organizations that have only focused on either of the initiatives.

2.4 Conclusion from literature review

Lean manufacturing focuses on eliminating the defects in terms of reducing cost and non-value added activities based on customers’ point of view. However, green manufacturing focuses on reducing all types of waste including solid waste to reduce environmental impact. Reducing all kinds of waste not only improve the environmental performance of the processes, it also decreases cost and social impacts associated with those types of waste. As it was stated before lean practices focus on reducing time and cost, but they do not consider employee’s satisfaction and result in poor quality of the employees' life.



Figure 1: Lean and Green manufacturing for the sustainable performance

The (Figure 1) shows the operational, environmental and social performance parameter for the organizational sustainable performance.

Table 2: Outcomes of Lean and Green implementation

Results	Lean manufacturing	Green manufacturing
Financial improvement	√	√
Cycle time reduction	√	√
Improve productivity	√	√
Improve capacity	√	
Decrease work in progress	√	
Save resources	√	√
Energy efficiency	√	√
Waste reduction	√	√
Emission reduction		√
Company reputation	√	√
Customer satisfaction	√	√
Product quality	√	√
Improve safety	√	√
Improve health		√



2.5 Gaps in existing research

Through the literature survey, it is concluded that, Lean manufacturing has proven its positive effects on operational and economic performance in multiple cases. The implementation of green manufacturing practices improves the social and environmental performance of the SMEs along with enhancement of economic performance in the long run by reducing raw material and energy costs. Environmental factors should be incorporated for the overall performance of the organization. [1, 4] A number of business and environmental factors need to be integrated. [10] There is a general need to focus on environmentally sustainable practices and outcomes in the manufacturing and service industries. [14] Environmentally sustainable practices can be treated as an extension of lean philosophy. [15] Academicians could investigate whether it is possible to shape a general Lean Green model for improving environmental performance. For instance, the model should propose different categories of environmental impacts in different sectors, linking them with the specific Lean tools which can reduce them. [17] The integration of Lean and Green practices will bring benefits to companies. [20] Author concluded that only some researchers have focused on the integration of Green-Lean and Sustainability as a joint approach and to take a holistic view of the inter-related factors in the context of SMEs. [22] Due to their restricted size and resources, SMEs struggle to effectively integrate lean management with green management. Lack of management support and missing metrics are the main factors that prevent companies from implementing lean management and green management. Employee involvement has been proven to be a crucial condition to allow integration to succeed. [22]

The literature review also demonstrates that significant shortcomings in regards to the understanding and application of Green-Lean and Sustainability still exist. These can be overcome by promoting their integration through a comprehensive, simplified and generic implementation framework. A toolkit for Green-Lean and Sustainability has also yet to be developed, as many tools have either not been adapted, are not mature enough or are frequently not recognized by the industry. The authors additionally recognize a need for a greater focus on the context of SMEs to assist them in effectively integrating both paradigms. [22] Through extensive literature survey it is found that, there is barely any exploratory research focused upon the implementation of lean and green manufacturing practices for sustainable organizational performance of Indian small scale industries. Moreover, considering the contribution of Indian small scale industries to the economic and industrial growth, it is interesting to investigate the degree of lean-green adoption in Indian small scale industries. Here, Integration of green and lean manufacturing have been proposed as a solution for manufacturing industries in minimizing adverse environmental impact. This research will aim to integrate lean and green manufacturing practices, develop a lean and green manufacturing implementation framework and implementation of the framework at small scale manufacturing industries.

III. Development of Framework of Integrated Lean and Green (LnG) methodologies

Developing a framework for the integration of Lean and Green manufacturing practices in small-scale manufacturing industries involves creating a structured approach that aligns with the goals of improving efficiency, reducing waste, and enhancing environmental sustainability.

3.1. Literature related to the Lean and Green (LnG) Framework

Siegel et al. (2019) discussed on Green-Lean in the context of manufacturing SMEs. The findings indicate that the most common challenge to Green-Lean implementation is a lack of metrics and measurement. 5S is the most used tool. Author have identified and analysed, through a systematic review, data on the challenges, success factors, tools and techniques, sustainability aspects, frameworks and benefits of Green-Lean in manufacturing SMEs. A systemic model representing the relationship among the determinants to implement a Green-Lean initiative for manufacturing SMEs is also presented (Figure 2) and discussed. [45]

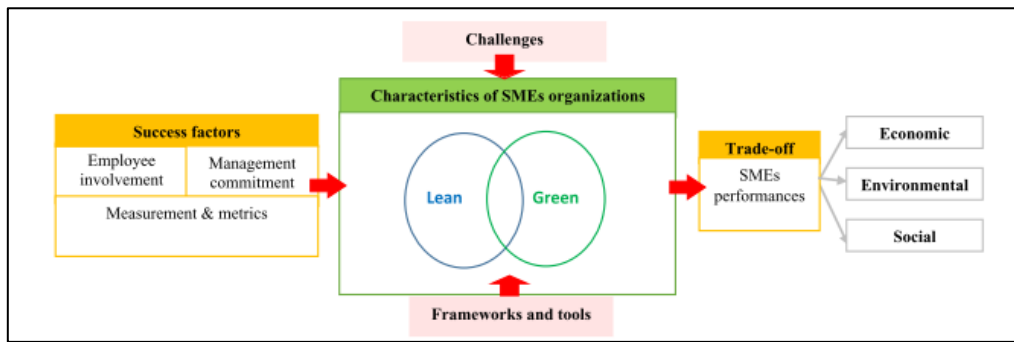


Figure 2: Framework for Green-Lean approach for SMEs [45]

The of Green-Lean tools based on literature survey has depicted (Figure 3) using radar chart. Through this 5S, TPM, VSM, Visual control, pull systems are the most common tool used by the researcher for the LnG implementation. [45]

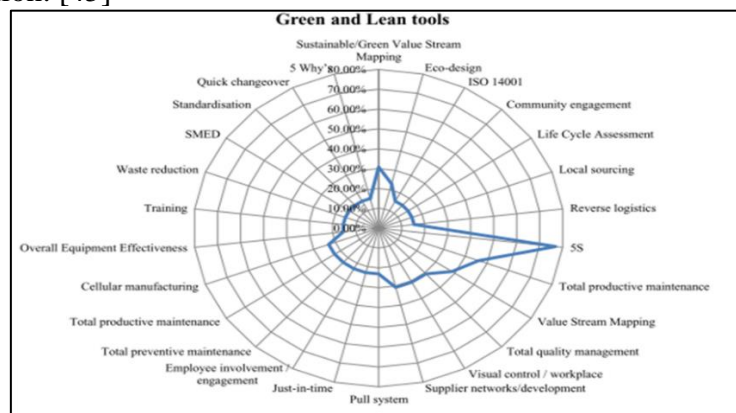


Figure 3: Green and Lean tools – radar chart [45]

Rafique et al. (2019) developed implementation framework of lean linked with technology (Figure 4) incorporating inputs from the literature. Value Stream Mapping (VSM) for lean implementation and Technology-Organisation-Environment (TOE) framework was considered as the most appropriate methodology. [46]

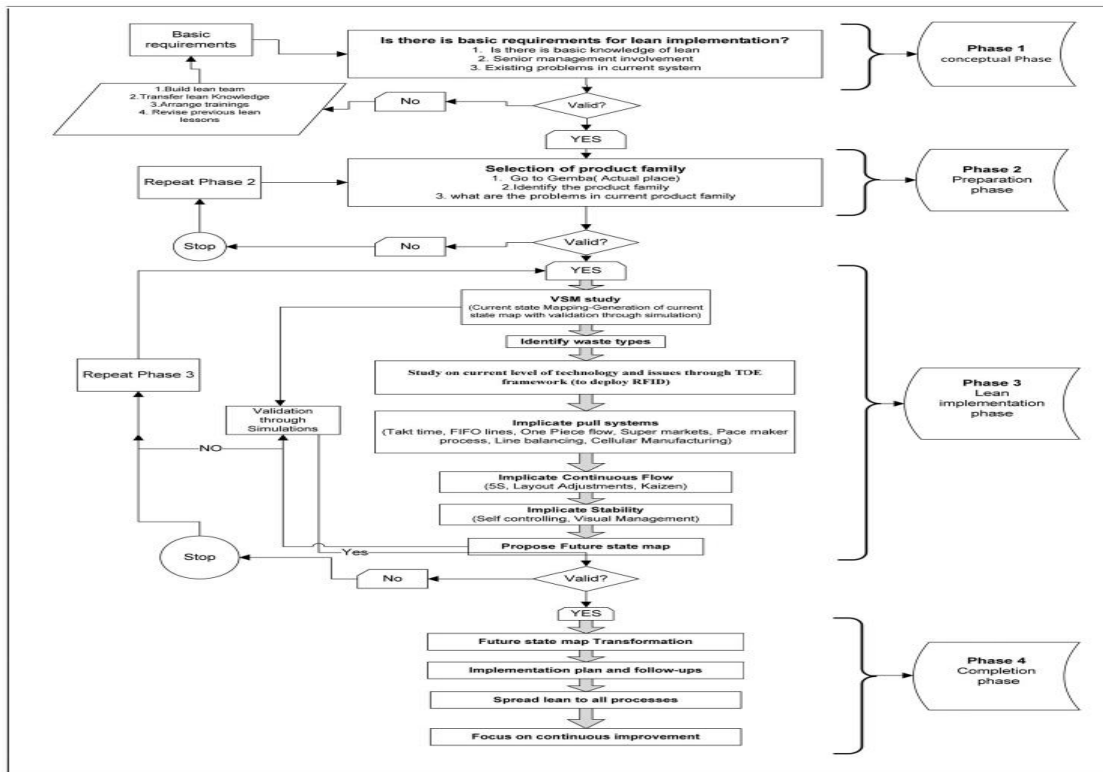


Figure 4: Implementation framework technology linked with lean [46]

David et al. (2016) have developed a methodological framework using a qualitative research approach to the implementation of Lean and Green principles in various industries. In implementing the methodology, the authors encountered obstacles such as low maturity. This lack of maturity could have created problems in adoption and implementation. [35] Cherraf et al. (2017) used a combination of methods to investigate barriers to the implementation of Green Lean practices and understand their contextual relationships. Using a systematic literature review (SLR), they identified and analyzed existing research on barriers to green lean adoption. These barriers involved many complex factors, including political, managerial, behavioral and technical factors. Main issues highlighted in their research included lack of environmental awareness, insufficient government support, financial constraints and various human factors. [36]

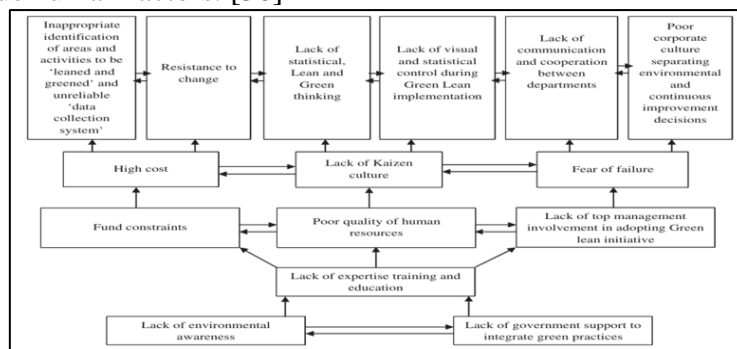


Figure 5: Barriers of Lean and Green adoption [36]

Duarte and Cruz Machado (2017) developed a conceptual framework to integrate green and lean management into organizational supply chains, they faced challenges related to the complexity of combining these two management models. [37] Belhadi, Touriki, and El Fezazi (2018) used a case study methodology to investigate the relationship between lean practices and environmental performance in small and medium-sized enterprises (SMEs), focusing on a pump manufacturing company. They adopted a lean and green integration framework (Figure 6) to investigate the relationship between improved operational and environmental resources in a company. The authors

encountered various obstacles in the implementation of their methodology. These barriers can be challenges related to changing the organizational culture to embrace lean and green principles, employee resistance to change, limited resources and difficulties in matching lean practices with environmental sustainability goals. The study showed a strong relationship between the adoptions of key lean practices such as 5S, Kanban, SMED, independent maintenance and quality control, and improvements to both operational and environmental metrics. [38]

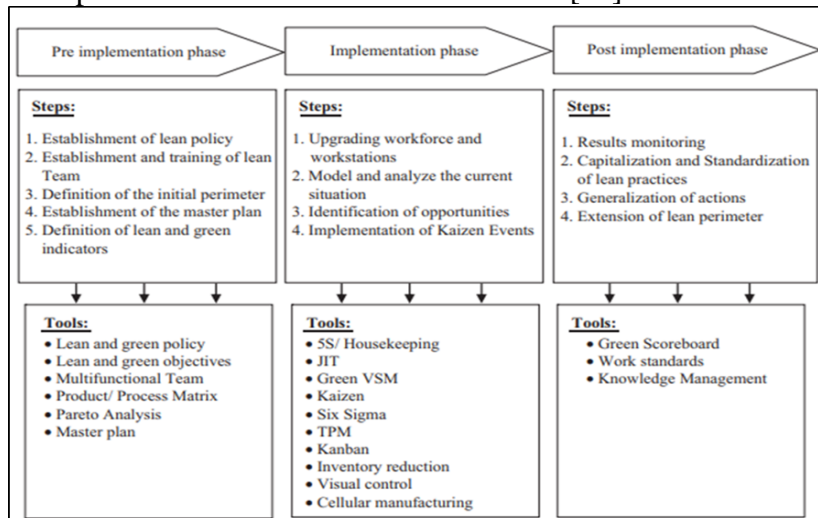


Figure 6: Methodology of lean and green implementation in SMEs [38]

Jamwal et al. (2019) used Total Interpretive Structural Modelling (TISM) as a method to study the adoption of Lean Manufacturing (LM) in a small-scale industry. They focused on identifying both barriers and facilitators to the adoption of LM in these sectors. After applying the methodology, the authors encountered various barriers to LM adoption. Cost has emerged as a crucial factor affecting industry practices and market dynamics. Other barriers include challenges related to resource limitations, lack of awareness or expertise, reluctance to change and difficulties in actually implementing LM principles. Despite these barriers, the study by Jamwal et al. provides valuable information on LM implementation. By identifying the barriers and using TISM to understand their relationships, the study contributes to strategic decision-making and helps to overcome the challenges of implementing LM in industry in the region. [39] Choudhary et al. (2019) initiated a study that aims to respond to the challenges faced by manufacturing SMEs in aligning operational efficiency and environmental sustainability. To address the specific challenges of SMEs implementing lean and eco-friendly practices, authors followed a systematic approach by conducting an extensive literature review. They developed a framework adapted to the unique context of SMEs, emphasizing the integration of lean and green strategies. This framework (Figure 7) served as a blueprint to effectively guide SMEs in solving the complex problems of integrating lean and green practices. Author suggested Green Integrated Value Stream Mapping (GIVSM), which aims to simplify carbon footprint measurement and waste visualization in SMEs. These tools aimed to provide SMEs with practical knowledge to promote sustainable practices. [40]

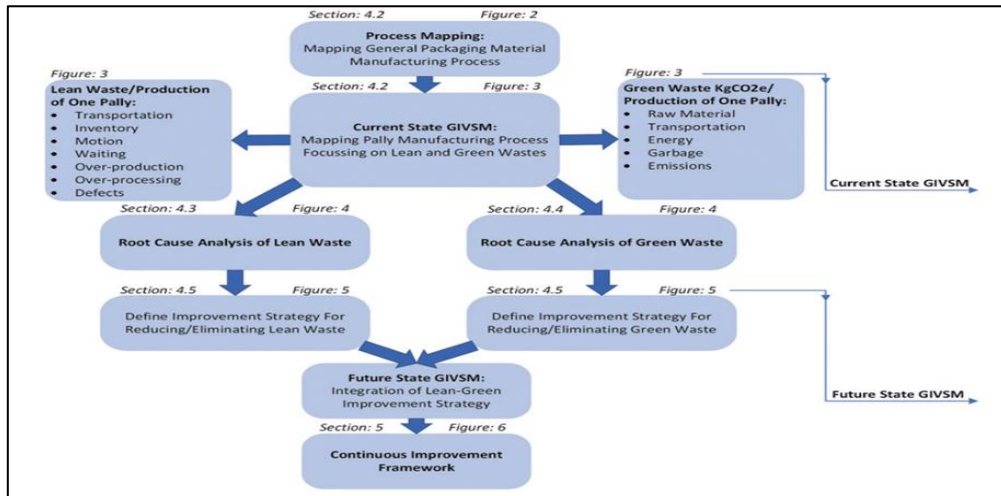


Figure 7: Integrated Lean and Green framework, GIVSM methodology [40]

Farias et al. (2019) used a systematic literature review (SLR) as a method to investigate the performance of lean and green production methods. Author proposed a conceptual framework (Figure 8) that helps in understanding the concepts and relationships involved in the lean and green performance assessment system [41]

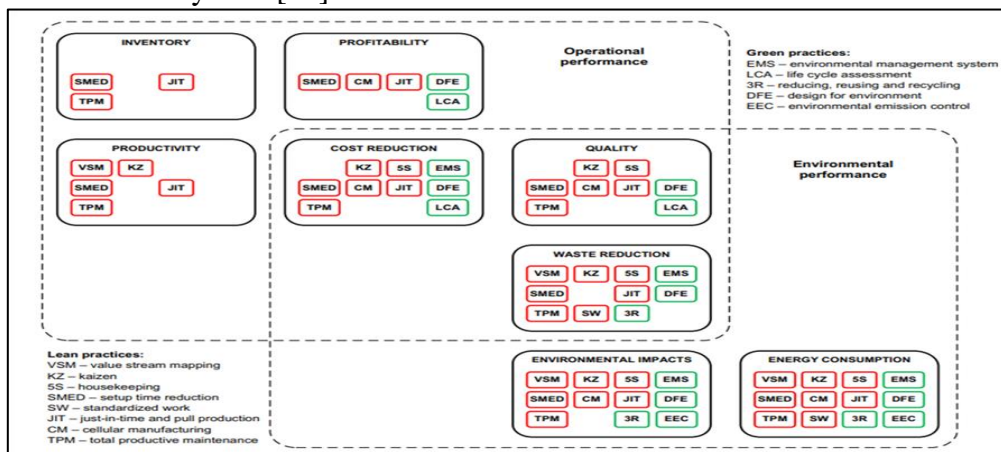


Figure 8: Lean and Green practices for Operational and Environmental performance [41]

Touriki et al. (2021) used a systematic literature review (SLR) methodology to investigate the integration of smart, green, resilient and lean (SGRL) paradigms in manufacturing specifically in the context of challenges such as COVID-19. The authors proposed two frameworks (Figure 9): one for integrating SGRL and one for future research directions. [42]

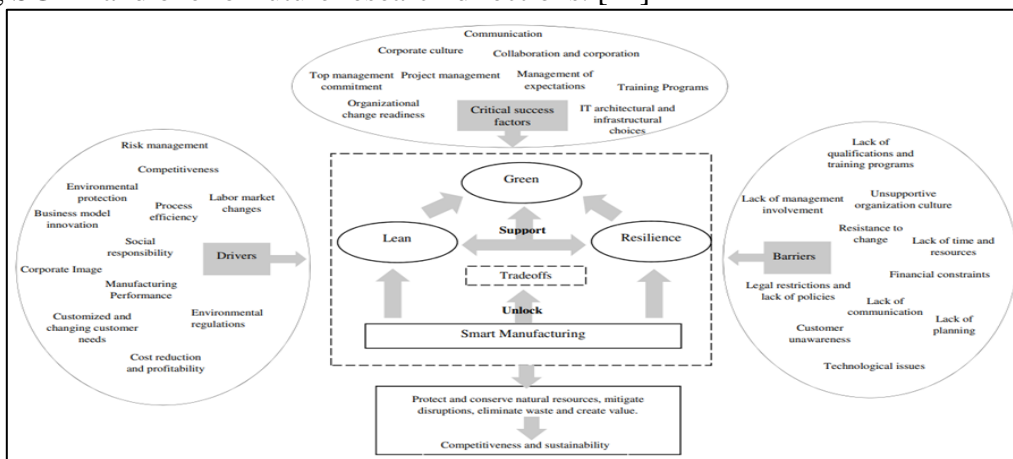


Figure 9: Integration of Smart, Green, Resilient and Lean (SGRL) paradigms [42]

Kaswan et al. (2023) integrated Lean, Green and Six Sigma (Figure 10) and developed a Green Lean Six Sigma (GLSS) implementation framework (Figure 11) for manufacturing firms. [43]

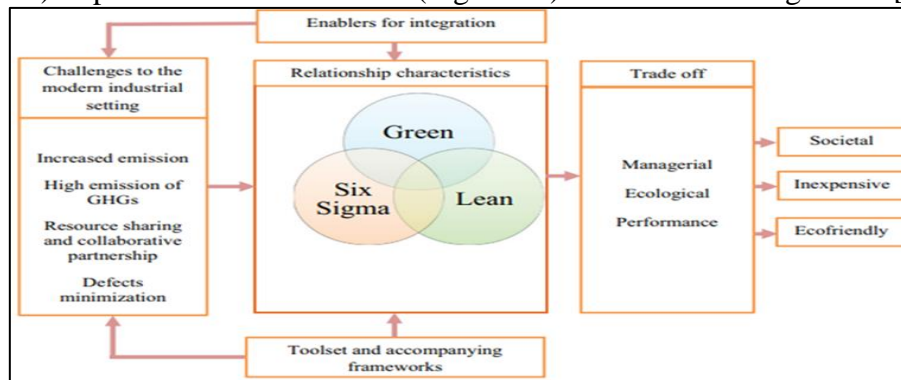


Figure 10: Integration of green lean and six sigma [43]

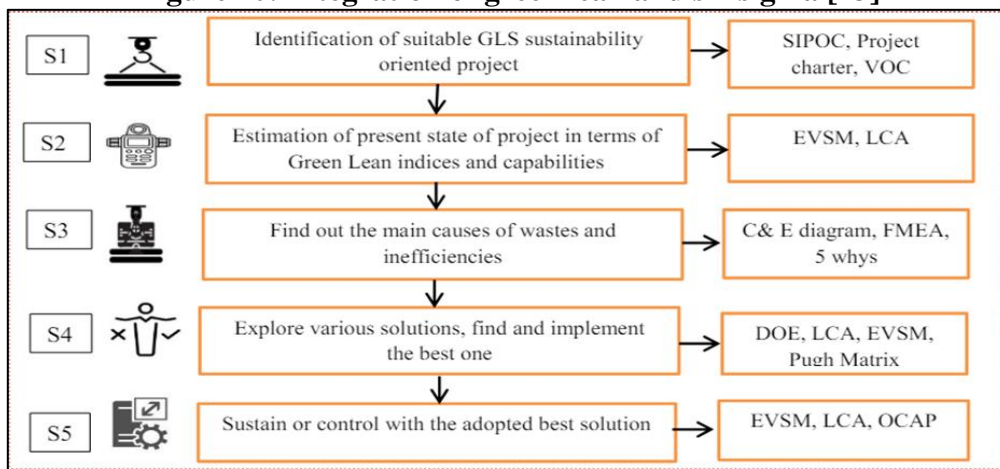


Figure 11: Green Lean Six Sigma (GLSS) implementation in manufacturing [43]

Siegel et al. (2022) conducted a comprehensive literature review to determine the importance of Green Lean practices, especially in SMEs. This method was the basis for identifying existing challenges and gaps in the literature. The authors have utilized surveys, conducted interviews with SME stakeholders to identify the specific barriers faced in implementing Green Lean methods. [44]

3.2. Development of Lean and Green Framework

The Lean and Green (LnG) Implementation Framework (Figure 12) provides a comprehensive, structured approach to enhance operational efficiency and environmental stewardship. This framework is meticulously designed to help small-scale manufacturers systematically assess, plan, implement, and evaluate Lean and Green practices, thereby fostering continuous improvement and long-term success.

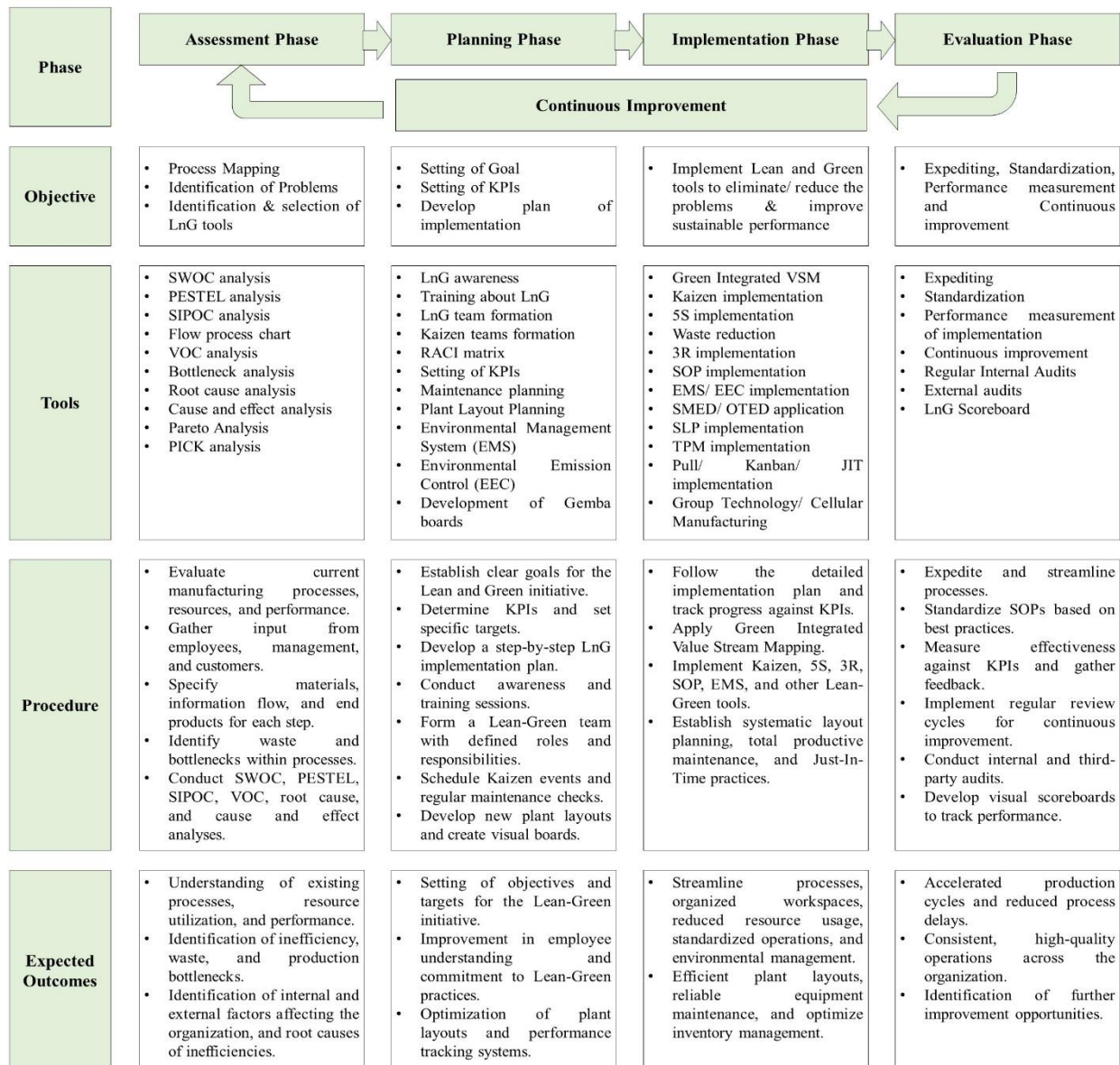


Figure 12: Suggested Integrated Lean & Green Framework

IV. Discussion on the Implementation of Lean and Green Framework

The proposed Lean-Green implementation framework provides a practical and effective approach for SSIs in India to enhance their sustainability and efficiency. By following the structured phases of assessment, planning, implementation, and evaluation, SSIs can systematically integrate Lean and Green practices into their operations. This framework not only addresses the current challenges faced by SSIs but also paves the way for sustainable growth and development in the manufacturing sector.

PHASE I: ASSESSMENT PHASE

By following these steps, small-scale manufacturing industries can systematically assess their processes, identify issues, select appropriate tools, and implement improvements to enhance efficiency and sustainability.

Step 1: Evaluate current manufacturing processes, resources, and performance.

Step 2: Gather input from employees, management, and customers to understand their perspectives.

Step 3: Create Detailed Process Maps of each step of the manufacturing process.

Step 4: Specify materials, information flow, and end products for each step.

Step 5: Identification of waste, and bottlenecks within the processes.



Step 5: Identification & Selection of LnG Tools

Step 6: SWOC Analysis: Identify internal strengths, weaknesses, external opportunities and challenges facing the organization.

Step 7: PESTEL Analysis: Government policies and regulations, economic factors, societal trends, technological advancements, sustainability initiatives and compliance issues.

Step 8: SIPOC Analysis: Identify key suppliers, list all inputs, Outline the process, Define the final products or services and identify the customers.

Step 9: Develop Flow Process Chart

Step 10: Voice of Customer (VOC) Analysis

Step 11: Conduct Root Cause Analysis: Using techniques like the 5 Whys to determine underlying causes of problems.

Step 12: Cause and Effect Analysis using Fishbone Diagram to map out potential causes of problems in categories (e.g., methods, materials, manpower).

Step 13: Pareto Analysis to identify the most significant causes of problems.

Step 14: PICK Analysis to Categorize actions into Possible, Implement, Challenge, and Kill based on impact and feasibility and to choose actions with high impact and ease of implementation.

PHASE II: PLANNING PHASE

By following these steps, small-scale manufacturing industries can systematically plan and prepare for the implementation of Lean and Green practices, ensuring a structured and effective approach to achieving sustainability and operational efficiency.

Step 1: Establish clear, specific, and measurable goals for the Lean and Green (LnG) initiative.

Step 2: Determine key performance indicators (KPIs) relevant to LnG goals and Define specific targets for each KPI to measure progress and success.

Step 3: Develop a step-by-step implementation plan outlining activities, timelines, and responsibilities.

Step 4: Organize workshops, seminars, and informational sessions to introduce LnG concepts.

Step 5: Conduct regular training sessions for all employees at different levels.

Step 5: LnG Team Formation: Choose employees from various departments with relevant expertise and define Roles and Responsibilities

Step 6: Make small, diverse Kaizen teams to focus on specific projects.

Step 7: Schedule regular Kaizen events to implement improvements.

Step 8: RACI Matrix: List all tasks involved in the LnG implementation, Assign Roles using the RACI (Responsible, Accountable, Consulted, Informed) framework.

Step 9: Create a timetable for regular maintenance checks and tasks and Assign personnel and budget for maintenance activities.

Step 10: Evaluate the existing plant layout for inefficiencies, develop a new layout to improve workflow and reduce waste and gradually transition to the new layout with minimal disruption.

Step 11: Create visual boards (Gemba Boards) to display key performance indicators and project status, Place Gemba boards in prominent locations within the plant and Update Regularly.

PHASE III: IMPLEMENTATION PHASE

By following these steps, small-scale manufacturing industries can systematically implement Lean and Green tools to enhance efficiency, reduce waste, and improve overall sustainability and performance.

Step 1: Follow the detailed implementation plan developed during the planning phase and continuously track progress against the set KPIs.

Step 2: Green Integrated Value Stream Mapping (VSM) : Map current processes (material flows, and energy usage), Identify areas of waste and high environmental impact, Develop an improved process map integrating Lean and Green practices and Implement the new process map and monitor improvements.

Step 3: Kaizen Implementation: Identify Improvement Areas, Conduct Kaizen Events and implement the Kaizen.



Step 4: 5S Implementation: Remove unnecessary items from the workspace, organize remaining items for easy access, Clean the workspace thoroughly, establish standards for maintaining organization and cleanliness and Ensure ongoing adherence to the 5S principles through regular audits.

Step 5: 3R Implementation (Reduce, Reuse, Recycle): Implement practices to minimize resource usage and waste generation, identify opportunities to reuse materials within the production process and establish systems for recycling waste materials.

Step 5: SOP Implementation: Create detailed standard operating procedures for key processes, Train staff on following SOPs accurately and regularly review and update SOPs to ensure they remain effective.

Step 6: Environmental Management System (EMS): Evaluate existing environmental practices and compliance, create a comprehensive plan, Execute the plan and train employees and regularly monitor environmental performance and conduct audits.

Step 7: Environmental Emission Control: Identify all sources of emissions within the facility, set targets for reducing emissions, apply technologies and practices to control and reduce emissions and regularly monitor emission levels and ensure compliance with regulations.

Step 8: SMED/ OTED Application: Evaluate the current changeover process and identify delays, Implement SMED (Single-Minute Exchange of Die) or OTED (One-Touch Exchange of Die) techniques to reduce changeover time, Train staff on new quick-changeover methods and continuously monitor changeover times and make improvements.

Step 9: Systematic Layout Planning (SLP) Implementation: Evaluate current workflow and layout, develop a new layout to improve efficiency and reduce movement, gradually transition to the new layout and Monitor the impact of layout changes on efficiency and adjust as needed.

Step 10: Total Productive Maintenance (TPM) Implementation: Evaluate existing maintenance practices and equipment reliability, create a plan incorporating preventive, predictive, and autonomous maintenance, Train staff on TPM practices and responsibilities and Continuously monitor equipment performance and refine maintenance practices.

Step 11: Pull/ Kanban/ Just-In-Time (JIT) Implementation: Evaluate existing inventory levels and production scheduling, introduce a Kanban system to signal demand and manage inventory flow, align production schedules closely with customer demand to minimize inventory and Continuously monitor inventory levels and production efficiency, adjusting as needed.

Step 12: Group Technology/ Cellular Manufacturing: Group similar processes and products into families, create manufacturing cells for each product family and regularly evaluate the performance of cells and make improvements.

PHASE IV: EVALUATION PHASE

By following these steps, small-scale manufacturing industries can effectively evaluate the success of Lean and Green implementations, ensure continuous improvement, and maintain high standards of performance and sustainability.

Step 1: Apply strategies to expedite and streamline processes and Track the effectiveness of expediting measures and make adjustments as necessary.

Step 2: Develop SOPs based on documented best practices, standardize and ensure all staff are trained on new SOPs to maintain consistency.

Step 3: Measure the effectiveness of implemented LnG tools against set KPIs through feedback from employees and stakeholders on the implementation process and Compare actual performance against targets and goals.

Step 4: Implement regular cycles for reviewing and improving processes (e.g., PDCA - Plan, Do, Check, Act) where employees can suggest improvements and continuously track improvement.

Step 5: Plan regular internal audits to evaluate compliance with SOPs and LnG practices, and address any non-conformities or issues identified during audits.

Step 6: Conduct third-party audit to review LnG practices and performance, analyze findings from external audits and take necessary actions for improvement.



Step 7: Develop a visual scoreboard to track and display key LnG performance indicators, Place scoreboards in prominent locations within the facility and Keep the scoreboard updated.

V. Conclusion

Integrating Lean and Green manufacturing practices offers a powerful way to boost the sustainability and efficiency of small-scale manufacturing industries. Research shows that Lean practices can improve how businesses operate and perform economically, while Green practices bring social, environmental, and economic benefits. However, small-scale industries often face challenges in adopting these practices due to limited resources and insufficient management support. The proposed Lean-Green implementation framework is designed to overcome these obstacles. It provides a step-by-step guide for small-scale manufacturers, starting with process mapping and waste identification, moving through the selection of appropriate tools, and ensuring continuous performance monitoring. By following this structured approach, small-scale industries can more effectively adopt Lean-Green practices, leading to sustainable growth and development in the manufacturing sector.

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Experimental investigation of wetting characteristics in Cu-In alloy

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Highlights

- Experimental investigation of wetting behaviour in Cu-In alloy is carried out.
- Studies based on scanning electron microscopy and energy dispersive spectroscopy are carried out to identify wetting behaviour.
- Indium seems to considerably affect the wetting transition at triple grain junction.

Abstract

This work investigates Cu-In alloy at 15% indium for wetting behaviour after heat treatment at 800 °C. The system is observed to show wetting behaviour at triple junction (grain junction) through Scanning electron microscope imaging. It is observed in energy dispersive spectroscopy that after annealing, increased segregation of indium near triple

junction is responsible for this wetting behaviour. The current work is critical to development of advanced materials with better mechanical characteristics at high temperatures.

Introduction

Engineering applications in current times requires materials with high strength, low weight and self-lubricating properties. These materials are largely studied for their suitability as a bulk material as well as surface modifier. Different metallic alloys are being investigated nowadays for their self-lubricating features. Ideal wetting characteristics require material to form a self-lubricating layer preferably at higher temperatures. This behaviour support not only in controlling friction and wear but also ensure smooth motion transmission in engineering components such as mechanical bearings. Additionally, the phenomenon of grain boundary (GB) wetting plays a crucial role in semisolid metal processing [1], liquid-phase sintering [2], and heat-exchanger tube applications in nuclear plants [3], etc.

Several materials such as Aluminum-Tin alloy [4], Zinc-Aluminum alloy [5], Tin-Indium alloy [6] etc. are extensively studied for wetting characteristics. This system shows partial and complete wetting at grain junctions and boundaries depending upon alloy composition, heat treatment etc. This study focuses on investigating the wetting behavior of Copper-Indium (Cu-15wt%In) alloy to observe wetting transitions at line defects like GB triple junctions (TJs).

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Section snippets

Experiments and methods

Cu-15wt%In samples were arc-melted and heat-treated to induce solute segregation in the copper matrix. Annealing above the eutectic temperature in a muffle furnace facilitated phase equilibrium. Annealing at 800°C for two hours followed by rapid quenching in de-ionized water maintained high-temperature structures. The

temperature variation is ± 1 °C. Fig. 1 shows the binary phase diagram. The binary phase diagrams was created using FactSage [7] software, showing the concentrations and ...

Analysis by scanning electron microscopy

SEM analysis was carried out in both the as-solidified as well as heat-treated samples, with the results shown in Fig. 2. In Fig. 2(a), the microstructure of the as-solidified alloy displays even distribution of In in the Cu matrix. Fig. 2(b) represents a heat treated sample showing a wetted triple junction in contact with three wetted grain boundaries. While in (c), a wetted triple junction in contact with one wetted GB is observed. As we have discussed above, if the alloys are above the bulk ...

Conclusion

The current work investigates the wetting of copper-indium (Cu-15wt%In) alloy at elevated temperature. Annealing temperature is fixed by analyzing binary phase diagram. Wetting is observed at elevated temperature making material suitable for engineering applications requiring self-lubricating characteristics. Results observed in SEM analysis and EDS analysis shows that indium segregation along grain junction is responsible for wetting. Further, analysis can be carried out for Cu-In alloy for ...

CRedit authorship contribution statement

Priya Tiwari: Conceptualization, Formal analysis, Resources, Writing – original draft. **Ranjit Kumar Dehury:** Investigation, Methodology, Supervision, Writing – review & editing. **Vinit Gupta:** Supervision, Writing – review & editing. **Rahul Kumar:** Validation, Writing – review & editing. **Yogesh G. Joshi:** Formal analysis, Validation. ...

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. ...

Acknowledgement

The authors wish to acknowledge the technical support from Dr. Abhay Gautam, Assistant Professor, Department of Materials Engineering, Indian Institute of Technology Gandhinagar (IITGN), India and also are thankful to IITGN for extending laboratory facilities. ...

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...Similarly, materials with self-lubricating characteristics particularly at elevated temperatures have drawn considerable interest to ensure smooth load transmission with higher wear resistance. Several alloys have been investigated for wetting characteristics for example Sn-In [1], Al-Sn [2], Cu-In [3] etc. to name a few. These alloy systems are observed to exhibit wetting tendencies at grain boundaries (GBs) and grain boundaries junctions depending on their compositions as well as the method of heat treatment....

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Review

Elemental Influence on Oxidation Behaviour of Cantor-Based and Refractory High Entropy Alloys: A Critical Review

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First published: 12 April 2024

<https://doi.org/10.1002/adem.202302124>

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Abstract

This article reviews the oxidation behaviour of the two most significant high entropy alloy systems (HEAs) namely Cantor-based and refractory HEAs. HEAs have been extensively researched and show potential applications in various industries, including marine engine manufacturing, chemical industry, furnaces, ducting, heat exchangers, jet engines, steam turbines, nuclear reactors and electronic devices, among others. Effect of the presence of elements such as aluminium, manganese, chromium, silicon, tantalum, vanadium etc. is studied for catalysing the oxidation of HEAs. Aluminium, chromium, and silicon are reportedly found to considerably impact the oxidation kinetics and enhance the oxidation resistance. However, silicon can positively or adversely affect the oxidation resistance depending on its concentration and alloy composition. Other elements like manganese tend to adversely impact the oxidation resistance of FeCoNi-based HEAs. Refractory elements are typically found to be not suitable for oxidation studies due to the formation of non-protective oxide layers. However, refractory HEAs offer interesting trends both in terms of enhancing or reducing oxidation resistance depending on the alloying elements. Similarly, findings related to other elements are also presented and elaborated.

Conflict of Interest

The authors declare no conflict of interest.

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Original Article

Comparative Analysis of Turning Parameters in Dry and Wet Machining of Haynes 25 Alloy Using L9 Taguchi Approach

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Received: 09 January 2024

Revised: 10 February 2024

Accepted: 08 March 2024

Published: 31 March 2024

Abstract - This study examines the impact of the machining environment, namely dry turning versus wet turning, on optimizing turning parameters for machining Haynes 25 alloy. The study utilizes the precise L9 Taguchi Methodology to investigate the critical parameters of cutting speed, depth of cut, and feed rate. The objective is to minimize tool wear and improve surface roughness under dry and wet conditions. The turning parameters, including cutting speed, depth of cut, and feed rate, are methodically adjusted. The cutting speeds are set at 500, 1000, 1500 rpm, the depth of cut at 0.6, 1.2, 1.8 mm, and the feed rates at 0.05, 0.1 and 0.15 mm/rev. In the dry turning experiments, there is no application of external coolant, but in the wet turning studies, a specific type of coolant is injected into the cutting zone. Both environments are closely scrutinized to ensure precise and verifiable results. Regression analysis is performed separately for dry and wet turning situations, resulting in predictive equations for tool wear and surface roughness in each environment. The ideal parameters for dry turning are determined as (insert optimal conditions for dry turning), whereas wet turning demonstrates superior outcomes under (insert optimal conditions for wet turning). Under the observed ideal parameters, the wet turning environment continually exceeds dry turning by significantly reducing tool wear and improving surface roughness.

Keywords - Haynes 25, Surface roughness, Tool wear, Dry turning, Wet turning.

1. Introduction

Modern industry struggles to produce high-performance alloys like Haynes 25, an aircraft material. Due to the alloy's high hardness, restricted heat conductivity, and work-hardening susceptibility, machining conditions must be understood to achieve the best performance. Modern industry struggles to manufacture high-performance alloys like Haynes 25, an aerospace-grade material. Understanding machining settings is crucial for optimal performance. High hardness, low heat conductivity, and a tendency to harden when worked on make the alloy unique.

The Haynes 25 alloy is known for its high-temperature strength and corrosion resistance. This material is crucial for gas turbine and aviation applications [1]. A precise balance between tool wear and surface roughness is needed to cut advanced materials efficiently, accurately, and cost-effectively [2]. Haynes 25, known as L-605, is used in harsh operational situations due to its excellent mechanical qualities. Due to its widespread use in aerospace and gas turbine manufacturing, effective machining procedures must be

examined. Conventional procedures typically fail due to the alloy's unusual composition and characteristics. An optimal methodology is needed to fully utilize the alloy's features and enable its smooth integration into important technological components [3]. This work aims to improve Haynes 25 alloy turning characteristics to reduce tool wear and improve surface roughness [4, 5]. Cutting speed, depth of cut, and feed rate significantly affect machining alloy performance [6-9]. L9 Taguchi Methodology is a reliable way to study these factors' complex effects on tool wear and surface roughness [10-14]. The work uses Taguchi's L9 analysis to optimize Haynes 25's machining parameters, which have not been disclosed and reported in earlier literatures.

2. Experimental Setup

The turning tests were conducted on an MTAB CNC Lathe to explore the impact of dry and wet turning on the machining of Haynes 25 alloy, leveraging a comprehensive design approach. The MTAB CNC lathe was chosen for its exceptional stability, precision, and versatility in metal cutting. The experiments utilized cylindrical segments of



Haynes 25 alloy, with the suitability of the cutting tool for Haynes 25 alloy guiding the decision-making process. A Tungsten Carbide tool was employed for turning Haynes 25, carefully selecting material, shape, and coating to enhance tool performance and machining efficiency. Key turning parameters such as cutting speed, depth of cut, and feed rate were identified as influential on tool wear and surface roughness, set at 500, 1000, and 1500 rpm for cutting speed; 0.6, 1.2, and 1.8 mm for depth of cut; and 0.05, 0.1, and 0.15 mm/rev for feed rate, forming a comprehensive Taguchi experimental design matrix.

Dry turning tests proceeded without using coolant to cool the cutting zone, intentionally omitting coolant to mirror normal machining conditions and facilitate comparison with wet turning. This approach aimed to ensure consistent results and eliminate inconsistencies in the machining process. In contrast, wet turning tests incorporated DROPCO coolant in the cutting zone, serving critical functions such as heat dissipation, chip removal, and lubrication, influencing tool wear and surface roughness. Industry standards in coolant selection offer insights into how coolants affect the machining of Haynes 25 alloy, with DROPCO coolant chosen for our wet turning experiments to boost experimental reliability.

Each set of turning parameters was replicated, and experimental runs were randomized to minimize uncontrollable variables and ensure the reliability and consistency of outcomes. Surface roughness, a pivotal indicator of machined surface quality, was measured using the TR-200 device. The L9 Taguchi methodology structured the experimental design, with the orthogonal array facilitating a systematic exploration of the parameter space with minimal experimentation. This design also included duplication of each set of turning parameters to account for variances and enhance the reliability of the findings.

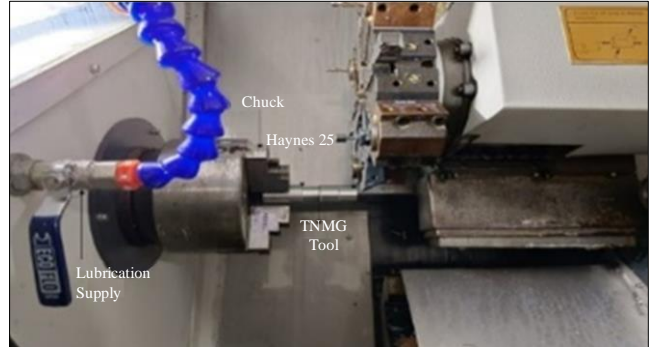


Fig. 1 Experimental setup (CNC)

Table 1. Machining responses obtained during dry turning

Run No.	Cutting Speed (rpm)	Feed Rate (mm/rev)	Depth of Cut (mm)	Surface Roughness (µm)	Tool Wear (µm)
1	500	0.05	0.6	0.3850	60.26
2	500	0.1	1.2	1.1633	126.92
3	500	0.15	1.8	2.1503	114.13
4	1000	0.05	1.2	0.4290	34.61
5	1000	0.1	1.8	0.6223	92.32
6	1000	0.15	0.6	0.8137	117.23
7	1500	0.05	1.8	0.4353	253.84
8	1500	0.1	0.6	5.4917	108.18
9	1500	0.15	1.2	1.2917	114.1

Table 2. Machining responses obtained during wet turning

Run No.	Cutting Speed (rpm)	Feed Rate (mm/rev)	Depth of Cut (mm)	Surface Roughness (µm)	Tool Wear (µm)
1	500	0.05	0.6	0.6310	49.62
2	500	0.1	1.2	0.5190	53.19
3	500	0.15	1.8	1.320	65.18
4	1000	0.05	0.6	0.4870	53.45
5	1000	0.1	1.2	0.3960	36.2
6	1000	0.15	1.8	1.4850	55.65
7	1500	0.05	0.6	2.0100	38.01
8	1500	0.1	1.2	0.6210	38.25
9	1500	0.15	1.8	1.1320	72.75

To strengthen the reliability of the experimental design, every combination of turning parameters was duplicated, and the sequence of experimental runs was randomized. This method reduces the influence of possible uncontrollable factors and guarantees the dependability and consistency of the outcomes.

3. Result and Discussion

The application of Taguchi analysis in optimizing turning parameters provided valuable insights into the impact of cutting speed, depth of cut, and feed rate on surface roughness and tool wear. The experimental design employed a systematic approach, exploring several combinations within the parameter space to determine the most favourable conditions for machining Haynes 25 alloy.

3.1. Impact of Dry Turning of Surface Roughness and Tool Wear

The selection of optimum based on the Taguchi analysis is apparent with respect to cutting speed at 1500 rpm, considering the depth of cut as 1.8 mm and assuming feed rate as 0.15 mm/rev for dry turning to reduce surface roughness and tool wear. Elaborate interactions between these parameters were quickly unveiled, proving that each was pivotal in its impact on the ultimate surface texture.

The Taguchi Signal-to-Noise (S/N) ratio qualitatively measured the significant effect of all combinations of process parameters on surface roughness (Figure 2), reflecting a superior preference towards the identified optimum conditions.

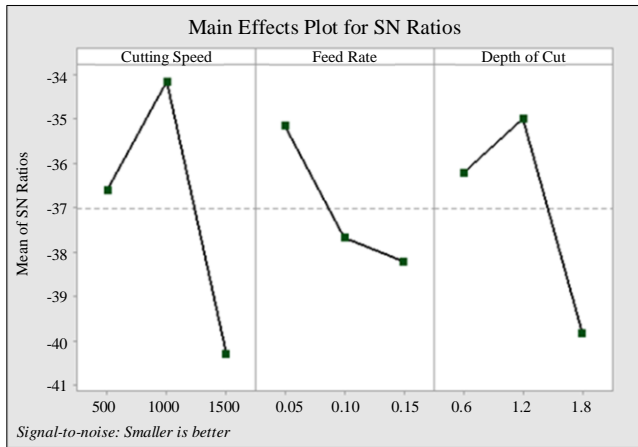


Fig. 2 SNR plot for machining parameters under dry turning

Regression analysis further supported the findings, which resulted in a predictive equation that establishes a relationship between the turning parameters and surface roughness (Equation 1).

$$\text{Surface Roughness} = 0.41 + 0.00117 \text{ Cutting Speed} + 10.0 \text{ Feed Rate} - 0.97 \text{ Depth of Cut} \quad (1)$$

Optimality was achieved by employing the complete factorial design. At the same time, verification of the regression model that linked the cutting speed, depth of cut, and feed rate to the reported surface roughness values was based on the probability map. The plot functions as a checking device of the model, representing graphically the level of agreement between the predicted and observed responses.

The application of the optimal conditions, that is, 1500 rpm (cutting speed), 1.8 mm (depth of cut), and 0.15 mm/rev (feed rate), recorded a distinctive severe curve (Figure 3) on the probability plot. The regression analysis findings similarly derived the turning parameters-tool wear predictive equation (Equation 2).

$$\text{Tool Wear} = -1.9 + 0.0583 \text{ Cutting Speed} - 11 \text{ Feed Rate} + 48.5 \text{ Depth of Cut} \quad (2)$$

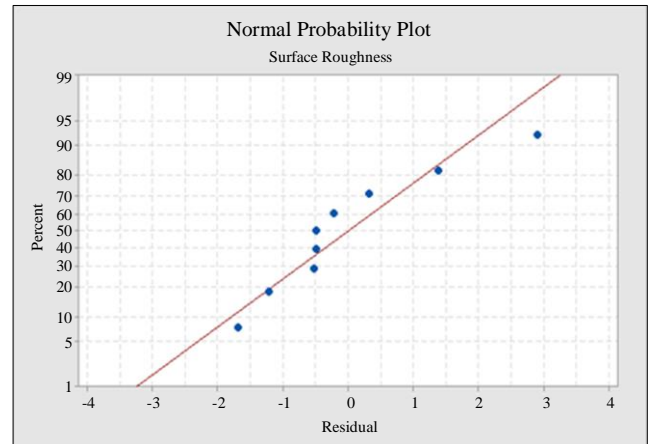


Fig. 3 Normal probability plot for surface roughness (dry turning)

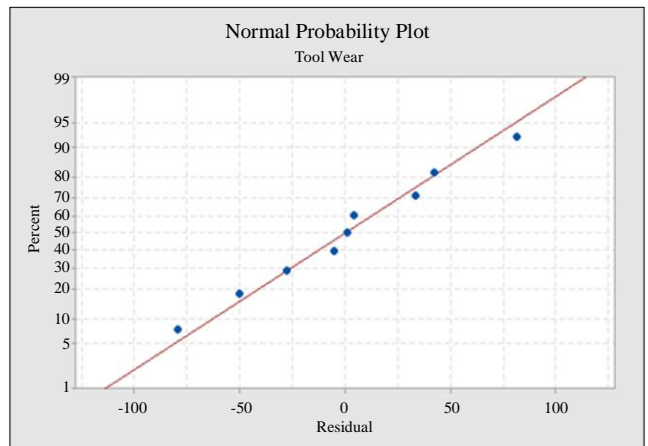


Fig. 4 Normal probability plot for tool wear (dry turning)

A probability plot was used to verify the tool wear values in the reported model over a range of cutting speeds, depth of cuts and feed rates. The probability plot is a powerful tool for verifying the regression models, as it provides visual insight into how well the expected responses agree with the actual

responses. The probability plot showed a steep, distinct curve when optimal conditions (cutting speed of 1500 rpm, depth of cut of 1.8 mm and feed rate of 0.15 mm/rev) were used (Figure 4).

3.2. Impact of Wet Turning of Surface Roughness and Tool Wear

The Taguchi analysis determined that the ideal option for minimizing surface roughness and tool wear in wet turning is a cutting speed of 500 rpm, a depth of cut of 1.2 mm, and a feed rate of 0.15 mm/rev. The deliberate manipulation of these parameters facilitated a thorough examination of their interplay, highlighting the pivotal influence of each on the ultimate surface texture.

The Taguchi Signal-to-Noise (S/N) ratio (Figure 5) quantitatively measured the impact of various parameter combinations on surface roughness, thereby highlighting the superiority of the identified optimal circumstances.

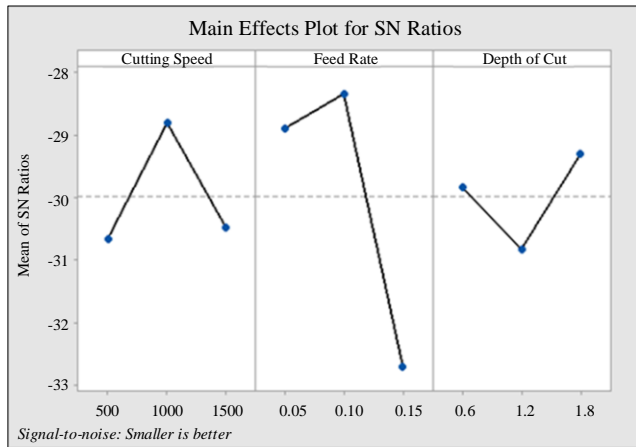


Fig. 5 SNR plot for machining parameters under wet turning

Regression analysis further supported the findings, which resulted in a predictive equation that establishes a relationship between the turning parameters and surface roughness (Equation 3).

$$\text{Surface Roughness} = -0.321 + 0.000587 \text{ Cutting Speed} + 3.21 \text{ Feed Rate} + 0.224 \text{ Depth of Cut} \quad (3)$$

A probability map was created to verify the regression model that links cutting speed, depth of cut, and feed rate to the reported surface roughness values. The plot visually illustrates the level of agreement between the expected and actual responses, making it a reliable tool for verifying the model.

The probability plot displayed a distinct and steep curve when the optimal conditions were applied, which included a cutting speed of 500 rpm, a depth of cut of 1.2 mm, and a feed rate of 0.15 mm/rev (Figure 6).

Similarly, the findings were supported by regression analysis, which resulted in a predictive equation that establishes a relationship between the turning parameters and tool wear (Equation 4).

$$\text{Tool Wear} = 32.1 + 0.00089 \text{ Cutting Speed} + 276.9 \text{ Feed Rate} - 0.85 \text{ Depth of Cut} \quad (4)$$

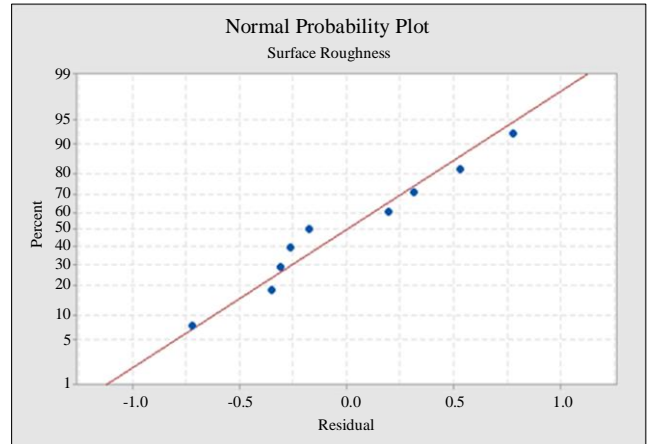


Fig. 6 Normal probability plot for surface roughness (wet turning)

A probability map was created to verify the regression model that links cutting speed, depth of cut, and feed rate to the reported tool wear values. The plot visually illustrates the level of agreement between the expected and actual responses, making it a reliable tool for verifying the model. The probability plot displayed a distinct and steep curve when the optimal conditions were applied, which included a cutting speed of 1000 rpm, a depth of cut of 1.2 mm, and a feed rate of 0.15 mm/rev (Figure 7).

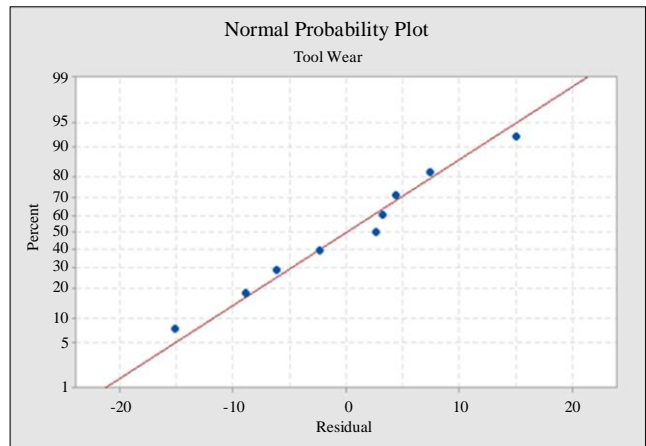


Fig. 7 Normal probability plot for surface roughness (wet turning)

3.3. Dry and Wet Turning Impact on Tool Wear and Surface Roughness

The surface roughness data for dry and wet turning are compared for each relevant experiment. Experiment 1 demonstrated that wet turning resulted in a surface roughness

of 0.3850, which was lower than the surface roughness of 0.5390 observed in dry turning. In contrast, dry turning consistently yielded lower surface roughness values than wet turning in Experiments 2, 3, 6, and 7. Experiment 8 deviates from the norm since wet turning resulted in a considerably higher surface roughness (5.4917) than dry turning (0.6210).

Experiments 4, 5, and 9 demonstrate similar or slightly reduced surface roughness levels in dry turning. Although there are cases where wet turning performs better than dry turning, the general pattern indicates that dry turning typically produces lower surface roughness values in this specific series of studies. The existence of an outlier in Experiment 8 emphasizes the necessity for additional examination of the specific circumstances of that particular experiment to comprehend the turning performance thoroughly.

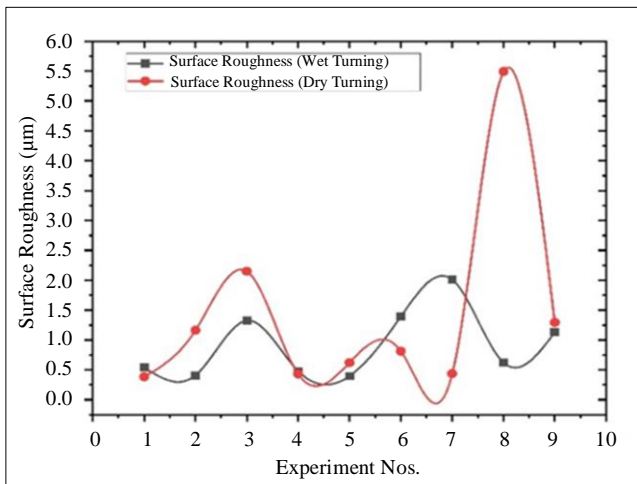


Fig. 8 Surface roughness in dry and wet environments

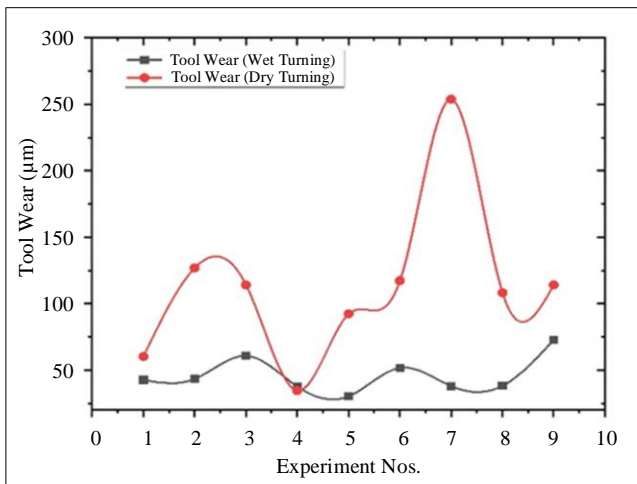


Fig. 9 Tool wear in dry and wet environments

Overall, wet turning consistently exhibited lower tool wear compared to dry turning in most studies, indicating that using coolant in wet turning leads to a decrease in tool wear.

Nevertheless, experiment 7 is noteworthy for its deviation from the norm, as wet turning exhibited somewhat more tool degradation than dry turning. The general pattern corresponds to the widely accepted notion that using a coolant, such as in wet turning, can reduce tool wear, leading to a longer tool lifespan and potentially increasing the overall effectiveness of the machining process.

The presence of an outlier in Experiment 7 complicates the comprehension of the situation, highlighting the importance of conducting a thorough analysis that considers multiple elements, such as cutting parameters and unique machining conditions.

4. Conclusion

This study examined how dry vs. wet turning affects Haynes 25 alloy turning parameter optimization. It used the L9 Taguchi methodology. Results show Haynes 25 alloy’s performance under varied cutting situations.

- Dry turning consistently reduced surface roughness. However, Experiment 8 showed that dry turning had a far higher surface roughness, highlighting the importance of specific conditions on machining results. Further investigation of this exceptional data point is needed to determine the causes of this variance.
- Wet turning consistently had lower tool wear than dry turning in most studies. This supports the idea that coolants reduce tool wear, extending tool life and improving machining efficiency. wet turning increased tool wear somewhat in Experiment 7, making it remarkable. The exact experiment settings need more study.
- The data demonstrate the complex relationship between Haynes 25 alloy machining environment, cutting settings, and outcomes. Dry turning was better for surface roughness, but wet turning was better for tool wear, underlining the necessity to select optimal machining conditions depending on machining goals and material properties.

4.1. Future Scope

Additional research should focus on understanding the causes of Experiment 8’s anomaly and Experiment 7’s surprising outcomes. Researching cutting settings and improved cooling procedures may help optimize machining operations for high-performance alloys like Haynes 25. Advanced modelling and predictive analytics may improve projection accuracy, making machining operations more robust.

Acknowledgement

Dr. A.P.J. Abdul Kalam University, Indore, supported this work.

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APPLICATION OF LEAN TOOLS IN INDIAN SMALL SCALE AGRICULTURAL POLYPROPYLENE BAGS MANUFACTURING INDUSTRY – A CASE STUDY

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Abstract

This study focuses on the application of Lean manufacturing principles, specifically 5S, Kaizen, and Value Stream Mapping (VSM), to address operational inefficiencies and enhance productivity in the agricultural industry. The Polypropylene (PP) Leno Bags are crucial for packaging and protecting agricultural products. The production process of Leno Mesh Bags involves several steps, from material selection to final product packaging. However, the industry faces challenges related to unorganized plant's tools, material and equipments, plant layout issues, lack of maintenance policies, and safety concerns. After conducting an extensive review of existing literature, this study leverages successful implementations of Lean manufacturing in various sectors, underscoring the efficacy of tools like 5S and Value Stream Mapping (VSM) in waste reduction and overall productivity improvement. VSM is implemented to map the entire production process, identifying value-added and non-value-added activities. The Current State VSM exposes a total lead time of 3 hours and 40 minutes for Leno bag production. The implementation of 5S techniques reduces searching time, while Kaizen focuses on minimizing setup time. Additionally, the suggested plant layout changes aim to improve overall workflow and reduce the total distance traveled during production. The Future State VSM reflects a reduced lead time of 2 hours after the implementation of Lean techniques. Plant layout analysis shows a significant reduction in the total distance traveled, from 80.8 meters to 66.8 meters.

Keywords: Application of Lean tools, Small Scale Manufacturing Industries, Agricultural Polypropylene bags, Leno Bags, 5S, VSM, Kaizen, Plant Layout Analysis.

Introduction

Polypropylene (PP) is a versatile thermoplastic polymer widely used in various applications such as packaging, textiles, and medical devices. In the context of Leno mesh bag production, PP's strength, durability, and resistance to moisture and chemicals make it ideal for creating the mesh material. Leno mesh bags have an open, net-like structure and are commonly used in agriculture for storing, transporting, and marketing crops. Leno mesh bags, play a crucial role in protecting and facilitating the handling of fruits, vegetables, and seeds in agricultural contexts.

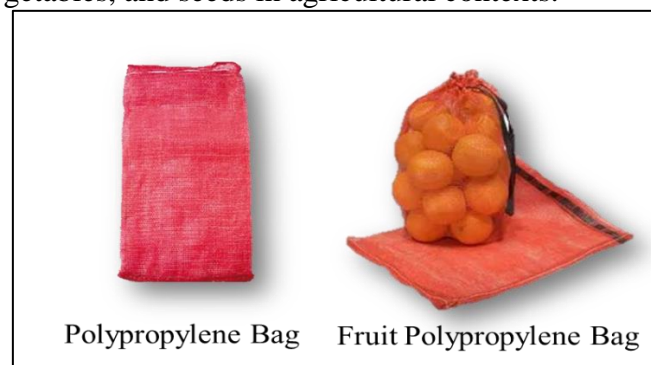


Fig.1. Polypropylene products

Leno Mesh Bags are a type of woven mesh fabric that is used for product packaging. They are made from polypropylene, a thermoplastic polymer, and are durable, breathable, and lightweight. L sewing

Mesh Bags are designed to allow air to circulate around the produce, helping to reduce spoilage and prolong the shelf life of the product. Leno Bag is used for packing onions, potato, garlic, fruits vegetables & also for packaging flowers. Leno bag is available in numerous sizes so as to meet the demand of customers.

Production process for Leno mesh bags:

Step 1. Material Selection: Choose the appropriate mesh material, such as polypropylene, based on the bag's intended use and durability requirements.

Step 2. Grinding: The selected polypropylene material is broken into small pieces using a grinding machine and then heated to a pre-decided temperature.

Step 3. Mixing: After the polypropylene is ground, the material is mixed in the hopper and heated to the predetermined temperature, causing changes in its thermal and physical properties.

Step 4. Moulding: Molding is the process employed to melt the polypropylene material to temperatures ranging from 215°C to 238°C within the molding machine. It operates as a heat exchanger.

Step 5. Stretching: Following grinding, mixing, and molding of the polypropylene material, it is stretched to the predetermined thickness using a stretching machine, a pivotal step in crafting polypropylene bags.

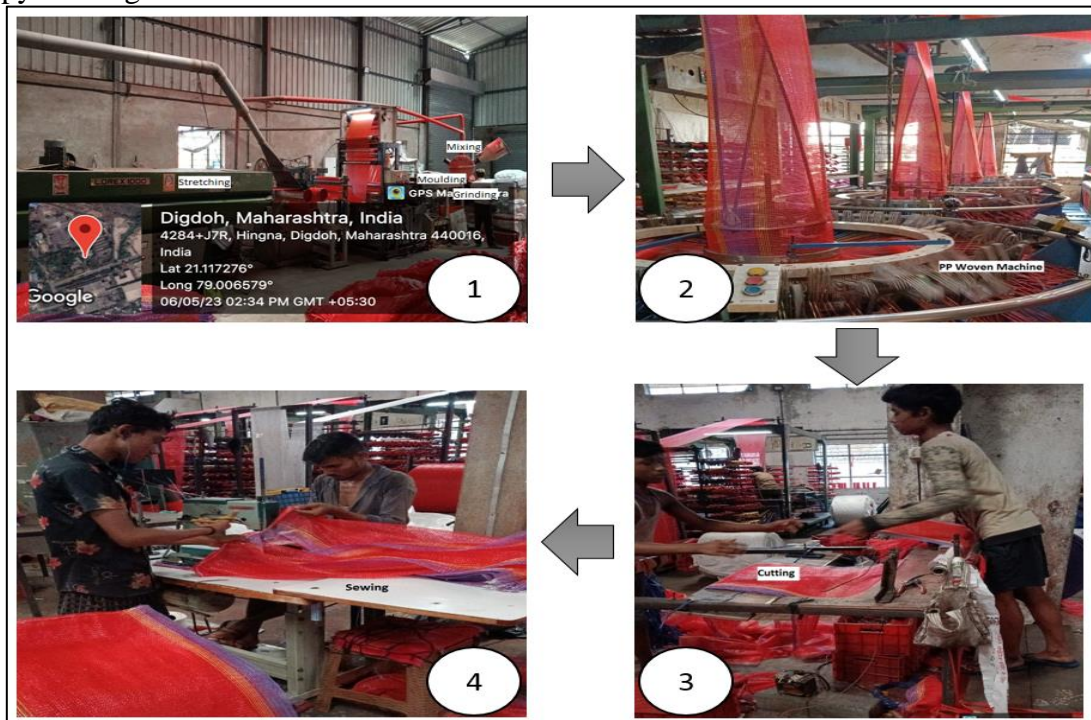


Fig.2. Production Process of making Leno bags

Step 6. Bobbin Rolling: The stretched polypropylene material is transformed into thin thread-like structures, which are then wound onto bobbins for storage. In this process, the bobbin rolling machine neatly rolls all the stretched polypropylene material into bundles.

Step 7. PP Woven : The bobbins are inserted into the PP woven machine, which is used to manufacture polypropylene bags. This machine utilizes 145 bobbins simultaneously to create sheets of polypropylene material for bag production. This process involves weaving thin polypropylene sheets using a woven technique.

Step 8. Cutting:- The woven polypropylene sheets proceed to the cutting operation, where employees cut the sheets according to the specifications outlined in the job card.

Step 9. Sewing : The cut polypropylene sheets are now sewn together to create the bags. Each roll of polypropylene material produces 1000 bags. Employees sew the bags continuously.

Process Sheet – Polypropylene Bags						V K Agropack	
Format No.				Document No.			
Rev .No.				Document Date.			
Process ID	Process Description	Workstation Name/ Machinery	Tool/ Equipment	Process Parameters/ Temperature	No. of Man	Process Time	Remarks
OP NO. 1	Grinding (Polypropylene material grind in the machine)	Grinding Machine	Grinding wheel	211°C	1	10 to 15min	The material should grind in proper temperature in the machine.
OP NO.2	Mixing	Hopper Machine	Mixing blade	225°C	1	5 to 6min.	The polypropylene material mixed in mixing machine properly.
OP NO.3	Moulding (Polypropylene material Melted in the machine)	Moulding Machine	Heater / T – Die	215°C to 238°C	1	10 to15min.	Take safety precautions.
OP NO. 4	Stretching (The polypropylene material stretch up to a decided thickness)	Stretching Machine	Rollers/Blade	136°C	1	1 hour.	Make sure that the machine stretch the material in pre-decided size.
OP NO. 5	Bobbin Rolling(The material rolled on the bobbin)	Bobbin Rolling Machine	Bobbin	–	1	1:30 Hour	The bobbin should be rolled in proper way.
OP NO. 6	PP Woven(In this process the material woven and make the sheets for bags)	PP Woven Machine	Cutting/Sewing	–	1	1 Day	Make Sure the machine produced proper sheets of polypropylene
OP NO. 7	Cutting(The sheet cut in decided size manually)	Cutting Machine	Cutting Blade	–	2	5 min.	Take safety precautions while cutting the sheets.
OP NO. 8	Sewing(The sheets are sewing and make the bags)	Sewing Machine	Sewing Needles	–	2	5min	Keep in mind that the machine can sewing the bag properly.

Fig.3. Process Sheet of Leno bags

The case industry has been facing lots of problems related to visual workplace management, plant layout issues, no maintenance policies and safety related issues. In the industry, there are instances of unused and underutilized areas where raw materials are stored randomly and carelessly throughout the workplace.

The equipment is placed randomly, resulting in workers spending more time searching for them, which negatively impacts their work efficiency. It has been observed that there is a lack of designated space for setting up the machining tools.

The worker does not use safety equipment while mixing the raw materials in a mixer, causing dust particles to enter the worker's eyes. The worker handles hot products in the stretching machine without wearing gloves. It has been observed that the raw materials are stored far away from the machine that needs to be used.

The women responsible for packing the final product are working in the middle of the work area, and the final products are stored in front of the manager's table. The machines are placed too closely to each other. In order to cut the sheets of the propylene bag into the designed dimensions, two workers are required. However, in the current process, one person simply gives continuous directions to the sheet while the other person manually cuts the sheet. This results in significantly more time being taken for a single operation, which effects the efficiency of the industry.

Lean manufacturing can help to minimize the problems faced by the case industry. Lean Production development centers on defining 'value,' analyzing the entire 'value stream,' and eliminating wasteful

steps while introducing flow. Lean tools such as 5S, kaizen and VSM have improved workplace and the productivity level effectively. [1] The tools of lean manufacturing such as 5S, Kaizen and VSM were developed for maximizing capacity utilization, reduction in cycle time, lead time and inventory, enhancing the product value. ‘Kaizen’ a Japanese philosophy that promotes continuous improvement in the workplace as a result of employees’ involvement [25]

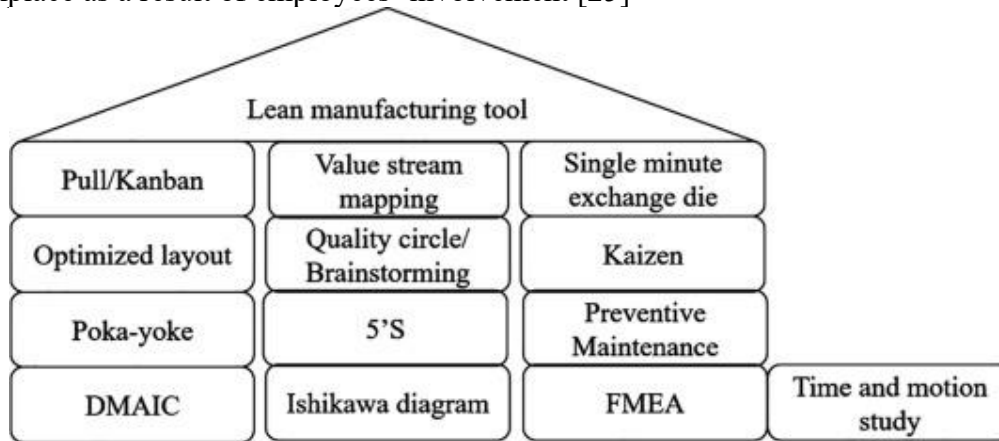


Fig.4. Lean manufacturing tools [25]

In recent decades, manufacturing companies have faced escalating pressures driven by heightened customer expectations and fierce competition. To meet these demands, manufacturers have sought to enhance product quality, reduce delivery times, and minimize production costs – or a combination of these objectives. [2] Value stream mapping (VSM) serves as a valuable tool for enterprise enhancement by providing a visual representation of the entire production process, encompassing material and information flow. It defines a value stream as a comprehensive collection of all activities, both value-added and non-value added, necessary for guiding products sharing resources from raw materials to end customers. VSM applications in an Indian industry case study, revealed the key findings. [5] Value stream mapping (VSM) has been used to reduce cycle times and achieve lean operations in order to meet hourly assembly line demands, fostering consistency in the supply of motorcycle frames from a dedicated supplier to an OEM. [3] The productivity of the edible cottonseed oil processing industry in India by applying the value stream mapping (VSM) approach. [4]

II. Literature review

A practical application of VSM through a case study conducted in a small manufacturing industry in Patiala, India. The study showcases substantial improvements, such as reduced lead time, processing time, work in process inventory, and manpower requirements. The literature review categorizes VSM-related work into four distinct types, highlighting its versatile global applicability. The provided case study in a Manufacturing Industry in India demonstrates the effectiveness of VSM in reducing waste. However, it also identifies potential areas for future research, including cost-benefit analysis, vendor management, the human factor impact, and comparisons with alternative waste reduction methods. [5] Author utilizes Value Stream Mapping (VSM) to rectify inefficiencies and waste within the supply chain of the Indian cottonseed oil industry, primarily in processing. Through observations, interviews, and VSM analysis, the study aims to uncover non-value-adding activities, excess inventory, and technological obstacles hindering productivity. The paper proposes applying lean manufacturing principles and VSM to identify, analyze, and eliminate these inefficiencies, ultimately improving the competitiveness of the cottonseed oil industry in India. The methodology involved extensive sampling, data collection, supply chain and process activity mapping, and stakeholder interviews, with the aim of identifying and addressing inefficiencies to enhance industry competitiveness. The proposed solutions include capacity utilization improvement, policy advocacy, lean manufacturing, and the use of tools like Value Stream Mapping. Implementing these measures will enhance efficiency, reduce



costs, and improve the competitiveness of the cottonseed oil industry in India. These insights have applicability to other edible oil sectors, aiding in addressing similar challenges in different contexts. [4]

This research paper's primary objective is to employ Value Stream Mapping (VSM) as a means to boost productivity within the automotive supplier network. By scrutinizing the existing and desired states of supplier shopfloor processes, the study identifies areas for enhancement, calculates takt times, and addresses factors conducive to increased production output and reduced inventory levels. The literature review centers on lean manufacturing and VSM, emphasizing waste reduction and operational efficiency. It covers lean manufacturing's origins in Japan, principles stressing waste reduction, various lean tools, VSM's role, and the paper's significance in applying VSM to enhance supplier-side productivity in India's motorcycle industry. Implementing VSM-based changes led to significant enhancements, such as the introduction of a Kanban system, reduced inventory levels, optimized manpower, and process improvements. These improvements resulted in increased production output, reduced lead times, and cost savings in the supply chain, ultimately achieving a lean and responsive operational environment. VSM, within a holistic lean framework, proves essential for genuine lean transformation by improving flow to the customer and reducing waste effectively. [3]

This paper introduces an innovative framework called "Improved Value Stream Mapping" (IVSM) that combines Value Stream Mapping with industrial engineering tools to enhance lean production in intricate manufacturing processes with merging flows, addressing the limitations of traditional VSM application. The paper discusses the core principles of Lean Production, emphasizing waste reduction and customer-centric manufacturing. The paper outlines a structured seven-step methodology for applying VSM to complex production systems with nonlinear value streams. This systematic approach aims to improve manufacturing processes and reduce lead times in intricate production environments. A case study in refrigerator manufacturing demonstrates the successful application of IVSM. By identifying critical value streams, creating current and future state maps, and implementing lean solutions, the authors achieved an impressive 68% reduction in production lead time, enhancing efficiency and customer responsiveness. The IVSM framework offers an advanced approach for implementing Lean Production in complex manufacturing processes, handling diverse product routings, and managing complex Bills of Materials and merging flows effectively. Future research avenues include economic measures and statistical/fuzzy analysis of manufacturing process variances. [1]

This research paper aims to present a case study on the implementation of lean principles at a small manufacturing company in the United States. The study focuses on identifying obstacles hindering progress toward lean transformation, utilizing the "5 whys" method to pinpoint root causes, and proposing solutions through kaizen events, Taguchi experiment design, and rabbit chasing techniques for process improvement. The literature review underscores the growing pressure on manufacturing firms to improve product quality, reduce delivery times, and minimize costs. It discusses lean manufacturing as a response to the shortcomings of mass production, emphasizing waste reduction and increased productivity through various lean tools and strategies. The study applies a structured approach, including kaizen, process mapping, value-stream mapping, waste identification, and design of experiments, to enhance manufacturing processes. This case study serves as a valuable reference for implementing lean systems in small manufacturing operations, showcasing its potential to enhance competitiveness. [2]

The primary objective is to apply the principles of 5S lean manufacturing to reduce non-value-adding operational time in a plastic bag manufacturing company based in Bangladesh. The study focuses on the blowing and printing operations within the manufacturing process. Through the meticulous application of the 5S methodology, the authors successfully achieved an 8% reduction in operational time in the blowing operation and an 18% reduction in the printing operation. The research underscores the importance of lean manufacturing principles, particularly the 5S approach, as a means to streamline



processes, boost productivity, and cultivate a culture of efficiency and safety. The case study centers on a company engaged in plastic bag production for garment packaging, which faces challenges due to variable raw material costs and the need for efficient production. The results highlight reduced search times, enhanced workplace safety, and a cleaner working environment. [7]

This research delves into Lean Six Sigma, a data-driven philosophy aimed at preventing defects, enhancing quality, and achieving customer satisfaction. It combines Lean, focused on eliminating waste, with Six Sigma, which reduces process variation. The synthesis of these principles enhances process efficiency and quality. Researchers have empirically investigated these principles and their impact on organizational performance. This paper systematically compiles their work and explores future research aspects in Lean manufacturing. Value Stream Mapping (VSM) was a widely used tool, often in combination with others like DMAIC, SMED, and 5S. Integrated Lean Six Sigma and Total Quality Management (TQM) approaches to enhance customer satisfaction and profitability remain relatively unexplored, especially in small and medium enterprises. [8]

The study in plastic bag manufacturing industries systematically employs methodologies like Value Stream Mapping (VSM), 5S, Visual Control, Kaizen, and Reduced lot size to identify and eliminate waste in the plastic bag manufacturing process. The successful application of these methods results in increased productivity, a 10.4% reduction in Manufacturing Lead Time, and a significant 35% decrease in the cycle time for the "Cutting/Packaging" process. The study employs Lean methodology and Value Stream Mapping to address issues related to waste, setup delays, and inadequate packaging, aiming to enhance manufacturing productivity. In the implementation phase, the study addresses identified waste sources through lean principles and techniques, leading to a more efficient "future state" production system, reducing manufacturing lead time and enhancing overall productivity. The results show the successful implementation of lean tools and techniques, reducing cycle times, setup times, and manufacturing lead times, while increasing weekly productivity. [9]

Table 1: Literature review on the use of Lean tools by the various Authors

Author	5S	Kaizen	Kanban	TPM	TQM	7 Waste	VSM	Poka Yoke	SMED	QMS	JIT
Roriz and Nunes [10]	✓						✓	✓	✓		
Rosa and Silva [11]				✓		✓	✓				
Oliveira and Sá [12]					✓	✓	✓				
Costa and Silva [13]											
Cheung, Leong, and Vichare [14]	✓		✓		✓		✓				✓
Khawale [15]											✓
Lucherini and Rapaccini [16]							✓				
Alves, Junior, and Mendes [17]				✓							
Akhil Khajuria [18]											✓
Alaa Alshammari [19]											✓

Brito and Ramos [20]										
Al-Akel Karam [21]								✓		✓
Veres and Marian [22]								✓		
Santosa and Sugarindra [23]			✓	✓			✓			
Ben Ruben and Vinodh [24]										✓

Note: TQM = Total quality management, VSM = Value stream mapping, TPM = Total productive maintenance, JIT = Just-in-Time, DMAIC = Define, measure, analyse, improve and control, SMED = Single minute exchange of die, QMS = Quality management system.

III. Application of Lean manufacturing tools

Through exhaustive literature survey based on the problems identified in the case industry 5S, Kaizen, VSM and Plant layout optimization tools has been selected for the implementation in the case industry. Firstly, VSM implemented to understand the current process and total value added and non-value added time for the production process. Through application of VSM, it is found that there is a lot of scope of improvement in terms of reducing the searching, transportation and setup time. For the reduction of searching time, 5S and workplace management principles were implemented in the industry. To reduce the transportation, Plant layout optimization tool were implemented and Kaizen were implemented to reduce the setup time and overall operations.

Implementation of Value stream mapping

Value stream mapping (VSM) has been implemented to map the entire process of production of Leno bags at the case industry. The process starts with the Raw Material inventory then Grinding, Mixing, Moulding, Stretching, Bobbin rolling, PP woven, Cutting, Sewing, Prepackaging, Packaging and Finish Product Inventory. The VSM uses various icons/ symbols for representation of various entities. In the implementation of VSM process, first we have to map the existing or current process and their associated time. The Current State VSM or CSVSM provides a pictorial view of the entire production process flow. Also, CSVSM gives us the scope of improvement possible in the production process.

Create a Current state VSM

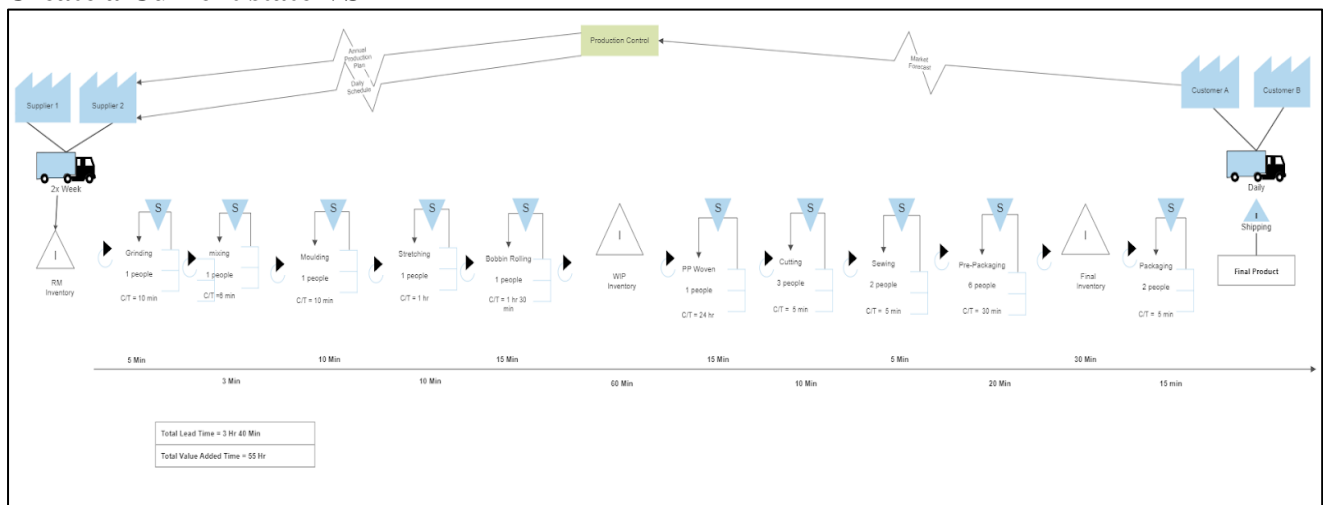


Fig.5. CSVSM of Leno bags

The implementation of VSM involved creating a Current State Value Stream Map (CSVSM), which visually represented the entire Leno mesh bag production process. This map identified each step, from

raw material selection to the final product's packaging and storage. The total lead time for the production process was measured and found to be 3 hours and 40 minutes. This served as a baseline to understand the efficiency of the existing workflow. The CVSM highlighted areas for improvement, such as excessive searching time, inefficient transportation, and prolonged setup times. It also brought attention to challenges related to the existing plant layout and organization of materials.

Future state VSM

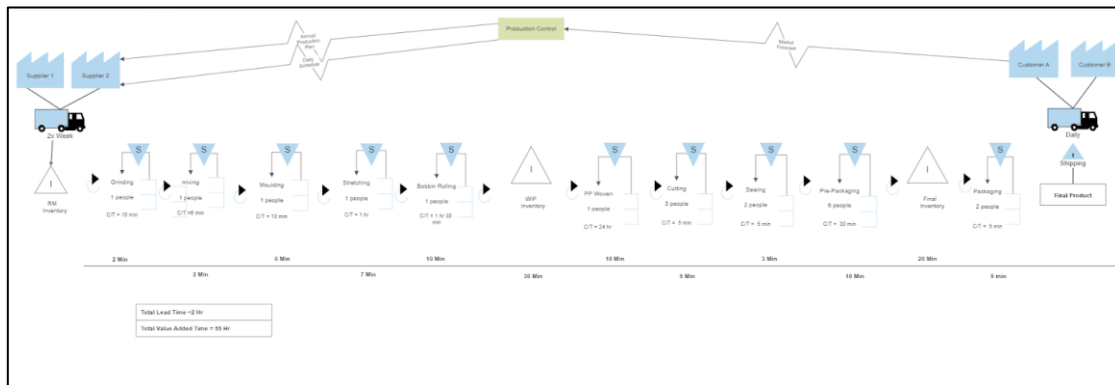


Fig.6. FSVSM of Leno bags

To address the identified issues, a series of lean manufacturing interventions were introduced, including 5S, Kaizen, and Plant Layout Optimization. These interventions aimed to enhance efficiency, reduce waste, and create a more organized and streamlined production environment. After the implementation of lean interventions, a Future State Value Stream Map (FSVSM) has developed. The FSVSM indicated a significant reduction in lead time from 3 hours and 40 minutes to 2 hours, showcasing the positive impact of the implemented lean practices. The suggested plant layout, combined with 5S practices, was projected to reduce the total distance traveled within the plant, indicating improved material flow and accessibility.

Plant Layout Analysis

The examination of the current plant layout revealed that the total distance traveled within the facility was approximately 80.8 meters. This measurement provided insights into the movement of raw materials, work in progress, and finished products throughout the production process. It was observed that the arrangement of machinery, storage, and workstations could be a contributing factor to inefficiencies and longer lead times.

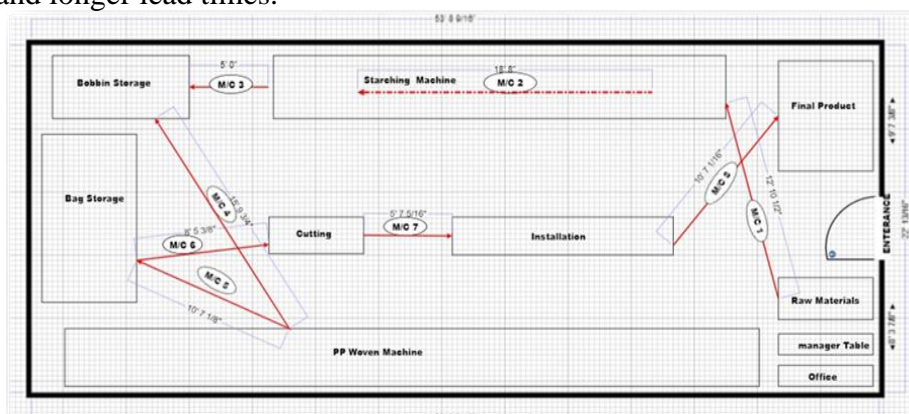


Fig.7. Current Plant Layout

A suggested plant layout was proposed with the aim of optimizing the arrangement of key elements in the production process. This involved considering the positioning of machinery, workstations, raw material storage, and finished product storage. The proposed layout was designed to minimize unnecessary movement and streamline the flow of materials, addressing the identified issues from the Value Stream Mapping (VSM) analysis.

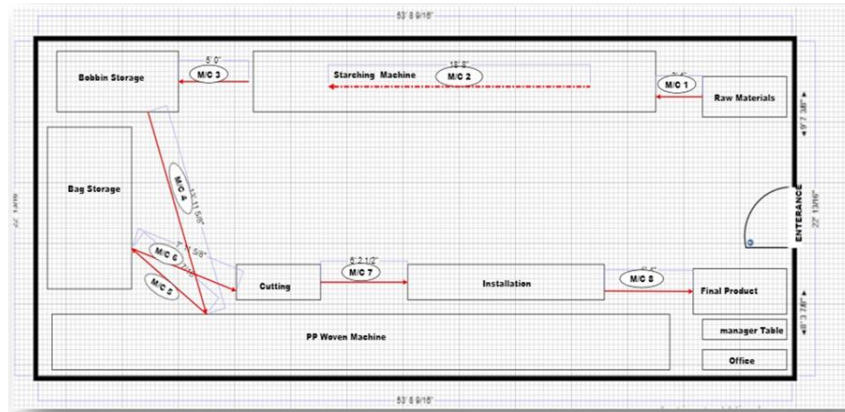


Fig.8. Suggested Plant Layout

The suggested plant layout, combined with the implementation of 5S practices, aimed to create a more streamlined and visually organized workspace. The total distance traveled within the plant was projected to decrease from 80.8 meters to 66.8 meters. This reduction in travel distance indicated a potential improvement in material flow and accessibility. By exchanging the positions of raw material and final product storage, the new layout aimed to create a more efficient and ergonomic workspace. This change was expected to contribute to overall operational efficiency, reducing lead times and enhancing the overall production process.

IV. Results and discussion

The implementation of Value Stream Mapping (VSM) in V.K Agropack's Leno mesh bag production process provided a comprehensive analysis of the existing workflow. The Current State VSM (CVSM) visually represented the production stages, revealing critical insights into both value-added and non-value-added activities. The total lead time for manufacturing Leno bags in the current state was identified as 3 hours and 40 minutes, serving as a baseline for assessing the effectiveness of subsequent lean manufacturing interventions. The CVSM highlighted several areas of improvement, including excessive searching time, inefficient transportation, and prolonged setup times. Additionally, issues related to the existing plant layout and organization of materials were identified as significant contributors to workflow inefficiencies.

To address these challenges, a combination of lean manufacturing tools, including 5S, Kaizen, and Plant Layout Optimization, was implemented. The introduction of 5S principles aimed to reduce searching time and enhance workplace organization through sorting, setting in order, systematic cleaning, standardizing, and sustaining. This intervention contributed to a more organized and visually efficient workplace. Plant Layout Optimization involved proposing a new arrangement for machinery, workstations, raw material storage, and finished product storage. This optimization aimed to minimize unnecessary movement and streamline material flow through the production process, addressing inefficiencies identified in the CVSM.

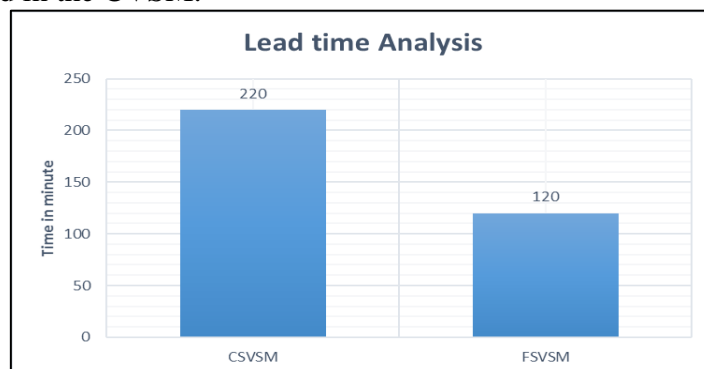


Fig.9. Comparison analysis of lead time through VSM



Kaizen principles were applied to streamline setup processes, particularly in the cutting and sewing stages. Continuous improvement initiatives were undertaken to reduce setup times and enhance overall operational efficiency. Following these lean manufacturing interventions, a Future State VSM (FSVSM) was created to visualize the expected improvements in the production process. The FSVSM projected a significant reduction in lead time from 3 hours and 40 minutes to 2 hours, demonstrating the positive impact of the implemented lean practices on overall efficiency. The suggested plant layout, combined with 5S practices, was projected to contribute to a more streamlined and visually organized workspace. The total distance traveled within the plant was expected to decrease from 80.8 meters to 66.8 meters, indicating a substantial improvement in material flow and accessibility.

V. Conclusions

Implementing lean manufacturing tools like 5S, Kaizen, and Value Stream Mapping made a significant positive impact on V.K Agropack's Leno mesh bag production. These changes led to real improvements in how quickly products were made, how the workplace was organized, and how materials moved through the process. Overall, it showed that with these tools, the production process could become more efficient, well-organized, and sustainable. The lessons learned from this study can be valuable for other manufacturing situations looking to improve productivity and operations through similar lean practices.

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Selection of Welding Method to Join AA6061 Alloy and Comparative Analysis of MIG and FSW

Ajay Anantrao Joshi, Pravin Nerkar

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Abstract

Aluminium 6061 material is one of the most common alloys of aluminum for general-purpose use because some excellent mechanical, thermal properties and light weight. It is most commonly used for construction of aircraft structures, such as wings and fuselages, more commonly in homebuilt aircraft than commercial or military aircraft, yacht construction, including small utility boats, automotive parts, such as the chassis of the Audi A8 and the Plymouth Prowler, flashlights, aluminum cans for the packaging of food and beverages, Scuba tanks and other high pressure gas storage cylinders etc. To develop products from Aluminium alloys Al 6061, various parts need to join by some means. Aluminium alloys are slightly difficult to weld using conventional welding process such as arc welding. Through exhaustive literature survey, it is found that conventional welding processes such as MIG welding produces joints but they have poor weld quality. So, again through literature survey, it is observed some modern welding techniques produces better weld quality such as Friction Stir Welding, Ultrasonic welding, Laser beam welding, Electron beam welding etc. There are various alternatives available to weld Al 6061 material; hence to select best suited welding technique for producing good weld quality in affordable range AHP is implemented. Through literature study and Analytic hierarchy process (AHP) it is concluded that Friction Stir Welding is one of best alternative to join Al 6061. Friction stir welding (FSW) is a solid-state, hot-shear joining process in which a rotating tool with a shoulder and terminating in a threaded pin moves along the butting surfaces of two rigidly clamped plates placed on a backing plate. The application of friction stir welding was the welding of long lengths of material in the aerospace, shipbuilding, and railway industries. However, while welding the Aluminum 6061 many problems are faced due to which good quality of welding is not obtained. The main problem in MIG welding while welding Aluminum is that it reacts with oxygen in the air to produce a thin hard film of aluminum oxide on the surface. Therefore, to reduce the heat affected zone lowest possible heat input is given. To understand it better, comparative study of conventional and modern welding techniques is carried out. Al 6061 material is welded using MIG and FSW and after various testing; it is found that FSW produces far better weld quality than MIG welding.

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Impact of magnetic field generated using neodymium-iron-boron magnetic pairs on condensation heat transfer coefficient for tetrafluroethane (R134a)

Rahul G. Deshmukh ^a  , Dinesh R. Zanwar ^a, Sandeep S. Joshi ^a, Yogesh G. Joshi ^b

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Abstract

A magnetic field produced using neodymium-iron-boron has been employed in recent years to enhance the performance of thermal systems. Its impact on the condensation heat transfer coefficient, however, has not been studied. In this work, convective heat transport was experimentally assessed while tetrafluroethane condensed in a smooth straight tube with an inner diameter of 8.38 mm. A total of four magnetizers were used in the tests, each of which had a 3000 Gauss intensity and a mean vapor quality between 0.4 and 0.5 for saturation temperatures between 40 and 45. The findings demonstrated that the coefficient of heat transfer was considerably impacted by the external magnetic field, saturation temperature, and mean vapor quality. It was found that regardless of the quantity of magnetizers, the coefficient of heat transfer normally decreases as the saturation temperature rises. Lower saturation temperatures and greater mean vapor quality were determined to be the conditions where the magnetic field's impact was more pronounced. There is a limit to how much the heat transfer coefficient may grow as

the number of magnetizer's increases. The limiting magnetizers for the current investigation were discovered to be two magnetizers. The heat transfer coefficient increased by 15.2 percent for the optimal number of magnetizers with saturation temperature and mean vapor quality of 40 and 0.5, whereas it increased by 8.65 percent for saturation temperature and mean vapor quality of 45 and 0.5.

Introduction

Condensers used in heat pump, air conditioner, and refrigeration systems play a vital role on the performance of a system and the information on heat transfer in these flows is important in the stated industrial applications for efficient design and improved operation. Additionally, the usage of refrigeration and air conditioning equipment significantly increases the amount of electricity used in households. These systems' condenser's marginal performance improvement may result in substantial energy savings. Therefore, it is essential to seek for solutions that improve a condenser's heat transfer coefficient. The use of nanoparticles [1], [2], [3], the use of phase change materials [4], the use of magnetic fields [5], the use of tube tilt [6], [7], and the use of improved surface tubes are few of the passive techniques that have been stated to increase the performance of the VCRES. Applying an external magnetic field was shown to be the most efficient method among these, since it is affordable, maintenance-free, and requires only minor adjustments to the current system.

There hasn't been a thorough investigation of how different external magnetic fields affect the fluids which having the electrical conductivity. But it is generally known that when an fluid with electrical conductivity passes via a magnetic field, significant changes are caused. The two primary classifications for the research of fluid responses to varied magnetic fields are EHD and MHD. While the EHD examines the impact of electric force, the MHD focuses with the impact of external magnetic fields on electrically conductive fluids. Additionally, EMHD addresses research on the impact of electric and external magnetic fields on magnetic or electrically conductive fluids [8]. It is widely known that magnetic treatment of electrically conducting fluids results in de-clustered fluids (Fig. 1), which results in small size particles and higher rate of mass flow.

In various research [9], [10], [11], [12], the application of external magnetic fields to improve VCRES performance has been shown. In constructed surface tubing air-cooled heat exchangers, Sami and Aucoin conducted an experimental examination of the impact of magnetization on the behaviour of various refrigerant combinations. Three magnetic elements, each with a 4000 Gauss magnetic field, were used to create the magnetization. The mixes that were being considered for the experiment were Freon 507, Freon 404A, R410A, and difluoromethane. It was reported that the external magnetic field forces applied somewhat raised the compressor discharge pressure and temperature, which led

to the compressor being protected. Additionally, the condenser and evaporator work better when an external magnetic exposure is provided on the condenser outlet. There was an improvement in the performance of the refrigeration system as a result [9].

Sami conducted an experimental study to see how novel refrigerant combinations' performance characteristics changed in various magnetic settings. Freon 507, Freon 404A, R410A, and difluoromethane were the refrigerant mixes employed in this research project. According to the test findings, the magnetization improves the evaporator and compressor's performance, raising the system's coefficient of performance (COP) [11]. According to Tipole et al., a magnetic field can be used to enhance the performance of the water chiller. The main fluid for this investigation was Freon 404A. Two magnets with a combined strength of 3000 Gauss were used to produce the magnetic exposure. According to the authors, the improvement in cooling capacity ranged from 0.58% to 8.82%. It was said that increasing the number of magnetic components from one to four might lower the compressor's energy usage by up to 4.43%. The VCRS's performance was improved by 8.94%. Additionally, a finding of a single pair of the critical magnetic pair was announced [5].

Condenser performance improvement has been the subject of extensive study in the past. This entails a number of passive heat transfer augmentation strategies, various condenser unit designs, tube inclination, the addition of additional subsystems, etc. All of these methods, nevertheless, need significant changes to the current system. The application of an external magnetic field in refrigeration system has recently been recommended as a solution to this drawback. However, there have only been a few number of documented research on such kinds of systems in the literature. The influence of the external magnetic field, mean vapor quality, and saturation temperature on the condenser heat transfer coefficient has not, as far as the author is aware, taken into account in any of the evaluated works.

The steady-state analysis of the magnetised VCRS is conducted in the current study. Examining the impact of the magnetic field, mean vapor quality, and saturation temperature on the condenser heat transfer coefficient of the VCRS is the primary goal of the current study. The R134a refrigerant's heat transfer coefficient is examined for a range of magnetizer counts with constant external magnetic field strengths. Additionally, an effort is made to determine whether any crucial magnetizers are present in the situation.

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Magnetic exposure

To offer magnetic exposure, a magnetizer was created. Four wooden magnetizers were used to magnetise the refrigerant R134a. Neodymium-Iron-Boron magnetic pair of grade 35 with dimensions of 50mm length, 25mm width, and 12.5mm height are included in each magnetizer. Each magnetizer had a 3000 Gauss intensity. Two magnets were inserted into two U-shaped slots to create the magnetic pair; the specifics of the magnetizer are shown in Fig. 2. The condenser's copper material exit pipe, which has a ...

Results and discussion

The effect of number of magnetic pairs, mean vapor quality and saturation temperature on the condenser heat transfer coefficient is discussed in the current section. The impact of the mean vapor quality, saturation temperature, and the number of magnetic pairs on the heat transfer coefficients will be covered in this section. For the purpose of this investigation, the experimental findings of refrigeration cycle in the absence of a magnetic field are employed as a benchmark.

For mean vapor ...

Conclusion

Using tetrafluoroethane as the primary fluid, an experimental examination was carried out to determine the impact of the magnetic field, mean vapor quality, and saturation temperature on the convective condensation heat transfer coefficient in the flat tube. In order to properly understand the impacts of the magnetic field, mean vapor quality, and saturation temperature on the convective condensation heat transfer coefficient, the current study was carried out in a laboratory test rig. A pair of ...

CRedit authorship contribution statement

Rahul G. Deshmukh: Writing – original draft, Methodology, Investigation. **Dinesh R. Zanwar:** Supervision. **Sandeep S. Joshi:** Writing – review & editing. **Yogesh G. Joshi:** Data curation. ...

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. ...

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Synthesis and performance investigation of novel graphene nanoplatelets-based nanosuspension in PAG and MO refrigeration lubricants

Yogesh G. Joshi ^a  , Dinesh Zanwar ^b, Vinit Gupta ^c, Pratik N. Dhandale ^a, Akshay Patil ^a, Ashwin Kudawale ^a

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Abstract

In this work, graphene nanoplatelets (GNP) based nanosuspension is synthesized by using POE (polyester oil) and MO (Mineral oil) as a base fluid. The synthesis process involves utilizing a high-power ultrasonicator to achieve suspension concentrations of 0.03wt%, 0.06wt%, and 0.09wt%. Scanning electron microscopy is employed to characterize the GNP, while the stability of the synthesized nanosuspension is assessed using a UV-spectrophotometer. The thermal conductivity, specific heat capacity, and density of both lubricants are determined through theoretical calculations and experimental measurements. The results indicate that the thermal conductivity and density increase as the weight percentage of the nanosuspension rises, while the specific heat capacity decreases. The findings are consistent with those reported for other nanoparticle based lubricants in literature. The outcomes can be attributed to the enhanced overall heat transfer resulting from the addition of nanoparticles.

Introduction

In the refrigeration system, lubrication oil plays a vital role in minimizing the compressor losses [1]. The efficiency of the compressor is indirectly affected by the lubrication oil. The losses in the compressor lead to the overall increase in power consumption. As per the statistics given by UNEP (United Nations Environment Programme), almost 20% of electricity is being utilized by the refrigeration sector [2], [3]. Also, 7.5% of global warming is reported due to the indirect emission from this sector alone. In recent years, researchers have explored the use of various nanomaterials to enhance the thermophysical properties of lubricating oils. The initial attempt to enhance fluid properties through the incorporation of nanomaterials was documented in 1995 by Choi et al. [4]. The influence of compressor lubricant oil on the power consumption of refrigeration systems has been well established. Building upon Choi's pioneering work, numerous nanomaterials have been employed to enhance the thermophysical properties of lubricating oils.

The nanomaterial such as aluminum oxide [5], [6], [7], [8], [9], copper oxide [10], [11], titanium dioxide [12], [13], [14], silicon-oxide [15], [16], [17], graphene [18], [19], [20], [21], multiwalled carbon nanotube [22], [23], [24], fullerene particle [25], [26], quantum dots [27], [28] have already been investigated theoretically and experimentally. To the best of the author's knowledge, the incorporation of these nanomaterials has led to notable enhancements in the thermophysical properties of the respective lubricating oils. More recently, graphene nanoplatelets have emerged as a promising addition for improving both the thermophysical and rheological properties of fluids [29]. Graphene nanoplatelets have garnered significant attention owing to their exceptional mechanical properties and elevated electrical conductivity. [30]. To the author's knowledge, the graphene nanoplatelets is not yet utilized to improve the thermophysical properties of a refrigeration lubrication oil. As part of this current investigation, the innovative substance of graphene nanoplatelets is utilized to enhance the thermophysical characteristics of polyester oil (POE) and mineral oil (MO).

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Synthesis of graphene nanoplatelet nanosuspension

A two-step method is employed to synthesize a nanosuspension of graphene nanoplatelets (GNP) in this study. Techinstro Pvt. Ltd., India provides the graphene nanoplatelets, while polyester oil (POE) and mineral oil (MO) serve as the base fluids for nanosuspension synthesis. The structure of the graphene nanoplatelets is analyzed using a Field Emission Scanning Electron Microscope (FESEM), as depicted in Fig. 1 and Fig. 2. Physical properties of both the graphene nanoplatelets and lubricant oils ...

UV spectra analysis

The synthesized nanofluid was subjected to analysis of key performance parameters, including thermal conductivity, specific heat, and density. To know the stability and heat transmission capability, these three properties are essential. To evaluate these different properties, the stability of nanofluid must be ensured. If the synthesized nanosuspension is unstable, the thermophysical properties will not be correctly obtained. Hence, before experimentation the nanofluid stability is checked by ...

Thermal conductivity and specific heat capacity of graphene nanoplatelet based nanosuspension

From the theoretical investigation along with experimental observation, it is evident that the GNP has significant impact over the polyester oil and mineral oil. According to the experimental as well as theoretical findings, the addition of GNP in mineral oil and polyester oil exhibit much higher thermal conductivity than the corresponding base oil. As the concentration of GNP increases in these oils, the thermal conductivity of the synthesized nano lubricant suspension also increases [41]. The ...

Conclusion

The above study demonstrates well the effect of addition of graphene nanoplatelets on properties of polyester and mineral oils which are normally used as refrigeration oils.

- The synthesis method of graphene nanoplatelet is described and corresponding stability is tested using UV Spectra analysis that shows that the resultant solution is stable. ...
- Also, the thermophysical properties including thermal conductivity, specific heat capacity, and density are evaluated through experimental analysis and ...

...

CRedit authorship contribution statement

Yogesh G. Joshi: . **Dinesh Zanwar**: Supervision. **Vinit Gupta**: Writing – review & editing, Supervision. **Pratik N. Dhandale**: Data curation. **Akshay Patil**: Data curation. **Ashwin Kudawale**: Data curation. ...

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Investigative comparison of R134a, R290, R600a and R152a refrigerants in conventional vapor compression refrigeration system

Jyoti Soni ^a, Vinit Gupta ^b  , Yogesh Joshi ^c, Satyam kumar Singh ^a, Aditya Upadhyay ^a, Rishikesh Kumar ^a, Sourabh Yadav ^a

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Abstract

This work represents the performance comparison of conventional vapour compression refrigeration system (VCRS) using various refrigerants such as R134a, R152a, R600a and R290. The theoretical model has been utilized for computing work input to the compressor, refrigerating effect and coefficient of performance (COP) for R134a, R290, R600a and R152a refrigerants. This investigation has been done for the evaporator temperature range of -30°C to 10°C and the condenser temperature range of 40°C to 45°C. In this performance analysis it is seen that R290 shows favourable properties and can serve as best refrigerant among all in the group. R290 shows almost equal COP to R600a in large operating temperature range and it has very high refrigerating capacity comparatively to R134a together with its low global warming potential and ozone depletion potential. R152a and R600a also show some satisfying properties.

Introduction

In current scenario, refrigeration sector has become increasingly important considering large requirements in food industry, medical sector, transportation, human comfort applications to name a few. This continuously growing need has resulted in large energy consumption attributed to refrigeration sector alone. Conventionally, R12 has been utilized widely as a refrigerant in conventional vapour compression refrigeration system (VCRS) cycle. The majority of conventional refrigerants, including hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs), have been identified to significantly increase global warming potential (GWP) and contribute to ozone depletion. These compounds have the potential to cause the ozone hole to form as well as climate change [1]. The refrigerant R12 (CFCs) has high performance and efficiency but has strong adverse effect on ozone layer and contributes significantly to global warming [1]. Numerous ozone depleting compounds and high-GWP refrigerants have been phased out as a result of international accords like the Montreal Protocol and the Kigali Amendment. This has resulted in strong alterations in climatic conditions thereby resulting in the need to replace this refrigerant with a more environment friendly refrigerant. The refrigerants R134a, R600a are nowadays recommended as alternatives of R12 in domestic refrigerator [2], [3], [4]. The refrigerant R134a is found to exert zero ozone layer depletion however has high global warming potential (GWP) of 1450. The refrigerant R600a has zero ozone layer depletion and also very less global warming potential of 4 and 3. Therefore, such refrigerants can easily replace R12 without any major changes in device design. Currently, R134a (1,1,1,2-Tetrafluoroethane) is a commonly used refrigerant in vapor compression refrigeration systems. While it has replaced more harmful refrigerants like CFCs and HCFCs due to its lower ozone depletion potential, R134a is still classified as a greenhouse gas and has a global warming potential (GWP) of 1,430 over a 100-year time horizon.

Recent developments in vapor compression refrigeration systems have focused on several key areas to improve efficiency, reduce environmental impact, and enhance overall performance. The development such as advanced compressor technology [5], use of nanosuspension [6], [7], [8], [9], [10], [11], [12], use of magnetic field [13], dual evaporator method [14], integrated renewable energy systems [15], [16] etc. However, the utilization of natural refrigerant are much easier compared to the such methods. In the present experimental study, the refrigerant R290, R600a and R152a are utilized for the replacement of R134a.

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Materials and method

In Fig. 1, a standard VCRS system's layout is illustrated. The refrigerant travels through a vapour-compression refrigeration system (VCRs), where it is periodically compressed and expanded to change its condition from liquid to vapour (Fig. 2). The system absorbs and releases heat when the refrigerant changes states, bringing the temperature of the conditioned environment down. Table 1 gives the important properties of refrigerants that were utilized in the current work.

In the current article ...

Work input at the compressor

The specific work done by the compressor on the refrigerant is also analysed (Fig. 3). The results show that the work input at the compressor is highest for R290 refrigerant for evaporator temperature of -30°C out of all the refrigerants in the group and work input decreases with increasing evaporator temperature. R600a has slightly lower specific work input than R290 and R134a has lowest work input requirement. ...

Refrigerating effect

The refrigeration system's primary function is to deliver refrigeration capacity. ...

Conclusion

Based on research findings, it can be concluded that R290 refrigerant exhibits superior performance compared to the other selected refrigerants in the vapor compression refrigeration system (VCRS). Throughout the entire range of operational temperatures, R290 demonstrates the highest refrigerating capacity. Additionally, R290 performs nearly as efficiently as R600a within a wide working temperature range. The advantages of R290 as a replacement refrigerant for older alternatives are evident, ...

CRedit authorship contribution statement

Jyoti Soni: Writing – original draft, Conceptualization. **Vinit Gupta:** Supervision. **Yogesh Joshi:** Validation. **Satyam kumar Singh:** . **Aditya Upadhyay:** Data curation. **Rishikesh Kumar:** Data curation. **Sourabh Yadav:** Data curation. ...

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. ...

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Flow boiling heat transfer and thermophysical characteristics of graphene-POE-R134a based nanorefrigerant

Yogesh G. Joshi ^a  , Vinit Gupta ^b, Rahul Deshmukh ^c, Kunal Khelkar ^d, Adesh Kolhe ^d, Akhilesh Bhoyar ^d

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Abstract

The nanomaterials utilized in heat transfer fluid are giving better performance results for different thermal-centric systems. Flow boiling is a crucial phenomenon that significantly influences the heat transfer capacity of various thermal systems. This study aims to develop a nanosuspension comprising graphene oxide (GO) by employing polyester oil (POE) as the base fluid. The primary objective is to examine the impact of this nanosuspension on the heat transfer coefficient during flow boiling, with a specific focus on its performance in the presence of R134a refrigerant. The nanosuspension is synthesized by using a high-power ultrasonicator with a suspension concentration of 0.02 wt%, 0.05 wt% and 0.07 wt%. The initial phase of the experimental investigation involves evaluating the thermophysical properties, including thermal conductivity, density, and specific heat. These properties are then compared with a theoretical model to assess their agreement and consistency. In the subsequent phase of the experimental study, various synthesized nanosuspensions are tested to examine their impact on the heat transfer coefficient during flow boiling. The experimental findings divulge a

substantial improvement in the flow boiling heat transfer coefficient when employing the nanosuspension composed of graphene oxide (GO) and polyester oil (POE). The highest gain of 17.3% is noted in the flow boiling heat transfer coefficient (FHTC) using 0.07wt% of GO-POE based nanosuspension. With the same concentration highest thermal conductivity gain of 0.8W/mK with a mild gain of 0.15 gm/ml density along with a significant reduction in the specific heat of the pure POE oil is noted.

Introduction

Flow boiling plays a pivotal role in enhancing the heat transfer efficiency of thermal systems. In many industrial areas such as refrigeration [1], automobile sector [2], and electronic sector [3]. The flow boiling Phenomenon have utilized to improve equipment efficiency with energy consumption. Modern Equipment nowadays requires higher heat transfer co-efficient specifically in the thermal sector to enhance the efficiency of the system. It has been more popular in recent years to use nanomaterials to improve the flow boiling heat transfer coefficient. In the past decades, many studies have been carried out for enhancing the flow boiling heat transfer coefficient in the refrigeration sector. As it is reported by UNEP (United Nation Environment Program that 20% of electricity globally consumes by the refrigeration sector alone [4]. Such a huge amount indirectly affects the emissions in power generation. Hence, it is necessary to optimize the refrigeration system, several works of literature covered the utilization of nanomaterial.

In order to increase the effectiveness and performance of refrigeration systems, flow boiling augmentation utilizing nanoparticles has emerged as a potential strategy [5], [6], [7]. In most studies, the experiment has been done on horizontal or vertical tubes. Metallic nanomaterials such as aluminum oxide [8], [9], [10], copper oxide [11], [12], [13], zinc oxide [14], and titanium oxide [15] have already been utilized with different refrigerants to enhance the flow boiling heat transfer coefficient (FHTC). The 2D-material such as MWCNT [16], CNT [17], have also been utilized to enhance the FHTC. The enhanced FHTC directly affects the heat extraction capacity of the refrigerant hence it is found to be feasible for utilization in the refrigeration system [18]. It is also observed that nanomaterials are a possible route for developing refrigeration technology to satisfy the demands of contemporary and sustainable cooling applications since they can reduce problems like boiling delays and enhance crucial heat flux properties [19], [20], [21], [22], [23].

To the author's knowledge, the available literature is limited to the utilization of pure refrigerant along with nanomaterial. The present study aims to examine the impact of a nano lubricant based on graphene on the heat transfer coefficient during flow boiling with R134a refrigerant. As a novel part of the current investigation, the combined effect

of graphene/POE-based nano lubricant is investigated to enhance the flow boiling heat transfer co-efficient with R134a refrigerant.

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Synthesis of graphene -POE-based nanosuspension

The graphene - POE nanosuspension is synthesized using a two-step method. The graphene nanoparticle is obtained from platonic nanotech Pvt. Ltd. Field emission scanning electron microscopy (FESEM) analysis was conducted to observe the layer morphology of the graphene nanomaterial under investigation. Corresponding properties are mentioned in Table 1. Further, the base fluid utilized in the experimentation is POE (Polyester Oil) (Fig. 1 and Fig. 2). The EDS (Energy-dispersive X-ray spectroscopy) ...

Thermal conductivity and specific heat capacity of graphene oxide-POE based nanosuspension

For the determination of theoretical values of thermal conductivity, Hamilton model is used (Eq. (3) [24], [25]. The Hamilton model is the modified Maxwell model of thermal conductivity. In the earlier models, the component of nanosuspension concentration is not taken into account (Eq. (2), however, in the modified version of the equation it is considered. In the given equations, K_{eff} denotes the effective thermal conductivity of the synthesized nanosuspensions, K_{bf} represents the thermal ...

Thermal conducting of GO-POE based nanofluid

The thermal conductivity of GO-POE based nanofluid is found to increase as the nanoparticle concentration increases. The gaining pattern in thermal conductivity is observed in the Hamilton model as well as in experimental results with Minor deviation. The thermal conductivity of the synthesized nanosuspension exhibited an increase of 38.3%, 44.2%, and 56.8% with the addition of 0.02wt%, 0.05wt%, and 0.07wt% of GO-POE-based nanosuspension, as illustrated in Fig. 7. This augmented thermal ...

Conclusion

The primary objective of this study is to analyze the influence of a nanosuspension containing graphene oxide on the flow boiling heat transfer coefficient of R134a. Experimental investigations were carried out using three different concentrations (0.02 wt%, 0.05 wt%, and 0.07 wt%) of graphene nanoparticles dispersed in a base fluid consisting of POE (Polyester) oil. Based on the findings of this investigation, the following conclusions can be inferred:

- The addition of graphene oxide ...

...

CRedit authorship contribution statement

Yogesh G. Joshi: . **Vinit Gupta**: Supervision. **Rahul Deshmukh**: Writing – review & editing. **Kunal Khelkar**: Data curation. **Adesh Kolhe**: Data curation. **Akhilesh Bhoyar**: Data curation. ...

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Various Image Inpainting Techniques - A Survey

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ABSTRACT

Considering its significant relevance and effectiveness in image processing operations to eliminate any sort of distortion, including text, blocks, noise, scratches, lines, etc. from the source images, researchers have been studying the image inpainting problem over the past several decades. The practice of adding missing areas or erasing unwanted objects from images is called as image inpainting. It necessitates a profound comprehension of an image features in terms of texture and structure. It is recognized as one of the most difficult idea in the image processing field in the scientific community. To give the research community a reference, it is vital to categorise and condense various methodologies. From a variety of perspectives, traditional methods of Image inpainting like Diffusion based method and Patch based method (Exemplar based algorithms) are categorized first. The Convolutional neural networks (CNNs approaches) and generative adversarial networks (GANs), are two deep learning techniques, are also categorised. In order to offer novel viewpoints in the subject of image inpainting, this study will review the advantages and disadvantages of each approach. We discuss some potential future works based on our findings.

KEYWORDS : : *CNN, GANs*

INTRODUCTION

The skill of image inpainting is used to restore old and damaged pictures. It may also be used to remove or replace unwanted items from the image. In computer vision applications, It has become a substantial and challenging field of research. It is utilised to fill up the empty space in a picture. First-generation image inpainting techniques fall into two categories: traditional techniques like diffusion-based and exemplar-based inpainting techniques, and more modern techniques utilising deep learning. Basically Inpainting technique is used to recover damaged or imperfect areas of a picture by interpolating nearby pixels. An image's damaged areas consist of a group of disconnected pixels enclosed by a group of known neighbouring pixels. The inpainting approach fills unknown regions with known information during the

restoration of unconnected pixels. Figure 1 displays several picture inpainting methods in their appropriate groupings.

Our review is divided into the following sections: Section 2, which categorises traditional inpainting techniques; Section 3, which examines deep learning techniques; Section 4, which summarizes the typical performance for image inpainting with merits and demerits; Section 5, which discusses the review's future directions; and Section 6, which contains our conclusion.

TRADITIONAL METHODS OF IMAGE IN-PAINTING

These methods works on either pixel level or on patch level. The diffusion-based inpainting algorithm is the most basic inpainting technique. The lower structures of texture and geometry are restored using diffusion-based methods.

Diffusion Based Inpainting

These methods fill the vacant spaces with local structure from the surrounding region which is based on local smooth priors. Filling of the region was done by spreading the local geometrical information along its isophote direction with the help of a partial differential equation (PDE). [1].

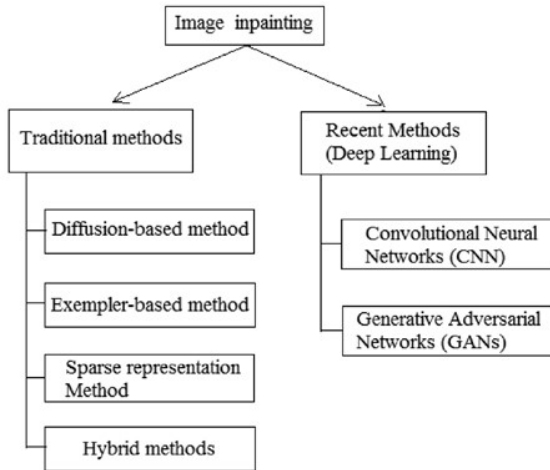


Fig. 1: Shows how image inpainting approaches may be categorized into two primary groups: Conventional / Traditional and modern deep learning methods. Conventional / Traditional Methods has four subcategories: Diffusion based, Exemplar based, Sparse Representation, and Hybrid Methods. CNNs and GANs are subcategories of deep learning methods.

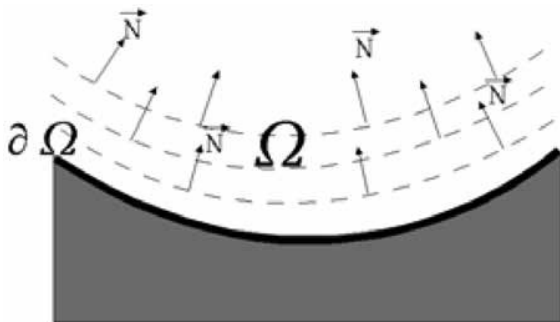


Fig. 2: Propagation in the normal direction as the boundary of the area that will be painted

Let, Ω stand for the area that will be painted, and $\partial\Omega$ serve as its border. The mechanism for this technique is as follows:

- (1) How to close the gap is determined by the overall picture.

- (2) The neighboring area’s structure is carried into the missing area and outline are drawn through the the persistence of those arriving at $\partial\Omega$.
- (3) All the missing parts are filled with colour to match those of $\partial\Omega$, as shown by the outline lines.
- (4) The “texture” is evenly applied, and the minor details are painted in the spaces that are missing them.

The first image inpainting technique is suggested by Bertalmio et al. [1]. Chan and Shen developed further partial differential equation based methods [2, 3], which were based on the same research as that of Bertalmio et al.

The Diffusion method seamlessly expands image contents from the border line to the inner part of missing area, especially the hole. In order to do this, Li H et al. [4] suggested a diffusion technique that included first localising the diffusion of the inpainted regions and finally, in order to identify the inpainted areas, developing a feature set dependent on the intra- channel and inter-channel local variations of the changes. Utilising the coefficients that were calculated using direction and distance between the distorted pixel and its adjacent pixels is another technique presented in a subsequent study by Li K et al. [5]. Another diffusion-based technique based on the Fourier transform and fractional order derivative and was proposed by Sridevi et al. [6].

In summary, diffusion-based systems perform well on pictures with minor occlusions and restricted damaged areas. This technique performs poorly when filling big regions because, if the target region is vast, it frequently causes visual blur. When the missing areas are big and textured, blurring artefacts may be created in practically all PDE-based techniques.

The second group of methodologies, texture synthesis techniques, were presented to cover huge regions with pure textures. These techniques all have the same goal of capturing data from the desired area to the destination area. According to the size of the sample texture, two types of texture generation methods are categorised: pixel-based sampling and patch-based sampling. The

algorithms used in pixel-based schemes are extremely sluggish since the filling operation is carried out pixel by pixel.

Exemplar-Based Inpainting:

Exemplar-based techniques represent the second group of approaches that have been put out to fill in huge areas of missing images. Both textural, structural information of the damaged big region may be concurrently repaired using exemplar-based picture inpainting techniques. Nonlocal self-similarity priors were first created in the texture creation field, are used to fill-up in the empty space in order to circumvent the drawbacks of local smooth priors.

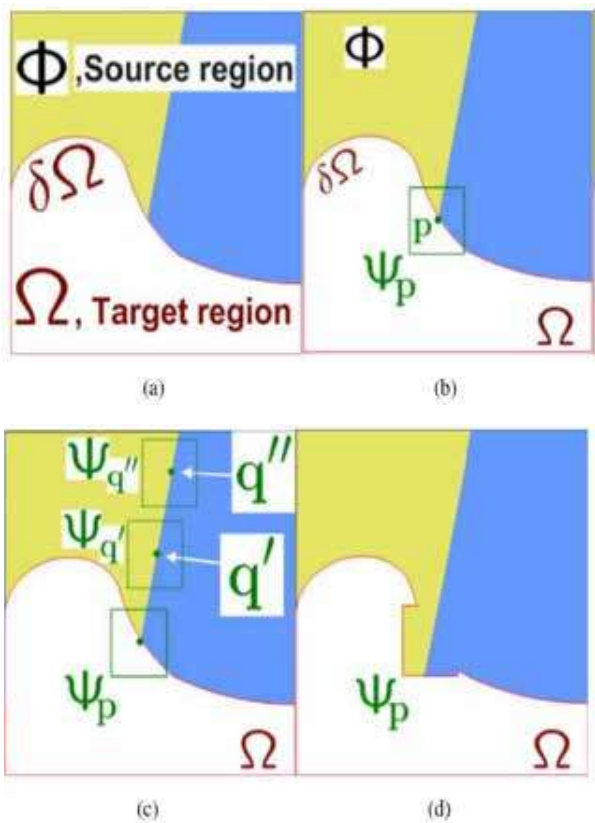


Fig. 3: Process of painting an image in example-based inpainting (A) The original picture, showing the source and target region. (B) displays the filled patch that was selected based on best matched pixel. The patch that is matching to the missing patch is shown in (c). The image in (d) demonstrates the best matching patch being transferred to its occupied spot from a candidate patch.

The propagation of linear structures from (a) to (d) during the inpainting process is shown in Figure 3. The target region, which is the area that has to be filled, is represented by Ω , and its contour is given by $\partial\Omega$. Samples are provided by the source region, ϕ , which is permanent throughout the algorithm, and are used for filling procedure. Assume that the square template $\psi_p \in \Omega$ centred at the point p (fig. 3b), is to be filled. The patch $\psi_q \in \phi$, which most closely resembles the areas that have previously been filled in with ψ_p , belongs from the source region that matches the best. As seen in the example in Fig. 3b, the best matches are most likely to be along similarly coloured edge if ψ_p is on the continuation of an edges of the image, as in the case of $\psi_{q'}$ and $\psi_{q''}$ in Fig. 3c. A straightforward transfer of the pattern from the source patch with the best match is all that is needed to propagate the isophote inwards (fig. 3d). The technique for filling regions is outlined as follows:

1. The fill front $\partial\Omega$ is first determined.
2. All patches whose centres align on the fill front $\partial\Omega$ have their patch priority are calculated.
3. The patch ψ_p with the highest patch priority is selected.
4. From the source area, the best matching candidate patch ψ_q is picked.
5. Switch over the data from ψ_q to ψ_p . In this stage, the target region's border $\partial\Omega$ of the target region Ω and the information required for assessing filling priorities are updated, resulting in a partial fill-in of the missing region Ω .

The exemplar based technique was presented by Criminisi et al. [7] and works well to synthesise the texture in target areas, making it more appropriate to cope with large regions, such as removing background people from photographs while maintaining picture features in the filled region [8–13].

Patch based concepts works on finding substitute patches that are well matched, and fills the missing portions into the image patch by patch (known as candidate patches). The patch- based methods has been proposed by several different ways. A patch based method was proposed by Rui'c et al. [14] and employed

a MRF-Markov random field to find the best matched patch in the texture component. Authors suggested method for restoring the damaged block in the picture using TSLRA i.e. Two Stage Low Rank Approximation [15] and gradient based low rank approximation [16]. Another inpainting technique was proposed by Fan and Zhang [17] and is based on summarising the differences between patches to determine how similar they are. Jiang [18] suggested a technique for image compression that involves removing blocks from a picture. Alilou et al. [19] suggested a method to recover the missing sections using single value decomposition also by an approximation matrix. A unique strategy combining picture completeness, texture generation, and image inpainting was proposed by Nikos Komodakis et al. [20]. They attempt to stay away from assigning greedy patches in order to prevent visibly inconsistent outcomes. Dynamic label trimming and Priority based message scheduling are two significant improvements over normal BP that are included in a unique optimisation strategy called priority-BP. A technique for exemplar-based picture inpainting that employs angle-aware patch matching and can choose several matched patches from the given region was proposed by Na Zhang et al. [21]. An angle aware rotation technique increases the likelihood of finding the best matched patch.

Although the sequential based systems, which include Diffusion-based and Exemplar- based approaches, show promise in number of aspects of image inpainting, such as filling texture details but still capturing the overall structure remains a difficult challenge [22].

In summary, the image inpainting systems classified under the exemplar-based structure synthesis category reconstruct the structure and texture of a missing region using similar patches from a recognised neighborhood. This is based on similarity of the pixel that was discovered by taking texture samples from recognised regions of the picture. Additionally, to close the gap and update priority, replace any missing pixels in this category with comparable pixels from the patch. Additionally, issues relating to speed, texture correctness (meaningless growth), and proper propagation of linear structures are addressed. Failures in curved constructions and depth uncertainty are additional drawbacks mentioned. Also,

it is a greedy approach that increases the chance of adding an undesirable item or artefact to the region to be painted because it always chooses the best patch for the current place.

Sparse Representation Method

Although there is less chance of introducing unwanted items or artefacts than in the exemplar-based technique, the features of the recovered image are less accurate since a sparse representation of an image is only an approximation. The sparse-based approaches presuppose the presence of signals in pictures that are likely to provide a sparse decomposition across a redundant dictionary. Chang et al. use colour space to rectify the overexposed facial pictures in digital photos of facial photographs.[41]. Selecting bright areas on the face is done using a sliding window-based approach. However, this technique cannot be used for other types of images and is only strongly advised for facial photographs. When examining two sample textures, Kawai et al.'s [42] method takes into account the fluctuations in image brightness and the spatial localization of texture patterns. This approach fills in the desired regions by reducing the energy function while initialising the missing regions with certain values. Another method of sparse representation was suggested by Shen et al. [43]. This technique uses a redundant dictionary that is built via a discrete cosine transform. This approach uses an iterative sequential computation over a sparse representation to fill in every incomplete patch at the target region's edge. A dual-phase algorithmic inpainting approach was put out by He et al. [44]. This approach makes use of the function called Thieles rational interpolation and the Newton Thieles function. The interpolation is done in the horizontal direction for the damaged vertical pixel point. To set and accept information about known pixel positions for performing pixel intensity interpolation, the image is scanned from line to line. This method's restriction is that the broken pixels must be oriented vertically.

Hybrid Methods

Researchers were inspired to investigate the combined properties of these two approaches after achieving notable results with the exemplar-based texture and

structure generation method in inpainting. It works well with buildings that have curves and small gaps. Using this technique, test image is broken down into structural and texture layers for inpainting. For texture generation the energy function is used, but the structural layer diffusion-based approach is used after decomposition. It adds synthesised textures produced using the method proposed by Leung et al. [45], whereas applies the diffusion-based methodology described by Bertalmio et al. for the structural layer. The patch stitching reduces the joint area while inpainting. The self-similarity measure is used to calculate how similar the centre filled pixel patch is with the known pixel in the source image region. A discrete Laplacian equation is used in this operation. This approach solves the smooth artefacts issue in diffusion-based techniques. However, this approach is ineffective if the vast missing region is visible in the image. To offer a strategy based on the idea of successive stitching, All'ene et al. [46] combined statistical Bertalmio et al. [1] with variational Efros and Freeman [47] approaches. However, this approach is equally ineffective since careful consideration must be given to choose the appropriate patches and associated pixels. For capturing the structure and texture of image without losing any information, Zhang et al. [48] devised a technique that makes use of the wavelet transform. A approach with a modified MRF was proposed by Ghorai et al. [49]. This method for eliminating artefacts chooses target patches from border regions using subspace clustering, which are subsequently improved with the use of joint patch filtering to capture patterns.

In conclusion, these techniques may fill complicated textures and structures while removing text. Although it can manage blur and border discontinuity and provide the finest visual quality, approaches in this category still struggle when it comes to some dis-occlusion and object removal tasks. Additionally, extra computing time is needed.

DEEP LEARNING METHODS

This is recent and efficient approach in the image inpainting field. CNNs (Convolutional neural networks) and GANs (Generative adversarial networks) are being used, and the results are looking excellent.

Convolutional Neural Network

Many studies have been presented for picture inpainting based on CNNs employing encoder and decoder networks. One of these techniques, Shift Net based on U Net architecture, recovers the lost blocks with high precision in terms fine detailed texture and structure [23]. Zhao et al. [25] employ the network for processing medical X-ray pictures, whereas Weerasekera et al. [24] takes input as depth map of the image to the CNNs. A technique for blind image inpainting called (BICNN) was proposed by Cai et al. [26]. Many studies have been presented for picture inpainting based on CNNs employing encoder and decoder network structure. A patch-based inpainting technique for forensics photos was put out by Zhu et al. [27]. utilising the same encoder and decoder network method. SCA i. e. Coherent semantic attention layer is a layer that Liu et al. [28] suggested for the encoder and decoder network for the picture inpainting approach. In contrast to the other techniques, Liao et al.'s [29] Artist-Net approach was put out for picture inpainting. Cai et al. [30], who suggested a semantic object elimination method utilising CNNs, accomplished the same objective.

Generative Adversarial Networks

It is a widely used approach, were first demonstrated for picture production in 2014 [31]. A generator G and a discriminator D, make up the framework known as generative adversarial networks (GANs). A network D is taught to discriminate amongst genuine and created pictures, while a network G is trained to produce an entirely identical image that is not easy to differentiate from actual photos. The feed forward networks, G and D make up the architecture known as GANs. D. Another GAN-based semantic image inpainting technique was proposed by HuH et al. [32] to repair the image. Li et al. [33] suggested a technique for inpainting and character identification for handwritten pictures. The two stage combined network is proposed by Sagong M-c et al. [34] to build a encoder and decoder network known as PEPSI. PEPSI++, which is an expanded version proposed by Shin YG at length [35]. Encoder-decoder networks and multi-scale GAN were utilised by Wang H et al. [36] for picture inpainting. In order to create a scene's backdrop by eliminating the foreground item, Dharmo et al. [37] employed CNNs and the GANs

structure. In order to restore the pictures, Jiao et al. [38] integrated a GAN, a multi-layer convolutional layer, and an encoder-decoder.

The GAN-based systems improve the results, but training speed is very slow, and requires highly powerful computers. This is because convolutional operations and network parameters all demand CPU resources. In their summary of various deep learning techniques, Hanyu Xiang et al. [40] noted that deep learning algorithms may better capture high level semantics and provide

noticeably superior outcomes in future.

In summary, deep learning methods (which includes CNN and GANs) show excellent outcomes in inpainting tasks as compared to traditional algorithms.

SUMMARY OF TRADITIONAL AND DEEP LEARNING METHODS

The advantages and disadvantages of most popular traditional and deep learning approaches for image inpainting techniques are shown in following Table 1.

Table 1: Merits and demerits of image inpainting techniques

Image inpainting Technique	Merits	Demerits
Diffusion based method Bertalmio et al. [1], Chan et al.[2,3], Sridevi et al.[6]	When filling up small areas, it produces good results. Appropriate to use for filling curves and lines. Gives high performance preserving all structural information.	For large missing regions, results in blurring artifacts
Texture synthesis based inpainting	No problem of blurring artifact.	Poor results for curved structures and thick scratches
Texture synthesis pixel based Li et al.[5]	Can be used for deterministic and stochastic textures	Large computation time required
Texture synthesis Patch based Liang et al.[8], Guo et al.[9]	Better performance and comparatively less time required.	Some times produces blur for inappropriate size of missing patch.
Exemplar based method Criminisi et al [7], Liang et. Al.[8], [8-13], Rui'c et al. [14], Nikos et al. [20]	Both structural and textural information can be preserved with promising results	Poor performance if corrupted region is spreaded along most of the area. Failures in curved constructions and depth uncertainty. it is a greedy approach that increases the chance of adding an undesirable item or artifact.
Sparse representation method Chang et al.[41], Kawai et al [42], Shen et al.[43], He et al.[44]	There is a low risk to introduce undesired objects or artifacts. Efficient for facial images distorted due to high light exposure.	In this technique damaged pixels are desirable to have in vertical direction. Gives Poor results for natural scene images.
Hybrid method Efros et al.[45], [46-49]	Applicable for structures with edges and curvatures and can remove text, complex textures.	it requires more computational time.
Deep learning methods Yan et al.[23], Zhao et al. [25], Zhu et al.[27], Cai et al. [30], [31-32], Hanyu et el.[40]	Compared to traditional algorithms, high effectiveness, hence giving promising outcomes.	The performance of these algorithms are dependent on the available data sets. Needs very good performance machines

DISCUSSION AND FUTURE SCOPE

For picture inpainting systems, a wide variety of diffusion-based, exemplar-based, Sparse method, hybrid approach, and deep learning techniques have been utilised in the past. The following are some of the issues with these techniques:

- **Blurring artefacts:** When the missing regions are big and textured, the diffusion-based approaches may cause blurring artefacts.
- **Recognising related patches:** Exemplar-based approaches are reliable for basic images, but it might be challenging to find a comparable patch when the image is complicated, such as when it has heavy concentration of texture and objects, or when the objects covers a big area of the image.
- **A wide range of distortions:** Recently, many researchers have been developing deep learning-based systems. The same method was shown to be ineffective for several categories of distortions. The outcomes of convention approaches (i.e. diffusion and exemplar based methods) rely on how complex the picture structures are.
- **Result Dependency:** In conventional neural network-based approaches (such as encoder and decoder CNN methods), results depend on the amount of training data that is available. The number and kind of the data utilised in CNN-based approaches affect how effective each strategy is.

CONCLUSION

We make an effort to synthesise both traditional and deep learning methods for picture inpainting. These techniques may be used to correct several sorts of visual distortion, including noise, text, objects, and scratches. It has been discovered that researchers have lately started using deep learning techniques, which are better at generalising to more complicated pictures. The greatest method for getting decent outcomes is to train a learning model using a lot of data. A summary of the benefits and drawbacks of various techniques is provided for the benefit of researchers working on image inpainting.

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Pragmatic Analysis of Network-on-Chip Routing Models from an Empirical Perspective

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ABSTRACT

Routing is the process of the path selection in any network. Routing creates efficiency in the network communication. Network communication failures result in long wait times for website pages to load users. Inadequate throughput performance may result from missed packets, delayed data, lower energy efficiency, and incorrect routing between on-chip nodes. To solve this issue, researchers created a variety of routing methods, such as XY Routing, Priority Routing, and others. Additionally, each of these models has machine learning-optimized variations that may be used to help create low-power, high-throughput communications. Performance indicators like throughput, energy utilization, and packet delivery ratio are just a few of the ones that are used to compare various strategies (PDR). There are also nuances, advantages, and drawbacks that are particular to the setting, as well as possible research areas. It is challenging for researchers to predict which routing models would provide the best results for the application-specific installations they are working on because to the wide diversity in performance. In order to dispel any remaining questions, this study offers a thorough analysis of the merits, applicability, and scalability performance of these models. Researchers and network designers will be able to deploy their on-chip networks using the most appropriate models thanks to this discussion, which will lower the costs of designing and implementing networks of all sizes. In order to identify application-specific routing strategies, this presentation includes a statistical analysis of the investigated models. According to the evaluation in this paper, it can be seen that show case higher efficiency of routing, while these models along with showcase lower delay when compared with other techniques.

KEYWORDS : *Routing, On-Chip, Control, Network, Delay, Throughput, Energy, PDR, Scenarios*

INTRODUCTION

From their beginning NoC router supporting different link bandwidths and number of VCs per Uni-directional port is presented and the main advantages are better ingress and egress bandwidth, decoupling, better performance and ability to configure the router according to the preferred cost performance ratio. Several modelling domains and activities are involved in designing on-chip routers, including rate

control, piggybacking, fidelity analysis, traffic estimate, and traffic redirection, among others. Researchers build these capabilities into on-chip networks using a variety of methods. The majority of routing models begin by identifying congestion at the packet level. Queue length, packet rate, service time, inter arrival time, delivery time, node latency, application fidelity, and channel condition are a few of the metrics stated above. The packet is transmitted to the next node on the chip, where it will be processed alongside other traffic if there

is no bottleneck. The on-chip routers get notifications of congestion, which they use to help activate the arbitration modules.

Emerging as a new approach for the creation of complicated on-chip communication architectures in today's electrical systems-on-chip, the term "network-on-chip" (NoC) was coined to describe this concept (SoCs). One of the most important elements of the construction of a NoC is the NoC routing, which establishes how data packages are sent from one point to another within the network. Cellular automata, also known as CA, are discontinuous mathematical model that have found widespread application in the field of research concerning complicated systems. Recent research has looked into the possibility of using CA as a transportation paradigm for NoC. Each router is represented as a cell in a cellular automaton in the CA-based NoC routing model. The decision regarding the sending of a data stream is made based on the local state of the router's surrounding cells.

The flexibility, fault-tolerance, and energy effectiveness of this strategy have all been demonstrated to have positive outcomes. Nevertheless, it also presents some difficulties, such as the need to create suitable CA rules for effective handling and find a solution to the problem of overcrowding. In general, the CA-based NoC routing model is a fascinating field of research that has the possibility for further investigation and expansion use cases.

At this layer, choices regarding congestion control result in packet rerouting or the adoption of additional procedures. Rate control, packet dropouts, additive increase/multiplicative decline (AIMD) in packet rate, and a growth in the number of resources are a few of them. This data is updated often on the router, which improves congestion management and avoidance at the packet level under a range of network conditions. Numerous route control models have been developed by researchers, each with unique deployment characteristics. The intricacy, applicability, and limits of these models are discussed in the next section, along with some possible future study possibilities. This debate will help researchers choose the best route control models for their deployments of application-specific on-chip networks. This background information is followed by

a statistical analysis of the studied models' performance indicators. End-to-end latency, throughput, packet delivery ratio (PDR), and other equivalent factors may be included in these performance evaluations. Readers will also benefit from this article's comparative study in evaluating which congestion control strategies are best suited for their particular network configurations. The article's last section draws some intriguing conclusions about the examined models and provides a range of suggestions for enhancing their effectiveness.

NETWORK ON CHIP : AN OVERVIEW

Network-on-chip (NoC) is an emerging paradigm for designing complex on-chip communication architectures in modern electronic systems-on-chip (SoCs). NoC routing is one of the key design aspects of NoC architecture, which determines how data packets are routed through the network. Cellular Automata (CA) is a discrete mathematical model that has been widely used in the study of complex systems. CA has been recently explored as a potential routing model for NoC. In the CA-based NoC routing model, each router is modelled as a cell in a cellular automaton, and the routing decision for a data packet is made based on the local state of the router's neighbouring cells. This approach has shown promising results in terms of scalability, fault-tolerance, and energy efficiency. However, it also poses some challenges such as designing appropriate CA rules for efficient routing and addressing the issue of congestion. Overall, the CA-based NoC routing model is an interesting area of research with potential for further exploration and development scenarios. In order to transfer information across NoC nodes, researchers have offered a plethora of different ideas. [1] Heterogeneous multi core computer platform designs have been developed for energy efficiency as a direct result of the demands of Big Data and AI. Today's heterogeneous multi core system-on-chip (SoC) asymmetric data-access traffic necessitates a tailored network-on-chip (NoC) offering connection variety (SoC). Single-source, multi-destination (SSMD) traffic allows for the use of cache coherency protocols, barrier synchronization, parallel processing, and DNN acceleration. Multicast routing increases network throughput by dispersing SSMD traffic. To avoid deadlocks in NoCs, multicast routing between active

routers must not rely on branch operations. Because stalemate circumstances are problematic, and the route Hamiltonian needed to apply the rule of labeling may not exist in topology-based NoCs, throughput-optimized multicast routing is difficult to achieve. The use of multicast routing in specialized NOCs has led researchers to two key findings: 1) No deadlocks will occur if branch operations are constrained to an endpoint, even the NoC lacks a route Hamiltonian. 2) Variable paths variation may be used in route allocation and branching in a topologically-specific routing scheme. This research provides specialized NoCs based on characteristics like free-deadlock, enhanced-throughput multicast routing (MRCN). Labeling router and extended routing rules prevent deadlocks in the MRCN. Partitioning at the final router destination and traffic-aware adaptive branching both reduced the number of hops a packet must make on its way to its intended receiver. Noxim, accurate-cycle NoC simulator, was used to analyze the MRCN under a variety of topologies and traffic loads. The experiment showed that compared to the bespoke NoC multicast routing, MRCN reduced average delay by 13.98% and increased throughput by 12.16% under heavy traffic loads.

According to [2], optical networks-on-chip (NoC) based on silicon photonics are promising on-chip communication architecture for chip multiprocessors. Since optical devices are susceptible to fluctuations in on-chip temperature, thermally induced optical power loss would dramatically degrade the power efficiency of optical NoCs. To address this problem, detail a thermal-aware adaptive routing system based on ant colony optimization (ACO). In order to reduce the amount of optical power that is lost due to changes in temperature, the ACO-based routing approach makes optimal routing selections. The classic ACO-based routing strategy requires a table in each node to store and update pheromone, the size of which grows linearly with the number of nodes. The approximation ACO-based routing (AACO) method uses linear regression to reduce unnecessary table lookups. According to a simulated traffic pattern and real-world applications on an 88 mesh-based optical NoC, the suggested routing algorithms may discover nearly-optimal pathways. We

put the routing systems through their paces on a bigger network.

Network-on-Chip (NoC) is the most promising on-chip connectivity architecture in Multi-Processor System-on-Chip (MPSoCs) [3, 4] because of its efficiency and scalability. Deep sub-micron NoC faults cause links and routers to malfunction. When parts of the NoC break, dependability drops across the board. This research proposes a Reinforcement Learning-based Fault-Tolerant Routing (RL-FTR) approach for dealing with link and router failures in mesh-based NoC architecture routing. A System-C based NoC simulator is used to evaluate the RL-FTR algorithm's performance on a cycle-by-cycle basis. Variations in mesh size are a stand-in for expanding networks and router malfunctions. After running the code through simulations, we see it in action in an FPGA implementation, showing how the RL-FTR approach works in real time. Hardware and simulation both indicate that the proposed RL-FTR algorithm improves routing from the source router to the destination router.

Single-cycle long-distance communication [4] is enabled by a dynamically reconfigurable Network-on-Chip (NoC) dubbed SMART (Single-cycle Multi-hop Asynchronous Repeated Traversal) that establishes single-bypass pathways between remote communication pairs. Disputes will easily splinter a system with just one possible way around. Since packets would be delayed at intermediate routers due to blocking latency from competing packets and additional router-stage time to reconstruct the remaining connection when it becomes available, the advantages of SMART NoC's bypassing would be reduced. We provide the first contention-aware routing strategy for SMART NoCs, which improves bypassing performance. We differentiate between a packet's direct route, which may only need to go through one intermediary router, and an indirect route, which may go over several of them (s). End-to-end latency may actually be reduced by using circuitous paths that hop across unrelated routers, contrary to common opinion (even if they are not minimum). Our innovative routing strategy maximizes route diversity, reduces interference between communication pairs, distributes loads uniformly, and makes maximum use of bypass channels. The proposed routing approach boosts

network performance by 35.48 percent, application schedule length by 28.31 percent, and communication latency by 37.59 percent as compared to SMART NoC routing using actual benchmarks.

In newly suggested high-performance NoC architecture, the express bypass is used to send uncomplicated flits to far-flung processing elements (PEs) in a single cycle. If a conflict occurs, lower priority flits will be buffered and limited in their ability to use bypass. As a result of its lack of arbitrary-turn routing, SMART is unable to use routing approaches that avoid congested routers and connections in order to reduce conflict. In order to reduce contentions and maximize bypass, It propose ArSMART, a SMART NoC with arbitrary-turn transmission. The cluster controller in ArSMART determines the best paths for the data to go while the buffer less reconfigurable router handles the throughput. Since the SMART NoC's long-distance transmission bypasses intermediate arbitration, setup the input and output ports' connection directly rather than using hop-by-hop tables for arbitration. Effective ArSMART-compatible adaptive routing algorithms are developed to broaden the available channels of communication. Because taken the time to properly craft our control mechanism, able to keep the cost of route calculation hidden, which is a major problem in adaptive routing systems. Results from experiments show that using a modern SMART NoC may reduce energy usage by 29.7 percent and the duration of application schedules by 40.7 percent.

Optical networks-on-chips (NoCs) based on silicon photonics were suggested for many-core chip multiprocessors in [6]. One important issue with silicon photonics is their susceptibility to temperature changes. Related work advises using adaptive routing based on Q-learning to chill things down. The overhead of using tables for Q-table routing grows rapidly as networks expand. This work proposes a table-free approximation Q-learning based thermal-aware adaptive routing method for determining the optimum low-loss pathways with on-chip temperature changes. The results of the simulations support the proposed table less approximation It is possible that Q-learning-based adaptive routing will converge more faster and deliver optimization benefits that are on par with the best table-

based Q-routing. The proposed approximation approach outperforms table-based Q-routing as the size of the network grows.

Both connection not accurate, congestion and failure have a negative impact on the performance of the network on the chip [7](NoC). NoCs are able to handle complicated and ever-changing applications because they use adaptive routing algorithms that are both fault-tolerant and aware of congestion. In this letter, Q-learning-based adaptive routing is proposed. HQ table may be able to prevent data diversions in fault zones and choose the route with least congestion by learning the accuracy, congestion and failular information of the pathways between to the source to destination nodes. Q-value decay and the dynamic learning rate method both deal with the issue of late updates to Q-learning values. The proposed routing methods may function well with a high failure rate (>25%) and little hardware overhead, as shown by the experiments.

Network-on-chips (NoCs) are the standard for system-on-chip connections, as stated in [8]. (SoCs). A NoC router's performance and footprint are limited by the physical layer media access mechanism it uses. When the Code Division Multiple Access (CDMA) is a method, it is using by many wireless communication networks, has been suggested as a NoC router switching strategy. Using direct-sequence spread spectrum on digital interconnects, multiple processor elements (PEs) may engage in simultaneous communication through a code division multiple access (CDMA) crossbar. Bit-wise designs, such as those used by conventional CDMA switches, repeatedly using the configurations to transfer multiples bits data, increasing crossbar space or cable density. It propose aggregated CDMA routing to increase router density, throughput, and efficiency in CDMA NoCs (ACDMA). The nature of static and the noise of relative immunity of the on-chip interconnects to allow ACDMA to combine multiple bits of data into M-ary symbols on single communication digital channel, therefore reducing crossbar wire density and space overhead. Different area-speed trade offs are made in the implementation of ACDMA crossbars employing serial and parallel Application-Specific integrated circuit(ASIC) 65 nm is a standard cell technology. The implementation shows the Throughput-Per-Area (TPA)

values for the Standard Basis (SB), Walsh Basis (SB) and the Overloaded CDMA Interconnect (OCI) crossbars are 96.3%, 18.2%, and 118.6% lower than the serial and parallel ACDMA crossbars, respectively. Fully realizing the node-65 NoC router ACDMA and comparing for the against of state-of-the-art CONNECT and CDMA routers under a variety of simulated workloads. A hybrid Automatic Repeated Request (ARQ) approach is presented improved the robustness of communication between ACDMA NoC routers in the presence of noise.

The Dual Data Rate (DDR) data path of the Network-on-Chip (NoC) known as Highway NoC almost reaches the optimal network performance [9]. Data paths on routers are faster than control ones, therefore a DDR NoC route will boost throughput at data path speeds rather than control ones. When there is less traffic, DDR NoCs may reduce packet delay by using pipeline bypassing. Current DDR routers simplify their logic by ignoring internal hops that do not include a turn. Highway NoC avoids DDR routers on local ports to speed up pings entering and leaving the network. As a result, it saves physical space and power by streamlining the allocation of DDR switches and router port interfaces. While compared to standard NoCs, Highway NoC excels when operating over a route and location of 28 nautical miles. Highway NoC decreases average packet delay by 7.3-27% and power consumption by 1-10% compared to DDR NoCs, all without degrading throughput. Highway NoC provides 17-22% greater throughput, 13.8 percentage points less packet delay, and varying degrees of energy efficiency compared to Single Data Rate NoCs.

Work in [10] declared Optical connections using wavelength-division multiplexing (WDM) are becoming a more appealing option for on-chip data transmission as bandwidth and power demands rise with the scaling down of VLSI technology. Previous research into WDM-aware optical routing has three major flaws: it manages optical routing with heuristics or constrained integer linear programming; it addresses only some forms of insertion loss and WDM overheads; and it does not account for crosstalk noise when multiple signals are transmitted simultaneously. This makes it such that they can't be sure of their WDM clustering results, the reliability of their optical network is compromised, or their calculations are excessively

time-consuming. A novel WDM-aware optical routing technology significantly accelerates throughput while simultaneously reducing insertion loss, WDM overheads, and crosstalk noise. WDM-aware route clustering gives an ideal solution for 1-, 2-, and 3-path clustering, but it has a consistent performance limit for most 4-path clustering. By taking into account crosstalk during the route assignment process, the possible number of signal pairs affected by crosstalk is reduced, hence keeping the total number of signal pairs within the displacement limit. Previous testing have shown that our optical router exceeds the competition in terms of wire length, insertion loss, wavelength power, crosstalk noise, and runtimes.

A proclamation was made in [11] Data-driven programs with huge memory footprints sometimes fail to use the cache because of insufficient on-chip caching. When applications make use of cache blocks that have been previously evicted, they risk incurring repeated miss penalties. NoC routers include input port buffers to prepare for catastrophic situations. Recent studies have shown that until network congestion occurs, buffers are underutilized. In order to do post-silicon debugging and verification, NoC routers use trace buffers. After a design is put into production, they sit unused in the routers. In this article, recently evicted cache blocks are stored in inefficient NoC router buffers and trace buffers. The NoC router may send replies to the data in these delayed blocks. Opportunistic caching of evicted blocks greatly reduces miss cost in NoC routers. According to results from experiments, the suggested designs have the potential to increase system performance by 19% (14%), while simultaneously decreasing miss penalty by 21% (16%). In spite of a small area and leakage power overhead of 2.58 and 3.94 percent, respectively, dynamic power drops by 6.12 percent as a consequence of performance improvements.

A silicon microchip can currently accommodate hundreds of processing components, as stated in [12]. This is all because to very large-scale integration. MPSoCs are the cutting edge of technology now available to the public. Network-on-Chip (NoC) is promising and scalable connecting network that enables MPSoCs to reach their full performance potential (NoC). Routers in NoCs use routing algorithms to

properly direct data packets to their final destinations. There are two qualities that routing algorithms should have. Congestion in a network may be avoided if the mechanism for selecting routes is flexible. Second, it must ensure that it does not broadcast outdated data about network congestion to other routers. A large number of researchers at academic institutions have looked into the problem of network congestion and proposed potential solutions. NoC performance may be enhanced by using strategies to reduce congestion. Hardware for gathering information about network congestion on the client side may be necessary. This article explores output selection approaches for routing algorithms with the goal of directing packets to less crowded networks. Using methods for handling and disseminating congestion data, It can classify them. Recent advances in selection methodology are used and analyzed in this work.

Torus, a Network-on-a-Chip (NoC) Through the use of wraparound channels, the number of hops in the traffic may be reduced [13]. However, cyclic pathways in wraparound channels cause a stalemate in a Torus NoC. The Turn model and the channel dependency graph are two common methods for identifying deadlocks in NoCs (CDG). We suggest an Arc model for avoiding deadlocks in Torus NoC. The Arc model, which was developed in order to overcome stalemate in the Torus model, is an extension of the Turn model. This research also presents a directional dependency graph (DDG) for deadlock identification in Torus NoCs, which makes use of the Turn model and causality diagram (CDG). DDG utilizes the Arc model and Turns to simplify deadlock identification, avoidance, and liberation.

Most chip multiprocessor (CMP) designs nowadays use network-on-chip (NoC) as their fabric architecture [14]. Market-driven CMP applications are fuelling a surge in multicast traffic necessary to improved multithreading, barrier, a cache coherence protocols and synchronization. While multicast packets may be routed through the NoC router using the shortest path, deadlocks caused by branching should be avoided. Network-On-Chip (NoC) studies on free-deadlock minimum routing path in multicast traffic have used several virtual channels or enormous buffers to retain full packets, considerably increasing router area. Present an effective use of the

spatial variety provided by the input buffer in a multicast router that helps avoid deadlocks. MRBS directs data packets via the network with the least number of virtual channels and buffers. Under random multicast traffic, the destination, network, packet, buffer, and injection rates all varied. Simulations demonstrate that over a wide range of network sizes, MRBS outperforms the tree-based router by a factor of 39.3 in terms of the area-delay product.

The modularization and widespread fabrication of many- core system-on-chips by a plethora of manufacturers makes hardware Trojans conceivable (HT). Similarly, transistors with smaller feature sizes may age and fail at a faster rate. Authentication codes, cryptography error correction codes and flow profiles of runtime to identify unusual activity are only some of the security and fault- tolerance strategies discussed in the academic literature. As of yet, there are no universally accepted methods for detecting assaults or blunders in communication (NoC). The cutting-edge presentation detailed how NoC attack defensive tactics increase the NoC's susceptibility to security breaches by adding hardware. In this approach, the detection of attacks and system failures are separated by separate data and control NoCs. Message transmission may be monitored, abnormal behavior can be identified, and the Communication Session Protocol can recover from failure or attack owing to a control NoC. There is a wide variety of application communication techniques, and their overhead on execution time varies from 3.5 percent to 33.3 percent. The protocol mitigates this cost by relaunching the program and modifying the routing between communicating task pairs whenever it detects abnormal communication behavior sets. A comparative survey of these models is discussed in the next section of this text.

PERFORMANCE EVALUATION & COMPARISON

It became clear from the comprehensive examination that the performance of the various NoC Routing models under investigation varies widely. These results were evaluated using the criteria of routing efficiency (ER), latency (D), deployment cost (DC), and scalability (S). Fuzzifying the values of these measures into Low (L =

2), Medium (M = 3), High (H = 4), and Very High (VH = 5) helps compare their performance on a standard scale. Models and their corresponding performance metrics are summarized in table 1 to facilitate this evaluation. Better performing models may be selected for various deployments based on this tabulation.

Table 1. Performance evaluation of different models

Method	ER	D	DC	S
DNN [1]	H	VH	H	H
AACO [2]	VH	M	H	VH
RL FTR [3]	H	H	VH	H
SMART [4]	H	H	H	H
ArS MART [5]	VH	M	H	H
QL [6]	H	H	H	M
HQL [7]	H	M	VH	H
ACDMA [8]	H	H	H	H
DDR [9]	H	H	H	H
WDM [10]	H	H	H	H
OC [11]	M	M	L	H
CC QL [12]	H	H	H	H
CDG [13]	M	H	H	VH
MRBS [14]	H	H	H	H
CSP [15]	H	H	H	H

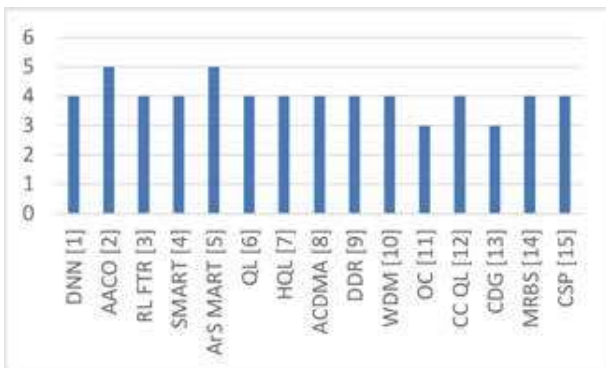


Figure 1. ER for different Models

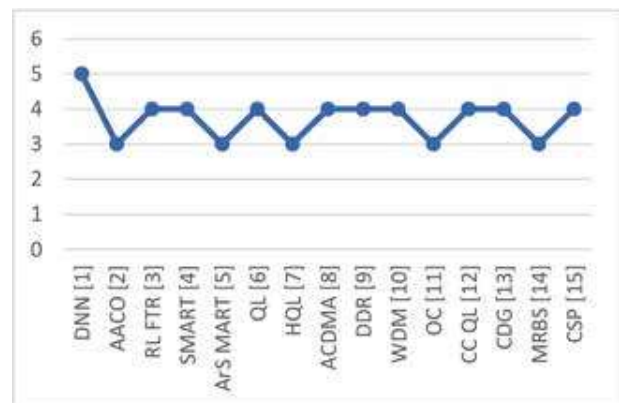


Figure 2. Delay of different models

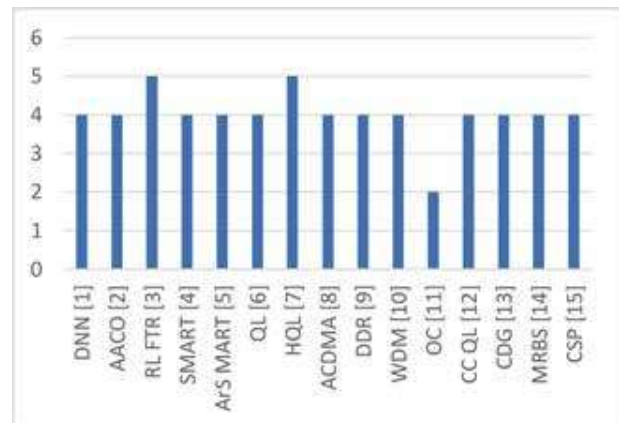


Figure 3. Deployment cost of different models

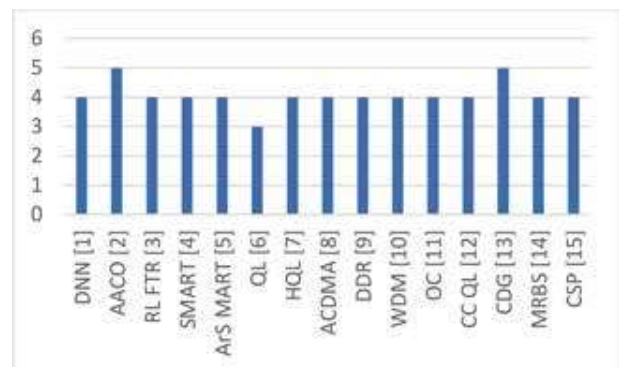


Figure 4. Scalability of different models

As per this evaluation & figures 1, 2, 3 & 4, it can be observed that AACO [2], and ArS MART [5] showcase higher efficiency of routing, while AACO [2], ArS MART [5], HQL [7], OC [11], and MRBS [14] showcase lower delay when compared with other techniques. It was also observed that OC [11] has lower deployment

cost, while AACO [2], and CDG [13] have higher scalability when compared with other models, thus can be used for a wide variety of NoC routing scenarios.

CONCLUSION AND FUTURE WORK

Inadequate throughput performance may occur as a consequence of lost packets, delayed data, reduced energy efficiency, and erroneous routing between on-chip nodes. In order to find a solution to this problem, researchers developed a number of different routing strategies, such as XY Routing and Priority Routing, amongst others. In addition, each of these models contains variants that have been optimized via the application of machine learning, and these variations may be utilized to assist in the creation of low-power, high-throughput communications. When comparing different techniques, some of the performance characteristics that are taken into consideration include throughput, energy consumption, and packet delivery ratio. These are just a few examples (PDR). In addition, there are special subtleties, benefits, and downsides, as well as potential study fields, that are associated with the location. Because there is such a broad variety in performance, it is difficult for researchers to make accurate predictions on which routing models will provide the greatest outcomes for the application-specific installations on which they are currently working. This research provided a comprehensive investigation of the merits, applicability, and scalability performance of these models in order to answer any problems that may have been left unanswered. According to the evaluation in this paper, it can be seen that AACO [2], and ArS MART [5] showcase higher efficiency of routing, while AACO [2], ArS MART [5], HQL [7], OC [11], and MRBS [14] showcase lower delay when compared with other techniques. In addition, AACO [2], and ArS MART [5] showcase higher efficiency of routing when compared with other techniques. When compared with other models, it was found that OC [11] has a lower cost of deployment, while AACO [2] and CDG [13] have superior scalability. As a result, these three models are versatile enough to be employed for a broad range of NoC routing situations. In future, researchers can fuse these models, and use cellular automata techniques to improve performance of these models under real-time use cases.

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Authors: Neha Dorle, Smita Acharya, Shraddha Shirbhate

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Abstract

Polymer-ceramic nanocomposite films using double perovskite ceramic phase offer promising prospects for developing multifunctional flexible films in general and energy storage system in specific. The manganese and iron-based double perovskite is emerging as potential system for various functional applications. In the present attempt, we explore

the application of poly (vinylidene fluoride) (PVDF):Nd₂MnFeO₆ (NMFO) composite films as an energy storage system. The NMFO was synthesized by sol-gel combustion method, and its structure is confirmed by X-ray diffraction (XRD) analysis, which demonstrates the formation of a single-phase monoclinic system with the space group $P_{21/n}$. Detailed structural information is extracted through Rietveld refinement of XRD data using full-prof software. To create flexible nanocomposite films, various volume percentages (10%, 20%, 30%, 40%, and 50%) of NMFO ceramic nanoparticles are incorporated as fillers in the PVDF polymer matrix using the solution casting method. The structural properties of the developed nanocomposite films are investigated using XRD and FTIR studies, while microstructural features are investigated through SEM analysis. Dielectric properties of

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Impact of Foreign Direct Investment (FDI) on Indian Economy

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ABSTRACT

This study examines the effects of foreign direct investment on the Indian economy, recognizing the crucial function of FDI as a major engine of economic growth. In the current global milieu, FDI has emerged as a momentous arena in burgeoning markets. The study primarily concentrates on scrutinizing the patterns of FDI influx into India from 2000-01 to 2019-2020. The main objectives include determining the impact of FDI on the Indian economy, evaluating the approvals of FDI inflows to India by country, and examining FDI inflows across various industries throughout the given timeframe. For this study, secondary information has been culled from a variety of sources, including the Reserve Bank of India Bulletin reports and the yearly reports issued by the Department of Industrial Policy and Promotion (DIPP) of the Government of India. The article concludes by offering suggestions to increase FDI inflows into India.

KEYWORDS: *Foreign direct investment, Sector-specific FDI inflows, FDI inflows by Country, RBI*

INTRODUCTION

The term of foreign direct investment (FDI) means the transfer of money from one country to another country through the purchase of stock in foreign corporations or the investment in real estate. FDI is typically used by businesses to increase their presence on foreign markets. Developing countries, in particular, actively seek FDI to spur economic growth and increase national income or GDP. FDI entails investing in domestic companies, organizations, and equipment, rather than participating in the stock market. It offers various advantages, including enhanced supply chain management (SCM), job creation, improved logistics and infrastructure, among others.

As a source of non-debt capital for India's economic growth, FDI has been crucial. India has had notable FDI development despite the COVID-19 pandemic, the global economic slump, and other obstacles. In order

to encourage FDI, the Indian government has taken a number of actions, including easing FDI restrictions in industries like oil refineries, telecommunications, power exchanges, stock exchanges, and defence.

Millions of people in India have been pulled out of poverty as a result of the country's exceptional GDP development over the previous two decades, making it a desirable destination for FDI. Significant FDI inflows have been observed in important industries like manufacturing, services, telecommunications, construction, computer software and hardware, and autos. India has received major FDI from countries like Mauritius, Singapore, the Netherlands, Japan, the United States, and the United Kingdom.

REVIEW OF LITERATURE

Bhattacharyya Jita and Bhattacharyya Mousumi (2012), in their empirical study titled "The Influence of Overseas

Direct Investment and Trade in Goods and Services on Economic Advancement in India,” examined the complex relationships between FDI, goods trade, service trade, and economic growth in the Indian setting. Their research aimed to identify the long-term relationships between these variables. The findings showed a one-way link in which FDI positively impacted economic growth and favorably impacted merchandise trade. The study also found that there were two-way relationships, demonstrating the interdependence between service trade and economic growth in India as well as trade in goods.

Shalini Singh and Manish Singh (2011) In “Exploring the Path of Overseas Capital in India,” a thorough investigation was made to delve into the dynamic world of foreign direct investment (FDI) in the Indian context. This study carefully examined the inflow of FDI into India, spanning a remarkable period from 1970 to 2007, by harnessing the power of secondary sources and using painstaking time series analysis. Primarily driven by the pursuit of unravelling the intricate relationship between FDI inflows and India’s economic growth, the overarching objective was to unravel the nuanced patterns of fluctuation in FDI inflows while unravelling their profound impacts. Employing a discerning lens, this research sought to unveil the underlying factors behind these ebbs and flows, ultimately painting a comprehensive portrait of the prevailing trends within the realm of FDI.

Gaurav Agarwal and Mohd. Amir Khan (2011) in a comparative study titled “Impact of FDI on GDP: China vs. India,” the researchers analyzed FDI’s influence on the Gross Domestic Product (GDP) of both countries from 1993 to 2009. They made use of a growth model that included factors like GDP, human capital, labor force, FDI, and gross capital formation into account. According to the results, a 1% increase in FDI led to a 0.07 percent boost in China’s GDP and a 0.02 percent increase in India’s GDP. Notably, China showed a greater link between FDI and economic development than India, indicating more effective FDI utilization.

Jatinder Singh (2010) in the study titled “Economic Reforms and FDI in India: Policy, Trends, and Patterns,” researchers analyzed the FDI inflows into India considering government policies since 1980. The analysis revealed a rising trend in post-reform FDI inflows. A comparison with other developing economies showcased significant growth in FDI inflows to India,

indicating a positive response to liberalization measures introduced in the early 1990s.

Gajendran Lenin Kumar and S. Karthika (2010) the “Sectoral Performance through Inflows of Foreign Direct Investment (FDI)” study investigated the impact of FDI on various Indian industries and the country’s economic growth. It highlighted FDI’s facilitation of technology transfer, increased domestic capital, raised production levels, and created employment opportunities. The study analyzed FDI inflows into India and the economic growth driven by the top 10 investing countries.

Joyshri Acharyya (2009) carried out a study titled “FDI, Growth, and the Environment: Evidence from India on CO2 Emission during the Last Two Decades.” This study looked at how FDI inflows affected environmental deterioration and India’s GDP development. The study analyzed the FDI inflows and their effects on India’s GDP growth over a two-decade period from 1980 to 2003. The study also highlighted the significant long-term economic impact of FDI inflows on carbon dioxide (CO2) emissions, emphasizing the environmental consequences resulting from economic activities. Keshava, Dr. S.R. Rathnamma (2008) conducted a comparative analysis titled “The Effect of FDI on the Indian and Chinese Economies.” This study analyzed the economies of India and China using comparative analysis. It highlighted that these two countries, with a combined population of 37% of the world, experienced significant GDP growth rates exceeding 9% (according to the Asian Development Outlook 2005 and World Development Report 2006). The study also provided statistics on FDI flows and stocks in India and China, indicating their respective contributions to the economies.

R. Banga (2006) in a thorough study titled “Unleashing Export Diversity: Assessing the Influence of Japanese and US Foreign Direct Investment on the Indian Manufacturing Sector,” the effect of FDI on export diversification in a developing country was carefully examined, with special attention paid to India. Intriguing revelations emerged from the investigation, emphasizing the distinctive impacts of FDI inflows from the US and Japan. Notably, the findings showcased that FDI from the US had a favorable and positive influence on India’s export intensity during the post-liberalization era. However, in contrast, Japanese FDI did not yield a significant impact on India’s overall exports. These

observations shed light on the nuanced role played by different countries' FDI in shaping export diversity within the Indian manufacturing sector.

Pradhan, Prakash J., Abraham, Vinoj, and Sahoo, Kumar M. (2004) in the paper "Foreign Direct Investment and Labor Dynamics: Unveiling the Indian Manufacturing Scenario," researchers looked at the effects of FDI on employment and wages in the Indian manufacturing sector. Comparing international companies to their domestic equivalents, the data showed that neither had a significant impact on manufacturing employment. However, an interesting pattern emerged as foreign firms demonstrated a tendency to offer comparatively higher wages to their workforce. This suggests that labor also reaped benefits from foreign investment in India.

OBJECTIVES OF THE STUDY

- 1) To examine the FDI trends in India during last two decades.
- 2) To assess the inflow of FDI in India from different countries.
- 3) To evaluate the distribution of FDI inflows across various sectors in India.

RESEARCH METHODOLOGY

Data Collection

This study only uses secondary data sources. The information was acquired from a number of trustworthy sources, including RBI Bulletin Reports and Annual Reports issued by the Department of Industrial Policy and Promotion (DIPP) of the Government of India, articles from newspapers and journals, textbooks, reliable internet sources, websites, and UNCTAD. The data collected covers a time span of twenty years, from 2000 to 2020, and is analyzed using graphs and tables.

Statistical Tools

For this research paper, the following statistical tools and methods have been employed; the percentage method and graph analysis conducted using Microsoft Excel software.

LIMITATIONS OF STUDY

- This study is solely concerned with how FDI affects the Indian economy.

- Only the chosen time period is considered in the analysis of FDI Inflows on the Indian Economy.
- Only information from 2000 to 2020 was collected.
- Only secondary data were used to examine how FDI affected the Indian economy.
- There were no continuous-time series data in the RBI Bulletin reports.
- Inadequate time was allotted for data collecting.

DATA ANALYSIS & INTERPRETATION:

Table 1. FDI Inflows by Financial Year from 2000 to 2020:
(Amount USD Million)

YEAR	FDI INFLOWS	FDI GROWTH RATE (In %)
2000-2001	4029	-
2001-2002	6130	(+) 52%
2002-2003	5035	(-) 18%
2003-2004	4322	(-) 14%
2004-2005	6051	(+) 40%
2005-2006	8961	(+) 48%
2006-2007	22826	(+) 155%
2007-2008	34843	(+) 53%
2008-2009	41873	(+) 20%
2009-2010	37745	(-) 10%
2010-2011	34847	(-) 08%
2011-2012	46556	(+) 34%
2012-2013	34298	(-) 26%
2013-2014	36046	(+) 05%
2014-2015	45148	(+) 25%
2015-2016	55559	(+) 23%
2016-2017	60220	(+) 08%
2017-2018	60974	(+) 01%
2018-2019	62001	(+) 02%
2019-2020	74390	(+) 20%
Grand Total	681854	

Source : Department of Industrial Policy and Promotion.

The table presented above illustrates the Foreign Direct Investment (FDI) inflows into the country in absolute terms, showcasing a significant growth from USD 4,029 million in the year 2000-2001 to USD 74,390 million in the year 2019-2020, reflecting a remarkable

increase of 19 times. This data highlights the FDI trends over the past two decades in India. Notably, there was a substantial increase of 52% in FDI inflows during the financial year 2001-2002, reaching USD 6,130 million compared to the preceding year. Despite minor fluctuations in the subsequent years from 2002- 2003 to 2005-2006, there was a substantial surge in FDI inflows during the financial year 2006- 2007, amounting to USD 22,826 million, representing a growth rate of 155% compared to the previous decade. Another significant increase occurred in the financial year 2007-2008, with FDI inflows amounting to USD 34,843 million, showing a growth rate of 53% compared to the previous year. In the year 2008-2009, there was considerable investment of USD 41,873 million in Foreign Direct Investment (FDI) and so forth. Following this, there were some fluctuations in FDI inflows between 2009 and 2014, with a subsequent increase in the financial year 2015-2016, where FDI inflows reached USD 55,559 million. Subsequently, FDI inflows continued to rise in the financial years between 2016 and 2019. Consequently, the year 2019-2020 recorded the highest FDI inflow figure of USD 74,390 million over the past 20 years.

2003-04	10,064	2,188	(-) 19 %
2004-05	14,653	3,219	(+) 47 %
2005-06	24,584	5,540	(+) 72 %
2006-07	56,390	12,492	(+) 125 %
2007-08	98,642	24,575	(+) 97 %
2008-09	142,829	31,396	(+) 28 %
2009-10	123,120	25,834	(-) 18 %
2010-11	97,320	21,383	(-) 17 %
2011-12	165,146	35,121	(+) 64 %
2012-13	121,907	22,423	(-) 36 %
2013-14	147,518	24,299	(+) 8%
2014-15	181,682	29,737	(+) 22%
2015-16	262,322	40,001	(+) 35%
2016-17	291,696	43,478	(+) 9%
2017-18	288,889	44,857	(+) 3%
2018-19	309,867	44,366	(-) 1%
2019-20	353,558	49,977	(+) 13%
Grand Total	2,732,444	470,119	

Source: Department of Industrial Policy and Promotion (As per DPIIT's FDI database)

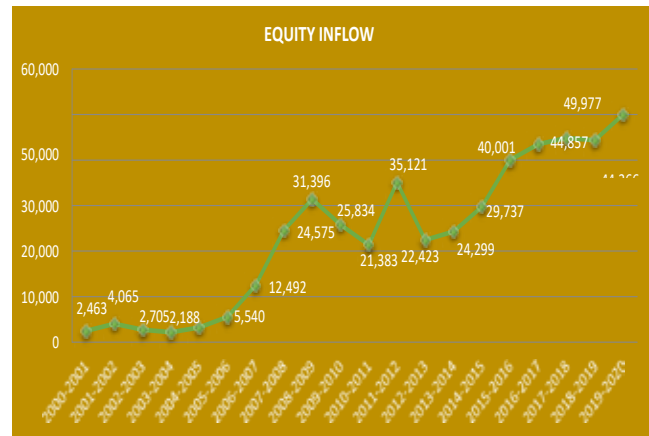
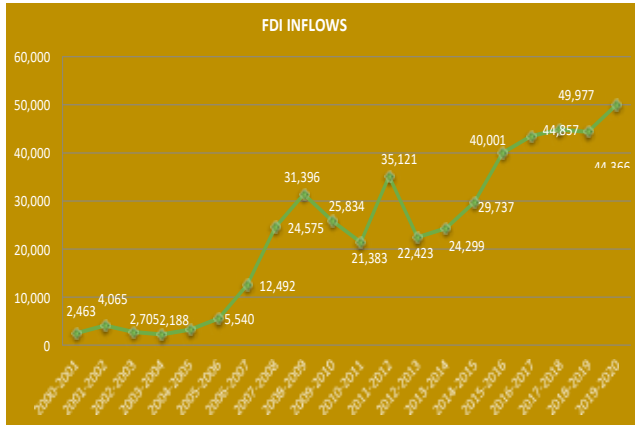


Table No. 2: FDI Equity Inflows by Financial Year (Amount USD Million)

Financial Year	Amt. of FDI Inflows		Percentage Growth over previous year
	In Rs Crores	In USD Million	
2000-01	10,733	2,463	-
2001-02	18,654	4,065	(+) 65 %
2002-03	12,871	2,705	(-) 33 %

The Foreign Direct Investment (FDI) Equity inflow into India has witnessed a substantial increase from Rs. 10,733 crores in the financial year 2000-2001 to Rs. 3,53,558 crores in the financial year 2019-2020, marking an impressive growth of 33 times. This information, as shown in the table and graph, gives a thorough picture of all FDI equity inflows into India from 2000 to 2020, a period of 20 years. Notably, FDI Equity Inflows in India saw a positive effect with a considerable

growth to Rs. 18,654 crores in the fiscal year 2001-2002. Furthermore, in the year 2008-2009, there was a significant investment of Rs. 1,42,829 crores in FDI Equity Inflows, highlighting a substantial growth in foreign investments. However, there were fluctuations in the inflow of FDI Equity Inflows between 2010 and 2014. Nonetheless, there was a considerable surge in FDI Equity Inflows in the financial year 2015-2016, reaching Rs. 2,62,322 crores. Subsequently, FDI Equity Inflows continued to rise in the financial years between 2016 and 2019, culminating in the highest figure of Rs. 3,53,558 crores in the year 2019-2020.

Table no. 3: Top Twenty Country-Wise FDI Inflow
(Amount USD Million)

Sr. No.	Country	Amt. of FDI Inflows		Percentage with Inflows
		(In Rs. crores)	(In USD Million)	
1	Mauritius	795,941.1	142,710.4	30.36
2	Singapore	609,561.5	97,669.6	20.78
3	Netherland	208,321.9	33,852.0	7.2
4	Japan	196,105.1	33,499.2	7.13
5	U.S.A	176,222.2	29,779.4	6.34
6	United Kingdom	150,411.1	28,210.9	6
7	Germany	68,944.3	12,196.0	2.59
8	Cyprus	57,993.5	10,748.4	2.29
9	France	50,511.0	8,539.3	1.82
10	Cayman Islands	49,847.8	7,535.9	1.6
11	UAE	41,702.7	6,990.6	1.49
12	Switzerland	27,240.9	4,842.4	1.03
13	South Korea	27,824.1	4,478.1	0.95
14	Hong Kong	27,220.7	4,408.0	0.94
15	Luxembourg	19,256.7	3,082.7	0.66
16	Spain	16,822.6	2,991.2	0.64
17	Italy	16,781.0	2,927.8	0.62
18	China	15,112.1	2,378.7	0.51
19	Belgium	12,153.2	1,977.6	0.42
20	Canada	11,971.9	1,937.1	0.41

Sources: Department of Industrial Policy and Promotion (As per DPIIT’s FDI database)

Upon analyzing the table, it becomes evident that Mauritius has emerged as the leading investor in Foreign Direct Investment (FDI) Equity Inflows in India, contributing a substantial amount of 142,710.44 million USD. This investment from Mauritius constitutes 30.36 percent of the total equity investments made by the top 20 investing countries in India from the years 2000-2001 to 2019-2020. Singapore holds the second position, with an equity inflow of 97,669.64 million USD, accounting for 20.78 percent of the total equity investments made by the top 20 countries. Notably, Singapore’s investment in India has positioned it as a significant contributor to the equity capital inflow. The Netherlands and Japan have also made notable equity capital investments, amounting to 33,852.04 million USD and 33,499.21 million USD, respectively. These investments represent

7.20 percent and 7.13 percent of the total equity investments made by the top 20 countries. Moreover, considerable the United States of America and the United Kingdom, respectively, have made equity capital investments of 29,779.40 million USD and 28,210.85 million USD. An intriguing aspect is that the combined equity investment inflows from Mauritius and Singapore, totalling 240,380.08 million USD, are nearly equivalent to the investments made by the remaining 18 top-level equity investing countries in India, which amount to 200,375.27 million USD. The difference between the investments from Mauritius, Singapore, and the other 18 countries is merely 40,004.81 million USD. Therefore, it is clear that Singapore and Mauritius are important players in the FDI equity landscape of India.

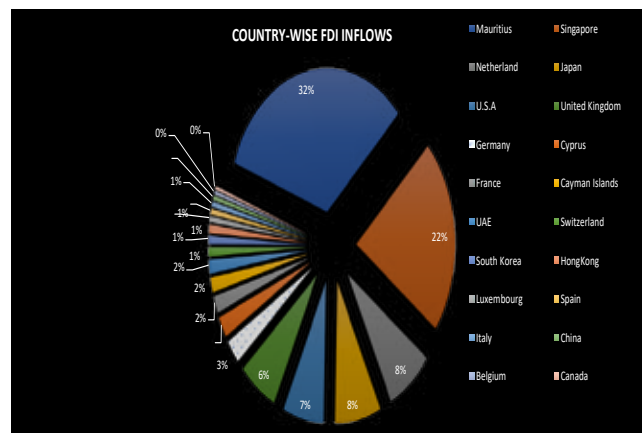
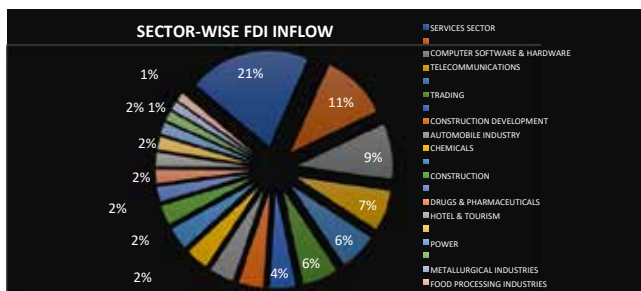


Table No. 4: Top 20 FDI Equity Inflows by Sector from 2000–2001 to 2019–2020

(Amount USD Million)

Sr. No.	Sectors	Amt. of FDI Inflows		% of Total Inflows
		(In crores)	(In USD Million)	
1	Finance, banking, insurance, non-financial business, outsourcing, research and development, courier, and technical testing and analysis.	471,730.1	82,003.0	17.45
2	Computer Software & Hardware	276,006.4	44,911.2	9.56
3	Telecommunications	219,188.6	37,271.0	7.93
4	Trading	176,004.7	27,595.0	5.87
5	Townships, Housing, Built-Up Infrastructure	123,964.0	25,662.3	5.46
6	Automobile Industry	143,741.7	24,210.7	5.15
7	Chemicals (Other Than Fertilizers)	98,554.4	17,639.5	3.75
8	Construction (Infrastructure) Activities	108,382.5	16,846.9	3.58
9	Drugs & Pharmaceuticals	87,814.3	16,500.6	3.51
10	Hotel & Tourism	91,778.5	15,289.0	3.25
11	Power	82,650.6	14,987.9	3.19
12	Metallurgical Industries	74,595.4	13,401.8	2.85
13	Food Processing Industries	61,811.5	9,980.8	2.12
14	Non-Conventional Energy	57,144.3	9,225.5	1.96
15	Information & Broadcasting	55,361.3	9,208.1	1.96
16	Electrical Equipments	50,720.0	8,604.0	1.83
17	Petroleum & Natural Gas	40,915.5	7,824.2	1.66
18	Hospital & Diagnostic Centers	41,154.7	6,726.9	1.43
19	Consultancy Services	34,701.9	5,834.8	1.24
20	Industrial Machinery	32,588.6	5,619.5	1.2

Source: Department of Industrial Policy and Promotion (As per DPIIT’s FDI database)



The table highlights that the services sector, including finance and banking, received the highest equity investment of USD 82,002.96 million, representing 17.45 percent of the top twenty sectors attracting FDI

equity inflow into India from 2000-2001 to 2019-2020. Conversely, the industrial machinery sector witnessed the lowest equity investment of USD 5,619.50 million, accounting for

1.20 percent of the top twenty sectors attracting FDI equity investment. A noteworthy investment was made in the computer software and hardware sector, totalling USD 44,911.95 million, or 9.56 percent of the top twenty industries. Similarly, the telecommunications services sector attracted equity investment of USD 37,270.95 million, covering 7.93 percent of the top twenty sectors. The trading sector received an investment of USD 27,594.95 million, constituting 5.87 percent of the top

twenty sectors' FDI equity investment. Investments in other sectors include USD 25,662.33 million in construction development, USD 24,210.68 million in the automobile industry, USD 17,639.48 million in the chemicals sector (excluding fertilizers), USD 16,846.88 million in construction infrastructure activities, USD 16,500.62 million in the drugs and pharmaceuticals sector, and USD 15,288.97 million in the hotel and tourism sector. Additionally, USD 14,987.93 million was invested in the power sector, USD 13,401.78 million in metallurgical industries, and USD 9,980.75 million in food processing industries.

FINDINGS OF THE STUDY

- The FDI inflows into the Indian economy showed a constant rising trend from 2000–2001 to 2019–2020, showing significant expansion.
- In 2019-2020 alone, India received FDI inflows amounting to USD 74,390 Million. The cumulative FDI inflow for the period between 2000-2001 and 2019-2020 reached USD 681,954 Million.
- The data reveals that in the last financial year (2019-2020), FDI equity inflows into India amounted to USD 49,977 Million. The cumulative FDI equity flow from 2000-2001 to 2019- 2020 totalled USD 470,119 Million.
- Analyzing the data, it becomes apparent that Mauritius and Singapore accounted for the highest FDI equity inflows, investing USD 142,710.44 Million and USD 97,669.64 Million, respectively, from 2000-2001 to 2019-2020. Mauritius and Singapore collectively contributed to 51% of the total FDI equity inflows, while other countries accounted for the remaining 49% during the same period.
- From 2000 to 2020, the services sector saw the biggest FDI equity inflows, totaling USD 82,002.96 million and accounting for 18% of all sectors. Notably, the computer software & hardware sector (10%), telecommunications sector (08%), trading sector (6%), and construction development sector (6%) were among the sectors that received significant FDI equity inflows.

CONCLUSION

The enormous contribution made by foreign direct investment (FDI) to India's economic growth is reiterated by this study. FDI is not only crucial for achieving sustainable economic development but also demonstrates a positive and accelerating trend within the country. The findings clearly indicate that India presents a highly promising investment destination for both developed and developing nations. To leverage this opportunity, it is essential to liberalize the rules and regulations surrounding FDI in India.

It is advised that the Department of Industrial Policy & Promotion take action to create new and update existing FDI policies with an emphasis on promoting, approving, and facilitating investments in light of the study completed. Additionally, efforts should be made to enhance ease of doing business indicators in various sectors, including streamlining processes related to starting a business, obtaining construction permits, accessing electricity, and labor market regulations. Such measures will create favourable conditions for foreign investors to explore opportunities in India.

In conclusion, Foreign Direct Investment not only contributes to employment generation in India but also provides support to medium and small-scale industries, such as MSMEs. Additionally, FDI is crucial to the nation's posture on the world stage as a result of the liberalization and globalization processes.

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Enrollment Excellence: Leveraging Hybrid Marketing Approaches to Achieve Full Admissions in Indian Graduation Colleges

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ABSTRACT

The competition among Indian graduation colleges for attracting and enrolling students has intensified in recent years. To achieve full admissions, colleges need to adopt effective marketing strategies that leverage both traditional and digital channels. This research article explores the concept of hybrid marketing approaches and their application in the context of Indian graduation colleges. By examining various strategies, including online platforms, social media, search engine optimization (SEO), content marketing, and offline promotional activities, this study aims to provide insights into how colleges can optimize their marketing efforts to achieve maximum enrollment. The findings highlight the significance of integrating traditional and digital marketing methods to effectively reach and engage prospective students.

INTRODUCTION

Competition among Indian graduation colleges to attract students is fierce, necessitating effective marketing strategies for full admissions. Hybrid marketing, combining traditional and digital approaches, offers potential solutions. This research explores hybrid marketing in Indian graduation colleges, analyzing online platforms, social media, SEO, content marketing, and offline promotions. The study aims to provide insights on optimizing marketing efforts for maximum enrollment.

Background

Indian graduation colleges face challenges differentiating themselves in a crowded market. Traditional marketing approaches have been relied upon, but digital advancements require hybrid marketing adoption.

Problem Statement

Indian graduation colleges lack comprehensive and effective marketing strategies for full admissions. Overemphasis on traditional channels limits reach,

engagement, and conversion rates, hindering enrollment targets and competitiveness.

Objectives:

1. Explore hybrid marketing in Indian graduation colleges.
2. Examine digital marketing strategies for enhanced enrollment.
3. Investigate benefits and challenges of hybrid marketing.
4. Provide recommendations and best practices for optimal marketing and full admissions.

Significance of the Study

The study is vital for Indian graduation colleges, offering insights on utilizing hybrid marketing for full admissions. Integration of traditional and digital strategies can expand reach, enhance brand visibility, engage prospective students, and increase conversion rates. The findings contribute to higher education marketing knowledge, specifically in the Indian context, and provide practical guidance.

Scope and Limitations

The research focuses on marketing practices of Indian graduation colleges, exploring hybrid marketing for full admissions. It investigates traditional and digital strategies, considering factors like target audience, location, and budget constraints. Generalizability may be limited to Indian graduation colleges' specific context. Nonetheless, the study provides valuable insights and adaptable recommendations for colleges to suit their circumstances and goals.

LITERATURE REVIEW

Marketing Strategies in Higher Education: Effective marketing strategies are crucial for achieving full admissions in higher education. The shift from traditional to digital approaches has been driven by technology and changing student behavior.

Traditional Marketing Approaches: Graduation colleges have traditionally used print media, direct mail, education fairs, billboards, radio, and TV ads. However, their impact has diminished as prospective students turn to digital platforms.

Digital Marketing Approaches: Digital marketing enables targeted messaging, personalized experiences, and campaign tracking. Strategies include website optimization, SEO, social media, email and content marketing, and online advertising.

Hybrid Marketing Approaches: Hybrid marketing combines traditional and digital strategies for cohesive campaigns. It maximizes reach and engagement by utilizing both online and offline channels.

Theoretical Framework: The Diffusion of Innovation theory explains the adoption of digital marketing in higher education. The Integrated Marketing Communication model ensures consistency across channels. Customer Journey Mapping optimizes enrollment by identifying touch points for hybrid marketing.

METHODOLOGY

Research Design: To achieve the objectives of this study and gain insights into the utilization of hybrid marketing approaches for achieving full admissions in Indian graduation colleges, a qualitative research design will be employed. This design allows for the

collection and analysis of qualitative data, providing in-depth understanding of the topic.

The research design will consist of qualitative data collection through interviews and focus groups with key stakeholders, such as college administrators, marketing professionals, and prospective students. These qualitative methods will help capture in-depth perspectives, experiences, and insights related to the implementation of hybrid marketing approaches in the context of Indian graduation colleges.

Data Collection: For the qualitative phase, semi-structured interviews and focus groups will be conducted. Key stakeholders from a diverse range of Indian graduation colleges will be selected using purposive sampling to ensure representation from different regions, sizes of institutions, and program offerings. The interviews and focus groups will be audio-recorded and transcribed for analysis. The data collected will focus on understanding the current marketing strategies employed, the integration of traditional and digital approaches, the challenges faced, the perceived benefits of hybrid marketing, and any best practices or success stories.

Data Analysis: The qualitative data collected from interviews and focus groups will be analyzed using thematic analysis. The transcripts will be coded, and emerging themes and patterns will be identified. The analysis will involve categorizing and grouping the data to identify common trends, challenges, and success factors related to the implementation of hybrid marketing approaches. The qualitative findings will provide rich insights and real-life examples to support the recommendations and best practices.

RESULTS AND DISCUSSION

Overview of Indian Graduation Colleges: Indian graduation colleges encompass a variety of institutions offering undergraduate programs across disciplines. Understanding their characteristics and dynamics sets the stage for exploring marketing strategies employed to achieve full admissions.

Traditional Marketing Strategies

Print Media Advertising: Indian graduation colleges use print media advertising, such as newspapers

and magazines, to target specific geographic areas. However, its effectiveness has declined with the rise of digital platforms.

Direct Mail Campaigns: Direct mail campaigns involve sending promotional materials to prospective students. While they create a tangible connection, their response rate has decreased with the prevalence of digital communication channels.

Education Fairs and Events: Education fairs and events provide opportunities for colleges to showcase programs and engage with prospective students. Their effectiveness may vary based on location, timing, and competition.

DIGITAL MARKETING STRATEGIES

Website Development and Optimization: Well-designed and user-friendly websites are crucial for Indian graduation colleges. Optimizing websites for search engines and mobile responsiveness enhances visibility and accessibility.

Search Engine Optimization (SEO): SEO techniques help colleges improve online visibility and search engine rankings. Optimizing website content, keywords, and meta tags increases the chances of being discovered by prospective students.

Social Media Marketing: Indian graduation colleges leverage social media platforms to engage with prospective students and share valuable content. Platforms like Facebook, Instagram, LinkedIn, and YouTube facilitate targeted advertising and interactive communication.

Content Marketing: Colleges utilize content marketing to provide informative blog articles, videos, webinars, and podcasts. By establishing themselves as authoritative sources, colleges build trust and credibility among prospective students.

Hybrid Marketing Approaches

Integrated Marketing Campaigns: Integrated campaigns combine traditional and digital channels to create a cohesive brand message. Aligning print media advertisements, direct mail campaigns, and digital marketing efforts ensures consistency and enhances effectiveness.

Personalized Communication: Personalized communication, through email marketing and CRM systems, helps colleges establish deeper connections with students and address their individual needs and concerns.

Data Analytics and Targeting: Leveraging data analytics tools, colleges track and analyze marketing campaigns, website traffic, social media engagement, and conversion rates. This data-driven approach informs decision-making and enhances targeting efforts.

Challenges and Opportunities: Challenges in implementing hybrid marketing approaches include budget constraints, limited expertise, resistance to change, and measuring impact. However, opportunities arise in reaching wider audiences, real-time engagement, performance tracking, and cost-effective marketing.

Best Practices and Case Studies: Successful implementation of hybrid marketing approaches involves developing comprehensive strategies, utilizing targeted social media advertising, creating informative website content, nurturing leads through personalized communication, and monitoring performance. Case studies highlight successful examples that inspire other colleges seeking enrollment excellence.

RECOMMENDATIONS

Integrated Marketing Strategy Framework: Indian graduation colleges should develop an integrated marketing strategy framework that integrates traditional and digital marketing channels. This framework should include a comprehensive plan, target audience identification, key objectives, effective resource allocation, and performance indicators.

Key Considerations for Hybrid Marketing

When implementing hybrid marketing approaches, colleges should consider understanding the target audience, customizing communication, ensuring a seamless user experience, maintaining consistent branding, and making data-driven decisions.

Developing a Digital Marketing Team

Building a dedicated digital marketing team or partnering with experienced agencies can enhance the effectiveness of hybrid marketing approaches. The team

should consist of professionals with expertise in various digital marketing channels.

Continuous Monitoring and Evaluation

Regular monitoring and evaluation of key performance indicators are crucial for optimizing hybrid marketing strategies. Colleges should establish a system for ongoing evaluation of enrollment outcomes, website analytics, social media engagement, lead generation, and conversion rates.

CONCLUSION

Summary of Findings: This study examined the utilization of hybrid marketing approaches in Indian graduation colleges. Traditional marketing strategies have been effective but face limitations in the digital age. Digital marketing strategies offer new avenues for engagement. Hybrid marketing approaches, integrating traditional and digital channels, enable colleges to reach a wider audience, personalize communication, track performance, and make data-driven decisions.

Implications for Practice: Colleges should adopt an integrated marketing strategy framework, prioritize personalized communication, invest in digital marketing expertise, and continuously monitor and evaluate campaigns. Collaboration among colleges can drive enrollment excellence.

Future Research: Further research can explore the long-term impact of hybrid marketing approaches, compare effectiveness across different college types and regions, investigate emerging digital marketing trends, and consider cultural and regional factors for localized strategies.

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AN EMPIRICAL STUDY ON CONSIDERATION OF TECHNICAL AND FUNDAMENTAL ANALYSIS BY RETAIL INVESTORS

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ABSTRACT

Money is the one thing that people take more seriously than their health. Retail investors' decisions on how to invest/trade their money are influenced by their behaviour and emotions. The goal of this research is to learn more about the factors that impact retail investors' decision to invest in capital markets. Researchers can eventually give personalized and normative recommendations to investors as well as the financial planning sector in successfully and efficiently dealing with clients by better understanding what leads retail investors to adopt a specific investing style.

Keywords: Capital Market, Investors, Retailers, Technical analysis & Fundamental analysis, Risk and Return.

INTRODUCTION

Every investor should be fully aware of how the stock market operates before making any investment selections. Most capital theorists put about as much trust in charts as astronomers do in astrology due to the amount of doubt that empirical research has placed in chart readers set out to find the appropriate degrees of diversity for investors that build portfolios based on advice from brokerage houses, research services, and other sources of financial information (Gordon et al., 2000); Geetha & Ramesh (2012) start out by demonstrating how expenditures and arbitrage may result in a tenable discount of roughly 13% in the UK. The first investigation of the interacting connections between the elements using the methodology of the Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process is provided by (Lee et al., 201; Abuhamad et al., 2013) provide an event-driven business intelligence method to generate trading signals based on several assessments in order to react instantly to any change in the market state investigate the interactions between investors and locals in western Ethiopia when it comes to commercial land sales Rodríguez et al. (2012); Singh et al. (2021). Survey information from the low-lying Benishangul-Gumuz area of Ethiopia is used in the empirical study Singh & Kediya (2020). The purpose of is to investigate entrepreneurial leadership and identify the entrepreneurial leadership competencies necessary for success in a context of a growing economy. The purpose of is to provide investors and potential investors a summary and

something to think about before choosing to purchase CTRA shares. Extended Summary analyses the effectiveness of buy and sell recommendations given on the Indian stock market by technical and fundamental specialists. A customer behaviour research is used to evaluate department stores' competitiveness to that of other retail company categories. Consumers perceptions of department shops and the criteria shoppers use to assess this category are revealed through an online poll Lin (2018); Marasović et al. (2018); Marshall & Cahan (2005); Marshall et al. (2008).

The foundation of technical analysis (TA) is the notion that trends in the past prices of instruments traded on asset markets may be used to predict future values. By understanding how price indicators for the portfolio's assets interact over time, it is hoped to increase return on an investment portfolio. TA is a technique for identifying asset price trends that is predicated on the idea that price series changes in line with investor expectations (Stankovic et al. 2015).

The economic as well as financial characteristics of stocks and markets are the subject of fundamental analysis (FA). To rationalize previous movements and forecast variations, FA looks to the microeconomic elements of enterprises as well as the macroeconomic fundamentals of sectors and nations known as market fundamentals (Lui & Mole 1998, Allen & Taylor 1990).

LITERATURE OF REVIEW

In a study, explored the association amid stock returns and fundamental factors. The market value of equity shows a negative association with stock return, although the book-to-market, sales price, and debt-to-equity ratio all have a significant positive relationship. Their research indicates that, out of all the variables included, the book to market ratio is the best stock predictor also examined the relationship between profit forecasts and fundamental analysis for 33 countries between 1990 and 2000. In addition to demonstrating that macroeconomic factors, business news, industry, and nation context have a significant influence on stock return prediction, fundamental analysis has also been demonstrated to estimate stock returns differently in the short and long term came to the conclusion that using fundamental analysis to predict future stock returns and comprehend the momentum phenomenon in stock prices is helpful examined how both technical and fundamental analysis affected the market-adjusted returns of European government bonds. Liquidity, international risk, and the state of the economy right now are examples of basic factors, showing how combining fundamental and technical study might result in significant future returns on European Government bonds Branch (1976).

An investor should do both a fundamental and a technical examination of the market before making any stock investments. The effectiveness of investors' investment choices is influenced by the rate of return that is produced when fundamental research is used, which is higher than the average market return (Abarbanell & Bushee, 1998); Bask & Fidrmuc (2009); Bülow (2017).

The effectiveness of investment decisions for investors is influenced by the usage of technical analysis since the use of buy and sells signals that come through the moving average as one of the technical analysis tools results in a higher rate of return than the market average (Vasiliou et al., 2006).

Significance of the Study

Investors, the public, traders, brokers, and others must be benefited from this research by making smarter investments and more correct estimates of forthcoming returns Harrison et al. (2018). It will likewise allow for a better understanding of financial measures' predictive capacity

and their function in projecting stock returns for theoretical reasons. Fundamental scrutiny at the corporate level will give a thorough grasp of the company's financial characteristics, as well as a forecast of future profitability. Investment decisions made without considering the fundamental as well as technical research are more likely to be mistaken and perilous, as well as encouraging further notional activity in the market, creating a insistent obstruction to its growth Teklemariam et al. (2017). The key relevance of this study is to undertake detailed analysis for a safe investment through a favourable predicted return Chatterjee et al. (2020). The relevance of the article is to enable investors to undertake exhaustive analysis to secure investment with a good expected return.

The goal of our research is to investigate use of Technical analysis & Fundamental Analysis by retail investors to avoid risk in investment return.

RESEARCH METHODOLOGY

The sample size finalized for the study is 400 and the respondents are from central India. Hence the universe for the study is central India. (Singh, D., & Kediya, S. 2020) and Kediya, S. O., Singh, D. K., Shukla, J., & Nagdive, A. S. (2021, November). The sampling technique used is Purposive sampling. Statistical tools used are Descriptive analysis -Mean and standard deviation. T test and regression has also been used for testing of hypothesis.(Singh, D. K., Kediya, S., Mahajan, R., & Asthana, P. K. 2021, November) and Dhale, S., & Singh, D. K. (2022)

H01: Technical analysis & Fundamental Analysis are two major factors that are being considered by retail investors to avoid risk in investment return.

H02. The efficacy of traders' investment decisions is not significantly impacted by the usage of fundamental analysis and technical analysis tools.

Conceptual model

Due to the distinctive nature of capital market instruments, fundamental considerations have a significant influence on investing decisions. In the real world, investors rely on fundamental research, broker advice, newspaper articles, or business channels to make investment and trading decisions, as well as sound technical analysis with an emphasis on trade management. It reduces risk and aids in its management. Fundamental analysis is focused on evaluating the issuer's revenue, market position, volume of sales, asset structure, and liability obligations. The demand and supply of securities, as well as the dynamics of rates and volumes of activities connected to their purchase and sale, are the primary focus of technical analysis. It entails keeping track of and evaluating the history of changes in price and volume indicators that describe market processes. Before executing a security transaction, the investor must assess the security's trustworthiness and prospective profitability, which are based on the market and true price of the security, among other factors. By using basic analysis, it is feasible to assess the true price of securities.

Extended Elucidation

As with ordinary investors, every stock market investment seeks to maximise profit while limiting associated risk. Fundamental analysis has been more popular recently among

professionals in the stock markets. It uses political and economic data, as well as recent and historical financial records, to determine a company's intrinsic worth and help spot mispriced assets.

In order to assess the market's present worth and their feelings on anticipated changes in market prices, investors find technical analysis to be more alluring when making short-term investment decisions (Allen and Taylor 1990; Lui and Mole 1998). With the intention of making market investments, fundamental and technical analysis is both employed to anticipate stock returns.

Perception of Retail Investors on Technical as well as Fundamental Analysis in Investment Decisions

Investors should protect themselves against all plausible challenges in the stock markets as investment decisions have turn into increasingly complex and precarious. Investors' must be well-informed on the performance of all other investment groups in the capital markets.

With an objective to understand the perspective of retail investor, the researcher has collected the data through structures questionnaires.

HO₁ – Technical analysis & Fundamental Analysis are two major factors which is being considered by retail investors to avoid risk in investment return.

To test the above hypothesis, student t test has been applied.

Considering the mean $\mu = 3$, the each item mean \bar{x} , $n=5$ (5 point likert item) and standard deviation σ

$$t_{cal} = \frac{\bar{x} - \mu}{\sigma / \sqrt{n-1}}$$

For $n-1$ d.f.

$t_{tab} = 2.76$ for two tail at 5% level of signification.

All the 24 items are statistically accepted as the entire item show that $t_{cal} < t_{tab}$ value at 5% level of significance. So the overall effect of all the items can also be accepted. i.e. Technical analysis & Fundamental Analysis are two major factors causing volatile behavior of retail investors of stock market is true. The study based on retail investor's responses suggests that Technical analysis & Fundamental Analysis is the two major factors causing volatile behavior of retail investors of stock market is true Gemmill & Thomas (2000); Lynch & Rothchild (2000).

A mix of fundamental as well as technical analysis appears to be more intriguing. Technical analysis, because certain of the methodologies utilized (for example, trend-following indicators and chart-pattern analysis) can provide reliable predicting predictions concerning the trend of a company's or industry's competitive position.

H02. The efficacy of traders' investment decisions is not significantly impacted by the usage of fundamental analysis and technical analysis tools.

Results of the Significance Test of the Multiple Regression Coefficients

Table 1					
VALUE: CALCULATED BY AUTHORS USING SPSS					
Anova			F	Sig.	
			64.856	.000b	
Coefficient Analyses					
Model		Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	1.870	.184	10.185	.000
	Fundamental Analysis	.247	.041	5.970	.000
	Technical Analysis	.267	.037	7.118	.000
a. Dependent Variable: Investment decision efficacy					

It can be evident from table 1 that the significance of the beta regression coefficient of investors' use of technical and fundamental analysis tools is clear as the value of P is less than the level of significance used, which is 5%, showing that H_0 is rejected. It can be concluded that investors' use of fundamental as well as technical analysis tools has a significant effect on the effectiveness of their investment decisions.

CONCLUSION

In today's world, the capital market is crucial for mobilizing and channeling resources into productive investments for the growth of the economy, including commerce and industry. The capital market also aids in capital generation and the country's economic progress. Individuals and financial intermediaries provide funds to the capital market, which are absorbed by all the major players. As a result, it promotes the flow of capital and allows it to be employed more productively and profitably, so increasing the nation's revenue and economy. It can be inferred that each parameter in fundamental and technical analysis has its own set of benefits and drawbacks. Fundamental analysis focuses on liabilities, assets, company loans, debt, and so on, whereas technical analysis focuses on previous trends. The investor may forecast their stock using these characteristics, but no strategy can guarantee a return, and there is always a danger in investing in the stock market, no matter how much study the investor does.

Future Scope of Study

Future research on the empirical examination of how retail investors use technical and fundamental analysis is quite likely. Here are a few suggested research areas:

Analysis in comparison: The research can be expanded to compare the merits of technical and fundamental analysis. Researchers can establish whether methodology is better at influencing investment choices by comparing the returns produced using each strategy.

Risk assessment: A future research may examine the dangers of retail investors using technical and fundamental analysis. This might point up any possible disadvantages of using these techniques and recommend measures to reduce risk.

The study might be expanded to investigate the behavioural elements that affect retail investors' choices between using technical and fundamental analysis. This could offer information on the psychological aspects that influence investors' judgements.

Effect of technology: With the growing use of technology in the investment industry, a future research may concentrate on how technology helps retail investors employ technical and fundamental analysis. Analyzing how trading platforms and robo-advisors affect investing choices may fall under this category.

Overall, the study on retail investors' use of technical and fundamental analysis lays a solid groundwork for further investigation in the area of finance and investing. By building on this research, researchers may obtain a greater knowledge of how retail investors make investment decisions and give insights into the most effective ways for optimizing investment returns.

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Received: 17-Mar-2023, Manuscript No. AMSJ-23-13350; **Editor assigned:** 20-Mar-2023, PreQC No. AMSJ-23-13350(PQ); **Reviewed:** 22-Apr-2023, QC No. AMSJ-23-13350; **Revised:** 21-Jun-2023, Manuscript No. AMSJ-23-13350(R); **Published:** 11-Jul-2023

Unveiling the Research Landscape of the Metaverse in Asia

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ABSTRACT

In order to give a thorough picture of the current state and trends within this burgeoning discipline, this report presents a bibliometric analysis of the Metaverse research environment in Asian nations. A sizable corpus of academic works on the Metaverse was extensively examined using bibliometric methods with help of VOS viewer and R Package- Bibliometrix, providing information on publishing output, teamwork dynamics, and topic focus. The results show that Asian nations have an increasing interest in the Metaverse, with a consistent rise in research output over time. Research efforts in the region were sparked by contributions from nations including China, Japan, and South Korea. It was discovered that collaborative efforts were common, with international partnerships significantly contributing to knowledge transfer and the development of the area. Virtual reality, augmented reality, virtual worlds, immersive technologies, and social interactions within the Metaverse were among the primary topics of concentration within the Asian Metaverse research landscape that were identified through thematic analysis. These results serve as a resource for academics and policymakers interested in improving the development and use of the Metaverse and offer insightful information on the research goals and directions in Asian nations.

KEYWORDS : *Metaverse, Bibliometric, Content analysis, Cluster analysis, Bibliographic coupling*

INTRODUCTION

Users can interact with a computer-generated environment and with others in real-time in the metaverse, a virtual reality setting. It creates an immersive and linked digital realm by fusing aspects of virtual reality, augmented reality, and the internet. The metaverse provides a variety of opportunities for social interaction, virtual world exploration, digital asset trade, gaming, and commercial dealing (Yang, 2023). Companies are investigating the metaverse's possibilities in many industries as a result of technological advancements, which have increased interest in it. Technical difficulties, ethical issues, privacy concerns, standardisation, and equal access are all problems, nevertheless (Schöbel & Leimeister, 2023).

In order to address these issues and comprehend how the metaverse affects behaviour, identity, job, and social

interactions (Syuhada et al., 2023). In order to create the metaverse as an inclusive environment that improves human experiences, stimulates creativity, cooperation, and meaningful relationships, interdisciplinary research in computer science, virtual reality, sociology, economics, and philosophy is being done (Zalan & Barbesino, 2023). The ultimate objective is to develop a digital environment that is transformational and advantageous to both people and society (JosephNg et al., 2023). The introduction of the metaverse has generated a great deal of attention and debate throughout the world and revolutionised the way we engage with digital surroundings and connect with one another (JosephNg et al., 2023). This virtual world has grabbed both academics and business experts because to its immersive experiences, augmented reality, and interconnection (Buhalis et al., 2023). Examining the metaverse's development and effects in various parts of the world is more important than ever as it continues

to develop and pick up steam (Kar & Varsha, 2023). This study presents a thorough survey of the current literature and research initiatives within this dynamic and quickly growing subject with a particular focus on the bibliometric analysis of the metaverse in Asian nations (Uyar et al., 2020). This study uses bibliometric methods to examine the academic environment, pinpoint significant contributors, and highlight new metaverse-related trends and patterns in Asian nations (Quarles et al., 2023).

Asian nations have been in the forefront of embracing and implementing cutting-edge technology because of their reputation for technical achievements and vibrant digital ecosystems (Dolata & Schwabe, 2023). Asian countries have taken a major role in determining the metaverse's future thanks to their various technology landscapes and rich cultural history (Zabel et al., 2023). This work aims to give useful insights into the regional research environment and throw light on the many elements of metaverse development and utilisation in this setting by exploring the bibliometric analysis of the metaverse in Asian nations (Weking et al., 2023).

This study will map the research trajectory, identify significant authors and institutions, and analyse the thematic clusters that have emerged within the metaverse discourse in Asian nations through a thorough analysis of scholarly articles, conference papers, and other pertinent publications (Reig-Mullor et al., 2022). This study also aims to highlight the interdisciplinary nature of metaverse research, emphasising the social sciences, virtual reality, gaming, and other relevant fields that contribute to the comprehension and development of the metaverse concept (Goldberg & Schär, 2023).

This article intends to present a thorough overview of the metaverse environment in Asian nations using bibliometric analysis, laying the groundwork for future research, policy development, and strategic decision-making (Kraus et al., 2023). The results of this study may serve as a roadmap for academics, government officials, and business leaders interested in discovering knowledge gaps, pursuing cooperative possibilities, and utilising the metaverse's potential in Asian contexts (Dwivedi et al., 2023).

In conclusion, this study offers a bibliometric analysis of the metaverse in Asian nations with the goal of providing a comprehensive picture of the academic landscape and

insightful information on the developments, trends, and consequences of the metaverse phenomena in this dynamic area (Fang et al., 2023). We hope that our in-depth analysis will add to the corpus of knowledge and promote a better comprehension of the transformational potential of the metaverse in Asian nations.

RESEARCH QUESTIONS

RQ1: What are the inclusive trends and total number of research publications published in Asia about the metaverse?

RQ2: Which major authors and nations are involved in the study of the metaverse in the chosen Asian nations?

RQ3: In Asian nations, what are the citation trends and effects of papers concentrating on the metaverse?

RQ4: What are the most popular metaverse research themes and areas of study in Asian nations?

RQ5: What possible research implications could result from the findings of this bibliometric analysis?

METHODOLOGY

To conduct the bibliometric analysis of the metaverse in Asian countries, a systematic search was performed using the Scopus database. The search string used was "TITLE-ABS-KEY (metaverse) AND (LIMIT-TO (AFFILCOUNTRY, 'China') OR LIMIT-TO (AFFILCOUNTRY, 'India') OR LIMIT-TO (AFFILCOUNTRY, 'Japan') OR LIMIT-TO (AFFILCOUNTRY, 'Singapore') OR LIMIT-TO (AFFILCOUNTRY, 'Malaysia') OR LIMIT-TO (AFFILCOUNTRY, 'Saudi Arabia') OR LIMIT-TO (AFFILCOUNTRY, 'Iran') OR LIMIT-TO (AFFILCOUNTRY, 'Thailand') OR LIMIT-TO (AFFILCOUNTRY, 'Pakistan') OR LIMIT-TO (AFFILCOUNTRY, 'Jordan'))".

This search phrase was created to discover papers that were linked to institutions in specified Asian nations, notably China, India, Japan, Singapore, Malaysia, Saudi Arabia, Iran, Thailand, Pakistan, and Jordan, and that had the word "metaverse" in their title, abstract, or keywords. The Scopus database, a large and frequently used repository for scholarly papers, was the only source that was included in the search (Zerbino, 2022). By concentrating on these Asian

nations, we sought to identify regional contributions to and trends in metaverse research. The Scopus search results were exported and then imported for additional examination into bibliometric analysis tools. From the retrieved publications, information such as publication year, authors, affiliations, citations, and keywords were extracted (Hassani & Bahini, 2022).

Numerous quantitative measurements, such as citation counts, co-authorship networks, keyword co-occurrence analysis, and trend analysis across time, will be used in the bibliometric study. These studies will offer perceptions into the research environment, significant contributors, topic clusters, and the development of the idea of the metaverse in the chosen Asian nations. By using this technique, we want to present a thorough and data-driven assessment of the scholarly output and trends connected to the metaverse in Asian nations, providing insightful information for academics, decision-makers, and business experts working in this area (De Jong et al., 2019).

RESULTS AND DISCUSSION

Annual Scientific Production

Figure 01 displays the number of articles that were released per year between 2008 and 2023. The number of publications varies with time, with very few papers published in previous years and a progressive rise in subsequent years. The number of articles increases noticeably in 2022 and then significantly in 2023. This shows a rise in research effort and interest in the field throughout those years (Wichianrak et al., 2023).



Figure 1. Annual Scientific Production

Most Influential Documents

Top 10 documents based on local and global citation is shown in the Table 01, together with information on each one's publication year, local and worldwide citation counts, LC/GC ratio (%), normalised local citation count, and normalised global citation count.

The quantity of citations from one source or document are referred to as "local citations," whilst citations from other sources are referred to as "global citations." It is clear from the statistics that the quantity of citations differs between the papers. Some papers, like Duan et al. (2021) and Dwivedi et al. (2022), have more local and international citations, demonstrating their major effect and influence within the discipline. Conversely, works by Suzuki et al. (2020) and Barry et al. (2015) have far less citations. The distribution of citations between local and international sources may be analysed using the LC/GC ratio. A lower LC/GC ratio denotes a more balanced or significant contribution from global sources, whereas a larger ratio implies a higher percentage of citations from local sources. A standard measure of citations is provided by the normalised local and global citations, enabling comparisons between texts. Higher numbers suggest a greater influence in terms of the number of citations compared to other papers. The table gives an overview of the citation performance of the listed publications, showing differences in citation counts, local-global citation distribution, and normalised effect within the field of study (Andreoli & Batista, 2020).

Most Prolific Authors

The Figure 02 lists researchers and shows how frequently their names appear in various contexts. The most often occurring names are Li Y, Wang X, and Wang Y, with 23, 22, and 21 occurrences each. These researchers are well-represented in the relevant environment. With 20 and 19 instances, respectively, Wang J and Wang F-Y also show very often. The number of occurrences for Liu Y, Niyato D, Chen Y, Li J, and Zhang X ranges from 18 to 13. The researchers who are most commonly cited or active in the field under examination are highlighted in the table (Boncinelli et al., 2023).

Most Influential Sources

Top 10 prolific sources are included in the Figure 03, along with the number of articles linked to each source (Ktisti et al., 2022). The most papers are found in "Lecture Notes in Computer Science," which has subseries on bioinformatics and artificial intelligence. With 17 papers, "IEEE Transactions on Systems, Man, and Cybernetics: Systems" comes in second place. Other noteworthy sources with 12 and 10 articles each are "ACM International Conference Proceeding

Series” and “Sustainability (Switzerland)”. Each of the following journals contributes 9 to 7 articles: “Frontiers in Psychology,” “Lecture Notes in Networks and Systems,” “Electronics (Switzerland),” “Frontiers in

Artificial Intelligence and Applications,” “Proceedings - 2023 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops, VRW 2023,” and “Proceedings of SPIE - The International Society for Optical Engineering.”

Table 1. Most Influential Documents

S.N.	Document	Year	Local Citations	Global Citations	LC/GC Ratio (%)	Normalized Local Citations	Normalized Global Citations
1	DUAN H, 2021, MM - PROC ACM INT CONF MULTIMED	2021	54	164	32.93	6.75	6.72
2	DWIVEDI YK, 2022, INT J INF MANAGE	2022	37	151	24.50	37.72	33.04
3	YANG Q, 2022, IEEE OPEN J COMPUT SOC	2022	26	46	56.52	26.51	10.07
4	TLILI A, 2022, SMART LEARN ENVIRON	2022	20	52	38.46	20.39	11.38
5	SHEN B, 2021, APPL SCI	2021	16	48	33.33	2.00	1.97
6	YANG D, 2022, CLIN EHEALTH	2022	14	37	37.84	14.27	8.10
7	WANG F-Y, 2022, IEEE TRANS COMPUTAT SOC SYST	2022	14	42	33.33	14.27	9.19
8	SUZUKI S-N, 2020, PROCEDIA COMPUT SCI	2020	14	50	28.00	1.00	1.00
9	BARRY DM, 2015, PROCEDIA COMPUT SCI	2015	13	33	39.39	1.00	1.00
10	KANEMATSU H, 2014, PROCEDIA COMPUT SCI	2014	12	28	42.86	2.00	1.87



Figure 2. Most Profiling authors

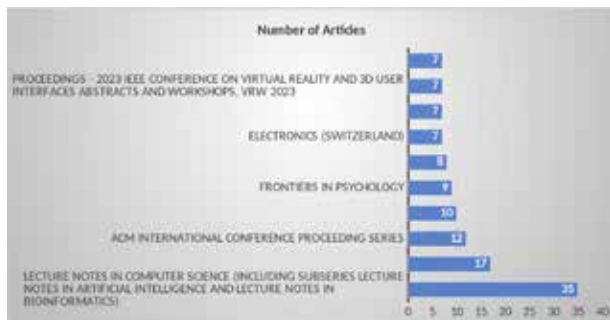


Figure 3. Most Influential Sources

Bibliographic Coupling of Countries

Based on common references in scientific papers, a technique called bibliographic coupling is used to evaluate international collaboration (Niñerola et al., 2021). It aids in the identification of research collaborations, interests, and new trends. Researchers and policymakers can learn more about global networks of collaboration and information sharing by examining bibliographic coupling patterns. This knowledge supports effective international research collaborations as well as strategic planning and research assessment. Based on the quantity of papers, citations, and overall link strength, the table provides information on the research production and influence of a few chosen nations. China has the most documents and citations, which shows that it is actively engaged in research. In spite of having fewer papers, the United States comes in second with a sizable number of citations. India has a modest research output and a comparatively strong

overall linkage. Germany and the United Kingdom have lower research outputs but significant citations and link strength as shown in Figure 04.

THEMATIC MAP

A thematic map aids in the visualisation of the properties of several research themes within a dataset during bibliometric analysis(Johnpaul et al., 2021). The thematic map incorporates a number of characteristics, including motor theme, emerging theme, specialty theme, and basic theme, as well as development degree and relevance degree. The level of development reflects the sophistication and depth of study in a certain topic. The degree of relevance reveals a theme’s significance and influence within the larger study domain. Other themes are driven and shaped by motor themes, which serve as important and key notions. While niche themes indicate specialised and narrow issues, emerging

themes represent brand-new, developing study fields. Fundamental concepts act as the field’s knowledge’s building blocks.

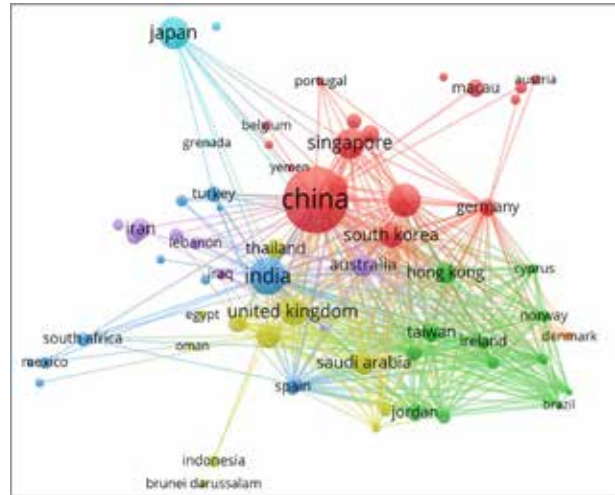


Figure 4. Collaboration among Countries

Centrality and Density details of Cluster Formed by Thematic Analysis

Table 2. Details of cluster

S.N O	Cluster	Callon Centrality	Callon Density	Rank Centrality	Rank Density	Cluster Frequency
1	reinforcement learning	2.28131533	33.99613041	9	9	117
2	3d modeling	1.41886022	32.04822955	6	8	81
3	e-learning	2.43224504	25.97081137	10	4	228
4	block-chain	5.78722389	25.96857443	12	3	406
5	human machine interface	0.74590277	40.01234568	3	11	46
6	machine-learning	3.50783770	23.95964482	11	2	139

The table provides a summary of various clusters related to different research topics in the field of Metaverse. It includes columns such as Callon Centrality, Callon Density, Rank Centrality, Rank Density, and Cluster Frequency. These metrics offer insights into the prominence and frequency of each cluster within the analyzed dataset. The Callon Centrality and Density values represent the centrality and density of the cluster, respectively, indicating the level of importance and interconnectedness of the research within that specific topic. Higher values suggest greater centrality and density, indicating a more prominent and cohesive

research area. The Rank Centrality and Density values denote the rank position of each cluster in terms of centrality and density, respectively. A lower rank value indicates higher centrality or density compared to other clusters, signifying a more influential or concentrated area of research. Lastly, the Cluster Frequency column indicates the number of publications associated with each cluster, providing an indication of the research activity and interest within each topic. Higher frequencies suggest a greater volume of research within a specific cluster. By evaluating these metrics, researchers can identify the most influential and

interconnected research areas (based on centrality and density), as well as the most prolific topics (based on cluster frequency). This information can guide further research efforts, collaborations, and the allocation of resources within the field of Metaverse research.

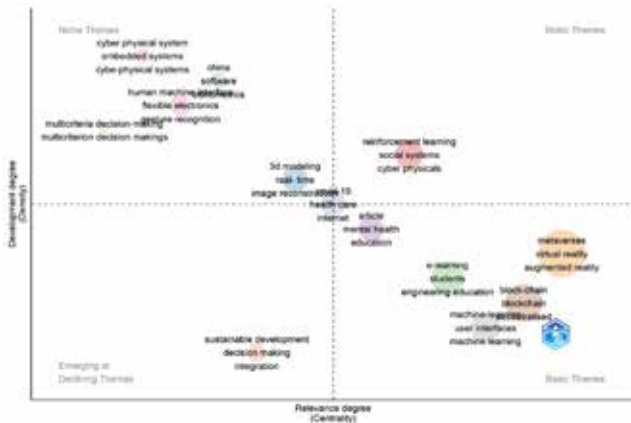


Figure 5. Thematic Map

Content Analysis

A technique for analysing and classifying textual or qualitative material into significant clusters or groupings is called content analysis using cluster analysis. It entails locating recurring themes, patterns, or subjects in a dataset. According to their content, such as words, phrases, or concepts, comparable objects are grouped together using mathematical methods in cluster analysis. This method offers a systematic method for organising and condensing enormous volumes of data and aids researchers in revealing hidden structures or links within the data. Researchers can better identify the major themes or categories included in the dataset and investigate the links between various clusters by clustering the data. Here from thematic map, we have examined 06 major clusters as follows:

Cluster analysis 1: Reinforcement Learning

The blending of “reinforcement learning,” “social systems,” “cyber physicals,” “cyberspaces,” “reinforcement learnings,” “task analysis,” and “computational modelling” creates an enthralling tapestry of interrelated topics in the vast metaverse. Reinforcement learning algorithms are essential in the metaverse for optimising user interactions and experiences, adjusting to unique preferences, and enhancing virtual worlds. In the metaverse, social

systems flourish, giving rise to vibrant communities, cooperative networks, and engaging interpersonal relationships. Cyber physicals smoothly combine digital and physical components, bridging the gap between the virtual and physical worlds, and turning interactions into palpable experiences. The metaverse’s digital cyberspaces, which provide limitless opportunities for connection and self-expression, serve as the setting for exploration, creativity, and participation. In the metaverse, task analysis assures effective job execution and boosts efficiency, while computational modelling enables designers and developers to create complex virtual environments and engaging simulations. These ideas come together to form the metaverse, a vast digital environment that is full of invention, connections, and life-changing events.

Cluster analysis 2: 3d Modelling

The fusion of “real-time,” “image reconstruction,” “three-dimensional displays,” “cameras,” “textures,” “holographic displays,” “3D modelling,” “algorithms,” and “image processing” in the metaverse results in an enthralling digital environment. While image reconstruction techniques completely meld digital and physical worlds, real-time interactions and experiences immerse users in dynamic virtual environments. The visual fidelity of the metaverse is improved through holographic and three-dimensional technology, allowing for lifelike representations and immersive experiences. The incorporation of aspects from the real world into the metaverse is made possible by cameras, which record the essence of the physical world. The complexity of virtual surroundings is enhanced by point clouds and textures, which replicate fine features and textures. The production and manipulation of 3D models is made possible by cutting-edge algorithms and image processing techniques, which help to shape the digital architecture of the metaverse. Liquid crystals aid in the creation of high-caliber displays by enhancing visual realism and clarity. These connected components serve as the building blocks of immersive experiences in the metaverse, allowing users to engage, create, and explore in a colourful and interesting digital world.

Cluster 03: E-learning

Students may engage in dynamic and engaging learning experiences outside of the typical classroom

environment because to the metaverse's immersive platform for e-learning. Teachers may use the metaverse to create personalised and adaptable learning experiences catered to each student's requirements using computer-aided education and knowledge-based systems. The establishment of engaging and dynamic learning environments where multimedia technologies excite students' perception and improve their grasp of difficult subjects is made possible by the educational metaverse. Students can successfully use problem-based learning approaches in the metaverse to address real-world issues and hone their critical thinking abilities. Additionally, the metaverse creates possibilities for online education, allowing students to access learning materials and participate in the learning process from any location.

Cluster 04: Blockchain

The metaverse uses blockchain technology to provide safe, decentralised transactions, digital asset ownership, and smart contract-based authentication. It offers a platform for immersive and interactive experiences inside of video games and other virtual worlds, having an influence on many different facets of everyday life, society, and the digital economy. The metaverse intends to provide the secure and effective flow of digital assets and electronic documents with an emphasis on information management, data privacy, and cybersecurity. In order to give consumers a smooth and engaging experience, it embraces intelligent systems, optimisations for displaying visuals, network security, and distributed computer systems. As Industry 4.0's metaverse develops, it attracts investments and spurs advancements in web 3.0, intelligent systems, and artistic computing. The metaverse aims to offer a safe and revolutionary digital environment for people and businesses alike by embracing decentralisation, cloud computing, and network optimisations.

Cluster 05: Machine Learning

Wearable technology and virtual avatars are only two examples of how "human-computer interaction" is made easy in the metaverse through the combination of "machine learning" and "user interfaces." The "complex networks" that support the metaverse grow, and it depends on effective "data handling" methods to manage massive volumes of data. "Decision trees" and

"learning algorithms" are used to improve decision-making processes so that "intelligent robots" can move around and interact in virtual settings. Advanced methods like "speech recognition" and "neural networks" enable intuitive and natural communication between people and the metaverse. The metaverse is researching topics like "convolution" and "brain-computer interfaces" in an effort to close the gap between the "human brain" and virtual experiences as technology advances.

Cluster 06: Human Interface

The idea of a "human-machine interface" is crucial in the metaverse because it allows for seamless communication between real world surroundings and virtual ones. New "flexible electronics" developments open the door to creative solutions that improve user experiences. "Gesture recognition" is essential for converting physical human motions into digital commands in the metaverse. By generating power from user interactions, cutting-edge technologies like "nanogenerators" and "triboelectricity" can power "wearable sensors" and other metaverse devices in a sustainable way. In order to record and decipher neural impulses, electrodes are used, enabling direct communication between the human brain and the virtual world. The metaverse experience gains an additional degree of expressiveness and control because to the recognition and interpretation of "gestures," which also makes it more user-friendly and immersive. The incorporation of these technologies results in a more seamless and interesting virtual world as the metaverse continues to develop.

CONCLUSION

The Metaverse in Asian nations was subjected to a thorough bibliometric study in this work, which offered insightful information on the state of the field and upcoming trends. This study provided insight into a variety of topics, including publishing productivity, collaborative patterns, and subject focus by methodically analysing a sizable corpus of scholarly publications. The results of this investigation showed that Asian nations have an increasing interest in the Metaverse, with a consistent rise in research output over time. The findings also showed how important particular nations—including China, Japan, and South Korea—have been in promoting study on the Metaverse in the area.

Collaboration was discovered to be a crucial component of research in the Metaverse, with a sizeable portion of publications coming from cross-border partnerships. This demonstrates the international scope of the topic and the necessity of international collaboration and knowledge exchange among academics. Additionally, the theme analysis revealed major areas of interest within Asia's Metaverse research environment. These included subjects including immersive technology, virtual reality, augmented reality, virtual worlds, and social interactions in the Metaverse. Such results are a useful resource for academics and policymakers interested in boosting the development and uptake of the Metaverse in Asian nations, and they also help us comprehend the existing research environment.

FUTURE SCOPE OF STUDY

Future research in the metaverse will focus on a number of important subjects in Asian nations. First, more investigation might focus on the qualitative components of Metaverse adoption, investigating user experiences, moral issues, and social effects. Investigations into how cutting-edge technology like blockchain and artificial intelligence are used in the Metaverse might also yield insightful results. Comparative research between Asian nations and other regions may also point up commonalities, discrepancies, and prospective opportunities for cooperation. The Metaverse's larger ramifications may be better understood through interdisciplinary study that combines disciplines like psychology, sociology, and economics. This will also help Asian nations develop the Metaverse responsibly and sustainably.

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Adoption of Virtual Reality (VR) and Augmented Reality (AR) in the Marketing Sphere

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ABSTRACT

The rapid advancements in technology have paved the way for the integration of emerging technologies in various industries. The marketing sphere has particularly embraced these immersive technologies to revolutionize customer experiences and enhance brand engagement. This research article explores the adoption of VR and AR in marketing and analyzes their impact on customer behavior, brand perception, and overall marketing effectiveness. Through an examination of current practices, this article aims to provide insights into the potential benefits and challenges associated with the integration of VR and AR in marketing campaigns. Additionally, it discusses the future prospects of VR and AR in the marketing sphere and offers recommendations for businesses looking to leverage these technologies effectively.

KEYWORDS : *Virtual reality (VR), Augmented reality (AR), Immersive technology, Consumer behaviour, Brand perception*

INTRODUCTION

In recent years, the rapid advancements in technology have transformed the way businesses engage with their customers. Emerging technologies have emerged as game-changing technologies that have found numerous applications in various industries, including marketing. VR refers to the computer-generated simulation of a three-dimensional environment that users can interact with, while AR overlaps digital information onto the real world, leading to enhanced user's perception of reality.

The marketing sphere has recognized the potential of VR and AR in creating immersive experiences that captivate and engage consumers. These technologies offer a unique opportunity for brands to stand out in a crowded marketplace, enhance brand awareness, and build lasting emotional connections with their target audience. By leveraging VR and AR, marketers can

transcend the limitations of traditional advertising methods and deliver interactive and personalized experiences to consumers.

The adoption of VR and AR in marketing has been fueled by several factors. Firstly, the increasing accessibility of VR and AR devices, such as headsets and smartphones, has made these technologies more widely available to consumers. Additionally, the declining costs of hardware and software development have made it more feasible for businesses of varying sizes to invest in VR and AR marketing campaigns.

Moreover, consumer expectations have shifted towards more immersive and engaging experiences. Traditional marketing approaches are often seen as intrusive or lacking interactivity. VR and AR provide an opportunity to break through these barriers and offer consumers a more memorable and personalized experience.

Furthermore, VR and AR technologies allow marketers to showcase products and services in innovative ways. They enable customers to visualize and experience the products before they buy, leading to increased confidence and informed decision-making. By blurring the line between the physical and digital worlds, VR and AR create a sense of enthusiasm and novelty, driving brand differentiation and customer loyalty.

RESEARCH OBJECTIVES

1. To investigate the current state of adoption of emerging technologies in the marketing sphere.
2. To examine the impact of VR and AR on customer behavior in the context of marketing
3. To assess the effects of VR and AR on brand perception and brand image
4. To identify the challenges and limitations faced by businesses in adopting VR and AR for marketing purposes
5. To provide recommendations and guidelines for businesses looking to effectively leverage VR and AR in their marketing strategies.

IMPACT OF VR AND AR ON CUSTOMER BEHAVIOR AND BRAND PERCEPTION

The integration of emerging technologies in marketing has had a profound impact on customer behavior and brand perception. By providing immersive experiences, VR and AR technologies have the ability to captivate and engage customers on a deeper level. These technologies evoke emotional connections, increase customer interactivity, and influence purchase intentions. The use of VR and AR in marketing campaigns enhances brand recall and memorability, leading to a positive impact on brand image and perceived innovation. Customers perceive brands utilizing VR and AR as cutting-edge, innovative, and customer-centric, thereby strengthening brand loyalty and advocacy. Overall, VR and AR have the power to reshape customer behavior and positively shape brand perception in the marketing sphere.

CHALLENGES AND LIMITATIONS OF VR AND AR IN MARKETING

While emerging technologies offer exciting opportunities for marketers, they also come with certain

challenges and limitations. Technological constraints and accessibility issues pose hurdles in widespread adoption, as high-quality VR and AR experiences often require expensive hardware and software. The cost factor is another challenge, with substantial investments needed for development and implementation. User adoption and familiarity present obstacles, as some consumers may be hesitant or unfamiliar with these technologies. Ethical and privacy concerns also arise, particularly regarding data collection and the potential for intrusive experiences. Additionally, integrating VR and AR with traditional marketing channels can be complex. Overcoming these challenges requires addressing technology limitations, ensuring cost-effectiveness, promoting user education, addressing ethical concerns, and finding seamless ways to integrate these technologies into existing marketing strategies.

FUTURE PROSPECTS AND RECOMMENDATIONS

The future prospects of Virtual Reality (VR) and Augmented Reality (AR) in the marketing sphere are promising. Advancements in VR and AR technologies, such as improved hardware capabilities and more realistic simulations, will enhance the immersive experiences offered to consumers. Integration with artificial intelligence and data analytics will enable personalized and targeted marketing campaigns. User-centric design and usability will play a crucial role in ensuring seamless and intuitive experiences. Collaboration with influencers and brand ambassadors can amplify the reach and impact of VR and AR marketing initiatives. Furthermore, customization and personalization will be key in tailoring experiences to individual preferences. To capitalize on these future prospects, businesses should stay updated with technology advancements, invest in research and development, and prioritize the seamless integration of VR and AR into their marketing strategies.

CONCLUSION

In conclusion, the adoption of emerging technologies in the marketing sphere has shown significant potential to transform customer experiences and enhance brand engagement. Through various applications such as product visualization, interactive brand experiences,

and personalized marketing, VR and AR have proven their effectiveness in influencing customer behavior, improving brand perception, and driving marketing effectiveness. However, challenges related to technology, cost, user adoption, and privacy must be addressed to fully leverage the benefits of VR and AR in marketing. By learning from successful case studies and keeping an eye on future advancements, businesses can capitalize on these immersive technologies to create compelling marketing campaigns that captivate audiences and deliver memorable brand experiences.

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Robotics in product development and business marketing

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AIP Conf. Proc. 2816, 130001 (2024)

<https://doi.org/10.1063/5.0177431>

Robotics involve programmable machine, which physically interacts with global context and is potentially capable of properly carrying out a complex form of series of actions and activities in autonomous or semi-autonomous manner. This research focuses on understanding role of robotics in terms of product development as well as proper business marketing. It involves proper review of literature through understanding robotics as a source of open-source development and proper convergence of disparate form of technologies. It also focuses on mobile computing that helps immensely in marketing and assures rapid advances in business performance. This research investigates problems associated with robotics usage, finds out ways in which robotics helps in proper development as well as marketing attributes, and reaches to a wider consumer target in the bigger terms. Hypothesis brings out a positive connectivity between marketing and product development and usage of robotics such as sensors in businesses in present marketing environment. Methods used in this research involve descriptive study design with a purposive form of sampling assuring suitable research outcomes in this context. Sample size includes aligning relevant articles and journals along with company reports as well as texts and databases (government) for bringing out ways of robotics usage in terms of proper form of product establishment as well as marketing attributes within the present organisational standards. Results of the research bring out proper description of use of robotics such as sensors. rapid prototyping for assuring

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impact on business competitive advantage and overall performance.

Topics

[Robotics](#), [3D printing](#), [Review](#), [Journal](#)

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Human Capital Management - Beyond Recruitment: A Review of Strategic Practices

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Abstract

This review paper examines the evolution and significance of Human Capital Management (HCM) in contemporary organizational practices. Historically, personnel management primarily focused on administrative tasks, but HCM represents a paradigm shift by recognizing employees as strategic assets vital for achieving competitive advantage. The paper explores the driving forces behind the adoption of HCM practices, including globalization, technological advancements, and demographic shifts. Through a comprehensive literature search and analysis, the paper investigates key components of HCM, including talent acquisition, development, performance management, and employee engagement. It also identifies challenges and opportunities facing organizations in managing their human capital effectively. Thematic evaluation reveals the evolution of research focus over time, highlighting emerging trends such as big data and industry 4.0. The word cloud and thematic map provide additional insights into prevalent topics and clusters within the literature.

Keywords: Human Capital Management (HCM), Organizational practices, Strategic assets, Competitive advantage, Personnel management

1. Introduction

The Human capital management (HCM) represents a paradigm shift in how organizations perceive and manage their most valuable asset: their people. Historically, the field of personnel management focused primarily on administrative tasks such as hiring, payroll, and compliance with labor laws. However, as organizations evolved and the business landscape became more dynamic, there arose a recognition that the workforce could be a source of competitive advantage if managed strategically (Lin et al., 2017).

The concept of human capital management emerged as a response to this realization, emphasizing the strategic importance of employees and their collective skills, knowledge, and abilities. Unlike traditional approaches,

which treated employees as interchangeable resources, HCM recognizes that each individual brings unique talents and perspectives to the organization. Therefore, effective management of human capital involves not only attracting and retaining talent but also developing and leveraging it to drive organizational success (Kucharčíková et al., 2015).

In recent years, several factors have accelerated the adoption of human capital management practices. Globalization has increased competition for talent, forcing organizations to seek out the best and brightest employees regardless of geographic location (Ullah et al., 2023). Technological advancements have transformed the nature of work, creating demand for new skills and competencies while rendering others obsolete. Moreover, demographic shifts, such as the aging workforce and the rise of millennials, have brought new challenges and opportunities for managing talent effectively (Kediya et al., 2023).

At its core, human capital management is about creating an environment where employees can thrive and contribute their full potential to organizational goals (Khan et al., 2023). This involves not only providing competitive compensation and benefits but also fostering a culture of learning, collaboration, and innovation. By investing in employee development, organizations can enhance their capabilities, adapt to changing market conditions, and stay ahead of the competition (Singh et al., 2023).

In the following sections, we will explore the key components of human capital management, including talent acquisition, development, performance management, and employee engagement. We will also discuss the challenges and opportunities facing organizations in this domain and examine emerging trends shaping the future of work. Ultimately, the effective management of human capital is essential for organizations seeking to achieve sustainable growth and long-term success in today's dynamic business environment (Paul et al., 2023).

2. Research Methodology

Literature Search: The research begins with a thorough literature search using academic databases Scopus. The search has been conducted using the specified search string ("Human Capital Management") limited to English-language publications. This initial search serves as the foundation for identifying relevant articles, books, and other scholarly sources related to HCM.

Inclusion and Exclusion Criteria: A set of inclusion and exclusion criteria has been established to ensure the selection of relevant studies. Inclusion criteria includes publications that provide theoretical frameworks, empirical research, case studies, and reviews related to HCM. Exclusion criteria may include non-peer-reviewed sources, duplicates, and publications in languages other than English. The search string used was TITLE-ABS-KEY ("Human Capital Management") AND (LIMIT-TO (LANGUAGE , "English"))

Data Extraction: Relevant data from selected studies has been extracted and organized systematically. This includes information on authors, publication year, key findings, and theoretical frameworks utilized.

3. Result and Analysis

3.1 Overview of publication

TABLE I: MAIN INFORMATION

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1998:2024
Sources (Journals, Books, etc)	402
Documents	547
Annual Growth Rate %	8.33
Document Average Age	7.87
Average citations per doc	12.74
References	1
DOCUMENT CONTENTS	
Keywords Plus (ID)	1461
Author's Keywords (DE)	1394

The dataset comprises 547 documents spanning from 1998 to 2024, sourced from 402 journals, books, and other scholarly publications. With an annual growth rate of 8.33%, the collection reflects a dynamic and evolving field of study. The average age of documents is approximately 7.87 years, indicating a relatively recent and up-to-date dataset. Each document receives an average of 12.74 citations, highlighting the academic significance and influence of the included works. The dataset also contains a rich array of keywords, with 1461 Keywords Plus (ID) and 1394 Author's Keywords (DE), suggesting a diverse range of topics and themes covered in the literature. This comprehensive dataset offers valuable insights into the trends, developments, and scholarly discourse within the subject area over the past few decades (Chokheli, 2012).

3.2 Most Influential Sources

The dataset comprises 547 documents spanning from 1998 to 2024, sourced from 402 journals, books, and other scholarly publications. With an annual growth rate of 8.33%, the collection reflects a dynamic and evolving field of study. The average age of documents is approximately 7.87 years, indicating a relatively recent and up-to-date dataset. Each document receives an average of 12.74 citations, highlighting the academic significance and influence of the included works. The dataset also contains a rich array of keywords, with 1461 Keywords Plus (ID) and 1394 Author's Keywords (DE), suggesting a diverse range of topics and themes covered in the literature. This comprehensive dataset offers valuable insights into the trends, developments, and scholarly discourse within the subject area over the past few decades (Grabara et al., 2019).

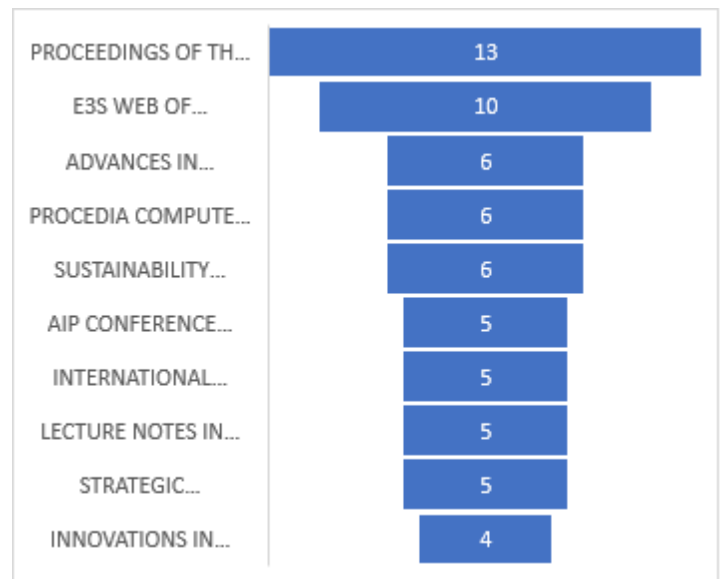


Figure 1: Most Influential Sources

3.3 Most Influential Authors

The dataset comprises articles authored by various individuals, with some authors being particularly prolific. Cahyaningsih E and Sensuse Di each contributed 12 articles, indicating a significant presence in the field. Following closely, Wibowo WC authored 9 articles, while Kucharčiková A, Brook RA, Kleinman NL, Mičiak M, Núñez-Ríos JE, and Sari WP each contributed 5 articles. These authors' consistent contributions suggest a depth of expertise and ongoing engagement with the subject matter. Additionally, Mkrtrtchian V authored 4 articles, indicating a notable but slightly lower level of contribution compared to the others listed. Overall, these authors' collective efforts contribute to the diversity and richness of the scholarly literature within the field (Chokheli, 2012).



Figure 2: Most Influential Authors

3.4 Word cloud

The word analysis reveals key terms prevalent within the dataset, shedding light on prominent themes and topics. “Human capital” emerges as the most frequently occurring term, appearing 89 times, underscoring the significance of human resources and talent within the literature. “Human resource management” follows closely with 46 occurrences, highlighting the focus on organizational practices related to personnel recruitment, development, and retention. “Knowledge management” is also notable, appearing 41 times, indicating a strong emphasis on the strategic management of knowledge assets within organizations. Additionally, terms such as “personnel,” “information management,” and “competition” feature prominently, suggesting a multifaceted exploration of workforce dynamics, information systems, and competitive strategies. The presence of terms like “humans” and “United States” hints at broader discussions encompassing societal and geographical contexts. Overall, the frequency analysis provides valuable insights into the central themes and

concepts addressed within the dataset, offering a foundation for further exploration and analysis.

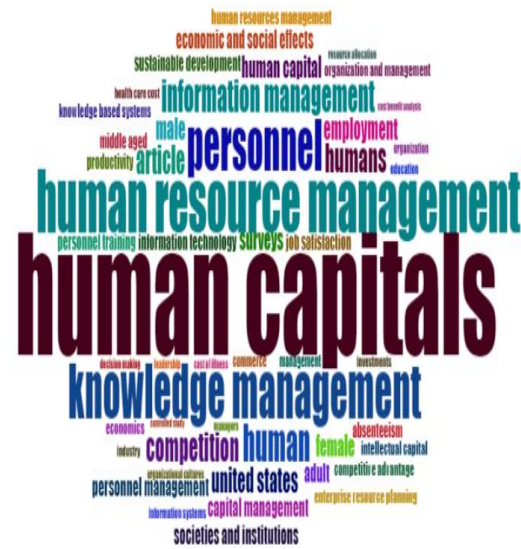


Figure 3: Word Map

3.5 Thematic Evaluation

The evolution of research focus within the realm of human capital management can be discerned through the transitions in key terms and concepts over distinct time periods. Initially, from 1998 to 2012, there was a notable emphasis on complementarity and human capital, with a gradual shift towards knowledge management and leadership by 2013 to 2017. Intellectual capital remained a consistent area of interest throughout both time frames. However, the years 2018 to 2021 witnessed a diversification of topics, with a surge in attention towards emerging fields such as big data, corporate social responsibility, and industry 4.0. This period also saw a continuation of themes from previous years, including human capital, human resources, and knowledge management, albeit with an increased focus on innovation and digitalization. The subsequent period, from 2022 to 2024, reflects a response to contemporary challenges, such as the COVID-19 pandemic, with research exploring the intersection of human capital with entrepreneurship, digital economy, and organizational performance. Furthermore, there is a noticeable trend towards exploring dynamic capabilities, job satisfaction, and machine learning, signifying a continued evolution in the understanding and application of human capital management principles in response to changing societal and technological landscapes (Dmitrieva et al., 2017).

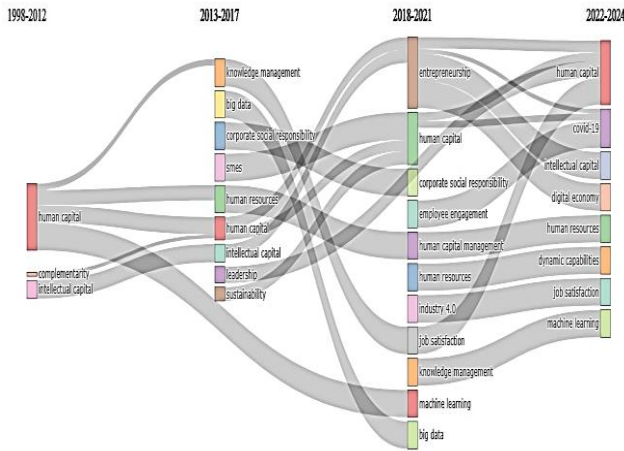


Figure 4: Thematic Evaluation

3.6 Thematic Map

In the provided figure 5, clusters have been formed based on related words and concepts, reflecting common themes or areas of focus within the field of human capital management. Here's a breakdown of some of the clusters:

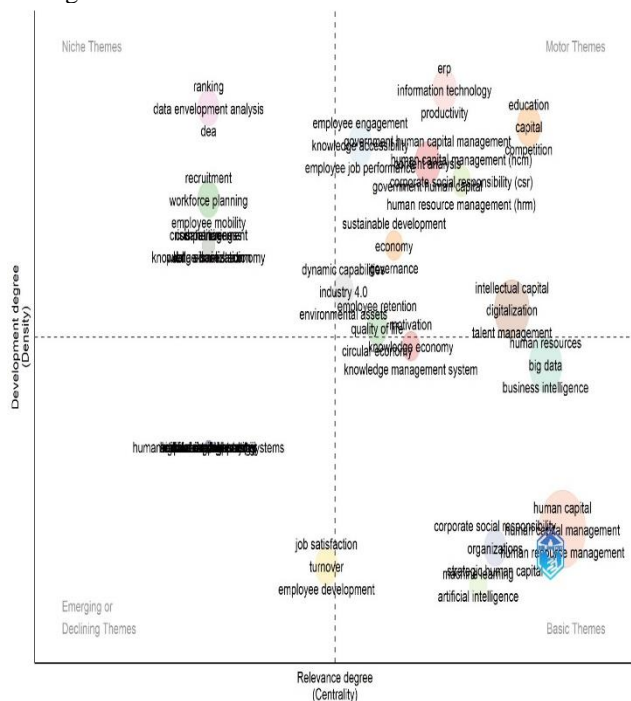


Figure 5: Thematic Map

Government Human Capital Management: This cluster encompasses terms related to human capital management within government organizations, including content analysis, risk analysis, enterprise risk management, and gap analysis. These terms indicate a focus on managing human resources effectively within government sectors (Vasilev et al., 2017).

Artificial Intelligence (AI): This cluster revolves around artificial intelligence and its applications in human capital management. Terms such as artificial intelligence (AI) are indicative of research exploring the integration of AI technologies in HR processes and decision-making (Kuzior et al., 2022).

Employee Retention: This cluster highlights factors contributing to employee retention, including quality of life, circular economy, economic growth, and Japan. It suggests research interest in understanding and enhancing employee satisfaction and retention strategies.

Higher Education Sector: Terms in this cluster relate to human capital management within the higher education sector, including education, capital, competition, and economic development. It indicates a focus on managing and leveraging human resources within educational institutions (Kuksa et al., 2019).

Intellectual Capital: This cluster encompasses terms related to intellectual capital management, such as talent management, digital economy, knowledge management, and innovation. It suggests research interest in managing intangible assets and promoting innovation within organizations.

Human Resources: This cluster covers various aspects of human resources management, including big data, workforce analytics, HRM, and HR analytics. It reflects research focusing on HR practices, data-driven decision-making, and organizational performance (Vukovich et al., 2018).

Corporate Social Responsibility (CSR): Terms in this cluster pertain to corporate social responsibility and its implications for human capital management. It includes terms like corporate social responsibility, organizations, and strategic human capital, indicating a focus on integrating CSR into HR strategies.

Dynamic Capabilities: This cluster revolves around dynamic capabilities and their role in human capital management, including industry 4.0, environmental assets, and Malaysia. It suggests research interest in adapting to dynamic business environments and fostering innovation.

Employee Engagement: This cluster focuses on factors influencing employee engagement, such as knowledge accessibility, leadership practices, and learning capacity. It indicates research interest in enhancing employee engagement and performance.

Machine Learning: This cluster pertains to machine learning and its applications in HR processes, including

recruitment, workforce planning, and incentive systems. It reflects research exploring the use of machine learning algorithms in talent acquisition and management (Gerasimov et al., 2019).

These clusters provide insights into the diverse areas of research within human capital management and highlight emerging trends and themes in the field.

4. Conclusions

In conclusion, this review paper delves into the paradigm shift represented by Human Capital Management (HCM) in organizational practices. Traditionally, personnel management focused on administrative tasks, but HCM recognizes employees as valuable assets crucial for achieving a competitive edge. It emphasizes strategic management, acknowledging each individual's unique skills and contributions. The paper identifies several driving forces behind the adoption of HCM practices, including globalization, technological advancements, and demographic shifts. Through an extensive literature search and analysis, the paper reveals the breadth and depth of research in HCM. It explores key components such as talent acquisition, development, performance management, and employee engagement. Furthermore, it highlights challenges and opportunities facing organizations, from attracting and retaining talent to adapting to dynamic market conditions. The thematic evaluation illustrates the evolution of research focus over time, from an initial emphasis on complementarity and human capital to emerging themes like big data and industry 4.0. The word cloud and thematic map provide additional insights into prevalent topics and clusters within the literature. Overall, this review underscores the critical importance of effective human capital management for organizational success in today's dynamic business environment. By investing in their workforce and fostering a culture of learning and innovation, organizations can enhance their capabilities and maintain a competitive edge.

5. Future Research Directions

Future research in human capital management (HCM) could explore several promising directions to address emerging challenges and leverage opportunities in the dynamic business landscape. Firstly, integrating emerging technologies like artificial intelligence (AI) and machine learning into HCM practices could enhance recruitment processes, talent retention strategies, and performance management systems. Secondly, with the widespread adoption of remote work, research could investigate effective ways to manage virtual teams, promote employee engagement, and address the unique challenges of remote work environments. Thirdly, there is a growing focus on diversity, equity, and inclusion (DEI) in organizations, prompting research into inclusive hiring practices, diversity

training programs, and equitable performance evaluation processes. Additionally, studies on workforce agility, resilience, and ethical considerations in HCM are needed to navigate complex ethical dilemmas and uncertain business environments. Moreover, global talent management, sustainability initiatives, reskilling, and upskilling programs are areas ripe for exploration to ensure organizations remain competitive and sustainable in an ever-changing world. By exploring these research avenues, scholars can contribute to advancing the field of HCM and supporting organizations in achieving their strategic goals.

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The concept of human capital management emerged as a response to this realization, emphasizing the strategic importance of employees and their collective skills, knowledge, and abilities. Unlike traditional approaches,

which treated employees as interchangeable resources, HCM recognizes that each individual brings unique talents and perspectives to the organization. Therefore, effective management of human capital involves not only attracting and retaining talent but also developing and leveraging it to drive organizational success (Kucharčíková et al., 2015).

In recent years, several factors have accelerated the adoption of human capital management practices. Globalization has increased competition for talent, forcing organizations to seek out the best and brightest employees regardless of geographic location (Ullah et al., 2023). Technological advancements have transformed the nature of work, creating demand for new skills and competencies while rendering others obsolete. Moreover, demographic shifts, such as the aging workforce and the rise of millennials, have brought new challenges and opportunities for managing talent effectively (Kediya et al., 2023).

At its core, human capital management is about creating an environment where employees can thrive and contribute their full potential to organizational goals (Khan et al., 2023). This involves not only providing competitive compensation and benefits but also fostering a culture of learning, collaboration, and innovation. By investing in employee development, organizations can enhance their capabilities, adapt to changing market conditions, and stay ahead of the competition (Singh et al., 2023).

In the following sections, we will explore the key components of human capital management, including talent acquisition, development, performance management, and employee engagement. We will also discuss the challenges and opportunities facing organizations in this domain and examine emerging trends shaping the future of work. Ultimately, the effective management of human capital is essential for organizations seeking to achieve sustainable growth and long-term success in today's dynamic business environment (Paul et al., 2023).

2. Research Methodology

Literature Search: The research begins with a thorough literature search using academic databases Scopus. The search has been conducted using the specified search string ("Human Capital Management") limited to English-language publications. This initial search serves as the foundation for identifying relevant articles, books, and other scholarly sources related to HCM.

Inclusion and Exclusion Criteria: A set of inclusion and exclusion criteria has been established to ensure the selection of relevant studies. Inclusion criteria includes publications that provide theoretical frameworks, empirical research, case studies, and reviews related to HCM. Exclusion criteria may include non-peer-reviewed sources, duplicates, and publications in languages other than English. The search string used was TITLE-ABS-KEY ("Human Capital Management") AND (LIMIT-TO (LANGUAGE , "English"))

Data Extraction: Relevant data from selected studies has been extracted and organized systematically. This includes information on authors, publication year, key findings, and theoretical frameworks utilized.

3. Result and Analysis

3.1 Overview of publication

TABLE I: MAIN INFORMATION

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1998:2024
Sources (Journals, Books, etc)	402
Documents	547
Annual Growth Rate %	8.33
Document Average Age	7.87
Average citations per doc	12.74
References	1
DOCUMENT CONTENTS	
Keywords Plus (ID)	1461
Author's Keywords (DE)	1394

The dataset comprises 547 documents spanning from 1998 to 2024, sourced from 402 journals, books, and other scholarly publications. With an annual growth rate of 8.33%, the collection reflects a dynamic and evolving field of study. The average age of documents is approximately 7.87 years, indicating a relatively recent and up-to-date dataset. Each document receives an average of 12.74 citations, highlighting the academic significance and influence of the included works. The dataset also contains a rich array of keywords, with 1461 Keywords Plus (ID) and 1394 Author's Keywords (DE), suggesting a diverse range of topics and themes covered in the literature. This comprehensive dataset offers valuable insights into the trends, developments, and scholarly discourse within the subject area over the past few decades (Chokheli, 2012).

3.2 Most Influential Sources

The dataset comprises 547 documents spanning from 1998 to 2024, sourced from 402 journals, books, and other scholarly publications. With an annual growth rate of 8.33%, the collection reflects a dynamic and evolving field of study. The average age of documents is approximately 7.87 years, indicating a relatively recent and up-to-date dataset. Each document receives an average of 12.74 citations, highlighting the academic significance and influence of the included works. The dataset also contains a rich array of keywords, with 1461 Keywords Plus (ID) and 1394 Author's Keywords (DE), suggesting a diverse range of topics and themes covered in the literature. This comprehensive dataset offers valuable insights into the trends, developments, and scholarly discourse within the subject area over the past few decades (Grabara et al., 2019).

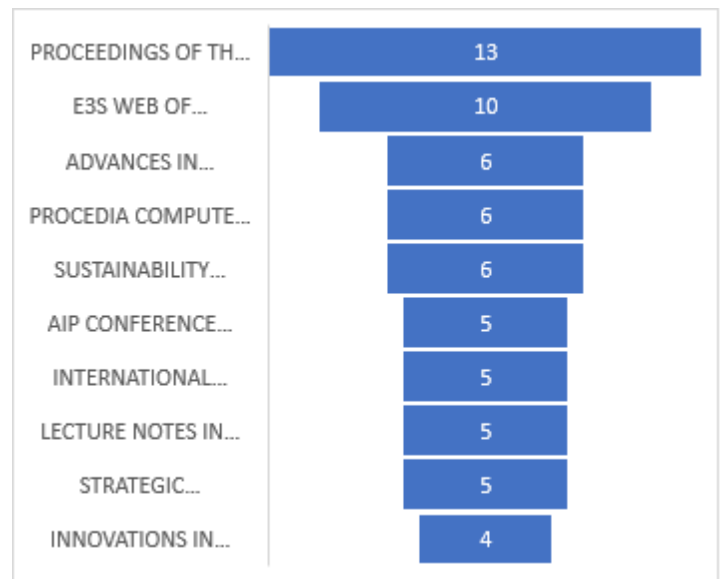


Figure 1: Most Influential Sources

3.3 Most Influential Authors

The dataset comprises articles authored by various individuals, with some authors being particularly prolific. Cahyaningsih E and Sensuse Di each contributed 12 articles, indicating a significant presence in the field. Following closely, Wibowo WC authored 9 articles, while Kucharčiková A, Brook RA, Kleinman NL, Mičiak M, Núñez-Ríos JE, and Sari WP each contributed 5 articles. These authors' consistent contributions suggest a depth of expertise and ongoing engagement with the subject matter. Additionally, Mkrtrtchian V authored 4 articles, indicating a notable but slightly lower level of contribution compared to the others listed. Overall, these authors' collective efforts contribute to the diversity and richness of the scholarly literature within the field (Chokheli, 2012).



Figure 2: Most Influential Authors

3.4 Word cloud

The word analysis reveals key terms prevalent within the dataset, shedding light on prominent themes and topics. “Human capital” emerges as the most frequently occurring term, appearing 89 times, underscoring the significance of human resources and talent within the literature. “Human resource management” follows closely with 46 occurrences, highlighting the focus on organizational practices related to personnel recruitment, development, and retention. “Knowledge management” is also notable, appearing 41 times, indicating a strong emphasis on the strategic management of knowledge assets within organizations. Additionally, terms such as “personnel,” “information management,” and “competition” feature prominently, suggesting a multifaceted exploration of workforce dynamics, information systems, and competitive strategies. The presence of terms like “humans” and “United States” hints at broader discussions encompassing societal and geographical contexts. Overall, the frequency analysis provides valuable insights into the central themes and

concepts addressed within the dataset, offering a foundation for further exploration and analysis.

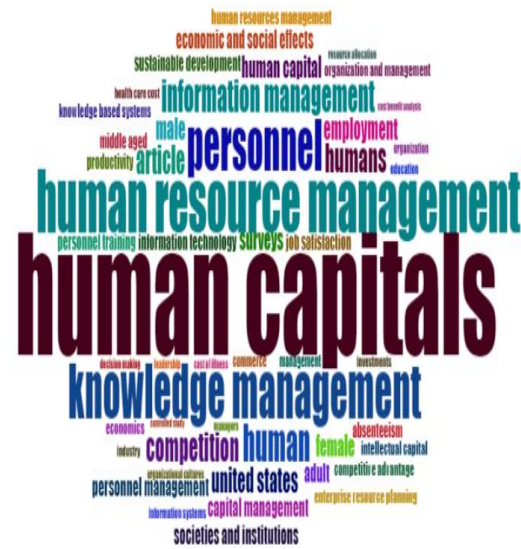


Figure 3: Word Map

3.5 Thematic Evaluation

The evolution of research focus within the realm of human capital management can be discerned through the transitions in key terms and concepts over distinct time periods. Initially, from 1998 to 2012, there was a notable emphasis on complementarity and human capital, with a gradual shift towards knowledge management and leadership by 2013 to 2017. Intellectual capital remained a consistent area of interest throughout both time frames. However, the years 2018 to 2021 witnessed a diversification of topics, with a surge in attention towards emerging fields such as big data, corporate social responsibility, and industry 4.0. This period also saw a continuation of themes from previous years, including human capital, human resources, and knowledge management, albeit with an increased focus on innovation and digitalization. The subsequent period, from 2022 to 2024, reflects a response to contemporary challenges, such as the COVID-19 pandemic, with research exploring the intersection of human capital with entrepreneurship, digital economy, and organizational performance. Furthermore, there is a noticeable trend towards exploring dynamic capabilities, job satisfaction, and machine learning, signifying a continued evolution in the understanding and application of human capital management principles in response to changing societal and technological landscapes (Dmitrieva et al., 2017).

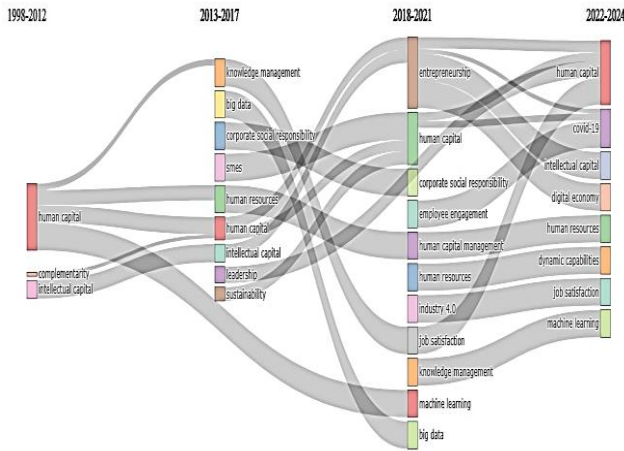


Figure 4: Thematic Evaluation

3.6 Thematic Map

In the provided figure 5, clusters have been formed based on related words and concepts, reflecting common themes or areas of focus within the field of human capital management. Here's a breakdown of some of the clusters:

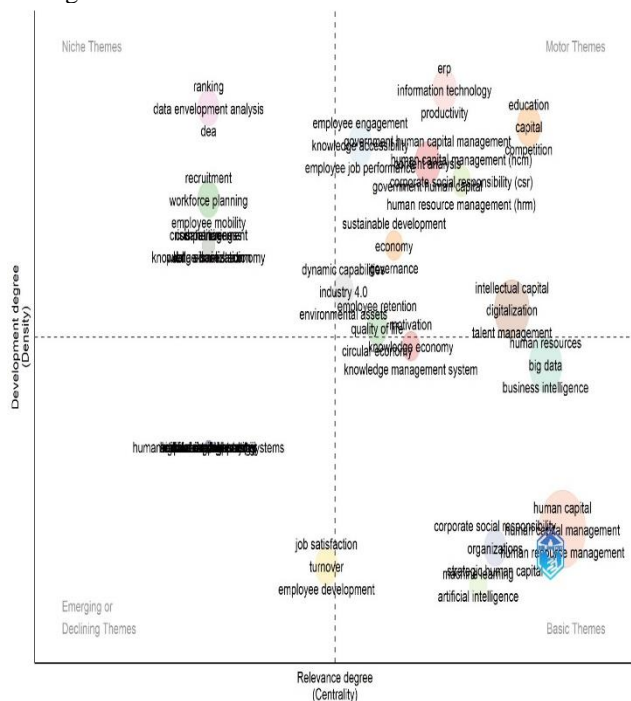


Figure 5: Thematic Map

Government Human Capital Management: This cluster encompasses terms related to human capital management within government organizations, including content analysis, risk analysis, enterprise risk management, and gap analysis. These terms indicate a focus on managing human resources effectively within government sectors (Vasilev et al., 2017).

Artificial Intelligence (AI): This cluster revolves around artificial intelligence and its applications in human capital management. Terms such as artificial intelligence (AI) are indicative of research exploring the integration of AI technologies in HR processes and decision-making (Kuzior et al., 2022).

Employee Retention: This cluster highlights factors contributing to employee retention, including quality of life, circular economy, economic growth, and Japan. It suggests research interest in understanding and enhancing employee satisfaction and retention strategies.

Higher Education Sector: Terms in this cluster relate to human capital management within the higher education sector, including education, capital, competition, and economic development. It indicates a focus on managing and leveraging human resources within educational institutions (Kuksa et al., 2019).

Intellectual Capital: This cluster encompasses terms related to intellectual capital management, such as talent management, digital economy, knowledge management, and innovation. It suggests research interest in managing intangible assets and promoting innovation within organizations.

Human Resources: This cluster covers various aspects of human resources management, including big data, workforce analytics, HRM, and HR analytics. It reflects research focusing on HR practices, data-driven decision-making, and organizational performance (Vukovich et al., 2018).

Corporate Social Responsibility (CSR): Terms in this cluster pertain to corporate social responsibility and its implications for human capital management. It includes terms like corporate social responsibility, organizations, and strategic human capital, indicating a focus on integrating CSR into HR strategies.

Dynamic Capabilities: This cluster revolves around dynamic capabilities and their role in human capital management, including industry 4.0, environmental assets, and Malaysia. It suggests research interest in adapting to dynamic business environments and fostering innovation.

Employee Engagement: This cluster focuses on factors influencing employee engagement, such as knowledge accessibility, leadership practices, and learning capacity. It indicates research interest in enhancing employee engagement and performance.

Machine Learning: This cluster pertains to machine learning and its applications in HR processes, including

recruitment, workforce planning, and incentive systems. It reflects research exploring the use of machine learning algorithms in talent acquisition and management (Gerasimov et al., 2019).

These clusters provide insights into the diverse areas of research within human capital management and highlight emerging trends and themes in the field.

4. Conclusions

In conclusion, this review paper delves into the paradigm shift represented by Human Capital Management (HCM) in organizational practices. Traditionally, personnel management focused on administrative tasks, but HCM recognizes employees as valuable assets crucial for achieving a competitive edge. It emphasizes strategic management, acknowledging each individual's unique skills and contributions. The paper identifies several driving forces behind the adoption of HCM practices, including globalization, technological advancements, and demographic shifts. Through an extensive literature search and analysis, the paper reveals the breadth and depth of research in HCM. It explores key components such as talent acquisition, development, performance management, and employee engagement. Furthermore, it highlights challenges and opportunities facing organizations, from attracting and retaining talent to adapting to dynamic market conditions. The thematic evaluation illustrates the evolution of research focus over time, from an initial emphasis on complementarity and human capital to emerging themes like big data and industry 4.0. The word cloud and thematic map provide additional insights into prevalent topics and clusters within the literature. Overall, this review underscores the critical importance of effective human capital management for organizational success in today's dynamic business environment. By investing in their workforce and fostering a culture of learning and innovation, organizations can enhance their capabilities and maintain a competitive edge.

5. Future Research Directions

Future research in human capital management (HCM) could explore several promising directions to address emerging challenges and leverage opportunities in the dynamic business landscape. Firstly, integrating emerging technologies like artificial intelligence (AI) and machine learning into HCM practices could enhance recruitment processes, talent retention strategies, and performance management systems. Secondly, with the widespread adoption of remote work, research could investigate effective ways to manage virtual teams, promote employee engagement, and address the unique challenges of remote work environments. Thirdly, there is a growing focus on diversity, equity, and inclusion (DEI) in organizations, prompting research into inclusive hiring practices, diversity

training programs, and equitable performance evaluation processes. Additionally, studies on workforce agility, resilience, and ethical considerations in HCM are needed to navigate complex ethical dilemmas and uncertain business environments. Moreover, global talent management, sustainability initiatives, reskilling, and upskilling programs are areas ripe for exploration to ensure organizations remain competitive and sustainable in an ever-changing world. By exploring these research avenues, scholars can contribute to advancing the field of HCM and supporting organizations in achieving their strategic goals.

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