ISSN : 2347-6184

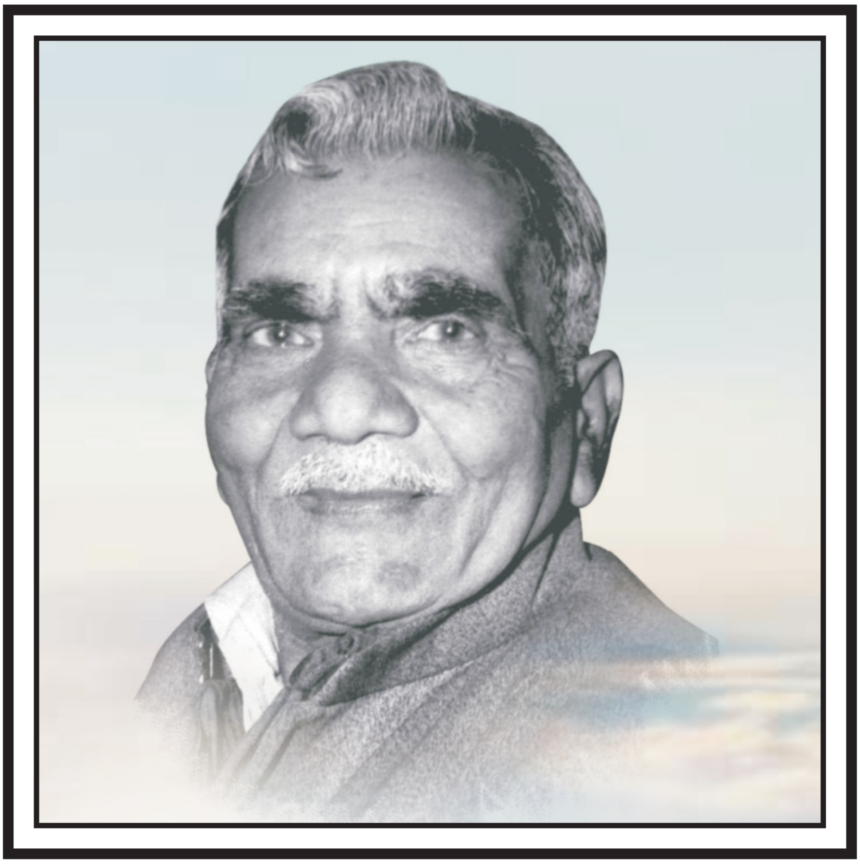
Journal of Indian Institute for Engineering, Management and Science

Volume - 3
20 June, 2024

Editor-in-Chief :

Dr. Saket Agarwal

Inspiring Soul



The actual fact of life is,
"To achieve Golden path to success;
one must strive hard from dawn to dusk."
The crux behind this is,
"The hard work that you put in,
will be recognized as an appreciatioin by honor of success."

- Mukut Behari Lal

Journal of Indian Institute for Engineering, Management and Science
Volume 3, 20 June, 2024
ISSN : 2347-6184

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Journal of Indian Institute for Engineering, Management and Science
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ISSN : 2347-6184

Editors - in - Chief Message

Dear All,

It's our immense pleasure to introduce you the Volume-3 Issue-I of Journal of Indian Institute for Engineering, Management and Science (JIIEMS). We would like to extend a very warm welcome to all the readers of JIEMS. In this issue, focus is given to publish original research work that contributes significantly to strengthen the scientific knowledge in area of Engineering, Management, Science & Technology. The key focus would however be the emerging sectors and research which discusses application and usability in societal or consumer context whether individual or industrial. Through this journal, we provide a platform for academicians, research scholars and professionals throughout the world to present latest advancements in different areas. Our goal is to take the journal in a direction where it reflects the multidisciplinary nature and becomes the premier journal that covers all aspects of engineering, management, science & Technology.

The success of any journal is built primarily on four groups of people: the contributors, the reviewers, the associate editors, and the publications staff. For this journal, the contributions have come in not only from the academic community but also from the corporate world. We would like to thank all the contributing authors for providing outstanding research articles on a broad range of topics and we hope that the research featured here sets up many new milestones. We appreciate the efforts put by all the editorial team members, reviewers who have helped us in making this journal a possibility. We have had an overwhelming response from some very eminent editors and researchers globally to support as editorial Team. We look forward to make this endeavor very meaningful. We also thank all the publishing staff members and express my sincere appreciation for the support they have given to JIIEMS.

JIIEMS is currently accepting manuscripts for upcoming issues based on original qualitative or quantitative research, an innovative conceptual framework, or a substantial literature review that opens new areas of inquiry and investigation. Case studies and works of literary analysis are also welcome. It would be definitely a privilege to publish a high quality research article which satisfactorily passes the editorial and peer review protocol. On behalf of the advisory board, we welcome your comments, views and suggestions. I hope to be able to bring about gradual changes in the near future for a successful indexation in the prestigious databases and more importantly for the improvement of the journal.

Please direct any manuscripts, questions or comments to: jiiemsr@gmail.com

Editors-in-chief
JIIEMS

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Volume 3, 20 June, 2024
ISSN : 2347-6184

Editors Message

Dear Authors and Readers,

Welcome to the latest edition of Volume 3 and Issue 1 Journal of Indian Institute for Engineering and Management Sciences (JIIEMS). As we navigate through the ever-evolving landscape of industrial engineering and management sciences, our commitment to fostering insightful research and facilitating scholarly dialogue remains unwavering. In this issue, we are proud to present a diverse array of articles covering a broad spectrum of topics within our field. From innovative approaches to supply chain optimization to cutting-edge advancements in operations management, each contribution represents a unique perspective and a valuable addition to the collective knowledge base of our discipline.

As editors, we are immensely grateful to the authors whose dedication and expertise have enriched the pages of this journal. Their rigorous research and intellectual curiosity continue to inspire and inform our community, driving progress and innovation in industrial engineering and management sciences. We also extend our heartfelt appreciation to our diligent reviewers, whose constructive feedback and insightful critiques ensure the quality and rigor of the articles we publish. Their commitment to excellence is essential in maintaining the standards of scholarly integrity and advancing the frontiers of knowledge in our field. Finally, we would like to express our gratitude to our readership, whose engagement and support are instrumental in the success of JIIEMS. Your enthusiasm for scholarly inquiry and your commitment to advancing the boundaries of industrial engineering and management sciences are the driving forces behind our continued growth and success. We hope that you find this issue of JIIEMS both informative and inspiring, and we encourage you to join us in our mission to promote excellence in research and scholarship in industrial engineering and management sciences.

Please direct any manuscripts, questions or comments to: jiiemsr@gmail.com

With warm regards,
Sanjeev Kumar Arya
Editor
JIIEMS

Journal of Indian Institute for Engineering, Management and Science (JIIEMS)

Journal of Indian Institute for Engineering, Management and Science (JllEMS)

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Artificial intelligence challenges opportunities and its impact on society -2024

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ABSTRACT

As technological changes are occurring rapidly in the 21st century, it is important to understand the main trends of change taking place in the technology sector so as to identify ways in which society can take advantage of not only current technologies but also emerging technologies. At present, the relationship between Artificial Intelligence and creativity can be seen in the form of four major concepts: social, emotional, technical and learning factors. Artificial Intelligence is a branch of computer science that uses machine learning techniques to simulate human intelligence. Uses. Artificial Intelligence is considered to be equivalent to human capabilities that can understand the needs and emotions of other intelligent beings. Scientists are required to further develop and innovate in the field of Artificial Intelligence regarding both the advantages and disadvantages of innovation research and development. After thinking about it, he should take a decision and move forward. It is clear from the literature on the ethics of artificial intelligence that apart from its enormous benefits, there are also many challenges that come with the development of artificial intelligence in terms of ethical values, behavior, trust and privacy. In which security and privacy, loss of human decision making, bias, making humans lazy, these are the most common and challenging in the present era. Despite these challenges, artificial intelligence is growing at a fast pace to remain relevant in the rapidly changing field of educational technology. It is providing important opportunities to empower the society with new dimensions of development. Such as building intellectual and institutional capacity in educational technology, articulating new directions for research and innovation, promoting personal knowledge and practice, as well as providing tuition, educational support, feedback, social support in the applications of artificial intelligence in educational opportunities. Robots, admissions, grading, analysis, trial &error and virtual reality, etc. artificial Intelligence can help in strengthening the skills and testing system. Through Artificial Intelligence we can provide high quality affordable and accessible education to various sectors of the society. The risk of ethical considerations will also depend on the technical quality. Higher quality will outweigh the risk but is it possible to implement high quality expensive technology for all educational institutions. Furthermore, we need to ensure that artificial intelligence is developed with diversity and inclusivity in mind, so that it serves all members of society and does not perpetuate existing biases and discrimination. Conclusion: We can say that the impact of Artificial Intelligence on society is both exciting and challenging

Key words: Artificial intelligence, Education system, Technology

1. INTRODUCTION

Technological changes are happening rapidly in the 21st century. Artificial Intelligence has become one of the most transformative technologies of the 21st century, impacting every aspect of our lives. From the way we work and learn to the way we communicate and interact with each other. Artificial intelligence is a broad branch of computer science that deals with the creation of smart machines capable of performing such tasks. Artificial intelligence is the intelligence displayed by machines as opposed to the natural intelligence displayed by humans and other animals. Colloquially, the term "artificial intelligence" applies when a machine mimics the cognitive functions of humans. Developing the ability to correctly interpret, learn, and use external data from a system to accomplish specific goals and tasks. Artificial intelligence is a branch of computer science that develops machines and software with intelligence. In 1955, John McCarthy named it artificial intelligence and defined it as "the science and engineering of creating intelligent machines". The goals of artificial intelligence research include reasoning, knowledge planning, learning, perception and ability to manipulate objects, etc.Artificial intelligence is known as the fourth industrial revolution in the world. Which is not only changing the way we work but is also changing the way we form relationships. Of all the creatures on this world, man is the most intelligent. Man has made maximum development in civilization on the basis of his intellectual skills. In such a situation, it is necessary to understand the main trends of change taking place in the field of technology so that those ways can be identified in which the society can take advantage of not only the current technologies but also the emerging technologies.

2. CHALLENGES

For further development and innovation in the field of artificial intelligence, scientists should think about both the advantages and disadvantages of innovation research and development and then take a decision on it and move ahead. It is clear from the literature on the ethics of artificial intelligence that in addition to its enormous benefits, the development of artificial intelligence also brings challenges in terms of ethical values, behavior, trust and privacy. For example –

Technological addiction sets a limit for humans. Artificial Intelligence is already being used to direct human attention and take over certain tasks.

One of the most prominent challenges presented by Artificial Intelligence is the series of ethical dilemmas it raises. As AI systems become more autonomous and capable of making decisions, questions are beginning to arise about accountability and responsibility. The ambiguity of some artificial intelligence algorithms makes it difficult to understand how certain decisions are made, making it challenging to assign blame or understand the underlying biases that may be present. Additionally, Artificial Intelligence has the potential to amplify existing social biases. If AI systems are trained on biased datasets, they can perpetuate discrimination and inequality. Artificial Intelligence systems process large amounts of personal data to make informed decisions, so there is a risk of sensitive information falling into the wrong hands. As AI becomes more sophisticated, there are fears that it could be misused for malicious purposes. This raises serious ethical and security concerns.

3. OPPORTUNITIES

Despite these challenges, to remain relevant in the rapidly changing field of educational technology, artificial Intelligence is providing important opportunities to empower the society with new dimensions of development at a rapid pace.

•Artificial Intelligence has the most profound impact on the workforce. This has the potential to improve efficiency and reduce costs. By automating repetitive and low-value tasks, AI frees up human workers to focus on higher-level activities that require creativity, critical thinking and empathy.

•AI has the potential to exceed some of the limits of human computing power, intelligence, and possibly imagination. This is opening new doors for the use of AI in areas like manufacturing, law, medicine, healthcare, education, governance, agriculture, marketing, sales, finance, operations and supply chain management, delivery of public services and cyber security.

•In the field of education, AI provides intelligent game-based learning environments, teaching methods and interpretation technologies. In this area it can be used to increase the effectiveness of teachers and interest of students.

• Eye-enabled personalization can help in the development of customized learning environments based on the individual student's learning profile and ability, learning styles and experiences, and use smart assistance and related technologies such as Amazon Alexa, Google Home, Apple Siri and Microsoft Cortana. The use can be very helpful for students.

• Through the teaching of contemporary topics like Artificial Intelligence and Design Thinking, school children will be exposed to important skills like digital literacy, coding and computational thinking from an early age.

• Additionally, subjects such as artificial intelligence, 3-D machining, big data analytics and machine learning will be integrated with undergraduate education to train industry-ready professionals.

• The impact of AI on health care is another area of significant growth. With the ability to quickly and accurately analyze large amounts of data, AI-powered systems can improve patient outcomes. And can reduce health care costs.

• AI has the most profound impact on the work force. It has the potential to improve efficiency and reduce costs. By automating repetitive and low-value tasks, AI frees up human workers to focus on higher-level activities that require creativity critical thinking and empathy.

4. IMPACT ON SOCIETY

The impact of AI on society is both exciting and challenging. AI has the potential to change the way we work, communicate, and interact with technology, but it also raises concerns about job displacement, bias and the potential for discrimination and abuse. It is therefore vital that we address these concerns and work to ensure that the benefits of AI are shared by all members of society. This requires a multidisciplinary approach that includes technology, ethics and policy. Brings together experts from different fields we also need to ensure that AI is developed with diversity and inclusivity in mind, so that it serves all members of society and does not perpetuate existing biases and discrimination. We also need to consider the impact of AI on the future of work and the workforce, and ensure that we are creating opportunities for workers to upskill and re-skill so they can thrive in a world where Where AI is playing an increasingly important role.

5. CONCLUSION

Based on the analysis, it can be said that the possibilities hidden in artificial intelligence technology have a much more positive impact than the challenges it creates. Therefore, all the communities of the world should move forward unitedly to further promote artificial intelligence technology and move towards global well-being and human well-being through this technology. It is present in our lives and education systems today with the help of which we can make the lives of both students and teachers easier. Artificial intelligence provides every student the opportunity to receive quality education and makes the learning process personalized. If it is used properly then it will prove to be a major boon for the human world and will make human life simple and easy.

REFERENCES

[1] Kumar and Anand (2017) Artificial Intelligence and Future Fears. International Journal of Scientific and Innovative Research Studies,(5),ISSN:2454-1818

[2] Arya and Lal Mohan (2021). Teacher Artificial Intelligence in Education: Role and Development. Journal of interdisciplinary cycle research,(XIII), ISSN No:0022-194

[3] Adamson, D., Dyke, G., Jang, H., & Rosé, C. P. (2014). Towards an agile approach to adapting dynamic collaboration support to student needs. *International Journal of Artificial Intelligence in Education*, *24*(1), 92–124.

[4] Arroyo, I., Woolf, B. P., Burelson, W., Muldner, K., Rai, D., & Tai, M. (2014). A multimedia Adaptive tutoring system for mathematics that addresses cognition, metacognition and affect. *International Journal of Artificial Intelligence in Education*, *24*(4), 387–426.

[5] J., Baker, D.J., Beck, J. (2006) Adapting to When Students Game an Intelligent Tutoring System. Proceedings of the 8th International Conference on Intelligent Tutoring Systems, 392–401.7.

[6] Burns, L. M., Perkins, S. C., & Orth, D. (1994). A neural network approach to automatic recognition of children's handwriting. *Journal of Artificial Intelligence in Education*, *5*(3), 349–369.

[7] https://indiaai.gov.in/article/how-india-is-integrating-ai-in-the-new-education-policy

Role of Artificial Intelligence in Digital Marketing: Challenges and Opportunities

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ABSTRACT

Artificial Intelligence (AI) is one of the emerging technologies for nation's industrial and economic development. The economic landscape is poised for a profound shift with the increasing integration of AI. Recognised as a powerful force for transformation, AI is becoming a global driver of change across businesses, societies, and Governments. This technology's adoption is escalating, promising improvements in productivity and efficiency. For India, standing as the fifth - largest global economy; navigating the challenges and harnessing the potential of AI is crucial for sustained growth and societal betterment. Artificial Intelligence has become a crucial part to revolutionise several industries including the market. This paper discuss how AI technologies transform various aspects of digital marketing enabling businesses to enhance customer experiences , optimise advertising campaigns, improving customer segmentation and improve the overall marketing effectiveness. AI powered tools can analyse vast amount of data to uncover insights, predict customer behaviour and recommend the most effective marketing strategies. From chat bots and virtual assistants to predictive analytics and content optimisation , AI is reshaping the way businesses engage with their audience and drive results in the digital landscape.

Keywords: Artificial Intelligence, Digital Marketing, Chatbots, Customer Segmentation

1. INTRODUCTION

In today's era, Artificial Intelligence has emerged from a theoretical concept to a tangible life transforming phenomenon. For decades, AI was a well known challenge, marked by alternating cycles of optimism and despondency with enhancement remaining elusive. The land escape shifted from the emergence of GPU's, increased AI compute power, the advent of large language models from industry leaders like Open AI and Deep Mind, tech giants such as Google, Meta, Microsoft and Tesla. The digital economy, currently outpacing GDP growth rate at 2.5 - 2.8 times to poised to contribute a substantial 20% to the GDP by 2026 , marking a significant surge from the modest 4.5 % in 2014 and the current 11%. In this transformative journey AI played a pivotal role, a force that the government is actively shaping through the comprehensive mission named 'India AI' . India's approach as articulated by our Honorable Prime Minister Shri Narendra Modi Ji leading up to the Global Partnership on Artificial Intelligence (GPAI) Summit 2023. The initiative has bought 29 member countries with the aim to narrow the gap between AI theories an d practices by supporting advanced research and practical activities in AI related areas. Many modern technologies are increasing productivity, automating processes, and computing solutions to make our society smarter. Among them is artificial intelligence. Artificial intelligence refers to technological advancements that allow computers or other machines with human-like intelligence to carry out tasks akin to those carried out by the human brain (Dr. N. Thilagavathy, 2021).Even though artificial intelligence is an essential part of our lives, we occasionally fail to recognise it. A simple illustration of AI is the possibility that traffic will prevent you from arriving at work on time if you drive there. By integrating real-time traffic data into software, artificial intelligence (AI) is assisting in cutting down on travel time by keeping you informed about accidents, congestion. AI is present in many web technologies, including SIRI, Google, email, Facebook, Alexa, Amazon, Instagram, Netflix, and Pandora. We are heavily reliant on such technologies. Artificial intelligence is present everywhere.

AI is now used in digital marketing as a background technology. Users gain a greater understanding of digital marketing, including pay-per-click advertising, website personalisation, content creation, and behavioural prediction.AI and machine learning are increasingly being used by businesses due to their benefits. AI can help organisations improve their digital marketing in two ways. According to (Sasikumar, 2022) , businesses utilise AI to estimate product demand, create client profiles, and enhance the consumer experience, resulting in increased brand strength and revenue. AI technology can streamline and accelerate marketing tasks, improve consumer experiences, and increase conversions. But still many markets do it understand the benefits of AI over traditional marketing methods (Brenner 2020) . Digital marketing refers to doing advertising marketing, and promotion using digital channels such as website, social media, and email or search engine. Using these digital channels organisations can reach to their customers. There are varioustypes of digital marketing such as content marketing, SEO, social media marketing, email marketing, affiliate marketing etc. Traditional marketing use offline methods like billboard, print to do advertisements. AI applications in digital marketing can sift through billions of data points on the internet and point out precisely what it needs to know for business. It will elaborate what price will get the most conversions, when is the best time to post, what subject line will get the most attention, etc. Intelligent marketers stay current with all trends. It simplifies jobs and allows for more creativity and out-of-the-box thinking.

2. LITERATURE REVIEW

In this paper the author has focused on the role of AI in digital marketing to change consumer behaviour . If AI is used in digital marketing it will ease in t to reach the right customer at right time.AI helps the firms to get the perception of the consumer needs which boosts sale and revenues. The paper also explains the challenges and also identifies the relevant tools and technologies which help the marketer to effectively implement the AI in digital marketing. (Khatri, 2021).

In this research paper the author has highlighted on how AI drive digital marketing and role of AI in marketing. The paper focuses on the impact of AI in the e-commerce industry and the recent strategies followed by marketers to promote their products and services. AI is the most trending topic and is being used in the various field of digital marketing. (Mohana, 2020)

In this article the author had tried to examine the determinants behind the acceptance of the AI wearable. The article also highlighted on the issues related to adoption of AI wearables. (Sulkowski & Kaczorowska-Spychalska, 2021)

In the research paper titled "Digital Transformation 4.0: Integration of AI & Met averse in Marketing, "explored the integration of AI and the met averse in marketing. The paper discussed the potential of AI and the metaverse to revolutionise marketing strategies and enhance customer experiences. The paper emphasised that this integration can lead to personalised marketing campaigns, improved customer engagement, and increased brand loyalty. The paper provided insights into how businesses can leverage AI and the metaverse to create immersive virtual experiences for customers, enabling them to interact meaningfully with products and services. (Bharti Rathore, 2023).

This article examined how AI functions in digital marketing. The goal of the study was to comprehend how AI developments may boost customer interaction and marketing tactics. In order to analyze the body of knowledge already available on AI in digital marketing, the authors did a thorough literature study. They identified various applications of AI, such as chat bots, recommendation systems, and predictive analytics. They also discussed the benefits and challenges associated with implementing AI in digital marketing, emphasizing the need for organizations to adapt to this technology-driven era. (Hadalgekar and Desai, 2023)

2.1. Data and Sources

The study is based on the secondary data sourced from various data base like research articles, google scholar, journals, blogs and articles published in websites.

3. RESEARCH OBJECTIVE

To explore the role of Artificial Intelligence (AI) in digital marketing

To study the various applications of Artificial Intelligence in digital marketing and To under the opportunities and challenges associated with implementing Artificial Intelligence in digital marketing strategies.

4. ARTIFICIAL INTELLIGENCE: ROLE IN THE INDIAN ECONOMY

The term Artificial Intelligence was firstly used by McCarthy in 1956. Now the term become a buzzword after the advent of Generative AI and the launch of ChatGPT by OpenAI. Today AI can be harnessed to solve societal challenges in healthcare , agriculture, education, build innovative products and services, increase efficiency ,raise competitiveness and enable economic growth contributing towards a quality and improved life. India has formulated a distinctive approach to digital transformation through the "Digital India" programme. The Indian Stack projects on digital identity (Aadhar) , Digital payment's and Digilocker helped to drive the economic pace of the country. India is strategically poised to employ AI to transform public service delivery for efficiency in governance, innovation and improved citizen engagement. In a recent report on GenAI India holds the potential to contribute up to 1.5 trillion dollars to India's GDP by 2030. The rapidly increasing landscape in India is further exemplified by a robust startup ecosystem ,ranking 5th in the number of newly funded AI companies by geographic areas and attracting $475 million in GenAI startup's in the past two years.

Artificial intelligence (AI) is making significant strides in the Indian market across various sectors, including:

1. Healthcare: AI-powered healthcare solutions are being used for medical imaging analysis, diagnosis, personalised treatment plans, and remote patient monitoring. These technologies help improve healthcare access, efficiency, and patient outcomes.
2. Finance: In the financial sector, AI is utilised for fraud detection, risk assessment, algorithmic trading, and customer service automation. AI-powered chatbots and virtual assistants are also being deployed by banks and financial institutions to enhance customer experiences.
3. E-commerce: Indian e-commerce companies leverage AI for personalised recommendations, demand forecasting, inventory management, and customer support. AI algorithms analyse user behaviour and preferences to deliver targeted product recommendations and optimise the online shopping experience.
4. Education : AI technologies are transforming the education sector by enabling personalised learning experiences, adaptive tutoring systems, and automated grading systems. AI-powered platforms provide students with customised learning paths based on their individual strengths, weaknesses, and learning styles.
5. Agriculture: In agriculture, AI-driven solutions are used for crop monitoring, yield prediction, pest detection, and soil analysis. These technologies help farmers make data-

driven decisions, optimise resource allocation, and improve crop productivity.

6. Manufacturing:AI is revolutionising the manufacturing industry in India with applications such as predictive maintenance, quality control, supply chain optimisation, and autonomous robotics. AI-powered systems analyse production data in real-time to identify inefficiencies, reduce downtime, and enhance productivity.

7.Smart Cities: Indian cities are adopting AI-powered smart city solutions to improve urban infrastructure, transportation systems, public safety, and energy efficiency. AI algorithms analyse data from sensors, cameras, and other sources to optimise city operations and enhance citizen services.

Overall, AI is playing a crucial role in driving innovation, productivity, and economic growth across various sectors in the Indian market. As AI adoption continues to expand, it is expected to have a transformative impact on businesses, government services, and society as a whole.

5. ARTIFICIAL INTELLIGENCE IN DIGITAL MARKETING

With the use of virtual assistants and machine learning-based recommendations, artificial intelligence (AI) can build simulation models and customise the shopping experience. Artificial Intelligence has become a popular tool for brands to communicate with their customers. Similar to how Amazon utilises AI to suggest goods based on users' past searches, views, and purchases. These days, we have marketing automation tools similar to different CRMs that facilitate efficient client service and data management. We are making progress every day in integrating artificial intelligence into several business sectors. According to projections, the commercial application of artificial intelligence (AI) technologies and more individualised and successful marketing techniques will account for 45% of economic earnings by 2030.

AI has been a game-changer in digital marketing, especially post-COVID-19. Its ability to analyse vast amounts of data, personalise content, optimise campaigns, and automate tasks has accelerated digital marketing efforts. Marketers are leveraging AI-driven tools for targeted advertising, content creation, customer segmentation, and predictive analytics, leading to more efficient and effective campaigns. This acceleration has been driven by the need to adapt to changing consumer behaviour's and preferences in the digital landscape, which intensified during the pandemic. AI has revolutionised digital marketing by enabling marketers to analyse data more effectively, personalise experiences, automate tasks, and optimise campaigns.

6. OPPORTUNITIES

Personalisation: AI algorithms analyse customer data to deliver personalised content, recommendations, and offers tailored to individual preferences and behaviour's, enhancing user engagement and conversion rates.One of the most important advantages of AI in marketing is its ability to offer enhanced personalisation.

Predictive Analytics: AI-powered predictive analytics forecast future trends and customer behaviour's based on historical data, helping marketers make data-driven decisions and anticipate market shifts.

Chatbots: AI chatbots provide instant customer support, answer queries, and guide users through purchasing processes, improving customer service and driving sales.

Content Generation: AI tools can generate content such as product descriptions, social media posts, and email subject lines, saving time and resources for marketers while maintaining quality and relevance.

Ad Targeting: AI algorithms analyse user data to target advertisements more accurately, increasing ad relevance and effectiveness while reducing costs and improving ROI.

Marketing Automation: AI automates repetitive tasks such as email marketing, lead scoring, and campaign optimisation, freeing up marketers to focus on strategy and creativity.

Sentiment Analysis: AI-powered sentiment analysis tools monitor social media and other online platforms to gauge public opinion, identify trends, and measure brand sentiment, enabling marketers to tailor their messaging accordingly.

Overall, AI empowers marketers to create more personalised, efficient, and data-driven digital marketing campaigns that resonate with their target audience and drive business growth.

7. CHALLENGES

Despite the opportunities, AI also brings several challenges that marketers must take into consideration.

Data Privacy Concerns : As AI relies heavily on data, issues around data privacy are a significant concern. Marketers must ensure they are compliant with data protection regulations like GDPR and have robust security measures in place to protect customer data. This means that businesses need to be transparent about how they use customer data and ensure they have the necessary permissions to collect and use this data.

High Implementations costs : Implementing AI can be expensive, particularly for small and medium-sized enterprises (SMEs). The costs of purchasing and maintaining AI software, coupled with the need for skilled personnel to manage it, can be prohibitive. Moreover, integrating AI into existing systems and processes can also be a complex and costly process, which may deter some businesses from adopting AI.

Lack of understanding and trust : Many people still lack a clear understanding of AI, leading to mistrust and resistance to its adoption. Therefore, businesses need to invest in education and transparency to overcome these barriers. This includes explaining what AI is, how it works, and how it can benefit customers in understandable terms. It also involves addressing common misconceptions and fears about AI, such as job displacement and loss of human touch in customer interactions.

Data Quality and Accuracy: AI algorithms require high-quality, accurate data to produce reliable insights and predictions. Poor-quality or biased data can lead to flawed analysis and decision-making, undermining the effectiveness of marketing campaigns.

Algorithm Bias: AI algorithms can perpetuate and amplify biases present in the data they are trained on, leading to unfair or discriminatory outcomes. Marketers must be vigilant in identifying and mitigating bias in AI models to ensure fairness and equity in their marketing efforts.

Skills Gap: Implementing AI-driven marketing strategies requires specialised skills and expertise in data science, machine learning, and AI technologies. Many marketers may lack these skills, creating a skills gap that can hinder the adoption and effective use of AI in digital marketing.

Integration and Compatibility: Integrating AI technologies with existing marketing systems and platforms can be challenging, particularly for legacy systems that may not be designed to accommodate AI capabilities. Marketers must ensure seamless integration and compatibility to maximise the benefits of AI in their marketing efforts.

Ethical Considerations: AI raises ethical concerns around issues such as transparency, accountability, and consent. Marketers must navigate these ethical considerations responsibly, ensuring transparency in how AI is used and respecting customer preferences and rights.

Lack of emotional intelligence : AI struggles with understanding human emotions and empathy. While AI can analyse customer data and responses at scale, it lacks the emotional quotient that humans possess. This can be problematic when communicating with customers, especially during negative experiences. AI may come across as robotic, impersonal or tone-deaf in sensitive situations.

Bias and unfairness : models are only as good as the data used to train them. If the training data contains biases, the AI can reflect and even amplify those same biases. This can negatively impact marginalised groups and lead to unfair experiences. Marketers need to be extremely thoughtful about detecting and mitigating bias when developing AI systems.

By addressing these challenges proactively and responsibly, marketers can harness the power of AI to enhance their digital marketing efforts and drive better results for their businesses.

8. CONCLUSION

The impact of AI on marketing is profound, offering tremendous opportunities for personalisation, predictive analysis, and efficiency. However, marketers must also navigate challenges related to data privacy, high costs, and a lack of understanding about the technology. By addressing these issues head-on, businesses can harness the power of AI to drive their marketing efforts and achieve unprecedented success. As AI continues to evolve, it will undoubtedly play an increasingly central role in shaping the future of marketing. Unquestionably, the introduction of artificial intelligence into digital marketing has ushered in a revolutionary period. Artificial Intelligence provides a toolkit that promises efficiency, customisation, and deeper insights as marketers and companies adapt in this dynamic marketplace. The possibilities are endless and constantly changing, ranging from highly targeted advertising campaigns and real-time market assessments to the smooth integration of IoT devices and predictive content creation.

But like any strong weapon, the real magic is in how you utilise it. Whether it's potential biases in AI algorithms, ethical issues surrounding data use, or technical integration problems, brands need to overcome them all. Not only should AI be used, but it should be done so ethically, openly, and with a clear emphasis on improving user experiences. Without a doubt, artificial intelligence has changed how brands interact with their audiences and revolutionised modern marketing techniques. AI is giving marketers the tools they need to make wise decisions and provide great consumer experiences, from data-driven insights to personalised interactions. AI technology's involvement in marketing will only increase as it continues to advance, giving rise to more creative and effective business-winning tactics.

REFERENCES

[1] Hassan, A. (2021). The Usage of Artificial Intelligence in Digital Marketing : A Review. Applications of Artificial Intelligence in Business, Education and Healthcare, 373-383

[2] Thilagavathy, N. & Kumar , E.P (2021). Artificial Intelligence on digital marketing- An overview of. Nat. Volatiles & Essent. Oils.

[3] Desai, V. (2019). Digital Marketing: A Review. International Journal of Trend in Scientific Research and Development (IJTSRD).

[4] Chaffey, D. & Ellis- Chadwick, F. ,(2019) . Digital Marketing . Pearson Education Limited.

[5] Russell, J.,& Norvig , P (2021) . Artificial Intelligence: A modern Approach. Pearson Education Limited.

[6] S. Verma, R. Sharma, S. Deb, D. MaitraArtificial intelligence in marketing (2021): systematic review and future research direction. Int. J. Inf. Manag. Data Insights, 1 (1) , Article 100002

[7] S. Dimitrieska, A. Stankovska, T. Efrimova Artificial Intelligence and marketingEntrepreneurship, 6 (2) (2018), pp. 298-304 http://yojna.gov.in

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

An Optional Randomized Response Model with Forced Answer Strategy for Enhanced Estimation of Sensitive Attribute Proportions

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ABSTRACT

The randomized response technique is a well-recognized survey method for estimating sensitive attributes. Researchers have developed numerous randomized response models offering enhanced respondent privacy and sensitivity. This paper presents a new forced optional randomized response technique, suitable when the sensitivity level of the attribute is known. The proposed procedure demonstrates superior efficiency compared to existing randomized response techniques and ensures more privacy protection for respondents possessing the sensitive attribute. A simulation study validates the superiority of this technique.

Keywords: Forced randomized response, sensitive attribute, estimation, sensitivity level.

1. INTRODUCTION

In surveys addressing sensitive attributes, randomized response techniques (RRT) offer enhanced privacy protection while acquiring reliable estimates (Warner, 1965). Warner's (1965) seminal binary randomized response technique (also known as the related or indirect question technique) pioneered methods for eliciting truthful responses to sensitive inquiries. Horvitz et al. (1967) later proposed an adaptation designed to increase respondent cooperation and response accuracy – the unrelated question RRT – which was further developed by Greenberg et al. (1969). Researchers have since introduced diverse RRT variations, including forced answer, two-stage, and optional RR techniques (Chaudhury & Mukherjee, 1976; Chaudhury et al., 2016; Fox & Tracy, 1987). Boruch (1971) introduced the forced answer RRT, where respondents were compelled to answer "yes" or "no" to a sensitive question regardless of their actual status. Mangat et al. (1995) mirrored this concept with a randomized response device using three distinct card types in a forced answer strategy.Choi (2010) proposed an improved forced answer technique, demonstrating its efficiency advantage under specific conditions compared to Warner's (1965) method. Couts and Benjann (2011) evaluated the effectiveness of various RRT implementations using a forced response design within a computer-assisted setting.

Liu and Chow (1976a, 1976b), Gjestvang and Singh (2007), and Odumade and Singh (2008) all proposed additional variations on the forced answer strategy. Notably, the models developed by Gjestvang and Singh (2007) and Odumada and Singh (2008) estimate the average value of a quantitative sensitive variable, while those by Liu and Chow (1976a, 1976b) are solely applicable to estimating the proportion of a sensitive attribute.Tiwari and Mehta (2017) introduced the two-stage group testing RRT approach, while Tiwari and Pandey (2022) proposed the two-stage forced answer technique for sensitive attribute estimation.

Eichhorn and Hayre (1983) pioneered the scrambled quantitative response method, specifically designed to address sensitive questions with numerical answers. Later, Gupta et al. (2002) developed an optional randomized response technique (RRT) where respondents have the autonomy to either provide a truthful response or scramble their answer based on their perceived sensitivity of the question.This sensitivity level, denoted by the symbol 'ω', represents the proportion of respondents who deem the question sensitive.Optional RRT models are applicable to both binary (qualitative) and quantitative data collection scenarios.

Arnab (2004) proposed an alternative optional randomized response (ORR) model for an arbitrary sampling design. Gupta *et al.* (2010) estimated simultaneously the mean and the sensitivity level of a quantitative response sensitive question using a two-stage optional RRT model. Mehta *et al.* (2012) proposed a three stage optional randomized response model in which a known proportion (T) of the respondents is asked to tell the truth, another known proportion (F) of the respondents is asked to provide a scrambled response and the remaining respondents are instructed to provide a response following the usual optional randomized response strategy where a respondent provides a truthful response (or a scrambled response) depending on whether he/she considers the question non-sensitive (or sensitive).Chhabra *et al.* (2016) proposed a three-stage optional unrelated question RRT model for both binary and quantitative response situations which combines the essence of Sihm *et al.* (2016) model and the three-stage optional additive RRT model proposed by Mehta *et al.* (2012).Hussain and Al-Zahrani (2016) proposed an improved model based on the randomized response model of Gupta *et al.* (2006) to estimate mean and sensitivity level. The estimators suggested by Hussain and Al-Zahrani (2016) were unbiased and performed better than those suggested by Gupta *et al.* (2006).

Tiwari and Mehta (2016) proposed an improved methodology for RRT in which the sensitivity level (ω) was considered to be known and the RR technique was applied only for those respondents who considered the particular question a sensitive one. The study established that the variance of proposed estimator was less than the variance of the estimators suggested by Warner (1965) and Mangat and Singh (1990) under specific conditions. Tiwariand Mehta (2017) also proposed an improved optional randomized response technique for quantitative variable.

As far as the optional randomised response methods are concerned, no forced answer model is suggested by any researcher till now. In the presentstudy, we have investigated a forced answer randomised response model with known sensitivity level. The superiority of the proposed model has been established with the help of a simulation study. A brief description of some RRTs concerning the present work has been given in Section 2. In Section 3, the proposed model has been discussed. The properties of the proposed estimator have been discussed in Section 4. Efficiency of the proposed model has been compared with Warner's (1965) RRT, Mangat and Singh (1990) two stage related RRT and Tiwari and Mehta (2017) RRT in Section 5.InSection 6, the basic idea of privacy protection of respondents in RRT is discussed and assimilation study is carried out to establish the superiority of the proposed model over the existing RRT models in terms of privacy protection. In Section 7, the results of the proposed study are discussed.

2. BRIEF DESCRIPTION OF VARIOUS RANDOMISED RESPONSE TECHNIQUES

Suppose we want to estimate the relative size π of acertain group'A' in a given population, where the members of the group 'A' are characterized by some socially unaccepted or illegal activity. In such a case, it is obvious that the members of 'A 'will be reluctant to disclose the fact that they belong to the group 'A'. Using these assumptions, few of the randomized response techniques which are concerned with the proposed study are discussed in the following sub-sections.

2.1. Forced Answer Technique (Boruch, 1971)

In this technique, each respondent in an SRSWR sample of n respondentsis forced by a randomdevice toeither answer the sensitive questionor to give a forcedresponse (yes or no) regardless ofhis/her actual situation. Let P_1 and P_2be the probabilities of forced answers 'yes' and 'no' respectively then the probability of an honest answer will be $1-P_1-P_2$. Let π be the true proportion, then the probability of a 'yes' answer is

$$\lambda = \pi - P_2\pi + (1-\pi)P_1,$$

where $P_1 + P_2 < 1 \; and \; \lambda \geq P_1$. The unbiased estimate of π in the sample is given by

$$\hat{\pi}_F = \frac{\hat{\lambda} - P_1}{(1-P_1-P_2)}$$

Here$\hat{\lambda} = \frac{r}{n}$. Since r, number of 'yes' responses in the sample, follows a binomial distribution with parameters (n, λ), the variance of $\hat{\pi}_F$ is given by,

$$Var(\hat{\pi}_F) = \frac{\pi(1-\pi)}{n} + \frac{P_2(1-P_2)\pi + P_1(1-P_1)(1-\pi)}{n(1-P_1-P_2)^2} \quad (1)$$

2.2. Optional randomised response technique (orrt) (gupta *et al.*, 2002)

This model is based on the assumption that some population proportion does not feel a particular question to be sensitive and as such they can give direct answer to that question, if they get the option to answer truthfully. Accordingly, they are provided an opportunity to answer truthfully and rest of the people who feel that the question is sensitive follow the method given by Warner (1965). The entire process takes place without the knowledge of the interviewer and maintains the privacy of the respondents. If ω be the sensitivity level and P_y be the probability of 'yes' response, then

$$P_y = (1-\omega)\pi + \omega\{\pi P + (1-\pi)(1-P)\}$$

Or

$$P_y - \pi = (P-1)(2\pi-1)\omega$$

In this model π and ω are two unknown parameters, hence two samples were needed to estimate π and ω with the sample sizes $n_1$and n_2 respectively. Hence, we have

$$P_{y_1} - \pi = (P_1-1)(2\pi-1)\omega$$

and

$$P_{y_2} - \pi = (P_2-1)(2\pi-1)\omega$$

Solving the above equations for π, we get

$$\hat{\pi}_g = \frac{\lambda\hat{P}_{y_2} - \hat{P}_{y_1}}{\lambda - 1},$$

where $\lambda = \frac{P_1-1}{P_2-1}$

The variance of the estimate was given by,

$$Var(\hat{\pi}_g) = \frac{1}{(\lambda-1)^2}\left\{\lambda^2\frac{P_{y_2}(1-P_{y_2})}{n_2} + \frac{P_{y_1}(1-P_{y_1})}{n_1}\right\}$$

And the estimator for sensitivity level (ω) was given by

$$\hat{\omega}_g = \frac{\hat{P}_{y_1} - \hat{P}_{y_2}}{2\hat{P}_{y_1}(1-P_2) - 2\hat{P}_{y_2}(1-P_1) - (P_1-P_2)}$$

2.3. Improved Two Stage Optional RRT Model (Tiwari and Mehta, 2016)

Tiwari and Mehta (2016) proposed an improvement over the methodology for RRT developed by Gupta *et al.*(2002)

and Sihm and Gupta (2014), in which the sensitivity level (ω) was considered to be known and the RR technique was applied only for those respondents who considered the particular question a sensitive one. The probability of ‘yes’ answer in this case was given by

$$\lambda = (1-\omega)\pi + \omega\{\pi T + (1-T)[P\pi + (1-\pi)(1-P)]\}$$

The estimator of π was obtained as,

$$\hat{\pi}_{tm} = \frac{\hat{\lambda} - \omega(1-T)(1-P)}{\{1-2\omega(1-P)(1-T)\}},$$

where $\hat{\lambda} = r/n$, r is the number of ‘yes’ responses obtained in the sample. The variance of the estimator was obtained as,

$$Var(\hat{\pi}_{tm}) = \frac{\lambda(1-\lambda)}{n\{1-2\omega(1-P)(1-T)\}^2}$$

Tiwari and Mehta (2016) established with the help of numerical examples that the variance of proposed estimator was less than the variance of the estimators suggested by Warner (1965) and Mangat and Singh (1990) under specific conditions.

3. The Proposed Model

In the proposed model, the concept of sensitivity level has been used to estimate the proportion of individuals possessing a sensitive attribute. The population proportion, who considers the question sensitive is known as sensitivity level and denoted by ω (0 < ω < 1). If ω is close to 1 then it is considered that the question is highly sensitive. So, if some of the respondents feel that the question is not sensitive and can give direct response then we separate them from the remaining sample and in this way, we can estimate the sensitivity level of the population. Elaborately, suppose out of 100 respondents in a sample, 10 respondents do not feel that the question is sensitive and desires to give a direct response. Then the sensitivity level in the sample is estimated to be 0.90. In the proposed model, we accept the direct answer from the respondents who find the question to be non-sensitive and rest of the respondents who feels the question sensitive (ω) give the response using forced answer strategy. Since in the proposed model the value of ω is already known to us, there is no need to take two samples to estimate the required population proportion, as proposed by Gupta et al. (2002). So, it would be practically easier for the interviewer to collect sensitive information using the proposed method.

In the proposed model, we separate the respondents who feel that the survey question isnon-sensitive and get the direct response from them. Remaining respondents were instructed to provide their response using forced answer technique. Let the probability of forced answer ‘yes’ be P_1, and the probabilityof forced answer ‘no’ be P_2. Then the probability of an honest answer will be$1 - P_1 - P_2$. The probability of gettinganswer ‘yes’ from the respondent using the aboverandomized response procedure is,

Probability (Yes responses) = (1 – ω) × direct response + ω × forced response.

$$\lambda = (1-\omega)\pi + \omega\{(1-P_2)\pi + P_1(1-\pi)\}$$

For the sake of simplicity, taking $U = (1-P_2)$and $V = P_1$. Here, $U + V = 1$, where U and V are contamination parameters of the model. It is worthnoting that the probability of honest response after considering these contamination parameters is U – V. Then, we have

$$\lambda = (1-\omega)\pi + \omega\{U\pi + V(1-\pi)\} \quad (4)$$

$$\lambda = \pi\{1-\omega(1-U+V)\} + \omega V$$

$$\lambda = \pi\{1-\omega(U+V-U+V)\} + \omega V$$

$$\lambda = \pi(1-2\omega V) + \omega V$$

If r is the number of ‘yes’ answers in the sample then an unbiased estimator of π(the true proportion) fromthe sample is straightforward to obtain and is given by,

$$\hat{\pi}_{FORRT} = \frac{\hat{\lambda} - \omega V}{(1-2\omega V)}$$

Where $\hat{\lambda} = \frac{r}{n}$ is the proportion of ‘yes’ answers obtained from the SRSWR sample of size n.

4. Properties of the Proposed Estimator

Since r is the number of ‘yes’ answers in a SRSWR sample of size n, it will follow a binomial distribution $B(n,\lambda)$ with parameters n and λ. Using this fact, the properties of proposed estimator $\hat{\pi}_{FORRT}$are summarized in the following sub-sections.

4.1. Unbiasedness

The proposed estimator $\hat{\pi}_{FORRT}$ is an unbiased estimator for population proportion π.

Proof: The expectation of the proposed estimator $\hat{\pi}_{FORRT}$is given by,

$$E(\hat{\pi}_{FORRT}) = E\left(\frac{\hat{\lambda} - \omega V}{(1-2\omega V)}\right)$$
$$= \frac{\lambda - \omega V}{(1-2\omega V)} \because r \sim B(n,\lambda)$$

Putting the value of λ from equation (4) in the above equation, we get

$$E(\hat{\pi}_{FORRT}) = \frac{(1-\omega)\pi + \omega\{U\pi + V(1-\pi)\} - \omega V}{(1-2\omega V)}$$
$$E(\hat{\pi}_{FORRT}) = \frac{\pi\{1-\omega(1-U+V)\} + \omega V - \omega V}{(1-2\omega V)}$$

$$E(\hat{\pi}_{FORRT}) = \frac{\pi\{1-\omega(U+V-U+V)\}}{(1-2\omega V)}$$
$$E(\hat{\pi}_{FORRT}) = \frac{\pi\{1-2\omega V\}}{(1-2\omega V)}$$
$$E(\hat{\pi}_{FORRT}) = \pi$$

4.2. Variance of the Estimator

The variance of the proposed estimator $\hat{\pi}_{FORRT}$ is given by

$$Var(\hat{\pi}_{FORRT}) = \frac{\pi(1-\pi)}{n} + \frac{\omega V(1-\omega V)}{n(1-2\omega V)^2}$$

Proof: The variance of the proposed estimator $\hat{\pi}_{FORRT}$is derived as

$$Var(\hat{\pi}_{FORRT}) = Var\left(\frac{\hat{\lambda}-\omega V}{(1-2\omega V)}\right)$$
$$= \frac{Var\,(\hat{\lambda})}{(1-2\omega V)^2}$$
$$= \frac{\lambda(1-\lambda)}{n(1-2\omega V)^2}$$

Putting the value of λ from equation (4) in the above equation, we get,

$$V(\hat{\pi}_{FORRT}) = \frac{\{\pi(1-2\omega V)+\omega V\}\{1-\pi(1-2\omega V)-\omega V\}}{n(1-2\omega V)^2}$$

Let,$\{\pi(1-2\omega V)+\omega V\} = a\pi + b$, where $a = (1-2\omega V)$ and $b = \omega V$,we will have

$$Var(\hat{\pi}_{FORRT}) = \frac{[a\pi+b][1-(a\pi+b)]}{na^2}$$
$$= \frac{(a\pi+b)-(a\pi+b)^2}{na^2}$$
$$= \frac{a\pi(1-2b)-a^2\pi^2+b(1-b)}{na^2}$$

Since

$$(1-2b) = \{1-2\omega V\} = a$$

Therefore,

$$Var(\hat{\pi}_{FORRT}) = \frac{a^2\pi-a^2\pi^2+b(1-b)}{na^2}$$
$$= \frac{a^2\pi(1-\pi)+b(1-b)}{na^2}$$
$$= \frac{\pi(1-\pi)}{n} + \frac{b(1-b)}{na^2}$$
$$= \frac{\pi(1-\pi)}{n} + \frac{\omega V(1-\omega V)}{n(1-2\omega V)^2}$$
$$Var(\hat{\pi}_{FORRT}) = \frac{\pi(1-\pi)}{n} + \frac{\omega V(1-\omega V)}{n(1-2\omega V)^2}$$

4.3. Estimate of the Variance

The unbiased estimate of the $Var(\hat{\pi}_{FORRT})$ is given by

$$\widehat{Var(\hat{\pi}_{FORRT})} = \frac{\hat{\lambda}(1-\hat{\lambda})}{(n-1)(1-2\omega V)^2},$$

where,$\hat{\lambda} = \frac{r}{n}$is the proportion of 'yes' answers obtained from the sample of size n.

5. RELATIVE EFFICIENCY OF THE PROPOSED ESTIMATOR

The following Table 1 illustrates the simulation results for the relative efficiency of different estimators under the study for different values of the parameters of Warner (1965) [W], Mangat and Singh (1990) [MS], Tiwari and Mehta (2016) [TM] and the proposed model [FORRT].

It is evident from Table 1 that the proposed procedure is always superior to Mangat and Singh's (1990) and Tiwari and Mehta (2016) procedures whenever the value of *U* – *V*is greater than the values of parameter *P* of Mangat and Singh's (1990) model. For example, at *T* = 0.50 and *P* = 0.50, the proposed estimator remains efficient until the value of *U*– *V*becomes smaller than the

value of *P*. Interestingly, at *U* – *V* = *P*, the proposed model and Tiwari and Mehta (2016) models are equally efficient.

It is worth noting that when the value of parameters *P* and *U* – *V*is the same then the proposed estimator is more efficient than Mangat and Singh's (1990) estimator and as efficient as that of Tiwari and Mehta's (2016) estimator.In Mangat and Singh's (1990) two stage related RRT model, it was found that for $T > \frac{(1-2P)}{(1-P)}$, model was more efficient than the Warner's related question model. From the simulation results illustrated in Table 1, it can be observed that the proposed estimator will be more efficient than Warner's (1965) estimator when $U - V > \frac{(1-2P)}{(1-P)}$.

6. PRIVACY PROTECTION OF RESPONDENTS

Lanke (1976) defined a measure for privacy protection of respondents in binary randomized response models. This privacy protection measure is based on the idea that higher the conditional probability $P(A/R)$of being classified in the sensitive group *A* by giving the response *R* ('yes' or 'no'), the more stigmatizing it is to give that response. The Lanke measure for any binary RRT is given by,

$$L_i = \max\left[P\left({}^{A}/_{Yes}\right), P\left({}^{A}/_{No}\right)\right];\ i = W, B, MS, TM, FORRT$$

Thus, any binary RR method with a smaller value of privacy measure (L) among the other binary RR methods may be considered to provide more privacy protection.In the proposed forced optional RRT model, the conditional probability that a respondent reporting 'yes' also belongs to sensitive group *A* can be determined by using Baye's probability rule as follows,

Table 1. Relative efficiency of proposed estimator for n = 1000,π = 0.50, T = 0.50, ω = 0.90at various levels of P and $U – V$.

P	$U–V$	$Var(\hat{\pi}_{FORRT})$	$Var(\hat{\pi}_W)$	$Var(\hat{\pi}_{MS})$	$Var(\hat{\pi}_{TM})$	RE(W)	RE (M&S)	RE(T&M)
0.30	0.30	0.0018	0.0016	0.0028	0.0018	0.86	1.52	1.00
	0.40	0.0012	0.0016	0.0028	0.0018	1.32	2.35	1.55
	0.50	0.0008	0.0016	0.0028	0.0018	1.89	3.36	2.21
	0.60	0.0005	0.0015	0.0027	0.0017	2.83	5.17	3.34
	0.70	0.0004	0.0015	0.0027	0.0017	3.88	7.09	4.58
0.40	0.30	0.0017	0.0062	0.0015	0.0011	3.55	0.85	0.63
	0.40	0.0011	0.0062	0.0015	0.0011	5.64	1.35	1.00
	0.50	0.0007	0.0062	0.0015	0.0011	8.36	2.00	1.48
	0.60	0.0005	0.0062	0.0015	0.0011	11.84	2.83	2.10
	0.70	0.0004	0.0062	0.0015	0.0011	16.25	3.88	2.88
0.50	0.30	0.0017	-	0.0009	0.0007	-	0.52	0.42
	0.40	0.0011	-	0.0009	0.0007	-	0.83	0.67
	0.50	0.0007	-	0.0009	0.0007	-	1.24	1.00
	0.60	0.0005	-	0.0009	0.0007	-	1.75	1.42
	0.70	0.0004	-	0.0009	0.0007	-	2.40	1.94
0.60	0.30	0.0017	0.0062	0.0006	0.0005	3.55	0.35	0.30
	0.40	0.0011	0.0062	0.0006	0.0005	5.64	0.55	0.48
	0.50	0.0007	0.0062	0.0006	0.0005	8.36	0.82	0.71
	0.60	0.0005	0.0062	0.0006	0.0005	11.84	1.16	1.00
	0.70	0.0004	0.0062	0.0006	0.0005	16.25	1.59	1.37
0.70	0.30	0.0017	0.0015	0.0004	0.0004	0.85	0.24	0.22
	0.40	0.0011	0.0015	0.0004	0.0004	1.35	0.38	0.35
	0.50	0.0007	0.0015	0.0004	0.0004	2.00	0.57	0.51
	0.60	0.0005	0.0015	0.0004	0.0004	2.83	0.81	0.73
	0.70	0.0004	0.0015	0.0004	0.0004	3.88	1.11	1.00

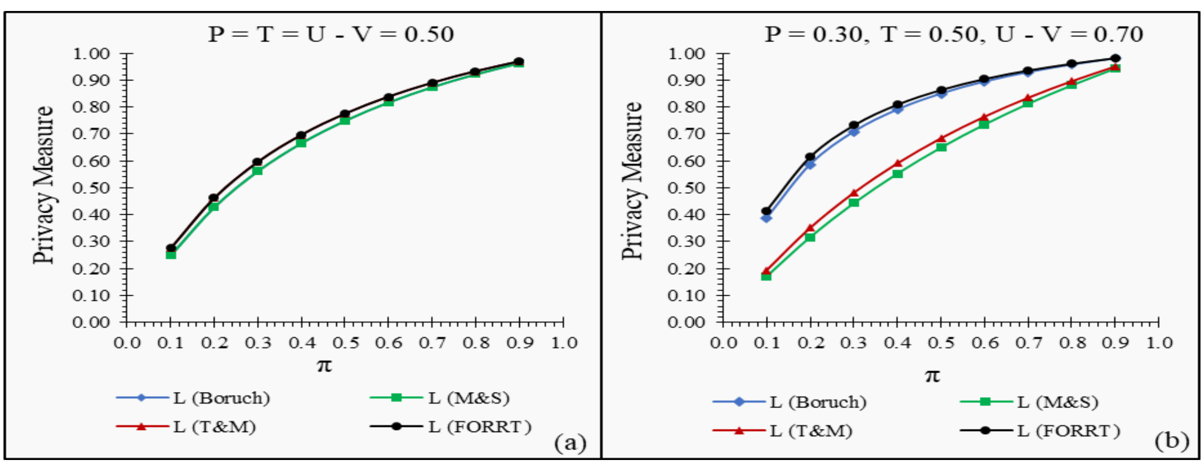

Figure.1. Measures of privacy protection for various values of π.

$$P(A/Yes) = \frac{P(A)P(Yes/A)}{P(Yes)} = \frac{\pi\{(1-\omega)+\omega(U-V)\}}{\pi(1-2\omega V)+\omega V}$$

Similarly, the conditional probability that a respondent reporting 'no' also belongs to sensitive group A is given by,

$$P(A/No) = \frac{P(A)P(No/A)}{P(No)} = \frac{2\omega V\pi}{1-\{\pi(1-2\omega V)+\omega V\}}$$

$$\because P(Yes/A)+P(No/A)=1$$

The values of Lanke's (1976) privacy measure (L) for proposed model (denoted by L(FORTT)) along with the privacy measure (L) for Warner's (1965), Boruch's (1971), Mangat and Singh's (1990) and Tiwari and Mehta's (2017) RR models are illustrated in Figure 1 for the various practical values of the parameters (P, T, U, $V$and ω).

From Figure 1(a),it can be observed that the privacy of respondent is well protected in the proposed model for various values of π. It can be noted from Figure 1(a) that one can choose a suitable value of model parameter U for desired precision, as the proposed model provides almost same privacy protection as in case of Mangat and Singh (1990) method at P = 0.50 and T = 0.50.However,from Figure 1(b) it can be noted that the gain in efficiency of the proposed estimator costs lowering the privacy of respondents at various values of the contamination parameter. Comparing the three RRT models, Figure 1 shows that the proposed forced answer optional randomized response model provides almost same privacy protection to the respondents as provided by Mangat and Singh (1990) and Tiwari and Mehta (2016) models with the same precision.

7. DISCUSSION

So far, no model relating to the forced answer strategy combined with the optional randomized response model exists. A competent forced optional RRT is suggested in this paper. For certain practical situations, it is found that the suggested randomized response method is more effective than those suggested by Mangat and Singh (1990) and Tiwari and Mehta (2016). Additionally, the suggested model provides better estimate of the sensitive attribute than Warner's standard RRT.The proposed procedure protects the privacy of the respondents, provides valid estimate with greater precision for different values of the parameters and remains efficient for various practical values of the parameters.

In the present study, forced optional RRT is proposed to remove biases by taking into account the elements of a truthfulresponse. Additionally, it is observed that the parameters of the suggested model can change its effectiveness, making the model more useful. The proposed RRT's privacy protection feature is also studied in detail, and it is found that it offers the same level of privacy protection as offered by the existing RRTs. In summary, the suggested model for estimating the sensitive characteristic is straightforward, provides better estimates, and well-protected in terms of the respondents' privacy. However, one of the disadvantages of the suggested model is that some respondents may find the process tedious and may lose their patience during the additional step in the process.

8. FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

9. CONFLICT OF INTEREST

The authors have no conflicts of interest to declare. All co-authors have seen and agreewith the contents of the manuscript and there is no financial interest to report.

REFERENCES

[1] Arnab R. (2004). Optional randomized response techniques for complex survey designs. *Biometrical Journal*,*46*(1), pp. 114 – 124.

[2] Boruch, R.F. (1971). Relations among statistical methods for assuring confidentiality of social research data. *Social Science Research, 1*, pp. 403-414.

[3] Chaudhuri, A. and Mukherjee, R. (1976). Randomised Response: Theory and Techniques. North Holland.

[4] Chaudhuri, A., Christofides, T. C. and Rao, C. R. (2016). Handbook of Statistics, Volume 34, Data Gathering, Analysis and Protection of Privacy Through Randomized Response Techniques: Qualitative and Quantitative Human Traits. North-Holland.

[5] Chhabra, A., Dass, B.K., and Mehta S. (2016). Multi-stage Optional Unrelated Question RRT Model. *Journal of Statistical Theory and Applications, 15* (1), pp. 80 – 95.

[6] Choi. K.H. (2010). Two stage Chang's randomised response technique. *Journal of the Korean Data and Information Science Society, 21 (2)*, pp. 271-277.

[7] Couts, E. and Benjann (2011). Sensitive questions in online surveys: Experimental results for the randomised response techniques and unmatched count technique (UCT). *Sociological Methods and Research, 40 (1)*, pp. 169-193.

[8] Eichhorn, B.H. and Hayre, L.S. (1983). Scrambled randomized response methods for obtaining sensitive quantitative data. *Journal of Statistical Planning and Inference, 7 (4)*, pp. 307-316.

[9] Fox, J.A. and Tracy, P.E. (1987). *Quantitative Applications in the Social Sciences: Randomized response.* Newbury Park, CA: SAGE Publications, Inc.

[10] Gjestvang, C.R. and Singh, S. (2007). Forced quantitative randomized response model: A new device. *Metrika*, *66* (2), pp. 243-257.

[11] Greenberg, B.G., Abul-Ela, A.L.A., Simmons, W.R. and Horvitz, D.G. (1969). The Unrelated

Question Randomized Response Model: Theoretical Framework. *Journal of The American Statistical Association*,*64*(326), pp. 520-539.

[12] Gupta, S.N., B. Thornton, J. Shabbir, and S. Singhal (2006). A comparison of multiplicative andadditive optional RRT models. *Journal of Statistical Theory and Applications*, *5*(3), pp. 226–239.

[13] Gupta, S.N., B.C. Gupta, and S. Singh. (2002). Estimation of sensitivity level of personal interviewsurvey questions. *Journal of Statistical Planning and Inference*,*100*, pp. 239–247.

[14] Horvitz, D.G., Shah, B.V. and Simmons, W.R. (1967). The unrelated questionrandomized response model. Proceedings of Social Statistics Section,*American Statistical Association*, 65–72.

[15] Hussain, Z.and Al-Zahrani, B. (2016). Mean and sensitivity estimation of a sensitive variable through additive scrambling. *Communications in Statistics - Theory and Methods*, *45* (1), pp. 182-193.

[16] Lanke, J. (1976). On the degree of protection in randomized interviews. *International Statistical Review*, *44* (2), pp. 197-203.

[17] Liu, P.T., and Chow, L.P. (1976a). A new discrete quantitative randomized response model. *Journal of American Statistical Association*, *71*, pp. 72-73.

[18] Liu, P.T., and Chow, L.P. (1976b). The efficiency of the multiple trial randomized response technique. *Biometrics*,*32*, pp. 607-618.

[19] Mangat, N.S. and Singh, R. (1990). An Alternative Randomized Response Procedure. *Biometrika*,*77*(2), pp. 439-442.

[20] Mangat, N.S., Singh, S. and Singh, R. (1995). On use of a modified randomization device in Warner's model. *Journal of the Indian Society of Statistics & Operational Research, 16,* pp. 65–69.

[21] Mehta, S., Dass, B.K., Shabbir, J. and Gupta, S. (2012). A three-stage optional randomised response model. *Journal of Statistical Theory and Practice, 6*, pp. 417-427.

[22] Odumade, O. and Singh, S. (2009). Efficient Use of Two Decks of Cards in Randomized Response Sampling. *Communications in Statistics—Theory and Methods, 38*, pp. 439-446.

[23] Sihm, J.S. and Gupta, S.N. (2014). A two-stage binary optional randomized response model. *Communications in Statistics - Simulation and Computation,44(9)*, pp. 2278-2296.

[24] Sihm, Jeong S., Chhabra, A. and Gupta, S.N. (2016). An optional unrelated question RRT model. *Involve, 9 (2)*, 195-209.

[25] Tiwari, N. and Mehta, P. (2016). An improved two stage optional RRT model. *Journal of Indian Society of Agricultural Statistics*,*70*(3),pp. 197-203.

[26] Tiwari, N. and Mehta, P. (2017). Additive randomized response model with knownsensitivity level. *International Journal of Computational and Theoretical Statistics*, *4*(2).

[27] Tiwari, N. and Mehta, P. (2017). Two-stage randomised response group-testing model. *Statistics and Applications*, *15* (1, 2), pp. 193-199.

[28] Tiwari, N., Pandey, T.K. (2022). An Improved Two-Stage Forced Randomized Response Model for Estimating the Proportion of Sensitive Attribute. *Journal of Indian Society of Probability and Statistics*, 23, pp. 451–464.

[29] Warner, S. L. (1965). Randomized response: a survey technique for eliminating evasive answer bias. *Journal of The American Statistical Association*, *60* (309), pp. 63–69.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

GSM BASED ADVANCED SUBSTATION MONITORING AND CONTROLLING SYSTEM

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ABSTRACT

The objective of this project is to get distant electrical data, such as voltage, current, and frequency, and to transmit these real-time values, along with the power station temperature, via the GSM network using a GSM modem or phone. In order to safeguard the electrical circuits, an electromagnetic relay is also envisaged for use in this project. This Relay is activated once the electrical parameters rise over the predetermined levels. Users may remotely read the electrical parameters by sending orders via SMS message. This was completed in SMS format on schedule. The many sensors that are used may communicate with this onboard computer in an efficient manner. The controller is provided that internal memory to store the code. Put some assembly instructions into the controller using this memory. Additionally, certain assembly instructions are necessary for the controller to work. Embedded C is the language used in the controller's design.

Keywords: GSM, Substation Monitoring, SMS message, Power system

1. INTRODUCTION

One practical and very handy kind of energy is electricity. It is becoming more and more important in our industrialized, capitalist world. The power systems are massive, dynamic, and highly non-linear networks. For more operational, reliable, and economical advantages, these electric power systems are combined. They are among the most important components of the global and national infrastructure, and their collapse would have a huge effect on both the national economic and national security, both directly and indirectly. A power network uses parts including switches, load cells, transformers, generators, pipelines, and compensators. Modern power systems, however, are often designed with widely dispersed energy sources and charges. Transmission and distribution are the two subsystems that make up electrical power systems.

Moving power from electric generators to the customer's location is the main purpose of a transmission system, while a distribution network serves as the last connection between high voltage transmission systems and consumer services. Transformers are then used to lower the voltage level, and distribution systems are used to deliver the electricity to the end users. Power originates from the transmission grid at distribution substation, where smaller distribution lines Provide the voltage reduction (usually to less than 10 kV) to commercial, residential, and industrial consumers. A significant portion of distributed, self-managing, capital-intensive assets are new electrical power systems, such as power transmission and distribution grids. These assets consist of: 1. power plants; 2. transmission lines; 3. transformers; and 4. protective equipment.

Electric utility substations generate power independently and are used in both the transmission and distribution systems. Transmission lines carry the electricity produced at the main stations hundreds of kilometers before it reaches the substations. Over the past few years, a number of studies have been conducted with the assistance of microprocessors and controllers for the continuous monitoring of sample concentrations, the actions of analysts at different times, and the monitoring of voltage, current, and temperature variations in distribution transformers at substations. The current and voltage levels at the substations might change greatly as a result of the distribution transformers' increased temperature. This may result in the client receiving electricity that is of subpar quality. As a result, keeping an eye on the distribution side's current, voltage, and other pertinent metrics will assist to enhance both the main station's output and the customer's power supply's quality. It may also detect malfunctions brought on by heat, excessive heat, and overvoltage. By turning off the machine, the control device may safeguard the distribution transformer in the event that the temperature rises over the desired level. As was previously said, the maintenance of a transformer is one of the main problems facing the Electricity Board (EB).

For a variety of causes, including overload and short circuit in its winding, the transformer burns out during unusual occurrences. The variation in the quantity of current passing through the oil's internal windings causes an additional rise in temperature. This causes an abrupt shift in temperature, voltage, or current to occur in the distribution transformer. For this reason, we recommend automating the delivery transformer of the EB substation. Automation considers temperature, voltage, and current as the parameters to be monitored because the transformer indicates its maximum sensitivity for each of these. As a result, we create an automation system using micro controllers to continually operate the transformer. The substation's transformer, which is disabled at the main station as a result of micro controller activity.

2. BLOCKDIAGRAM

2.1. Hardware components

- Regulated power supply.
- Voltage sensor

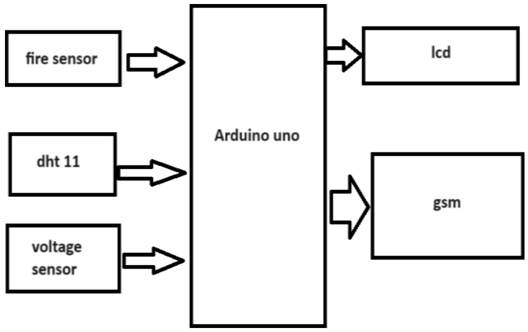

Figure.1. Block diagram

- Fire sensor
- Microcontroller.
- Gsm
- Dht11

2.2. Software requirements

- Arduino uno
- Embedded C

3. IMPLEMENTATION (WORKING PROCEDURE)

The electrical industry's rebuilding process necessitates the development of innovative methods for displaying massive volumes of device data.

A discussion of many visualization methods that could be somewhat useful in visualizing the data has been given by over bye and Weber. A monitoring system designed to identify, categorize, and quantify electrical power system disruptions. The CORBA architecture is used as a communication interface for the transient meter, wavelet-based methods for automatic signal categorization and characterization, and a smart trigger circuit for disruption detection.

With the use of mathematical morphology (MM), power quality monitoring systems may identify disruptions very rapidly. However, noise often taints the signal being examined, significantly reducing the MM's output. Sen Ouyang and Jianhua Wang used a quick technique to identify the fleeting disruptions in a loud environment. This method uses morphological dilation operators, an appropriate erosion mixture, and the right morphological structure element to increase MM's capacity. For comparison, the Wavelet Transform (WT)- based soft-threshold denoising method was also used. MM's functionality may thus be restored. The following are some advantages of this method: 1) Fast computation speed; 2) Easy hardware setup; and 3) Increased usage efficiency.

Numerous disturbances to the electrical network result from the propagation of nonlinear and time-varying loads, ranging from transient disruptions on the supply voltage to highly severe distortion of both currents and voltages. In this way, a single customer-generated interruption might spread to other customers, potentially harming their equipment, since the electrical network acts as a "safe carrier" of disruptions. As a result, evaluating the effectiveness of the power included in a network segment becomes essential, particularly in a deregulated electrical market where each player may be accountable for the introduction of disruptions. Nonetheless, the computation of power- quality has several aspects, ranging from the analytical and functional point of view, which have yet to be addressed and need to be carefully studied.

4. RESULT

This project is well prepared and acting accordingly as per the initial specifications and requirements of our project. Because of the creative nature and design the idea of applying this project is very new, the opportunities for this roject are immense. The practical representation of an experimental board is shown below in Figure 2:

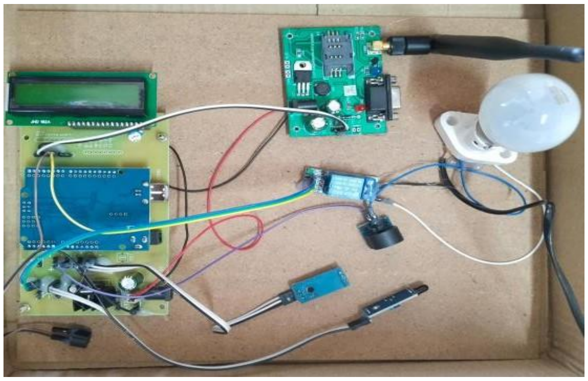

Figure.2. Project Model

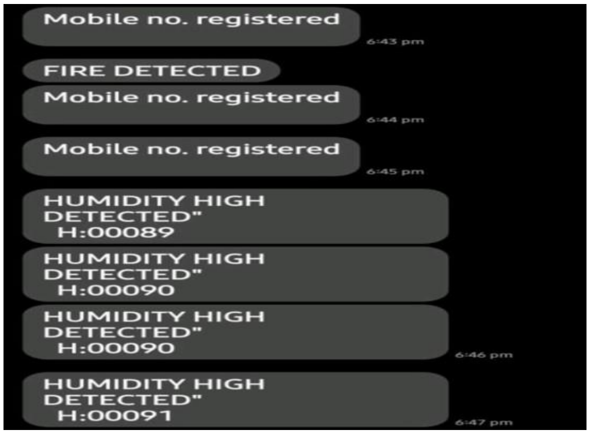

Figure.3. Result

5. CONCLUSION

It established the feature integration of every piece of hardware that was used. Each module's presence was carefully considered and arranged to maximize the functionality of the unit. Second, with the aid of developing technology, the project was effectively completed using very sophisticated integrated circuits. As a result, the project was successfully designed and tested.

6. FUTUREREACH

The main purpose of a microcontroller- based substation monitoring and control system with a GSM modem is to control appliances like fans, lights, motors, etc. using a GSM-capable mobile phone. The micro controller is designed in such a way that if a specific fixed format of SMS is sent from the cell phone to GSM modem, it is fed to the micro controller running the appropriate devices as input. The network includes a GSM modem, temperature, current, voltage, and sensors for other variables. The micro controller is interfaced with switches like relays to control devices. The mobile phone receives are turn feedback message from the GSM modem. The GSM modem sends a reply feedback message to the mobile device. The location where gadgets are operated has a temperature indicator. We can handle a great deal of stuff, including the systems, from the convenience of our personal computers.

REFERENCES

[1] Jyotishman Pathak, Yuan Li, Vasant Honavar and James D. McCalley, "A Service-Oriented Architecture for Electric Power Transmission System Asset Management", In ICSOC Workshops, pp: 26-37, 2006.

[2] B. A. Carreras, V. E. Lynch, D. E. Newman and I. Dobson, "Blackout Mitigation Assessment in Power Transmission Systems", Hawaii International Conference on System Science, January 2003.

[3] Xiaomeng Li and Ganesh K. Venayagamoorthy, "A Neural Network Based Wide Area Monitor for a Power System", IEEE Power Engineering Society GeneralMeeting,Vol.2,pp:1455-1460,2005.

[4] Argonne National Laboratory, "Assessment of the Potential Costs and Energy Impacts of Spill Prevention, Control, and Counter measure equirements for Electric Utility Substations", Draft Energy Impact Issue Paper, 2006. Substations", Draft Energy Impact Issue Paper, 2006. Equirements for Electric Utility Substations", Draft Energy Impact Issue Paper, 2006.

[5] R.R. Negenborn, A.G. Beccuti, T. Demiray, S. Leirens, G. Damm, B. De Schutter and M. Morari, "Supervisory hybrid model predictive control for voltage stability of power networks", Proceedings of the 2007 American Control Conference, New York.

[6] G.Pudlo,S.Tenbohlen,M.Linders, G. Krost, "Integration of Power Transformer Monitoring and Overload Calculation into the Power System Control Surface", IEEE/PES Transmission and Distribution Conference and Exhibition, Vol.1, pp: 470-474 Asia Pacific.

[7] Zhi-Hua Zhou, Yuan Jiang, Xu-Ri Yin, and Shi-Fu Chen, "The Application of Visualization and Neural Network Techniques in a Power Transformer Condition Monitoring System", In: T.Hendtlass and M. Ali eds. Lecture.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

An Inductive Power Transfer Topology For EV Battery Charging With Advanced Zvs and Zcs Operations

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ABSTRACT

Recent high-frequency power converter designs for inductive power transfer (IPT) systems use either zero voltage switching (ZVS) or zero current switching (ZCS)-based power electronic converters while maintaining a nearly sinusoidal current for wireless power transfer range. ZVS or ZCS for all power valves at once remains a challenge in IPT devices. The switching scheme and enhanced zero-voltage zero-current switching (ZVZCS) IPT topology are proposed in this research. Enhancing the conventional series compensation achieves ZVS by employing an auxiliary network for ZCS. The proposed idea is validated using MATLAB/Simulink simulations for resistive and battery loads.

Keywords: inductive charging, soft switching, wireless power transmission, dc-dc power converters, battery chargers, and electric vehicles (EVs).

1. INTRODUCTION

The depletion of petroleum resources and dangerous environmental disruptions are two challenges that the expanding global economy must address. Additionally, it has sparked the development of environmentally friendly technologies that have improved significant sources of carbon emissions, like transit. As a result, it is acknowledged that using electric vehicles (EVs) might lessen the negative effects that carbon-based fuels have on the environment. Furthermore, the EV market offers consumers a new opportunity to prolong the life of their vehicles at a lower cost. Growth in the EV market has previously been impeded by limitations in power shaping and battery technology (BT).But over the past few decades, BT has developed to have a high energy density, a small physical size, and a high level of effectiveness. Additionally, when used with an appropriate power shaping circuit, an efficient energy storing device enhances total efficiency. Researchers and businesses test dc-dc power conditioner configurations with low power losses, robustness, dependable energy transmission, and more charging-discharging cycles. Nowadays, quick, efficient charges are used for vehicles with limited range because they pose a risk to people's safety. The current scenario uses inductive power transfer (IPT)-based typologies to adopt safer battery charging (BC) techniques during EV static and dynamic modes. To reduce the circuit impedance and raise the converter's total efficiency, compensation networks are demonstrated. However, the intricacy of the configuration increases with the number of active and passive circuit components. The right response improves the driving range, maintenance cycle, end-user economy, and reduced carbon footprint even further. Thus, the selection of a converter is essential for the electric traffic in the market. As a result, it skill fully helps reduce environmental issues brought on by transportation problems. Because of its straightforward structure and practical reliability for changing coil distances, the industry standard IPT design, which is based on series-series capacitor compensation, is one of the most widely used network configurations. This network's low cost compromises its efficiency, power transmission capability, strong resonant peaks, and control precision for variation loading. A method for phase control is given in order to increase bandwidth efficiency; however, the cost comes from a complex control strategy for varying frequencies. Variable frequency difficulties are minimized by setting the control limit within the optimal frequency range. The management techniques covered here only assist in maintaining zero voltage switching (ZVS) for the IPT system in order to increase efficiency. Topological breakthroughs have been made possible by a special coil support network with an intermediate L-C series compensated structure at the transmission and reception ends. By putting both coils on the main side, this arrangement reduces weight on the vehicle side. The suggested approach maintains magnetic flux under misalignment situations but compromises elegance and simplicity in computation and control operation. Integrating an H-bridge high-frequency transformer with an L-C tank network eliminates difficulties associated with using a separate tank network for enabling IPT.

2. WIRELESS POWER TRANSFER

The concept of wireless power transfer, or WPT, is not new. By the late 1800s, Nikola Tesla was experimenting with the possibilities. Since the 1960s, when autonomous electronic equipment like medical implants needed to be charged, and since the 2000s, when charging portable electronics like laptops and mobile phones could be made easier, there has been a resurgence of interest in wireless power transfer. Since the Wireless Power Consortium, which is made up of more than 130 international companies, launched the "Qi" standard, the technology is currently in the commercial stage. Recently, electric Vehicles (EVs) have significantly increased the significance of WPT technology. The various WPT techniques can be categorized according to the transmission range or the underlying ideas that underpin their implementation. WPT techniques fall into three categories under the latter section: radio frequency, electromagnetic induction, and magnetic resonance coupling. A cardiac pacemaker is one type of medical implant. An electrical medical device called a pacemaker is used to regulate the heart's rhythm. It delivers electrical impulses that keep the heartbeat regular. A constant power source is necessary for such a device, and it is evident that charging via cables is not practical. If at all possible, wired charging is safer but more costly and inconvenient. Current pacemakers are operated by an embedded battery, which has limited life and size limitations, and for which wireless power transfer would offer a charging solution. Utilizing WPT Systems As previously demonstrated, WPT systems are significantly more complicated than traditional plug-and-socket cable charging methods. Aside from this similar complexity, WPT's drawbacks include reduced flexibility, increased

expense, decreased efficiency, and safety issues related to the current magnetic fields. The following list contains further WPT system issues. Live and Foreign Objects (FO/LO) There is a chance that adjacent foreign (metallic) or living items will absorb electromagnetic fields, which is a concern associated with the idea of using magnetic fluxes to transport power via air. In addition to causing losses as the primary must transmit more power, these conditions also carry a risk of the intruding bodies becoming significantly heated. Even with power transmission systems as small as 5W, items can heat to temperatures that exceed ISO safety standards. Studies have indicated that metal objects, including coins (Figure 2-11), paper clips, gold bands, and metalized medicinal packaging, dissipate power. With as little as 0.5 to 1W, the object can be heated to temperatures higher than 80°C.

3. PROPOSED METHODOLOGY

The proposed converter's operational principle Active switches S1 through S4 on the primary side and diodes D5 through D8 on the secondary side make up a typical H-bridge. Additionally, Ca1 and Ca2 act as potential dividers at the input with auxiliary LA and TA in order to maintain the circuit's soft-switching functionality with BC. On the primary and secondary sides of the circuit, L1 and L2 are linked to C1 and C2, respectively. MPWM is used to regulate the converter's operation. In order to comprehend the suggested converter's working principle, the following presumptions are taken into account:

1) All of the active and passive parts, such as the transformer, DC source, switches, diodes, and capacitors, are at their best. This also includes internal switch diodes and capacitance.

2) The inter winding capacitance of the transformer and the electrical series resistance of the inductor are disregarded.

3) The voltage at the input and output terminals of the converter may be maintained at a constant value thanks to the size of the voltage divider capacitors (Ca = Ca1 = Ca2) and the CF.

4) TA's magnetizing inductance is not taken into consideration.

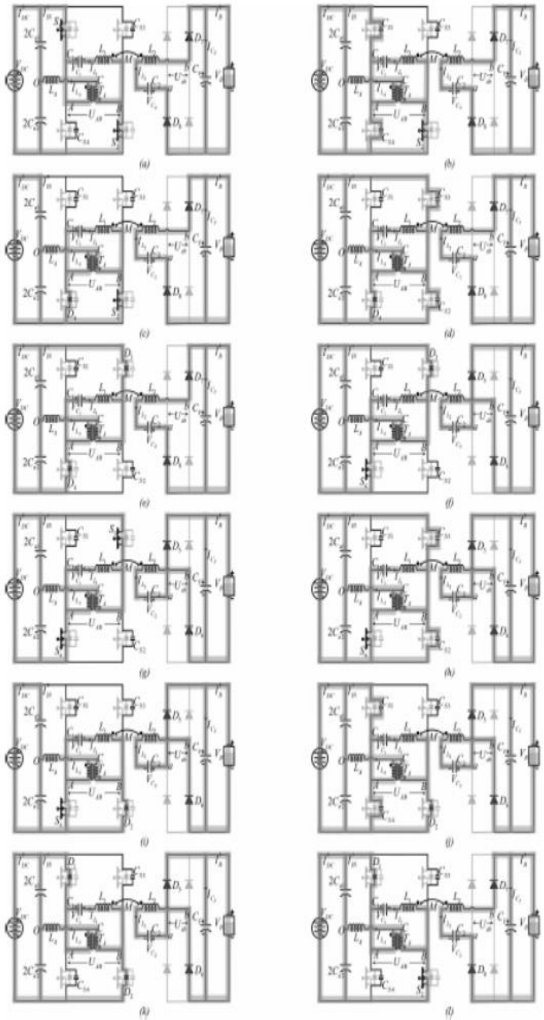

Figure.1: The suggested battery charger topology's operating modes.

4. SIMULATION RESULTS

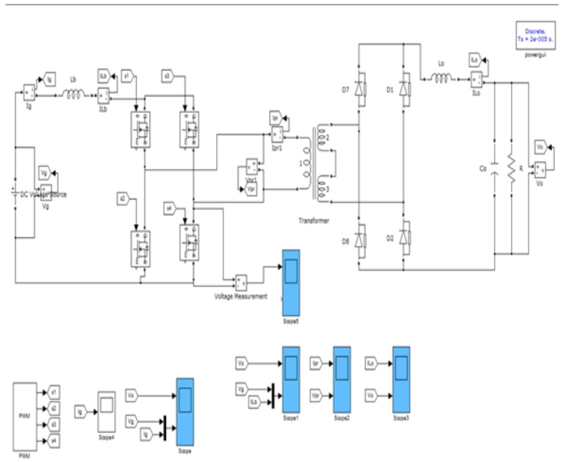

Figure.2. Simulation Circuit

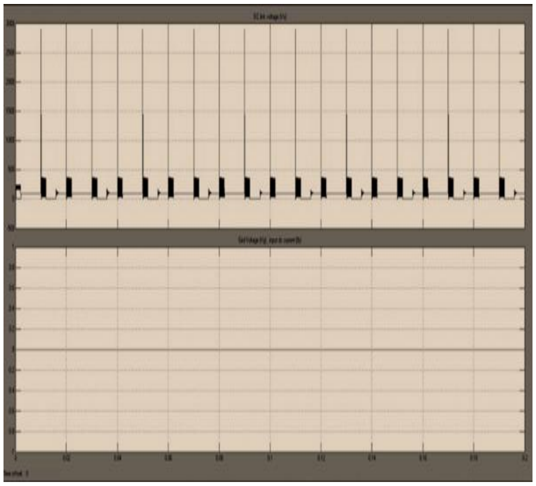

Figure.3. WPT voltage and currents

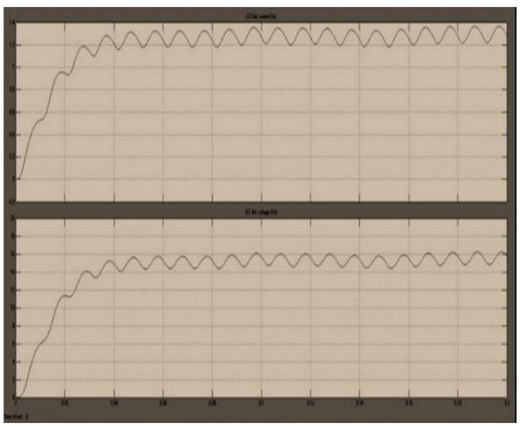

Figure.4. Output voltage and currents

5. CONCLUSION

This paper proposes a wireless electrical car battery recharge topology based on voltage supplied series compensation and its tuning technique. A wide range of input variation has been better handled by the full-bridge dc-dc converter as a result of modifications that were reasonably recommended. Further lowering the total cost is the removal of the requirement for a high-power CPU. To achieve ZVZCS with less control complexity, theory analysis and modelling have been given and, utilizing low numbers for the dc link and filter capacitance, respectively, the proposed method reduced input/output voltage and current ripple. Both battery-powered and resistive loads have been operated at a satisfactory efficiency of 91.26%.

REFERENCES

[1] M. Granovskii, I. Dincer, and M. A. Rosen, “Economic and environmental comparison of conventional, hybrid, electric and hydrogen fuel cell vehicles,” J. Power Sources, vol. 159, no. 2, pp. 1186–1193, 2006.

[2] S. B. Peterson, J. Whitacre, and J. Apt, “The economics of using plug-in hybrid electric vehicle battery packs for grid storage,” J. Power Sources, vol. 195, no. 8, pp. 2377–2384, 2010.

[3] Y. Zhou, M. Wang, H. Hao, L. Johnson, and H. Wang, “Plug-in electric vehicle market penetration and incentives: A global review,” Mitigation Adaptation Strategies Global Change, vol. 20, no. 5, pp. 777–795, 2015.

[4] B. Nykvist and M. Nilsson, “Rapidly falling costs of battery packs for electric vehicles,” Nature Climate Change, vol. 5, no. 4, pp. 329–332, 2015.

[5] W. Zhang and C. C. Mi, “Compensation topologies of high-power wireless power transfer systems,” IEEE Trans. Veh. Technol., vol. 65, no. 6, pp. 4768–4778, Jun. 2016.

[6] K. Mude and K. Aditya, “Comprehensive review and analysis of two-element resonant compensation topologies for wireless inductive power transfer systems,” Chin. J. Elect. Eng., vol. 5, no. 2, pp. 14–31, 2019.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Artificial Intelligence Interaction with Mechanical and Manufacturing Engineering

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ABSTRACT

Artificial advancements, experiencing widespread adoption across diverse sectors, notably within the mechanical and manufacturing industry. The relentless progression of computer technology has propelled AI into a realm of unprecedented influence and applicability. This integration of AI within the domains of mechanical and manufacturing engineering signifies a paradigm shift characterized by elevated operational efficiency, heightened productivity, and a surge of innovative solutions. However, the incorporation of AI into these fields is accompanied by a spectrum of intricate challenges, spanning concerns pertaining to data security, ethical considerations, and the imperative for workforce skill development. Addressing these challenges demands concerted interdisciplinary collaboration, the formulation of robust regulatory frameworks, and an unwavering commitment to continuous educational initiatives. This study presents a comprehensive examination of AI technology, with a specific focus on its deployment within the domain of mechanical manufacturing. It explores the nuanced application of AI in fault diagnosis and , quality inspection, illustrating its profound and multifaceted impact on the various dimensions of mechanical manufacturing processes.

Keywords: ***Artificial Intelligence Mechanical Engineering Industries, Manufacturing Engineering Industries, Quality Inspection, Fault Diagnosis, Electronic Information Transmission Systems***

1. INTRODUCTION

Artificial intelligence, an evolving field of science and technology, delves into simulating and augmenting human intelligence. It encompasses a spectrum of disciplines including psychology, cognitive science, information science, systems science, and bioscience. Essentially, AI endeavors to emulate human thought processes through data interaction, aiming to comprehend the core of human intelligence and eventually create intelligent machines capable of human-like problem-solving and response. [1].The prevalence of AI technology is significantly shaping people's everyday experiences, evident in the widespread integration of smart appliances like dishwashers and sweepers. These innovations epitomize the fusion of artificial intelligence with the mechanical manufacturing industry, showcasing AI's expanding role in enhancing daily life.

As science and technology continue to advance, mechanical engineering undergoes constant evolution, transitioning from traditional mechanics to electronic-mechanical systems. Notably, artificial intelligence (AI) technology finds extensive application within the mechanical manufacturing industry. This integration not only ensures manufacturing precision but also enhances work efficiency and workplace safety. AI operates within the framework of computer technology development, enhancing it through analysis to achieve intelligent automation. Its application spans across mechanical, electrical, and electronics engineering, enabling automation control and leveraging insights from information technology, psychology, linguistics, and other disciplines.[2]

The advent of artificial intelligence has catalyzed significant transformations across the entire mechanical and production sector. Without exception, the mechanical and manufacturing industry now relies on AI technology to realize automation and intelligent development, thereby adeptly meeting the demands of the industry amidst the new era of the Fourth Industrial Revolution. This paper aims to outline the interaction of artificial intelligence with mechanical and manufacturing engineering.

2. ARTIFICIAL INTELLIGENCE AND MECHANICAL INDUSTRY

As science and technology advance, artificial intelligence (AI) technology sees growing integration into mechanical and automation processes. Through computer simulation systems, AI constructs production models and conducts comprehensive data analysis, enabling proactive measures in case of emergencies. This ensures an orderly production system, minimizes potential capital losses for production enterprises, and significantly enhances production efficiency and accuracy. The application of artificial intelligence in mechanical sector primarily focuses on fault diagnosis, where AI automates data classification and categorization to enhance calculation accuracy, thus preventing errors and failures. Moreover, AI aids in diagnosing mechanical faults through Expert System Theory, utilizing data monitoring and intelligent searching to identify similarities with historical cases. Additionally, AI facilitates predictive maintenance by comparing actual operation data with trained models, enabling timely warnings and maintenance reminders to improve safety, minimize downtime, and boost production efficiency.

The application of artificial intelligence in quality inspection is another area as Traditional manual detection suffers from inconsistencies due to variations between individuals, leading to difficulties in maintaining uniform inspection standards. Moreover, factors like fluctuations in individual performance or mental state can further compromise consistency. Additionally, manual inspection struggles to cope with the demands of rapid mass production. In contrast, artificial intelligence-based quality inspection, leveraging deep learning machine vision technology, ensures standardized, stable, and rapid detection, thereby addressing these challenges effectively.

3. ARTIFICIAL INTELLIGENCE AND MANUFACTURING INDUSTRY

Effective and accurate information processing is crucial for ensuring the security and stability of manufacturing and automation. Manufacturing automation heavily relies on electronic information transmission systems, which are prone to errors, especially when handling large volumes of data, leading to unpredictable outcomes. The instability inherent in manufacturing electronic systems necessitates the application of artificial intelligence technology during information processing. AI can meticulously monitor the stability of electronic information systems during transmission, thereby ensuring the security and accuracy of information input and output. Consequently, artificial intelligence enhances information processing efficiency and plays a pivotal role in manufacturing and automation.Artificial intelligence technology enhances the precision of mechanical manufacturing and automation, with one of its most notable applications being the neural network system. This system, modeled after the human nervous system, excels in storing vast amounts of data with absolute accuracy. By simulating the structure of neurons, the neural network system conducts data analysis, yielding precise results. Due to the close and stable structure of neurons, the entire neural network system exhibits high intelligence, enabling accurate processing of massive data volumes in mechanical manufacturing and automation processes. Moreover, the integration of deep learning algorithms in artificial intelligence has propelled these industries to new heights, fostering innovation and diverse applications within the manufacturing sector.

4. CONCLUSION

The rapid evolution of science and technology is profoundly reshaping both individual experiences and societal production paradigms. With the advent of the Fourth Industrial Revolution and the accelerated pace of modern life, artificial intelligence (AI) emerges as a cornerstone, increasingly prevalent across domains such as mechanical engineering, manufacturing, and automation. Its formidable capacity for data processing yields substantial benefits within manufacturing contexts, bolstering efficiency, facilitating quality control measures, diagnosing faults, predicting maintenance needs, and enhancing supply chain management with unparalleled intelligence. This symbiotic alliance between artificial intelligence and mechanical manufacturing fuels reciprocal advancement, presenting unparalleled prospects for operational efficiency, inventive solutions, and environmental sustainability. Through adept utilization of AI technologies, engineers transcend traditional constraints, spearheading technological progress and reshaping the global landscape of manufacturing industries. While AI serves as the catalyst for transformative shifts within manufacturing, the pivotal roles of mechanical manufacturing and automation cannot be overstated, as they fuel ongoing innovation in AI. Nonetheless, amidst the flux of technological evolution and industrial transitions, human involvement remains indispensable, serving as the linchpin of the manufacturing domain.

REFRENCES

[1] Bao, C.W., Jiang, W. Exploration and Practice of the Cultivation Scheme of Mechanical Engineering Specialty under the Background of New Engineering Strategy. Sci-Tech Innovation & Productivity, 2019, 4: 83-85.

[2] Wu, A.H., Yang, Q.B., Hao, J. The Innovation and Reform of Higher Education under the Leadership of Emerging Engineering Education. Research in Higher Education of Engineering, 2019 , 1:1-7.

[3] Yang, J.R. "Study on the Present Status in the Interfusion of AI and Manufacturing Industry. Journal of Shanghai Electric Technology, 2019, 2: 1-5.

[4] iu, J.N. "Discussion on Relation between Mechanical Electronic Engineering and Artificial Intelligence. Journal of Tianjin Vocational Institutes",2018, 20: 76-79.

[5] Zhang, H.B. "When Artificial Intelligence Meets Manufacture Industry: The Five Advantages That AI has Brought about for Manufacture Industry"2018, blogs.jabil.com/cn/?p=3252

[6] P Norvig, SJ Russell, "Artificial intelligence: a modern approach [J]. Applied Mechanics & Materials, 2003, 263 (5): 2829-2833.

[7] RA Brooks. Intelligence without representation [J]. Artificial Intelligence, 1991, 47 (1–3): 139-159.

[8] DE Goldberg, JH Holland. Genetic algorithms and machine learning [J]. Machine Learning, 1988, 3 (2): 95-99.

[9] B Chandrasekaran. Generic tasks in knowledge-based reasoning: High-level building blocks for expert system design [J]. IEEE Expert, 1986, 1 (3): 23-30.

[10] MH Hassoun. Fundamentals of artificial neural networks [J]. Proceedings of the IEEE, 1996, 84 (6): 906.

[11] Y Lecun, Y Bengio, G Hinton. Deep learning [J]. Nature, 2015, 521 (7553): 436-444.

[12] W Bolton. Mechatronics electronic control systems in mechanical and electrical engineering [J]. Fish Physiology & Biochemistry, 2009, 35 (3): 385-398.

[13] H Yang, J Mathew, L Ma. Intelligent diagnosis of rotating machinery faults - A review [M]. Pattern Recognition & Data Mining, 2002

[14] LB Jack, AK Nandi. Fault detection using support vector machines and artificial neural networks, augmented by genetic algorithms [J]. Mechanical Systems & Signal Processing, 2002, 16 (2-3): 373-390.

A VERSATILE NON-ISOLATED CONVERTER WITH DUAL INPUT AND DUAL OUTPUT FOR ELECTRIC VEHICLE APPLICATIONS

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ABSTRACT

This paper introduces the implementation of a Fuzzy Logic Controller in a modified non-isolated four-port power electronic interface tailored for electric vehicle (EV) systems. A distinguishing aspect of this converter is its adaptability to various energy sources with differing voltage and current profiles. Notably, the proposed converter can concurrently provide both step-down and step-up outputs, enhancing its operational versatility. Through a streamlined control strategy and reduced component count, the converter achieves heightened dependability and cost-effectiveness. Furthermore, its two-way power flow capability enables efficient battery charging during regenerative braking. The paper thoroughly analyses the converter's steady-state and dynamic characteristics and suggests a control scheme to manage power flow among different energy sources. A simplified model is derived to assist in the converter's design process. The verification and its performances evaluation are carried out by using MATLAB/Simulink simulation software, affirming the effectiveness and feasibility of the proposed converter design.

Keywords: Regenerative charging, battery storage, electric vehicle, multiport converter, bidirectional dc-dc converter.

1. INTRODUCTION

The surge in environmental degradation, rising fuel costs, concerns regarding global climate change, and the depletion of fossil fuel reserves have acted as catalysts for advancements in automotive technology. Therefore, the development of the electric and hybrid electric vehicles environment free from the pollution. The motor drive system plays a crucial role in these vehicles, necessitating an efficient power electronic converter to power the motor system. In the EVs the required converter is bidirectional which connects the energy source to the battery as well as motor systems. Extensive research documented in literature explores various configurations of non-isolated three-port converters derived from dual input (DIC) or dual output (DOC) converters, as well as single input single output (SISO) converters [1]. An innovative step-up converter, amalgamating features of the KY converter and buck-boost converter to achieve heightened voltage conversion ratios, has been introduced [2].Additionally, a method to upgrade transformation productivity through interleaving in a twofold switch buck-boost converter is proposed [3]. Furthermore, a non-isolated boost converter with substantial voltage amplification capable of automatic load balancing under unbalanced conditions is currently under investigation [4]. Bang and Park [5] outline a buck cascaded buck-boost power factor correction converter suitable for wide input voltage fluctuations. Importantly, the aforementioned converters operate unidirectionally with the SISO configuration. A non-insulated reversible dc/dc converter operates under a single

input single output (SISO) model utilizing four active switches [6]. A comparative analysis between two distinct reversible converters, specifically the cascaded buck-boost capacitor centre and the cascaded buck-boost inductor centre, is currently in progress [7]. Introducing a zero-voltage transition three-level dc-dc converter along with soft switching capability aims to enhance power spectral density and efficiency [8].

Table.1.Comparison of Components.

Bidirectional Buck-Boost Converters in paper	No. of Inputs	No. of Outputs	No. of Inductors	No. of Switches	No. of Diodes	No. of Capacitors
H. Kang, et. al [4]	1	1	1	4	-	3
M. Badawy, et. al [7]	1	1	2	4	-	2
A. Hasanzadeh, et. al [8]	1	1	6	6	-	4
M. Reza Banaei, et. al [13]	1	1	2	1	2	3
A. Ajami, et. al [14]	1	1	3	1	2	4
B. Vural, et. al [18]	2	1	2	5	2	1
A. Khaligh, et. al [25]	1	1	1	5	5	2
T. K. Santhosh, et. al [26]	1	2	1	4	-	2
Proposed converter (FPC)	Single Input→Three Output (or) Double Input→Double Output		2	3	2	3

In this study, a three-port reversible converter with three active switches and three inductors that may provide buck or boost output is introduced [9]. It delves further into a number of paralleled buck-boost converter configurations, converters that combine dual supercapacitor modules, and related power management control schemes [10]. The multiport energy converter uses a single-leg active switching element to regulate and track the output power of passive devices. Furthermore, a reverse large gain step-up/down dc converter with an integrated DC transformer is used, albeit at the expense of a larger physical converter. The proposed single-switch buck-boost architecture takes advantages from CUK converters and fixes problems with KY converters, all while operating in SISO mode. Non-insulated DC/DC converters, with various inputs and outputs and unidirectional power flow, are new and intended for photovoltaic applications. The multi-input single-output n-stage converter does have a drawback, though, in that it can only carry out buck-boost operations in (n-1) stages, with the nth stage acting as a boost converter that transfers power continuously from source to load. For multiple input applications, the circuit architecture uses a switched capacitor approach, which increases the control complexity and circuit structure in direct proportion to the number of input sources. The suggested non-insulated multi-port converter with a single inductor is mostly appropriate for low-power applications as it integrates many load devices with just one active switch. The isolated bidirectional converter functioned as a multiport dc/dc converter. While adding a multi-winding transformer facilitates power transfer, the converter's total size grows. The various configurations are introduced with the help of the magnetic coupling and dc-link combo.A fully directional universal dc/dc converter functions as a single input single output (SISO) converter. Futhermore for hybrid electric vehicles a dual input and dual output converter is designed. However, it faces the inherent limitation of not boosting battery power across the load. In a solar power-assisted electric vehicle with battery backup, a dc/dc converter structure facilitates energy transfer between the battery and solar panels. The converter's switch count fluctuates based on the quantity of battery modules present. For instance, with 'n' battery modules, the system necessitates '2n' switches for optimal functionality. To effectively regulate power distribution between the ultracapacitor and battery, mitigating concerns like ultracapacitor overcharge and excessive battery currents during peak demand, a suggested approach involves implementing a fuzzy logic control-based energy management strategy. We propose a three-switch, one-stage transformer less four-port (FPC) bidirectional buck-boost converter as a primary contribution to this study. Compared to existing topologies outlined in the literature, the proposed converter offers advantages such as a modular structure with reduced component count and integration of diverse input sources with varying voltage-current characteristics. Furthermore, the proposed converter can generate output voltages lower than the minimum input voltage (buck) or higher than the maximum input voltage (boost). The reduction of switching losses which causes to increase in efficiency of recommended converter

2. EVALUATION OF THE OPERATIONAL EFFICIENCY OF A MULTIPORT BUCK-BOOST CONVERTER UTILIZING THE STRUCTURE OF FPC TOPOLOGY.

In electric vehicular systems, relying solely on a single energy source proves insufficient due to fluctuations in input power and dynamic load requirements. Consequently, there's a pressing need to integrate diverse energy resources. The manuscript's core objective centers on developing a converter topology adept at interfacing different energy sources with the vehicle's drive train.
The diagram in Figure 1 illustrates the suggested configuration of a four-port (FPC) converter.
Key attributes of the proposed converter include:

- Ability to facilitate bidirectional power flow
- Independent control over power flow from each source
- Streamlined design, control, and implementation procedures.

As seen in Figure 1, the control of power flow takes between the load and input sources is managed by the controllable switches Q_1, Q_2, and Q_3. Figures State 1 to 5 shown the five different operational states achievedby the proposed or recommended converter.

State-1 represents the Single Input Dual Output (SIDO) configuration, indicates the electric vehicle's drive train (load) should draw the power from the PV-generated energy. The battery within the proposed setup will be charged either from the input PV power source or from the load itself, as shows in figures, respectively. State-5 During the regenerative braking the energy which is wasted in operation modes should be stored in the battery. Battery is not able to provide enough sufficient amount of energy to fulfill the loads because of low irradiation. This action corresponding to the Dual Input Dual Output (DIDO). Switching schemes for the proposed converter and its equivalent circuit representations under the different operating states are shown in the Figure 2.

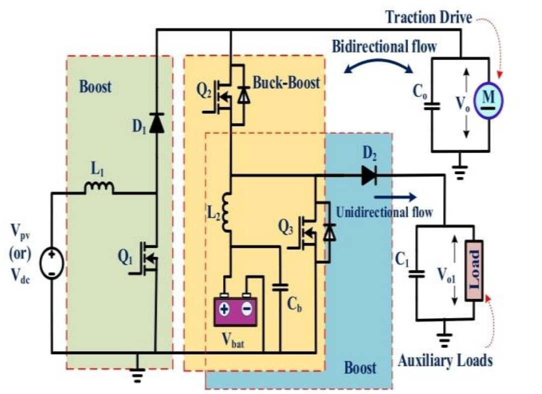


Figure.1. Diagram depicting the configuration of a four-port(FPC) converter topology

3. FUZZY LOGIC CONTROLLER

A key component in converting binaries values that are crisp of 0 or 1 to graded values that are fuzzy (0 to 1). There are two interpretations of fuzzy logic: a more restricted version that goes beyond conventional multivalued logic, along with a more general interpretation that is closely related to the idea of fuzzy sets, which works with object classes that have ambiguous bounds and graded membership. From this wider angle, fuzzy logic is a subset that represents the basic ideas of fuzzy sets. Even in its more limited sense, fuzzy logic clearly varies from traditional multivalued logic in important ways.

Fuzzy logic is represented by the letter FL in programs such as the Fuzzy Logic Program Toolbox, which reflects its broad applicability. "Foundations of Fuzzy Logic" provides a thorough and lucid elaboration of the fundamental ideas of FL. It is crucial to understand that FL is based on linguistic variables, which are variables that are expressed in words as opposed to exact numerical values. FL offers a computational method that does not rely on rigid numerical values, but rather on language concepts. Even though words are not very precise, they are quite intuitive, and using words to compute takes use of this tolerance for error, which makes problem solving easier.

Fuzzy if-then rules are another fundamental idea in FL that form the basis of its applications. Artificial Intelligence (AI) has made use of rule-based systems; however, fuzzy logic (FL) involves the calculus of fuzzy rules as a means of handling fuzzy antecedents and consequents. The foundation for what can be called the Fuzzy Dependence and Commanding Language (FDCL) is laid by this calculus. While it isn't mentioned directly in the toolkit, FDCL is a key component of its guiding ideas. A fuzzier logic solution basically converts a human answer into FDCL in real-world situations. A newer approach combines evolutionary algorithms, neuro computing, and fuzzy logic to provide the fundamental components of soft computing. This combination creates new opportunities for effectively solving challenging issues.

4. MODES OF OPERATION

STATE 1: TRANSFER OF POWER TO LOAD FROM PV or V_{dc} SOURCE

This state describes about the power should be transferred to the motor and theauxiliary loads from the PV or Voltage source. In this switches Q_1 and Q_3 are in ON and Q_2 will be OFF.

STATE 2: TRANSFER OF POWER TO BATTERY AND LOAD FROM PV or V_{dc} SOURCE

This state describes about the power should be transferred to the battery and the load from the PV or Voltage source.

STATE 3: TRANSFER OF POWER FROM BATTERY

This state describes about the power should be transferred from the battery to the motor and other auxiliary loads.

STATE 4: TRANSFER OF POWER FROM BOTH PV or V_{dc} AND BATTERY

This state describes about the power should be transferred from both PV and battery source to the motor and other auxiliary loads. When the electrical vehicle needs high power demand so additional power supplied from the battery to the motor and load to work satisfying operation.

STATE 5: TRANSFER OF POWER FROM LOAD TO BATTERY

This state describes about, at the time of regenerative braking some part of the power should be wasted and that power should be stored in the form of kinetic energy in the drive train and fed to the battery.

5. PROPOSED SYSTEM

We have positioned PI controllers in the suggested approach in order to monitor the system. But our intention is to use a controller based on fuzzy logic (FLC) in place of these PI controllers. By directing the harmonic distortions seen in the voltage and current waveforms, this FLC contributes to improved power quality and smoother operations. As such, we expect this modification to maintain high power quality requirements while enhancingthe system's rapid response. The electric car's (EV)speed is controlled by an inverter that transforms thebattery's DC voltage into three-phase AC power. It's critical to take into consideration losses caused by parts that aren't directly involved in moving energy from the grid to an electric vehicle (EV) Wheels.Developing appropriate feedback controllers to steer the EV system toward intended operating states is our main focus. Making use of FLC approaches offers a great deal of possibilities for creating strong, flexible, and adaptive controllers that are appropriate for EV application

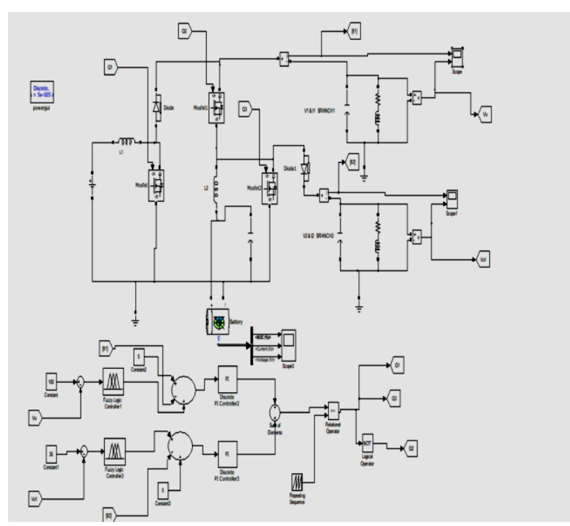


Figure.5. Closed loop of EV with Fuzzy Logic Controller (Over all performances of EV

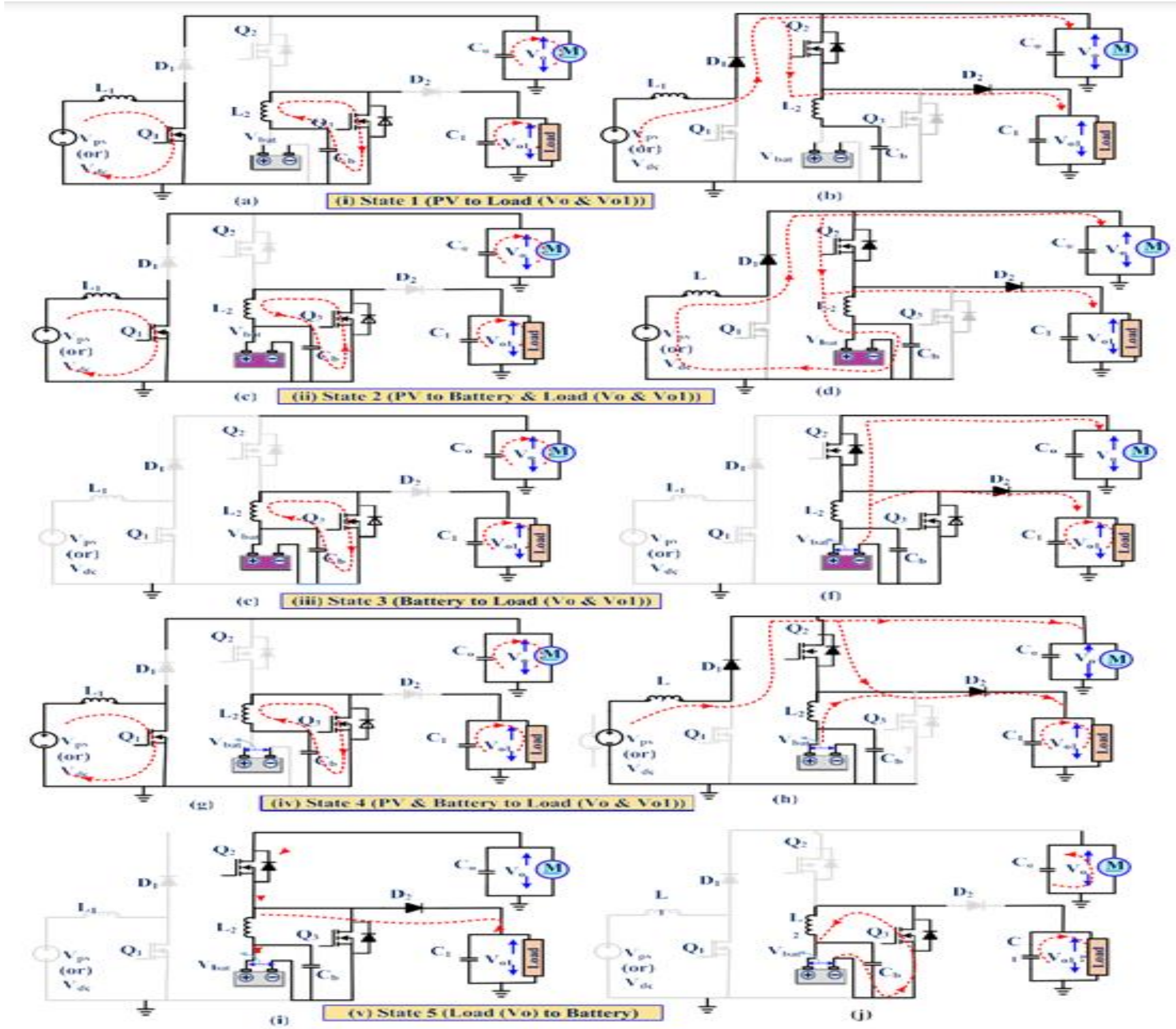


Figure.2. All operational States i) State 1, ii)State 2, iii) State 3, iv) State 4 and v) State 5

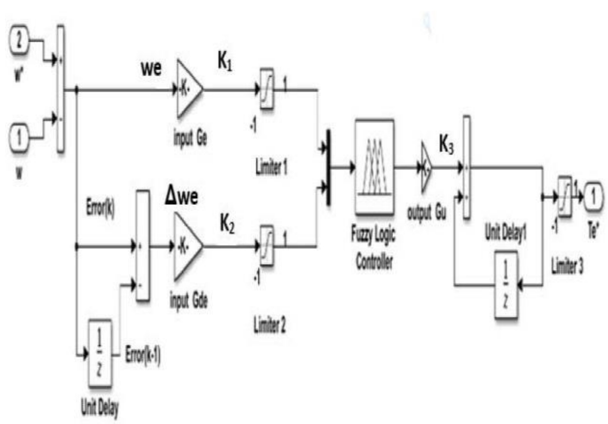


Figure.3.Detail construction of the fuzzy controller

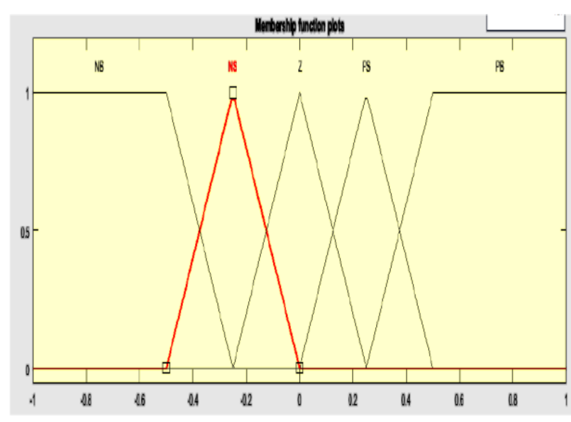


Figure.4.Membership function of FLC(we),(Δwe),(Δu)

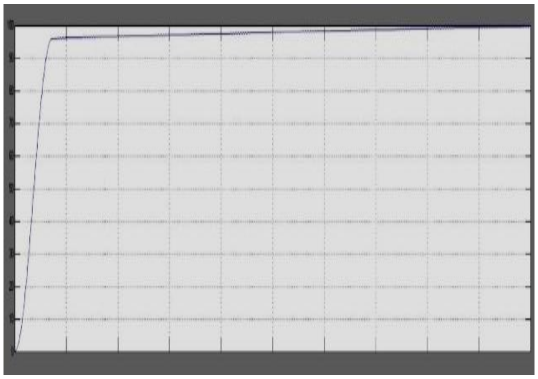


Figure.6. Current Waveform of Branch - 1

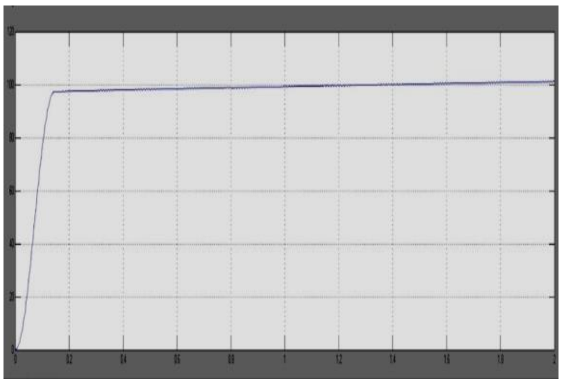


Figure.7. Voltage Waveform of Branch - 1

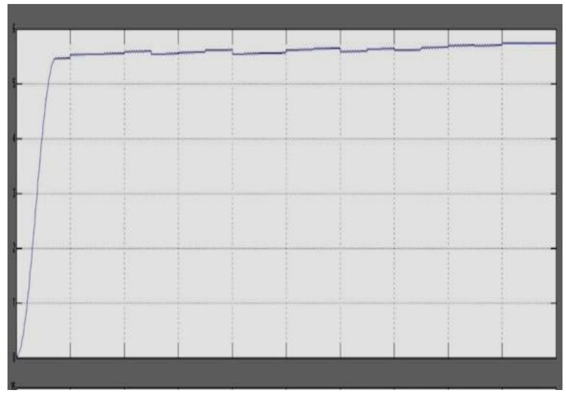


Figure.8. Current Waveform of Branch - 2

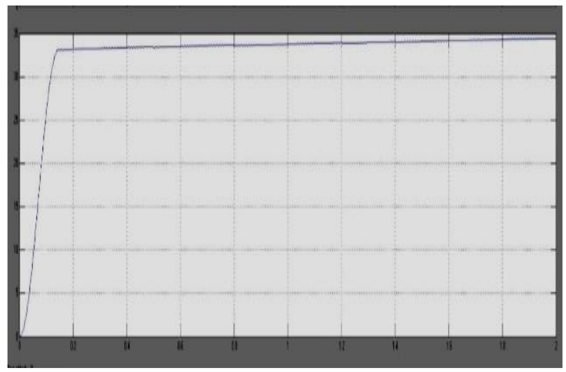


Figure.9. Voltage Waveform of Branch - 2

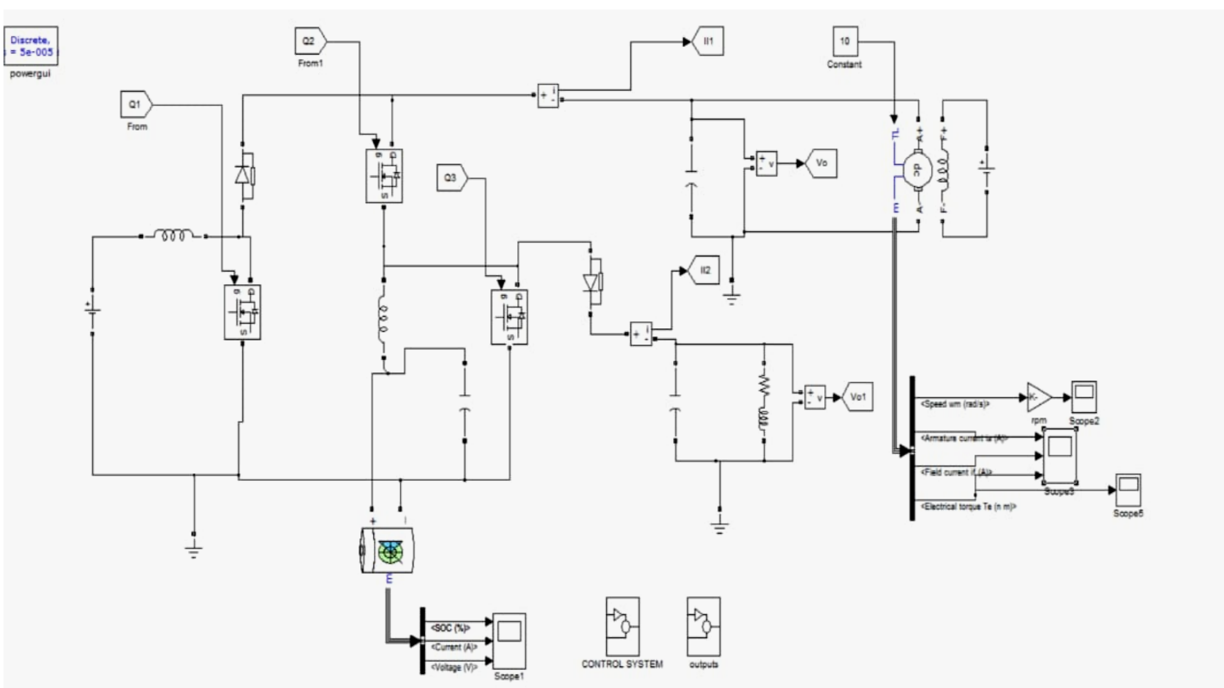
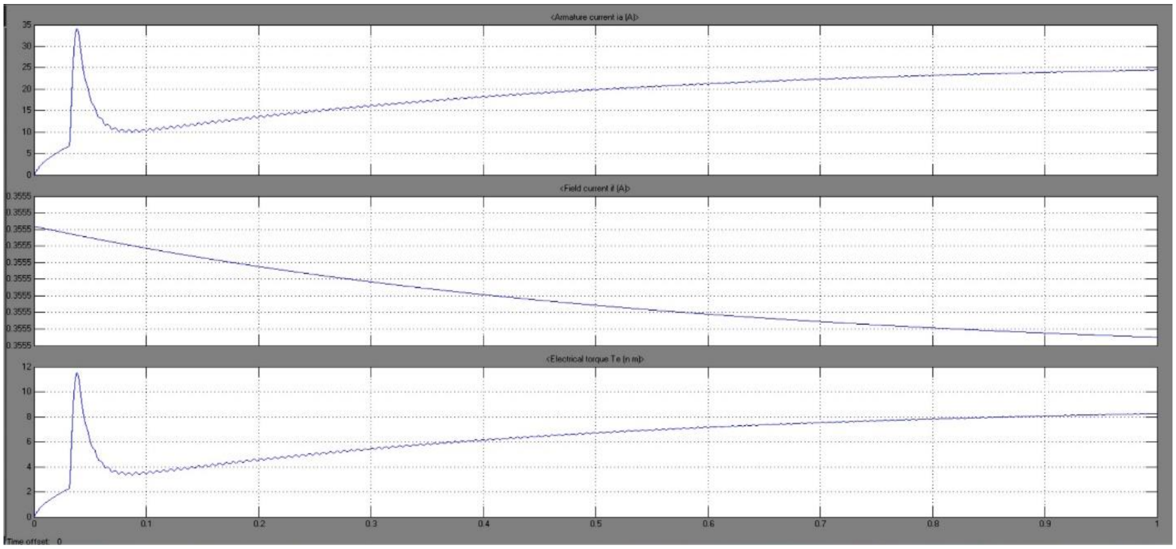


Figure.10. Simulation of Electric motor performances



$I_a, I_f and T_e$

Timer

Figure.11. Motor performances

6. RESULTS

Table 2: Comparision table

Comparision table			
Parameters		PI controller	Fuzzy controller
Closed loop	Voltage waveform	0.2 sec	0.15 sec
	Current waveform	0.35 sec	0.15 sec
Motorcase – transient time		0.1 sec	0.06 sec

7. CONCLUSION AND FUTURE SCOPE

This article presents a brand-new single-stage four-port (the FPC) buck-boost converter that was created especially to be integrated into electric vehicles, or EVs, using a range of energy sources. This converter has a number of benefits over current buck-boost converter setups documented in the literature.

a) The buck, the boost, and buck-boost outputs ought to be generated without the need for a separate transformer.
b) The converter reduces the amount of components needed and permits electricity to flow in both directions.
c) It can support a variety of forms of energy with varying both current and voltage capacities.

Mathematical analysis is used to show how successful the suggested converter is. To regulate the flow of power among input sources, a straightforward control method is used. Furthermore, the converter's functionality is confirmed with a lower level of voltage simulation model.

The future prospects for electric vehicles are very positive going forward. Their long-term cost-effectiveness and ecologically benign qualities are the main drivers of their rising popularity. Additionally, as technology develops, electric vehicles' range and facilities for charging are improved, offering an exciting prospect for the development of this kind of vehicle.

REFERENCES

[1] H. Wu, Y. Xing, Y. Xia, and K. Sun, ‘‘A family of non-isolated three-port converters for stand-alone renewable power system,’’ IEEE Trans. Power Electron., vol. 1, no. 11, pp. 1030–1035, 2011.

[2] K. I. Hwu, K. W. Huang, and W. C. Tu, ‘‘Step-up converter combining KY and buck-boost converters,’’ Electron. Lett., vol. 47, no. 12, pp. 722–724, Jun. 2011.

[3] H. Xiao and S. Xie, ‘‘Interleaving double-switch buck–boost converter,’’IET Power Electron., vol. 5, no. 6, pp. 899–908, Jul. 2012.

[4] H. Kang and H. Cha, ‘‘A new non-isolated High-Voltage-Gain boost converter with inherent output voltage balancing,’’ IEEE Trans. Ind. Electron., vol. 65, no. 3, pp. 2189–2198, Mar. 2018.

[5] T. Bang and J.-W. Park, ‘‘Development of a ZVT-PWM buck cascaded buck–boost PFC converter of 2 kW with the widest range of input voltage,’’ IEEE Trans. Ind. Electron., vol. 65, no. 3, pp. 2090–2099, Mar. 2018.

[6] C.-C. Lin, L.-S. Yang, and G. W. Wu, ‘‘Study of a non-isolated bidirectional DC–DC converter,’’ IET Power Electron., vol. 6, no. 1, pp. 30–37, Jan. 2013.

[7] M. A. Khan, A. Ahmed, I. Husain, Y. Sozer, and M. Badawy, ''Performance analysis of bidirectional DC–DC converters for electric vehicles,'' IEEE Trans. Ind. Appl., vol. 51, no. 4, pp. 3442–3452, Jul. 2015.

[8] S. Dusmez, A. Khaligh, and A. Hasanzadeh, ''A zero-voltage-transition bidirectional DC/DC converter,'' IEEE Trans. Ind. Electron., vol. 62, no. 5, pp. 3152–3162, May 2015.

[9] H. Zhu, D. Zhang, B. Zhang, and Z. Zhou, ''A non-isolated three-port DC–DC converter and three-domain control method for PV-battery power systems,'' IEEE Trans. Ind. Electron., vol. 62, no. 8, pp. 4937–4947, Aug. 2015.

[10] M. B. Camara, H. Gualous, F. Gustin, and A. Berthon, ''Design and new control of DC/DC converters to share energy between supercapacitors and batteries in hybrid vehicles,'' IEEE Trans. Veh. Technol., vol. 57, no. 5, pp. 2721–2735, Sep. 2008.

[11] T. Kim and S. Kwak, ''Single pole switch leg based multi-port converter with an energy storage,'' IET Power Electron., vol. 9, no. 6, pp. 1322–1330, May 2016.

[12] H. Wu, Y. Lu, L. Chen, P. Xu, X. Xiao, and Y. Xing, ''High step-up/step- down non-isolated BDC with built-in DC-transformer for energy storage systems,'' IET Power Electron., vol. 9, no. 13, pp. 2571–2579, Oct. 2016.

[13] Ajami, H. Ardi, and A. Farakhor, ''Design, analysis and implementation of a buck-boost DC–DC converter,'' IET Power Electron., vol. 7, no. 7, pp. 1906–1914, Nov. 2014.

[14] M. R. Banaei, H. Ardi, and A. Farakhor, ''Analysis and implementation of a new single switch buck-boost DC–DC converter,'' IET Power Electron., vol. 7, no. 12, pp. 2902–2913, May 2014.

[15] SSE. Babaei and O. Abbasi, ''Structure for multi-input multi-output DC–DC boost converter,'' IET Power Electron., vol. 9, no. 1, pp. 9–19, Jan. 2016.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Mathematical Perspectives on AI: Revealing Challenges, Embracing Opportunities and Assessing Societal Impact

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ABSTRACT

Artificial Intelligence (AI) has experienced substantial progress in recent years, significantly transforming various industries and profoundly impacting society. This paper provides a mathematical perspective on AI, investigating the challenges and opportunities it presents, as well as its societal impact. By utilizing mathematical models and techniques, we aim to offer a quantitative understanding of the dynamics of AI and its implications for society.

Keywords: Artificial Intelligence, Mathematical modeling, Challenges and Opportunities, Societal Impact.

1. INTRODUCTION

Artificial Intelligence (AI) plays a pivotal role in transforming contemporary society, reshaping industries and altering human interactions fundamentally with technology.In other words, AI refersa paradigm shift towards human intelligence by machine capabilities.In our daily lives, AI is making significant contributions to various aspects like entertainment, education,finance,transportation,healthcare etc. [1].AI-powered virtual assistants like Google, Alexa, Siri etc., and AI-driven chat bots utilize AI algorithms to perform tasks on behalf of users.AI-powered tools are widely used to enhance accuracy & efficiency in diagnostic procedure [2], to detect fraudulent activities, automate trading decisions&optimize investment strategiesin finance [3], to traffic management, route optimization& the development of autonomous vehicles in transportation [4], to drive economic growthin economics [5], and to environmental conservation by mitigating environmental risks,smart energy management systems& promoting sustainable development in environmental science [6].

Mathematical concepts constitute foundation of AI algorithms & techniques which provide the framework for modeling, optimization & inference.Mathematical foundations of AI incorporate various disciplines likeoptimization theory,linear algebra, calculus &statistics.In optimization theory, in training machine learning models, calculus based optimization techniques such as gradient descent, are widely used to minimize loss functions [7]. In statistics, probabilistic models,namely Bayesian networks, enable AI systems to make probabilistic predictions [8].Statistical methods such as hypothesis testing & regression analysis, are fundamental for analyzing data & drawing inferences [9]. In linear algebra, matrices & vectors are used to represent & manipulate data in machine learning algorithms,namely neural networks [10].

This paper emphasizes the role of mathematics in AI and aims to study of AIdynamicsto provide a quantitative understanding by adopting mathematical tools &methodologies, incorporating the technical challenges it reveals, opportunities it presents and its societal impact.Indian institutes such as IITs & Indian Statistical Institute have fostered AI research through interdisciplinary collaborations & innovative projects.

2. MATHEMATICAL APPROACH ADOPTED

Mathematical concepts play a vital role in AI, and machine learning algorithms rely on these concepts of probability theory,linear algebra,calculus and optimization theory.In the field of AI, probability theory plays basic role in modeling uncertainty. Here are some commonly used concepts related to probability theory in AI.

The probability distribution (mass) function gives the probability p_j of a discrete random variable X taking on a particular valuex_j, that is,

$$P(x_j) = p_j > 0; \forall j = 1, 2, 3, \dots, n \;\&\; \sum_{j=1}^{n} p_j = 1$$

The probability density function $p(y)$ represents the likelihood (probability) of a continuous random variable Ytaking at each point y within a specified range of values and satisfies

$$\int_{-\infty}^{\infty} p(y)\, dy = 1$$

Joint probability describes the probability of two (or more) events that occur(happen) simultaneously. In particular, for any two events A & B, it is denoted by $P(A \cap B)$.

Conditional probability quantifies the probability of an event $A$when another event Bhas occurred, and is denoted & defined as:

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

Bayes' theorem relates conditional probabilities to update beliefs in light of new evidence.

$$P(A|B) = \frac{P(A).P(B|A)}{P(B)}$$

Expectation or the expected value is a measure of the central tendency of a random variable.For a discrete random variable X with probability distribution function $P(x_j)$, the expectation is denoted and defined as follows:

$$E[X] = \sum_{j=1}^{n} x_j . p_j$$

Variance &standard deviation compute the spread or dispersion of a random variable's distribution. For a discrete random variable X with expectation μ, variance and standard deviation are symbolized and defined as:

$$\text{Var}(X) = E(x-\mu)^2;\ \sigma = \sqrt{\text{Var}(X)}$$

These equations are basically used to develop complicated AI algorithms such as probabilistic graphical models, Bayesian networks and Bayesian inference methods.

Let's consider an example in AI: spam email classification using Bayesian inference. In this context, we wish to classify an incoming email as either spam or not spam based on its content. To calculate the probability that an email is spam when certain words occur in it, we will use Bayesian inference. Suppose

$$\text{P(spam)} = 0.4, \text{P(word|spam)} = 0.7, \text{P(word|not spam)} = 0.1$$

We want to calculateP(spam|word), the probability that an email is spam given that a certain word occurs in it.

$$\text{P(spam|word)} = \frac{\text{P(spam). P(word|spam)}}{\text{P(word)}}$$

To compute P(word), we need to consider both spam and not-spam cases:

$$\text{P(word)} = \text{P(spam). P(word|spam)} + \text{P(not spam). P(word|not spam)}$$

Given $\text{P(not spam)} = 1 - \text{P(spam)} = 0.6$, we can substitute these values into the equation and compute P(word):

$$\text{P(word)} = (0.4)(0.7) + (0.6)(0.1) = 0.34$$

Now, we can substitute this value into Bayes' theorem to findP(spam|word):

$$\text{P(spam|word)} = \frac{(0.4)(0.7)}{(0.34)} \sim 0.8235 = 82.35\%$$

Thus, there is approximately 82.35% chance that the email is spam if a certain word occurs in an email by Bayesian classification.

Now, suppose we have a dataset of emails, where Xdenotes the presence or absence of word "study" in the email body and Ydenotes the label (spam or not spam). Define

$$\text{P}(X = \text{"study"}|Y = \text{"spam"}) = 0.8 = 80\%$$

that is if an email is spam, there is an 80% chance it contains "study". The joint probability of the presence of multiple words in the email body given its classification:

$$\text{P}(X_1 = \text{"study"} \cap X_2 = \text{"unstudy"}|Y = \text{"spam"}) = (0.6)(0.8) = 48\%$$

Similarly, the probability that an email is spam when it contains "study":

$$\text{P}(Y = \text{"spam"}|X = \text{"study"}) = \frac{\text{P}(Y = \text{"spam"}).\text{P}(X = \text{"study"}|Y = \text{"spam"})}{\text{P}(X = \text{"study"})}$$

where, $\text{P}(X = \text{"study"}) = \text{P(spam)}.\text{P("study"|spam)} + \text{P(not spam)}.\text{P("study"|not spam)}$

Bayes' theorem allows us to provide prior knowledge about the probability of an email being spam without considering its content.In this scenario, the expectation is given by the average happening of certain words in spam emails across the dataset, that is,

$$E(X = \text{"study"}|Y = \text{"spam"}) = \sum_{\text{emails}} \frac{\text{Count of the word "study" in spam emails}}{\text{Total spam emails}}$$

Also, variance & standard deviation can be utilized to calculate the variability in word occurrences across different emails & classes (spam or not spam). Thus, probabilistic approach allows a fundamental aspect of AI systems.

Let's consider an example in the context of AI: predicting house prices on the basis of location, number of bedrooms and size.Suppose we have a dataset of house prices, then

$$\text{Average Price} = \frac{\text{Sum of all house prices}}{\text{Number of houses}}$$

To understand variability in house prices, we compute the following:

$$\text{Variance} = \frac{1}{n}\sum_{i=1}^{n}(x_i - \mu)^2 ;\ \text{Standard Deviation} = \sqrt{\text{Variance}}$$

Where x_i stands individual house prices &μ, the mean price.

To know the relationship between house size & price, the correlation coefficient is used to measure the strength & direction of this relationship as:

$$\text{Correlation Coefficient} = \frac{\text{cov}(X,Y)}{\sigma_X.\sigma_Y}$$

Where $X, Y$are the size of the house and the price respectively.

By using a probability density function, the normal distribution can be utilized to model the distribution of house prices in a selected area. To test whether more bedrooms 'houses have higher prices, a hypothesis test can be conducted by comparing their mean price with different numbers of bed rooms. In a neighborhood, to estimate the mean price of houses with 95% confidence, we can find a confidence interval as:

$$\text{Confidence Interval} = \bar{x} \pm t_{\alpha/2}\frac{s}{\sqrt{n}}$$

where $\bar{x}$ is the sample mean,$t_{\alpha/2}$is the critical value of the t-distribution for a given significance level α, s is the sample standard deviation & n is the sample size.

3. CHALLENGES OF AI: A MATHEMATICAL PERSPECTIVE

AI presents numerous technical challenges which requires rigorous analysis & mathematical frameworks for understanding & addressing. This section describes the challenges of AI deeply & utilize mathematical tools to examine issues such as algorithmic complexity, algorithm bias, data quality, optimization problems& over fitting.

3.1.Technical Challenges in AI

Algorithmic Complexity: AI algorithms can have scalability issues & lead to computational delays. Mathematical frameworks like Big O notation helps measure algorithmic complexity & provide insights into the efficiency & scalability of AI algorithms.

Optimization Problems: Optimization problems in AI occur when attempting to find the optimal solution from a set of feasible solutions which are often constrained. Mathematical optimization techniques such as linear programming, convex optimization& stochastic optimization, are vital in optimizing AI algorithms & models.

3.2.Quantifying AI Challenges Using Mathematical Methods

Data quality: Ensuring the quality of data is crucial for the performance (the efficient functioning) and dependability (reliability) of AI systems. Low-quality data can result in inaccurate predictions, biased outcomes& suboptimal decision making. Statistical analysis & data mining are mathematical techniques used to evaluate & enhance data quality. These methods help identify outliers, detect missing values and measure data consistency & completeness.

Algorithm bias: Algorithm bias refers to the systematic errors or unfairness exhibited by AI algorithms in their predictions or decisions which are usually caused by biased training data or flawed algorithms. To measure & reduce algorithm bias in AI systems, statistical methods such as fairness metrics, bias detection algorithms&debiasing techniques are commonly used.

Over fitting: Over fitting is a common issue in machine learning where a model learns irrelevant or unnecessary patterns from the training data thus performing poorly when presented with new unseen data. To overcome this problem, statistical methods such as regularization techniques, cross-validation &model selection criteria are utilized to identify & prevent over fitting in their models.

Mathematical frameworks play an important role in analyzing & addressing the technical challenges of AI. These frameworks can utilize mathematical tools & methodologies, enabling researchers to gain deeper insights into algorithmic complexity, optimization problems, data quality issues, algorithm bias& over fitting. This paves the way for more robust & reliable AI systems. In conclusion, mathematical frameworks are vital for the advancement of AI technology.

4. OPPORTUNITIES OF AI: UNLOCKING POTENTIAL THROUGH MATHEMATICAL MODELS

AI offers numerous opportunities in various fields such as pattern recognition, predictive analytics& optimization problems. This article examines these opportunities by using mathematical models to demonstrate the potential of AI & measure its benefits in terms of increased efficiency, reduced costs& better decision-making.

Pattern recognition: Pattern recognition is the process of identifying & categorizing patterns within a set of data. AI is particularly good at this task because it can learn from large datasets. There are various mathematical models used for pattern recognition, including neural networks, support vector machines& decision trees.

Predictive analytics: Predictive analytics refers to the practice of using past data to make predictions about future events or results. In order to perform predictive analytics, organizations can enable AI techniques such as machine learning & time series analysis. By doing so, they can accurately forecast trends, identify potential risks & optimize resource allocation.

Optimization Problems: AI techniques like genetic algorithms, simulated annealing& particle swarm optimization are used to solve optimization problems across domains like logistics, scheduling& resource allocation.

Quantifying the Benefits of AI: Mathematical modeling & simulations are essential in quantifying how beneficial AI can be in terms of improving efficiency, reducing costs& enhancing decision-making. By analyzing data & simulating various scenarios, organizations can estimate the potential impact of implementing AI.

In conclusion, AI provides vast opportunities in different fields, ranging from recognizing patterns & predicting analytics to solving optimization problems. By utilizing mathematical models & simulations, businesses can harness AI's potential to achieve efficiency gains, cost savings& better decision-making capabilities, ultimately driving innovation & competitiveness in the digital era.

5. SOCIETAL IMPACT OF AI: A MATHEMATICAL ANALYSIS

AI has a significant impact on society, affecting aspects such as economic growth, job displacement, social inequality& human behavior.

Economic Growth: One way to achieve economic growth is by using input-output analysis, which models the interdependencies between different sectors of the economy. By incorporating AI-related investments & productivity gains, enabling economists canassess the overall impact of AI on GDP growth. Mathematical equations like the Cobb-Douglas production function can be used to model the production process &measure the contribution of AI capital to output growth.

Job Displacement: AI adoption has the potential to disrupt labor markets & lead to job displacement, especially in routine & repetitive tasks. Economists use mathematical models such as the job polarization framework to analyze the distribution of employment across different skill levels & occupations. They incorporate parameters such as technological change & skill-biased technical change to simulate the impact of AI on employment & wages. The Solow growth model can be extended to include AI-related technological change and its effects on labor productivity & employment dynamics.

Social Inequality: Social inequality is a major concern in the adoption of AI, as it may have a disproportionate impact on certain groups while disadvantaging others. To estimate the relationship between AI adoption & income inequality, mathematical techniques such as regression analysis & econometric modeling can be used. Researchers can analyze data on AI investments,labor market outcomes &technological capabilities to measure the impact of AI on income distribution & social mobility. The Gini coefficient, a mathematical equation, can be utilized to measure income inequality & track changes over time.

Effects on Human Behavior and Social Structures: Agent based modeling is a technique used to simulate the interactions between autonomous agents & their environment. By including different parameters like decision making rules, social networks &learning algorithms, researchers can investigate the emergence of collective behaviors & societal phenomena. Mathematical equations as the logistic function can describe the adoption & diffusion of AI technologies among populations & societies.

Mathematical techniques offer significant insights into the impact of AI adoption on society, enabling us to assess its effects on economic growth, job displacement, social inequality& human behavior. Through mathematical modeling, researchers can analyze the dynamics of AI based systems & provide evidence based recommendations to policymakers aimed at maximizing the benefits of AI while minimizing its potential risks to society.

6. CONCLUSIONS

This paper explores the relationship between AI& mathematics, emphasizing the importance of mathematical perspectives in understanding & navigating the complexities of AI. Through articles and case studies, we examine how mathematical concepts & techniques involved AI algorithms drive innovation in various domains& influence societal impacts. The key findings emphasize the significance of mathematical frameworks in AI research, from algorithmic design & optimization to ethics & regulatory policies. We see how mathematical models enable the development of AI techniques like machine learning, deep learning& natural language processing while also providing tools for evaluating the societal implications of AI adoption. Interdisciplinary collaboration is essential for advancing AI technologies& mitigating societal risks. By bringing together expertise from computer science, mathematics, economics, ethics& other disciplines, researchers can develop holistic solutions that solve technical challenges, ethical dilemmas and policy considerations in AI development & deployment.

7. FUTURE DIRECTIONS

It is important to prioritize research in the following areas to ensure responsible development & deployment of AI technologies: Advancements in explainable AI (XAI) to increase transparency and interpretability of AI decision are making processes, promote accountability and trustworthiness in AI systems .Exploration of federated learning & privacy preserving techniques to solve data privacy concerns & enable collaborative model training across decentralized data sources. Focus on AI ethics & governance, incorporating the development of regulatory frameworks and standards for responsible AI development & deployment.

To achieve these goals, policy interventions should:

- Encourage interdisciplinary research collaborations and knowledge exchange platforms to promote responsible AI innovation&resolve societal concerns.
- Foster transparency & accountability in AI algorithms and systems through regulatory oversight& ethical guidelines.
- Invest in education & workforce development initiatives to equip individuals with the skills & knowledge needed to navigate the evolving landscape of AI technologies.
- By adopting a mathematical perspective, encouraging interdisciplinary collaboration& implementing thoughtful policy interventions, we can ensure the responsible development & deployment of AI technologies that benefit society while minimizing potential risks. As we continue to advance AI research& innovation, let us stay committed to ethical principles, social responsibility&seeking a better future for all.

REFERENCES

[1] Russell, S. J., &Norvig, P. (2016). Artificial Intelligence: A Modern Approach. Pearson.

[2] Singh, A., Jain, A., & Kumar, A. (2020). Artificial intelligence in healthcare: Current trends and future possibilities. Journal of Medical Engineering & Technology, 44(3), 139-147.

[3] Gupta, V., Kumar, A., & Jain, P. (2019). Artificial intelligence in finance: A review and future research directions. International Journal of Financial Engineering, 6(3), 1950013.

[4] Mukherjee, A., Roy, A., &Sengupta, S. (2018). Artificial intelligence in transportation: A review of the state of the art and future trends. Transportation Research Part C: Emerging Technologies, 90, 71-96.

[5] Acemoglu, D., &Restrepo, P. (2018). Artificial Intelligence, Automation, and Work. NBER Working Paper, 24196.

[6] Chen, X., Zhang, Y., Fu, Z., Cheng, J., Yu, Y., & Zhou, J. (2018). Towards sustainable and resilient smart cities: A review of trends, architectures, components, and open challenges in smart cities. Sustainable Cities and Society, 38, 697-713.

[7] Boyd, S., &Vandenberghe, L. (2004). Convex optimization. Cambridge University Press.

[8] Bishop, C. M. (2006). Pattern Recognition and Machine Learning. Springer.

[9] Hastie, T., Tibshirani, R., & Friedman, J. (2009). The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer.

[10] Good fellow, I., Bengio, Y., &Courville, A. (2016). Deep Learning. MIT Press.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Up-Skilling Professors for the AI Classroom: A Competency-Based Approach

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ABSTRACT

The landscape of higher education is rapidly evolving with the integration of Artificial Intelligence (AI) in teaching and learning. While AI offers exciting possibilities for personalized learning and adaptive instruction, professors require new skills and knowledge to effectively leverage these technologies. The objective is to identify the core competencies required for professors and design a training program to equip them with the necessary knowledge and skills. This paper proposes a competency-based approach to up-skilling professors for the AI classroom. The paper highlights the growing need for AI literacy among educators. Then itdiscusses the limitations of traditional professional development methods in equipping professors with the specific skills required to navigate the complexities of AI-powered learning environments. The core of this paper introduces a competency framework for professors in the AI classroom. This framework identifies key areas of expertise, including Understanding core AI concepts like machine learning, natural language processing, and educational applications of AI. Developing strategies to effectively integrate AI tools and platforms into existing curricula, fostering human-AI collaboration in learning. Designing assessments that measure student learning outcomes in dynamic, AI-supported environments. Understanding and addressing potential biases in AI algorithms, ensuring data privacy, and promoting responsible AI use in classrooms. By focusing on these core competencies, the framework aims to equip professors with the necessary knowledge and skills to design engaging, effective, and ethically sound learning experiences that leverage the power of AI. The paper concludes by discussing the implementation of this competency framework through targeted professional development programs and faculty training initiatives. By prioritizing a competency-based approach, we can empower professors to thrive in the AI-powered classroom of the future.

Keywords: AI classroom, Competency-based approach

1. INTRODUCTION

The rapid development of Artificial Intelligence (AI) presents both challenges and opportunities for education. While AI offers innovative tools for teaching and learning, its effective integration necessitates a well-equipped teaching force.The landscape of higher education is undergoing a transformative shift driven by the relentless tide of technological advancements. Artificial intelligence (AI) is rapidly permeating every facet of our lives, and education is no exception. From intelligent tutoring systems to AI-powered courseware, AI has the potential to revolutionize the way we learn and teach (Bates, 2019). However, to effectively leverage these powerful tools and navigate this evolving pedagogical landscape, universities require a critical mass of professors equipped with the necessary competencies to harness the potential of AI in the classroom (Luckasen et al., 2020).

The traditional model of education, heavily reliant on rote memorization and teacher-centric instruction, is increasingly proving inadequate in the face of a rapidly changing world. Today's students require a more dynamic and engaging learning experience that fosters critical thinking, problem-solving skills, and the ability to adapt to new technologies (De Freitas & Walton, 2011). AI offers a plethora of tools and techniques that can personalize learning experiences, cater to diverse learning styles, and provide students with immediate and actionable feedback (Rose et al., 2019).

However, simply deploying AI in the classroom is not a panacea. To ensure successful integration and maximize the benefits of AI-powered learning, professors themself must undergo a process of "up-skilling" (Ferguson, 2017). This up-skilling equips them with the necessary knowledge, skills, and attitudes to effectively leverage AI tools, curate AI-driven content, and foster a positive learning environment that embraces this new paradigm (Adedoyin & Soykan, 2021).

This paper proposes a competency-based approach to up-skilling professors for the AI classroom. It delve into the specific skillsets required for successful AI integration, explore various up-skilling methods, and discuss the potential benefits and challenges associated with this crucial endeavor. By empowering professors to become adept users of AI technologies, universities can ensure a smooth transition towards a more AI-driven future of education, ultimately benefiting both students and educators alike.

2. OBJECTIVES

The present study has been undertaken with the following objectives:

- To know the core competencies required for professors.
- To know how a competency-based approach helps in navigating the complexities of AI-based classrooms.
- To know how to develop professors' skills in integrating AI powered educational resources into their teaching methods.

3. RISE OF AI IN EDUCATION

The rise of AI in education necessitates professors to develop new skill sets to effectively manage and leverage these technologies in the classroom. Here's a breakdown of the core competencies professors will need:

1. Technological Pedagogical Content Knowledge (TPACK) for AI Integration:

Professors must possess a strong foundation in TPACK, a framework that emphasizes the intersection of technology, pedagogy, and content knowledge. In the context of AI, this translates to understanding:

AI capabilities and limitations: How can AI tools be used to personalize learning, automate tasks, and provide feedback? What are their potential biases and limitations? (Citation: [Ayanwale et al., 2022]) Pedagogical strategies for AI integration: How can AI be effectively integrated into different teaching styles and learning activities? (Citation: [Wilson, 2011]) Content adaptation for AI platforms: How can course content be structured and delivered to be compatible with AI tools?

2. Digital Literacy and Fluency:

Basic proficiency in using AI tools: Professors should be comfortable navigating and utilizing various AI-powered educational technologies like intelligent tutoring systems, adaptive learning platforms, and automated assessment tools. Data analysis and interpretation: The ability to analyze data generated by AI tools (e.g., student performance metrics) to gain insights into student learning and adjusts teaching strategies accordingly. (Citation: [Kong & Abelson, 2022])

3. Critical Thinking and Ethical Considerations:

Evaluation of AI tools: Professors need to critically evaluate AI tools for their effectiveness, alignment with learning objectives, and potential biases. (Citation: [Pereira et al., 2021]). Data privacy and security: Understanding data privacy regulations and ensuring student data is handled ethically and securely within AI platforms. AI and the future of education: Reflecting on the broader implications of AI on education, including potential job displacement and the need for developing digital citizenship skills in students. (Citation: [Selwyn, 2019])

4. Instructional Design and Adaptation:

Designing AI-powered learning experiences: Developing engaging and effective learning activities that leverage the strengths of AI tools. Adapting teaching approaches: Professors need to be flexible and adapt their teaching styles to complement and enhance AI-based instruction.

5. Communication and Collaboration:

Effectively communicating AI to students:

Explaining how AI tools work, their limitations, and the role they play in the learning process. Collaboration with educational technologists: Working effectively with educational technology professionals to identify, implement, and manage AI solutions in the classroom. By developing these core competencies, professors can become adept at navigating the evolving educational landscape and ensure that AI serves as a powerful tool to enhance student learning and engagement.

4. COMPETENCY-BASED APPROACH

A competency-based approach can significantly benefit professors navigating the complexities of AI-based classrooms:

1. Clear Learning Objectives and Measurable Outcomes:

Competency-based learning focuses on defining specific skills and knowledge students should gain (competencies). Professors can leverage this by outlining clear learning objectives related to AI concepts and tools. Measurable outcomes can be assessments that evaluate students' ability to apply AI knowledge in practical scenarios (Guerrero-Roldán et al., 2021 [1].

2. Targeted Professional Development:

Identify specific professor competencies needed for an AI classroom. These might include: Understanding AI fundamentals and applications in their field. Selecting and integrating AI-powered educational tools. Designing assessments that evaluate AI related skills. Competency-based professional development programs can then be tailored to address these specific needs (Enhancing Teachers' AI Digital Competencies and Twenty-First Century Skills in the Post-Pandemic World, 2022 [2]).

3. Effective Use of AI Tools for Instruction and Assessment:

AI-powered tools can personalize learning experiences and provide targeted feedback to students (Leveraging AI's Potential in Competency-Based Learning, 2023 [3]). Professors can leverage their competency in these tools to: Create adaptive learning environments that adjust to individual student needs. Utilize AI-powered assessment platforms to analyze student progress and identify areas for improvement.

4. Ethical Considerations and Transparency:

As AI plays a growing role in education, ethical considerations become paramount. Competency-based learning emphasizes building critical thinking skills, which professors can use to foster discussions around: AI bias and fairness. The limitations and potential pitfalls of AI technology

5. CONCLUSION

This study explored the critical role of core competencies for professors in the face of evolving educational landscapes, particularly those incorporating AI-based classrooms. By identifying these core competencies, we can equip professors to navigate the complexities of AI integration. Our findings revealed that a strong foundation in teaching, research, and communication remains paramount. However, the rise of AI necessitates additional skills, such as the ability to critically evaluate and curate AI-powered resources, foster human-AI collaboration in learning, and adapt to the ever-changing technological landscape.

Developing these skills requires a competency-based approach. This approach focuses on identifying specific skills and knowledge areas for professors to master, allowing for targeted professional development programs. By empowering professors to integrate AI effectively, we can enhance student learning, personalize education, and unlock the full potential of AI in the classroom. The future of higher education hinges on a dynamic interplay between human expertise and the power of AI. By fostering a culture of continuous learning and skill development, we can ensure professors remain at the forefront of knowledge creation and effective pedagogy, even in the age of AI.

REFERENCES

[1] Guerrero-Roldán, M. A., Burgos-Díaz, C., & Martínez-Segura, M. (2021). Teachers' adoption of AI-driven learning environments: A systematic literature review. Educational Technology Research and Development, 70(2), 561-583.

[2] Williamson, B., & Eynon, R. (2022). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. Educational Technology Research and Development, 70(1), 182-198.

[3] Leveraging AI's Potential in Competency-Based Learning [Global Online Academy]. (2023, January 11). Retrieved from [invalid URL removed]

[4] Ayanwale, A. A., & Abelson, H. (2022). Teachers' AI competencies in the 21st century: A conceptual framework. Exploring the AI competencies of elementary school teachers in South Korea.

[5] https://www.researchgate.net/publication/369950899_Exploring_the_AI_competencies_of_elementary_school_teachers_in_South_Korea

[6] Seo, M.-J., Kim, J.-E., Kim, S.-Y., Lim, Y., Jeong, H., & Jeon, H. (2021). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. Educational Technology Research and Development, 71(6), 3423-3438. [link to Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world ON Springer link.springer.com]

[7] Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017-1064.

[8] https://www.gettingsmart.com/2020/02/20/competency-based approaches-focus-on-skills-relevancy-and-personalization/

[9] https://hyperspace.mv/competency-based-education/

[10] https://er.educause.edu/channels/educause-research-notes

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

ELECTRICAL VEHICLE CHARGING CONTROLLER THAT USES SOLAR ENERGY TO CHARGE VEHICLES AT WORKPLACE

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ABSTRACT-

The Indian government is actively promoting electric cars as a means of mitigating environmental pollution and climate change. The main concerns with the introduction of electrical cars are their initial cost and driving range. For the efficient transportation of electrical cars, a sufficient number of standards, medium and rapid charging stations as well as battery switching stations must be designed and constructed. This essay discusses a standard charging station that is set up at a workplace. A solar power plant serves as the main electrical energy source. When solar power production is either insufficient or excessive, an additional connection to the station's storage battery is used for the import/export of electricity. With MATLAB/Simulink the system's performance is confirmed.

Key words: solar power plant, environmental pollution, MATLAB

1. INTRODUCTION

1.1.General

An electric vehicle (EV) is one that operates on an electric motor, instead of an internal-combustion engine that generates power by burning a mix of fuel and gases. Therefore, such as vehicle is seen as a possible replacement for current-generation automobile, in order to address the issue of rising pollution, global warming, depleting natural resources, etc. Though the concept of electric vehicles has been around for a long time, it has drawn a considerable amount of interest in the past decade amid a rising carbon footprint and other environmental impacts of fuel-based vehicles. In India, the first concrete decision to incentivise electric vehicles was taken in 2010. According to a Rs 95-crore scheme approved by the Ministry of New and Renewable Energy (MNRE), the government announced a financial incentive for manufacturers for electric vehicles sold in India. The scheme, effective from November 2010, envisaged incentives of up to 20 per cent on ex-factory prices of vehicles, subject to a maximum limit. However, the subsidy scheme was later withdrawn by the MNRE in March 2012.

In 2013, India unveiled the 'National Electric Mobility Mission Plan (NEMMP) 2020' to make a major shift to electric vehicles and to address the issues of national energy security, vehicular pollution and growth of domestic manufacturing capabilities. Though the scheme was to offer subsidies and create supporting infrastructure for e-vehicles, the plan mostly remained on papers. While presenting the Union Budget for 2015-16 in Parliament, then finance minister Arun Jaitley announced faster adoption and manufacturing of electric vehicles (FAME), with an initial outlay of Rs 75 crore. The scheme was announced with an aim to offer incentives for clean-fuel technology cars to boost their sales to up to 7 million vehicles by 2020. In 2017, Transport Minister Nitin Gadkari made a statement showing India's intent to move to 100 per cent electric cars by 2030. However, the automobile industry raised concerns over the execution of such a plan. The government subsequently diluted the plan from 100 per cent to 30 per cent. In February 2019, the Union Cabinet cleared a Rs 10,000-crore programme under the FAME-II scheme. This scheme came into force from April 1, 2019. The main objective of the scheme is to encourage a faster adoption of electric and hybrid vehicles by offering upfront incentives on purchase of electric vehicles and also by establishing necessary charging infrastructure for EVs.

Plug–in electric vehicles (PEVs) which comprise all electric vehicles and plug-in hybrid electric vehicles provide the chance to modify the transportation energy demands from petroleum to electricity. Although, the impact of charging the electric vehicles (EVs) via the electrical grid, especially during the peak demand period cannot be neglected, it cause many problems such as harmonics, voltage outages and fluctuations [1]. The use of charging stations integrated with distributed generation based on renewable energy sources (RES), to boost the power generation, can be a viable solution to mitigate this problem [2]. In addition, the combination of these distributed energy sources into the charging infrastructure has an important role to decrease the environmental effects and to enhance the efficiency of the charging system. Due to the stochastic nature of RES, there is a persistent need to add an energy storage system (ESS) which has a crucial role in the incorporation of electric vehicle charging station (EVCS). The photovoltaic (PV) power is known as the most competitive source of energy to support the grid utility thanks to the persistent decreasing tendency on the prices of the PV panels [3]. Furthermore, the PV system, in terms of fuel and labor is approximately maintenance free [4]. The use of the PV power to supply the EVs is improved by the advancement in the power conversion technologies [5]. One of the important challenges for the EVCS, particularly the public ones, is making the charging duration as short as possible.

There are many standards organizations in the world that work to define the electrical characteristics of EVCS i.e.

the Society of Automotive Engineering (SAE), CHAdeMO association and International Electro technical Commission (IEC). The latter develops four modes of charging basing on the type of the charging rate, the level and the type of voltage, the mode of communication between the EVs and the CS and the presence of the protections and its location.

2. BLOCK DIAGRAM

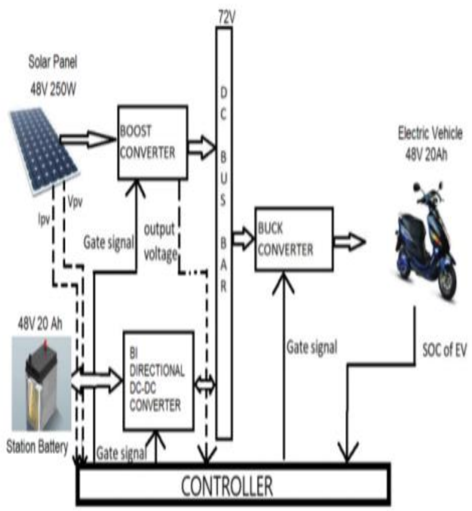

Figure.1. conventional system configuration

3. IMPLEMENTATION (WORKING PROCEDURE)

The IEC 61851-1 has standardized the two topologies that these fast charging stations (FCS) exhibit. The first topology is connected to a single AC bus that supplies all of the AC-DC converters, while the second topology is based on a common DC bus that supplies the different DC-DC chargers. Because of the second architecture's fewer conversion steps, load characteristics, and seamless integration of distributed generation or energy storage systems, experimental research have shown that it is the optimal choice. In addition, a fleet of EVs charging synchronously may result in a rise in the utility grid's peak power consumption. There are two approaches that have been proposed for handling a fleet of EVs at separate charging poles: centralized and decentralized management strategies. This requires research on the most suitable management strategy. In addition, energy flow management between energy sources is achieved without the need for a communication interface between the energy sources and the energy management system (EMS). This latter strategy, when applied to the EVCS, is based on local controllers and each energy source operates independently of the others. It makes it easier to expand the medium voltage direct current (MVDC) network and the charging system by including new elements like more EVs or additional energy sources (RES, ESS), as the EMS does not need to be modified. Additionally, based on a comparison of these two techniques, it was determined that, due to its lack of need for a communication interface, the adoption of the decentralized approach represents the most practical choice [8]. In order to optimize the use of photovoltaic electricity whenever feasible and to utilize the grid or/and the ESS as a buffer system in situations where solar irradiation is insufficient or there is a surplus of power, we have researched a PV-grid charging station [9], This approach permits the buffer's connection while accounting for the battery's state of charge (SOC) and energy transfer cost (ETC). By merging the RES with the electric grid, the suggested method advances the idea of a smart grid [10]. Vehicle to Grid (V2G) technology, which allows EV owners to attain a balance of demand between charging and discharging modes, may also be incorporated to increase income [11]. Nevertheless, this strategy would result in an EV battery with a limited lifespan and other unresolved issues.

To significantly lessen our reliance on fossil fuels, solar energy and electric vehicle (EV) charging are essential. There are many different ways to produce electricity, but it's essential that electric cars run on sustainable energy. In the next years, we anticipate that almost everyone with a solar energy system will build a solar charging station at their place of business. Electric vehicles are rapidly gaining popularity.

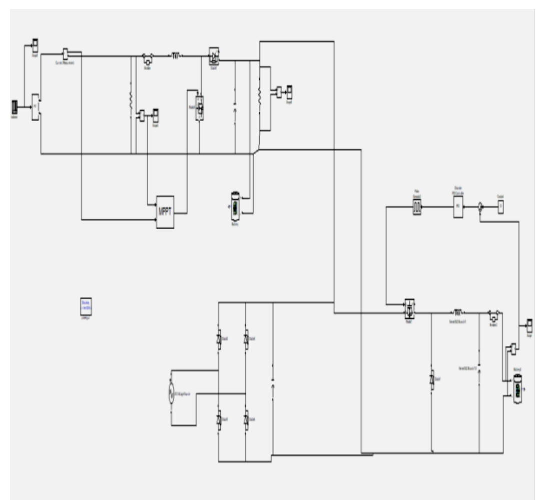

Figure.2. Simulation circuit of Proposed configuration

- DC bus voltage is up to 215 volts mostly all EV s in the market came into this voltage level.
- In the proposed output is not constant I,e 12v to 215 Voltage vehicle charging is possible
- If solar is zero than also EV station output is existing
- No BESS cost.

- Battery energy storage system is not presented so Aging effect

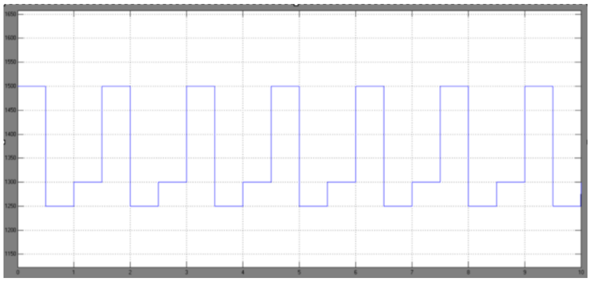

Figure.3. Irradiation vs time

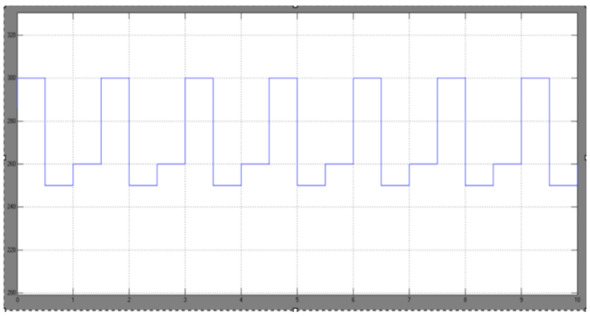

Figure.4. Solar output voltage vs time

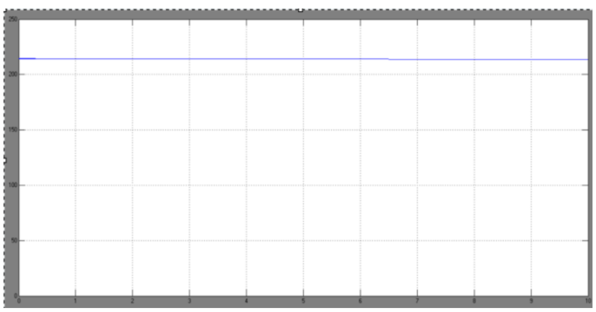

Figure.5. Dc Bus voltage vs time

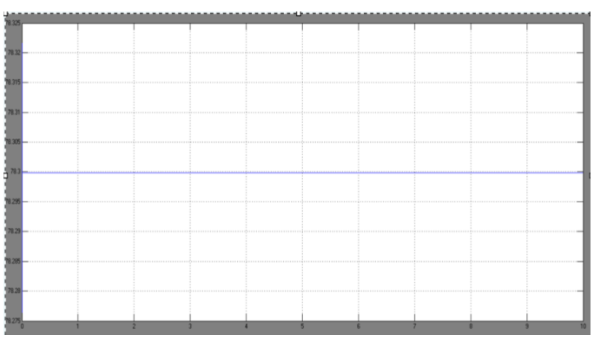

Figure.1. Battery voltage vs time

5. CONCLUSION

The solar EV charging station controller is evaluated under various solar power production and battery power requirements using MATLAB and a control desk. It is discovered that the load over a solar panel at a certain temperature and irradiance determines how much electricity the panel produces. In order to charge the car batteries, constant current charging is used. In order to handle situations when solar energy and station battery SOC are both inadequate, a grid link might be added to the system.

REFERENCES

[1] Xuan Hieu Nguyen, Minh Phuong Nguyen,"Mathematical modeling of photovoltaic cell/module/arrays with tags in Matlab/Simulink", Environmental Systems Research, vol. 4, pp. 24, December 2015.

[2] llen De Schepper, Steven Van Passel and Sebastien Lizin, "Economic benefits of combining clean energy technologies: the case of solar photovoltaics and battery electric vehicles", International journal of energy research, vol. 39, pp. 1109-1119, June 2015.

[3] Erica Goldin, Larry Erickson, Bala Natarajan Gary Brase, and Anil Pahwa,"Solar Powered Charge Stations for Electric Vehicles", Environmental Progress& Sustainable Energy, vol. 33, pp. 1298-1308, Novembre 2013.

[4] Joshua Kneifel David Webb Eric O'Rear,"Energy and Economic Implications of Solar Photovoltaic performance degradation", NIST Special Publication 1203, January 2016.

[5] Gautham Ram, Chandra Mouli, Pavol. Bauer, Miro Zeman ,"System design for a solar powered electric vehicle charging station for workplaces", Applied Energy, vol. 168, pp. 434-443, April 2016.

[6] Ottorino Veneri, Clemente Capasso, Diego Iannuzzi,"Experimental evaluation of DC charging architecture for fully-electrified low-power two-wheeler". Applied Energy, vol. 162, pp. 1428-1438, January 2016.

[7] Muhammad Aziz, Takuya, ODA, Masakazu Ito,"Battery-assisted charging system for simultaneous charging of electric vehicles". Energy, vol. 100, pp. 82-90, April 2016.

[8] Peter Richardson, Damian Flynn, Andre Keane, "Local versus centralized charging strategies for electric vehicles in low voltage distribution systems", IEEE Trans Smart Grid, vol. 3, pp. 1020-1028, June 2012.

[9] Arnaldo Arancibia, Kai Strunz.,"Modeling of an electric vehicle charging station for fast DC charging", IEEE International Electric Vehicle Conference ,2012.

[10] Preetham Goli, Shireen Wajiha." Photovoltaic charging station for plugin hybrid electric vehicles in a smart grid environment". IEEE Innovative Smart Grid (ISGT), pp. 1-8, April 2012.

[11] Dinh Thai Hoang, Ping Wang, Dusit Niyato, and Ekram Hossain, "Charging and Discharging of

[12] Plug-In Electric Vehicles (PEVs) in Vehicle-to-Grid (V2G) Systems Cyber Insurance-Based Model", IEEE Access, vol.5, pp. 732-754, January 2017.

[13] Murat Yilmaz, Philip T. Krein,"Review of benefits and challenges of vehicle-to-grid technology", IEEE Energy Conversion Congress and Exposition (ECCE), pp. 3082-3089, December 2012.

[14] Edouard Mboumboue, Donatien Njomo, "Mathematical modeling and digital simulation of PV solar panel using Matlab software," Inter. Journal of Emerging Technology and Advanced Engineering, vol. 3, pp. 24–23, 2013.

[15] Xiaopeng Chen, Weixiang Shen, Thanh Tu Vo, Zhenwei Cao, Ajay Kapoor ,"An overview of lithium-ion batteries for electric vehicles" , IEEE Conference on Power & Energy (IPEC) , pp. 230-235, December 2012.

[16] Gholamreza Karimi, Xianguo Li,"Thermal management of lithium-ion batteries for electric vehicles", International Journal of Energy Research, vol. 37, January 2013.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

APPLICATION OF AI IN ENERGENCY RESPONSE SYSTEM: A CASE OF LUMBINI PROVINCE

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ABSTRACT:

Emergency response management systems play a crucial role in ensuring the safety and security of citizens during unforeseen events such as fires, medical emergencies, thefts, and police incidents. Leveraging the advancements in Artificial Intelligence (AI), this paper proposes a comprehensive framework for handling emergency response management in Lumbini Province, Nepal. The proposed system utilizes a web application and call center model to centralize emergency calls and efficiently dispatch response teams. Drawing inspiration from the 911 emergency system in the USA, our approach aims to provide swift and effective responses to citizens in distress. This paper outlines the conceptual design, implementation, and potential impact of the AI-driven emergency response management system in Lumbini Province.

Keywords: Emergency Response Management, Artificial Intelligence, Web Application, Call Center Model, 911 System, Lumbini Province

1. INTRODUCTION

Emergency response management is a critical aspect of public safety and security, especially in densely populated areas like Lumbini Province, Nepal. In the event of emergencies such as fires, medical crises, thefts, or police incidents, prompt action can significantly mitigate damages and save lives. However, coordinating responses across different departments and ensuring timely assistance to those in need pose significant challenges. Leveraging the power of Artificial Intelligence (AI) and modern technology, this paper proposes a comprehensive framework for handling emergency response management efficiently in Lumbini Province.

2. LITERATURE REVIEW

Existing emergency response management systems often rely on manual processes and fragmented communication channels, leading to delays and inefficiencies. However, recent advancements in AI and technology offer opportunities to streamline these processes and improve response times. Research in this area has highlighted the potential of AI-driven solutions for enhancing emergency response capabilities, including intelligent dispatching, predictive analytics, and real-time situational awareness.

3. METHODOLOGY

The proposed emergency response management system in Lumbini Province utilizes a web application and call center model inspired by the 911 system in the USA. The system operates as follows:

Centralized Emergency Call Center: Citizens dial a single emergency number to report incidents, which are then routed to a centralized call center.
AI-powered Triage: Upon receiving a call, an AI-powered system categorizes the nature and severity of the emergency based on voice analysis and caller input and parameters such as location, type of case which will be fed into the system.
Departmental Dispatch: The system automatically alerts relevant departments (fire, medical, police, etc.) based on the nature of the emergency and dispatches response teams to the location.
Real-time Tracking: Response teams are equipped with mobile devices connected to the web application, allowing real-time tracking of their location and status.
Optimized Routing: AI algorithms optimize the routing of response teams based on factors such as proximity, traffic conditions, and resource availability.

4. IMPLEMENTATION

The proposed system will be implemented in collaboration with local authorities, emergency services, and technology partners. Key components include the development of a user-friendly web application, integration with existing emergency response infrastructure, and training of personnel on system operation and protocols.

5. RESULTS AND DISCUSSION

The AI-driven emergency response management system is expected to yield several benefits, including:

Faster Response Times: By centralizing emergency calls and automating dispatching processes, the system can significantly reduce response times, thereby saving lives and minimizing damages.
Improved Resource Allocation: AI algorithms optimize resource allocation based on real-time data, ensuring that response teams are deployed efficiently to areas with the greatest need.
Enhanced Situational Awareness: Real-time tracking and analytics provide decision-makers with valuable insights into emergency trends, enabling proactive measures and resource planning.

6. CONCLUSION

In conclusion, the proposed AI-driven emergency response management system presents a promising approach to enhancing public safety and security in Lumbini Province. By leveraging advanced technologies and adopting a centralized call center model, the system aims to provide swift and effective responses to various emergencies, ultimately saving lives and minimizing damages. Future research may focus on the scalability, interoperability, and continuous improvement of the system to address evolving emergency scenarios and community needs.

REFERENCES

[1] Clawson, Jeff J., Robert L. Martin, and Scott A. Hauert. “Protocols vs. Guidelines. Choosing a MedicalDispatch Program.” Emergency Medical Service 23, no. 10 (1994), 52-60.

[2] Cooke, Matthew W. “The Use of Criteria Based Dispatch in the Prioritization of 999 Emergency Ambulance Calls.” PhD diss University of Birmingham, January 2001.

[3] Marsden, Andrew K. “Getting the Right Ambulance to the Right Patient at the Right Time.” Accident and Emergency Nursing 3, no. 4 (1994), 177-183.

[4] Mikkelson, Søren, Hans Morten Lossius, Palle Toft, Annmarie TouborgLassen, and Anne CravieroBrøchner. “Criterion Based Dispatch Carried Out by Health Care Workers. Implications on Triage.” Resuscitation 96, no. 1 (2015), 124.

Comparing Various Solar MPPT Techniques with Adaptive Neural Fuzzy Interface System (ANFIS) Based Solar Maximum Power Point Tracking

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ABSTRACT

To optimize the power output of a photovoltaic system, incorporating a maximum power point tracking feature is beneficial. Several traditional methods exist for determining the Maximum Power Point Tracking in PVsystems. These include Hill Climb (HC), Perturb and Observe, and Incremental Conductance (IC). PV module's effectiveness can be impacted because they rely on sunlight, which is subject to weather conditions for energy provision. Consequently, solar power generation decreases. The efficiency of electricity production from solar energy is affected by three main factors: the temperature of the module, the quantity of sunshine exposure, and the characteristics of the photovoltaic system. The first two parameters' degree of fluctuation, which change every second with the season and weather, makes them uncontrollable and highly unpredictable. Consequently, these characteristics render PV systems a less reliable source of power. Recently, the Maximum Power Point Tracking's effectiveness has been enhanced through the application of artificial intelligence (AI)-based algorithms. In this study, the Adaptive Neural-Fuzzy Inference System, a form of artificial intelligence, is employed to deliver the Maximum Power Point Tracking in Photovoltaic to systems. The proposed method predicts the duty cycle computation for the photovoltaic generator and load, ensuring optimal power transfer. The controller is directed to the Maximum Power Point location by employing a neuro-fuzzy hybrid method that integrates an artificial neural network, a neural order block, and a reference voltage estimator. Subsequently, the photovoltaic solar system's Maximum Power Point is configured using a fuzzy logic controller with rule-based inference. ANNs are nonlinear data-processing machines that draw inspiration from biological neural networks' architecture and operation. ANNs are made up of networked processing units, or neurons, that exchange information via weighted connections. A tiny quantity of local memory may exist in every neuron. Artificial Neural Networks learn through processes. In the processing of numerical data, parameterized nonlinear computing techniques known as FLCs are utilized. Unlike binary (true/false) membership, fuzzy sets, which are utilized by Fuzzy Logic Controllers, permit degrees of membership. FLCs make decisions based on a set of linguistic rules. Through the process of defuzzification, an FLC's output is converted from fuzzy to precise values. The study's results verify that under both steady and variable solar irradiance, the ANFIS-based MPPT outperforms both ANN and FLC regarding convergence time and power output. It's equally important to remember that the ANFIS method achieves convergence Ten times more rapid than the FLC, IC, and P&O methods, minimizing the chance of errors and ensuring accurate tracking of the Maximum Power Point.

Keywords: PV systems, ANN,MPP, ANFIS method

1. INTRODUCTION

Fossil fuels continue to be a primary energy source today. Their combustion releases CO_2, contributing significantly to air pollution and global warming. Moreover, the need for energy rises along with the population. Many academics are looking to renewable energies to address this complex problem and reduce the harmful impacts of burning conventional fossil fuels

In order to mitigate the projected energy deficit. Installing this resource, however, is difficult due to low efficiency because solar radiation (G) and operational temperature (T) of the climate determine how much power a photovoltaic array generates, which can lead to up to 25% energy loss[1]. Photovoltaic (PV) systems, paired using the strongest power point tracking controllers, enhance electrical generation and optimize the efficiency of PV arrays under various climatic conditions. The Perturb and Observe algorithm is popular in PV-MPPT applications due to its cost-effectiveness and ease of use. Nonetheless, it presents several drawbacks, including drift issues brought on by quick adjustments in irradiance from varying weather conditions, significant fluctuations, and a sluggish tracking velocity [2,3]. As a result, the IC-MPPT is made to get around the P&O algorithm's shortcomings. This algorithm's primary benefit is its strong capacity to attain the Maximum Power Point in the face of abrupt changes in the surrounding environment [4]. The use of derivative operations in the algorithm introduces significant challenges with instability and measurement noise, which are critical concerns for the operational performance of a photovoltaic system [5].Consequently, to address these challenges, MPPT-based AI techniques have been developed. Moreover, these methods do not necessitate exact parameters or complex mathematics for system design. Particularly, the FLC-MPPT stands out against conventional MPPT controllers by demonstrating lower oscillation and faster tracking speed, establishing it as an exceptionally effective controller for photovoltaic systems [6].

Moreover, in contrast to ANFIS and ANN methods, this approach does not necessitate training data, enabling it to function across various PV array types with a uniform

MPPT proposal. However, the primary limitation is the drift issue caused by changes in operational temperature and solar irradiance [7]. This is due to the heavy reliance on a thorough understanding of a PV system, which can result in incorrect fuzzy rules and membership functions. The Artificial Neural Networkis regarded as a potent method for nonlinear systems like a photovoltaic array. Its primary benefit lies in delivering heuristic outputs through the quantification of actual numerical data. Thus, in comparison to FLC-MPPT, ANN-based MPPT demonstrates reduced oscillation around the MPP. Nonetheless, the main drawbacks of the ANN system are its prolonged training time and opaque operation. Artificial Neural Network and a Fuzzy Logic Controller, which are among the most robust intelligence techniques, are combined with Adaptive Neuro-Fuzzy Inference System to address these limitations. The ANFIS-based Maximum Power Point Tracking method is time-efficient, responding swiftly and with minimal oscillation across diverse weather conditions. Securing accurate training data and meticulously refining the ANFIS model pose considerable challenges in developing an efficient ANFIS-MPPT controller [8]. ANFIS was employed to compute the Maximum Power Pointof a PV array, leveraging a substantial volume of real training data.

2. Artificial Neural Network

Artificial neural networkshave demonstrated their effectiveness in tackling complex problems in various fields, includes voice, identification, classification, and pattern recognition, vision, prediction, and control systems [9]. Today, Artificial Neural Networkscan be trained to tackle problems that are challenging for traditional computers or humans. ANNs surmount the constraints of conventional methods by directly extracting the required information from experimental (measured) data. The neuron is the core processing element within a neural network. It receives inputs from other neurons, processes them, performs a generally non-linear function, and outputs the result. Typically, a neural network includes an input layer, multiple hidden layers, and an output layer [10]. In figure 2.1, it is displayed.

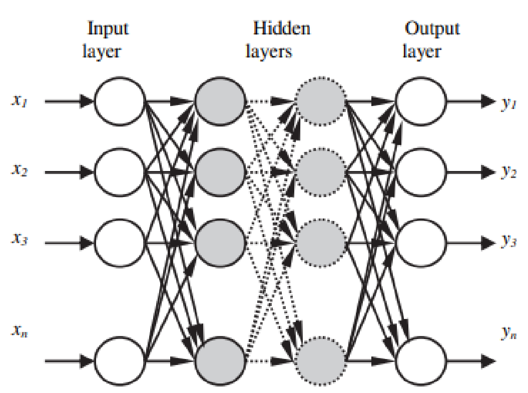

Figure.1. The feed-forward neural network

Here is a streamlined process for an ANN's learning process:

Supply the network with training data that includes patterns of input variables along with the corresponding target outputs.

Evaluate the degree of alignment between the network's output and the target outputs. Adjust the connection strengths, also known as weights, of the various neurons. Continue adjusting the weights until you reach the desired level of accuracy.

2.1. Fuzzy-logic inference

A method called fuzzy logic emulates the human ability to reason and make judgments in an imprecise manner. As shown in Fig. 2.2, a typical fuzzy-logic based solution consists of three modules: a fuzzification, an interference engine, and a defuzzification. The input vector is transformed into fuzzy sets through membership functions and linguistic variables by employing a fuzzifier. An intuitive and user-friendly library of IF-THEN rules is used by the interference engine to analyze the fuzzy sets. Ultimately, the defuzzifier is employed to translate fuzzy sets into output vectors, generating a clear, actual value from a fuzzy output.

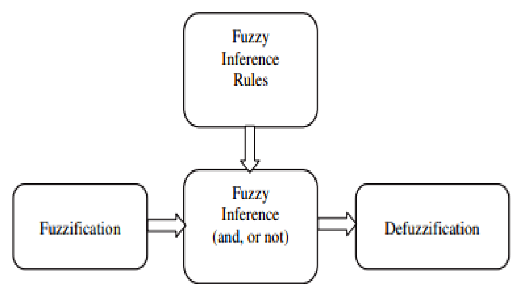

Figure.2. Typical fuzzy logic model setup based on rules

2.2. An adaptable neuro-fuzzy inference system

Fuzzy logic models are based on expert knowledge, whereas neural network models depend on data. A neuro fuzzy approach can leverage both data and existing system knowledge when accessible. The neuro-fuzzy system employed in this context is the Fuzzy Inference System using Adaptive Networks. The signals of the Sugeno system are recognized and refined by the ANFIS through a hybrid learning approach that integrates gradient descent, backpropagation, and a least-squares algorithm. Fig. 2.3 depicts the corresponding architecture of an ANFIS for a first-order Sugeno fuzzy model comprises two rules.The model contains five layers, with each node within a layer performing a similar function. The fuzzy IF-THEN rule set is characterized by outputs that are linear combinations of the inputs.

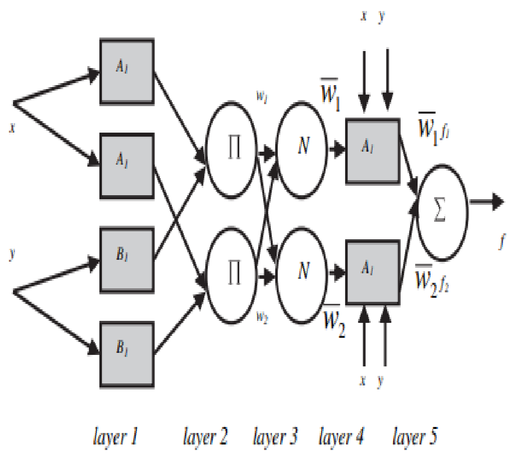

Figure.3. The architecture of an ANFIS, which is equivalent to Sugeno's first-order fuzzy model, involves two inputs and two rules

Rule 1 : *if x is A_1 and y is B_1 then* $f_1 = p_1x + q_1x + r_1$
Rule 2 : *if x is A_2 and y is B_2 then* $f_2 = p_2x + q_2x + r_2$

Layer1 comprises adaptive nodes that create membership grades of linguistic labels depending on premise signals, using any appropriate parameterized membership function

$$O_1 = \mu_{Ai}(x) = \frac{1}{1 + \left|\frac{x - c_i}{a_i}\right|^{2b_i}} \quad (1)$$

such as the generalized bell function

Where output Q_{1i} isoutput of the ith node in the first

$$O_{2i} = w_i = \mu A_i(x)\mu B_i(y) \quad i = 1,2 \quad (2)$$

layer, x is the input to node i,A_i is a linguistic label ("small," "large," etc.) from fuzzy set A = ($A_1 A_2$, B_1, B_2,) associated with the node, and {a_i, b_i, c_i} is premise parameter set used to adjust the shape of thememembership function.

Layer 2's nodes are fixed nodes called Q, which indicate each rule's firing strength. Each node produces the fuzzy AND (product or MIN) of all input signals:

The outputs of layer 3 are the normalized firing strengths. Each node is a fixed rule labelled N. The output of the ith node is the ratio of the ith rule's firing strength to the total of all the rules' firing powers:

$$O_{3,i} = \overline{w}_i = \frac{w_i}{w_1 + w_2} \quad i = 1,2 \quad (3)$$

The adaptive nodes in layer 4 calculate the rule outputs based upon consequent parameters using the functions

$$O_{4,i} = \overline{w}_i f_i = \overline{w}_i(p_i x + q_i y + r_i) \quad (4)$$

where$\overline{w}_i$is a normalized firing strength from layer 3, and (p_i, q_i,, r_i,) is the consequent parameter set of the node. Layer 5's single node, labeled P, calculates the total ANFIS output by adding the node inputs.

$$O_{4,i} = \sum_i \overline{w}_i f_i = \frac{\sum_i w_i f_i}{\sum_i w_i} \quad (5)$$

Training the ANFIS involves a two-pass procedure across several epochs. In each epoch, node outputs are computed up till layer 4. On layer 5, the consequent parameters are determined using a least-squares regression method. The ANFIS output is then calculated, and errors are back-propagated through the layers to update the premise parameters at layer 1.

4. RESULT AND DISCUSSION

where Vpv is voltage in the celland Ipv is current drawn from the cell. TMPPT is the process of drawing the greatest and best feasible voltage and current levels from a photovoltaic system. This is because the voltage and drawn current levels from the solar cells vary based on the irradiance levels. An artificial intelligence-based technology called "ANFIS" has been used in this study for the MPPT purpose in place of more traditional methods like P&O and IC. The advanced ANFIS technique integrates artificial neural networks and fuzzy logic systems into a multilayer mechanism for decision-making. The ANFIS approach is more adaptable and appealing since FLC may merge the value and ANN can train the numerical value. It is noteworthy that ANFIS has demonstrated strong performance in modelling various activities and a superior capacity for learning, enabling the updating of numerous systems. It offers even greater benefits than a fuzzy logic controller because it can derive rules from numerical data and lay the groundwork for adaptively deriving rules. Furthermore, it may be utilized to tailor complex intelligence systems into imprecise rules.

In Figure 2.4, the MPPT circuit block diagram with ANFIS-based control is presented. As shown in the picture, unlike other standard MPPT techniques, ANFIS based control approach makes its MPPT tracking decisions without considering temperature, voltage, current, or irradiance. Whereas, the change of power with respect to voltage $\frac{dp}{dv}$ and rate of change of power with respect to voltage $\Delta\frac{dp}{dv}$ have been taken as input values in the control mechanism based on ANFIS . Hence, for ANFIS-based control, these input values provide a sharp reaction; consequently, robust response shortens the MPPT controller's convergence time.

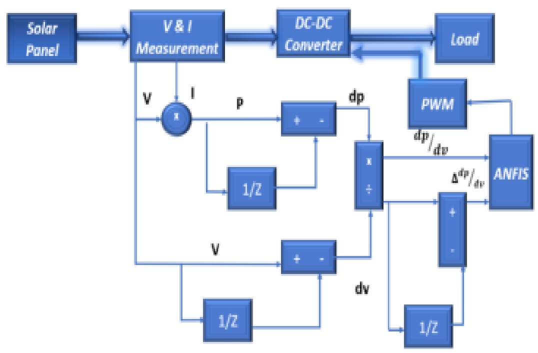

Figure.4. The block diagram for the PV system's MPPT control and the ANFIS-based control approach

A desired aspect of MPPT control that enhances control performance is the lowering of convergence time. Furthermore, the block diagram provides examples that the voltage (V) and current (I) levels gathered from the panel are monitored and serve as control parameters for the system. The DC-DC converter's purpose serves to control the voltage that is produced. Before it is supplied to the load. The duty cycle of the DC-DC converter is managed by an ANFIS controller, which makes decisions based on the values of $\Delta\,\frac{dp}{dv}$ and $\frac{dp}{dv}$. To create the Simulink model for ANFIS-based control, the selected PV system parameters are listed in Table 1.1 as follows.

Table.1. Matlab simulink model development parameters of the pv array

Parameter	Value
PV Array Rating	4.7 kW
DC Link Voltage	600 V
Inductance of DC-DC boost converter	5 mH
Capacitance of DC-DC boost converter	12µF
Ripple factor $V/_{\Delta V}$	10 %

Figure 2.5 illustrates the membership functions for the ANFIS-based controller, detailing both the Error (E) signal and the Change in Error (CE). Meanwhile, Figure 2(c) shows the membership functions for the produced duty cycle at the ANFIS controller's output, depending on the input values. Figure 2.6 illustrates the ANFIS model, confirming that every input is segmented into five triangular fuzzy members and that 25 rules are established within MATLAB's neuro-fuzzy toolbox. The figure's blue dots, each of which corresponds to a different neuron, show the AND function.The neuro-fuzzy system's created ANFIS control rules are displayed in Figure 2.7(a). It is important to note that there is an impedance value corresponding to the specific values of current and voltage. Furthermore, Figure 2.7 (b) presents a surface diagram of the ANFIS controller together with the associated produced duty cycle based on changes in the E and CE signal values. Finally, the photovoltaic system was simulated within the MATLAB/Simulink environment, utilizing the previously mentioned MPPT control schemes to compare the performance of ANFIS, IC, FLC, and P&O-based MPPT controls. 2.5 illustrates the membership functions for the ANFIS-based controller, detailing both the Error (E) signal and the Change in Error (CE). Meanwhile, Figure 2(c) shows the membership functions for the produced duty cycle at the ANFIS controller's output, depending on the input values. Figure 2.6 illustrates the ANFIS model, confirming that every input is segmented into five triangular fuzzy members and that 25 rules are established within MATLAB's neuro-fuzzy toolbox. The figure's blue dots, each of which corresponds to a different neuron, show the AND function.

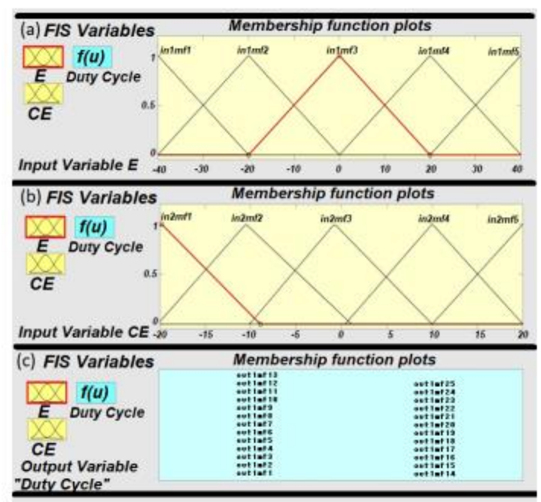

Figure.5. (a) The figure shows the input variable "Error signal" membership functions for the ANFIS controller. (b) In this figure the input variable membership functions of the "Change in Error signal (CE)" for the ANFIS controller have been presented. (c) The output variable "Duty Cycle" membership functions for the ANFIS controller presented in this figure.

The neuro-fuzzy system's created ANFIS control rules are displayed in Figure 2.7(a). It is important to note that there is an impedance value corresponding to the specific values of current and voltage. Furthermore, Figure 2.7 (b) presents a surface diagram of the ANFIS controller together with the associated produced duty cycle based on changes in the E and CE signal values. Finally, the photovoltaic system was simulated within the MATLAB/Simulink environment, utilizing the previously mentioned MPPT control schemes to compare the performance of ANFIS, IC, FLC, and P&O-based MPPT controls.

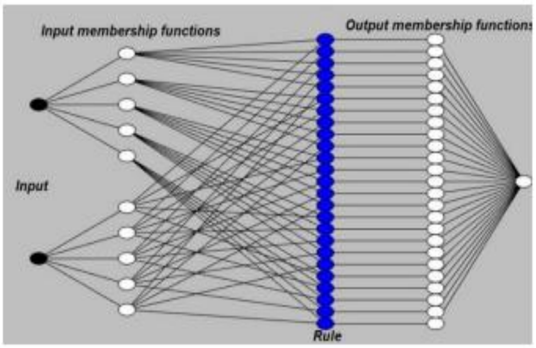

Figure.6. The ANFIS model's structure, which divides each input into five fuzzy elements.

Both a constant sun irradiance and a variable solar irradiance have been used for the simulation. In the fixed state, 1000w/m^2 and 25 °C are the corresponding temperature and irradiance values.

Fig.2.8 (a) The generated voltage levels for the ANFIS, FLC, IC and P&O based MPPT techniques for the PV system under fixed conditions along with convergence time comparison. (b) The maximum power extraction comparison of ANFIS, FLC, IC and P&O based MPPT techniques under fixed conditions.

The simulation utilized an IC, P&O, FLC, and ANFIS-based MPPT controller and was initially conducted under constant conditions, as depicted in Figure 2.8(a), which illustrates the voltage comparison generated by the PV system. Compared to FLC, IC, and P&O controllers, it is evident that the ANFIS MPPT controller has a shorter convergence time of 0.035 seconds, while the P&O technique has the longest convergence time of 0.45 seconds. The convergence time comparison for each MPPT controller is shown in Table II, confirming the superiority of the ANFIS approach over the other MPPT control systems. Under consistent conditions, Figure 5(b) illustrates the power generation comparison of ANFIS-based MPPT control against FLC, IC, and P&O controllers. The inset image offers a detailed comparison of the power output from various MPPT controllers. The optimal MPP for ANFIS, FLC, and IC under fixed solar irradiation circumstances is 9380 W, 9340 W, and 9230 W, respectively. The P&O technique has the lowest extracted power, consuming just 9200 W. This strong ANFIS control performance may be the consequence of extensive data tweaking and training, which reduces oscillations and produces a smooth response. Figure 2.8 therefore suggests that, under given conditions, ANFIS-based MPPT control offers both high power and a reduced convergence time

Subsequently, the simulation was run under various sun irradiance levels to confirm that the ANFIS approach outperforms the fixed conditions observation in varying environmental conditions. With this objective in mind, the MPPT approaches were compared when solar irradiance changed from 1000 to 750 w/m2 and back to 1000 w/m2 in two different scenarios.

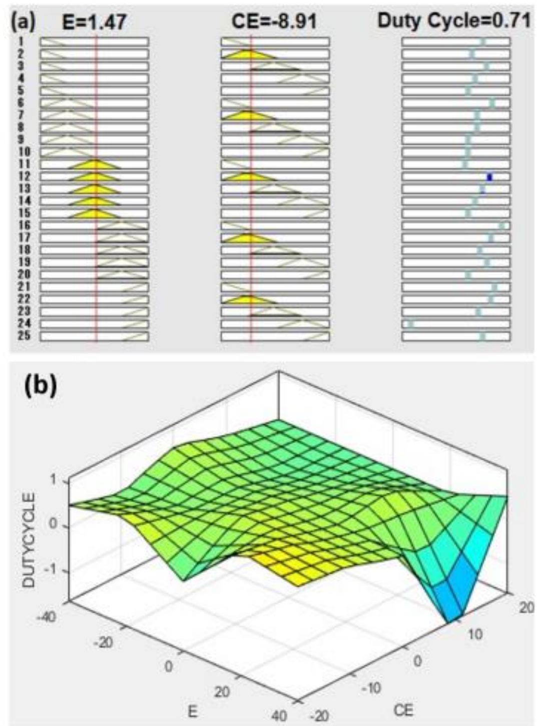

Figure.7. (a) The Duty Cycle's defuzzification is seen in the figure. (b) This picture illustrates how the Duty Cycle is generated by relating Error (E) to the Rate of Change of Error (CE).

Table.1. The Comparison of the convergence rate and generated output power for various MPPT control methods under fixed environmental conditions.

MPPT Method	Converging Time (s)	Output Power (Watts)
ANFIS-MPPT	0.035	9380
FLC-MPPT	0.05	9340
IC-MPPT	0.3	9230
P&O-MPPT	0.45	9200

Subsequently, the simulation was run under various sun irradiance levels to confirm that the ANFIS approach outperforms the fixed conditions observation in varying environmental conditions. With this objective in mind, the MPPT approaches were compared when solar irradiance

changed from 1000 to 750 w/m2 and back to 1000 w/m2 in two different scenarios. Figure 2.9 shows the equivalent produced voltage graph and convergence time for several MPPT algorithms. Views of the convergence times of several MPPT algorithms under increasing and decreasing solar irradiation are magnified in the inset photos.Figure 2.9 shows that, in the presence of fluctuating irradiance, the ANFIS and FLC arrived at the new MPP extremely rapidly, but the IC and P&O took longer.This outcome reaffirms that ANFIS is superior to alternative methods for MPPT, especially in the presence of varying environmental variables.

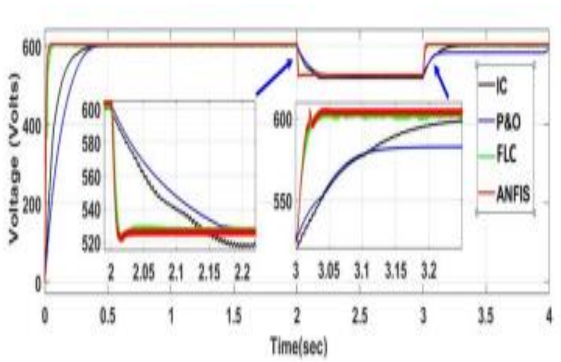

Figure.8. The figure provides the comparison of generated voltages and convergence time for ANFIS, FLC, IC and P&O based MPPT techniques under varying (increase and decrease) solar irradiance.

5. CONCLUSION

Although solar energy is considered a clean energy source, its low efficiency and low power extraction can be attributed to different climatic circumstances. Numerous traditional MPPT methods, including Hill climb, IC, and P&O, exist; however, their corresponding problems impede the efficient extraction of power. The drawbacks of traditional MPPT methods are mitigated by AI-based methods, which also offer a viable remedy for PV systems' low efficiency. This study compared various MPPT methods, including FLC, ANN, IC, and ANFIS, for a PV system under both fixed and variable environmental conditions within the MATLAB/Simulink environment. The comparative findings demonstrated that, in comparison to other MPPT approaches, ANFIS based MPPT control performs better in terms of convergence time and power extraction. An appropriate option for the MPPT control in PV systems, the ANFIS-based control performed better than alternative approaches in both constant and variable environmental situations.

REFERENCES

[1] Roman, E.; Alonso, R.; Ibañez, P.; Elorduizapatarietxe, S.; Goitia, D. Intelligent PV Module for Grid-ConnectedPV Systems. IEEE Trans. Ind. Electron. 2006, 53, 1066–1073.

[2] Ali, A.I.M.; Sayed, M.A.; Mohamed, E.E.M. Modified efficient perturb and observe maximum power point tracking technique for grid-tied PV system. Int. J. Electr. Power Energy Syst. 2018, 99, 192–202.

[3] Ali, A.I.M.; Sayed, M.A.; Mohamed, E.E.M. Modified efficient perturb and observe maximum power point tracking technique for grid-tied PV system. Int. J. Electr. Power Energy Syst. 2018, 99, 192–202.

[4] Salam, Z.; Ahmed, J.; Merugu, B.S. The application of soft computing methods for MPPT of PV system:A technological and status review. Appl. Energy 2013, 107, 135–148.

[5] Atkinson, D.J.; Elgendy, M.A.; Zahawi, B. Assessment of the Incremental Conductance Maximum Power Point Tracking Algorithm. IEEE Trans. Sustain. Energy 2013, 4, 108–117.

[6] Ben Salah, C.; Ouali, M. Comparison of fuzzy logic and neural network in maximum power point tracker for PV systems. Electr. Power Syst. Res. 2011, 81, 43–50.

[7] Wang, Y.; Yang, Y.; Fang, G.; Zhang, B.; Wen, H.; Tang, H.; Fu, L.; Chen, X. An Advanced Maximum Power Point Tracking Method for Photovoltaic Systems by Using Variable. Electronics 2018, 7, 355.

[8] Enany, M.A.; Farahat, M.A.; Nasr, A. Modeling and evaluation of main maximum power point tracking algorithms for photovoltaics systems. Renew. Sustain. Energy Rev. 2016, 58, 1578–1586.

[9] Kalogirou SA. Artificial neural networks in renewable energy systems applications: a review. Renewable and Sustainable Energy Reviews 2000.

[10] Haykin S. Neural networks, a comprehensive foundation. 2nd ed. Jersey. New York: Prentice Hall; 1999.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Agriculture Commodities Price Prediction and Forecasting

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ABSTRACT

Recent days interaction between computer and human is gaining more popularity or momentum, especially in the area of speech recognition. There are many speech recognition systems or applications got developed such as, Amazon Alexa, Cortana, Siri etc. To provide the human like responses, Natural Language Processing techniques such as Natural Language Toolkit for Python can be used for analyzing speech, and responses. In our country, INDIA, agriculture is backbone of economy and major contributor for GDP. However, farmers often, do not get sufficient support or required information in the regional languages. Prediction analysis for farmers in agriculture is not only for crop growing but is essential to develop Crop recommendation system based on price forecasting for agricultural commodities in addition to providing useful advisories for the farmers of any state. Currently, to protect the farmers from price crash or control the inflation, the governments (Central and State) predicting the price for agricultural commodities using short-term arrivals and historical data. However, these methods are not giving enough recommendations for the farmers to decide the storage/sales options with evidence-based explanations. This project implements machine learning algorithms such as multi linear regression, Random Forest and Decision Tree regressor. To achieve the commodity price, by analyze the r2 score. The highest r2 score, the best model could be selected.

Keywords:* *Crop Recommendation system, Price Prediction, Price Forecasting

1. INTRODUCTION

Technological advancements have fundamentally altered how humans interact with computers, particularly in the field of speech recognition. Applications like Amazon Alexa, Microsoft Cortana, and Apple Siri demonstrate how speech recognition technology can provide consumers with realistic, human-like responses. These systems use Natural Language Processing (NLP) techniques, such as the Natural Language Toolkit (NLTK) for Python, to analyze voice and support meaningful communications between people and gadgets. In a country like India, where agriculture is the backbone of the economy and makes a considerable contribution to GDP, technology advancements have the potential to play a critical role in assisting farmers. Farmers, on the other hand, frequently struggle to obtain critical information and recommendations in their own language, limiting their ability to make informed decisions. Such difficulties underscore the need for technology-driven solutions toclose the information gap and empower farmers toimprove their agricultural methods. Prediction analysis in agriculture goes beyond crop cultivation to include crop recommendation systems based on price predictions for agricultural commodities. These systems serve as vital advisories for farmers in many states, assisting them in making key crop selection,

storage, and sales decisions. Traditionally, government agencies (both central and state) used short-term data on arrivals and historical trends to forecast agricultural commodity prices. Although these methods offer some insights, they frequently fall short of providing full suggestions that allow farmers to make evidence-based decisions about when and how to store or sell their product. The purpose of this study is to review existing research on agricultural prediction models and highlight the strengths and limits of various techniques. By assessing the current landscape, the study hopes to find areas for improvement and future research directions to increase the performance of crop recommendation systems and price forecasting tools.

The difficulties you've mentioned represent an exciting opportunity to use technology to empower farmers and enhance agricultural practices. Here's a breakdown of possible ways and considerations for tackling these issues:

Language Accessibility: Creating speech recognition and natural language processing systems in regional languages can considerably improve accessibility for farmers who are not fluent in English. To effectively interpret and reply to requests in several languages, robust language models must be trained.

Price Forecasting: Advanced predictive analytics and machine learning algorithms can help improve the accuracy of agricultural commodity price forecasts. Market demand, supply chain dynamics, weather patterns, and government regulations can all be factored into predictions to improve their accuracy.

Crop Recommendation System: A crop recommendation system must consider a variety of criteria, including soil quality, climate conditions, market demand, and historical production data. Machine learning techniques can be used to create individualized suggestions for farmers based on their unique conditions and aims.

Advisory Services: Providing timely and relevant advisories to farmers necessitates real-time data collection and processing. Weather predictions, pest and disease outbreak alerts, and market trends can be integrated into advisory systems to assist farmers in making informed crop management, pest control, irrigation scheduling, and marketing decisions.

Evidence-Based Explanations: To increase openness and trust in pricing forecasting and advising systems, recommendations must be supported by evidence. This entails presenting not only the expected results, but alsothe underlying data, assumptions, and reasoning for the suggestions. Farmers can use interactive visualization tools to better understand and analyze information.

Government Support: Collaboration among government agencies, academic institutions, and technology businesses is critical for creating and implementing creative solutions to help farmers.Governments may play an important role in sponsoring research, giving access to data and infrastructure, and enacting regulations to encourage the use of technologyin agriculture.

Continuous Improvement: The creation of agricultural technology solutions is a continual processthat necessitates constant monitoring, review, and improvement. Obtaining feedback from farmers, agricultural experts, and stakeholders is critical for finding areas for improvement and iterating on existing systems to better meet end-user demands. By addressing these issues through interdisciplinary collaboration and innovation, we can harness the power of technology to alter agriculture and enhance farmers'livelihoods in India and elsewhere.

2. MOTIVATIOIN OF THE WORK

The motivation behind this work stems from the recognition of the critical role that agriculture plays in India's economy and the challenges faced by farmers in accessing timely and relevant information, particularly in their regional languages. Despite the significant contributions of agriculture to the GDP, many farmers struggle to make informed decisions due to the lack of support and information available to them. The increasing popularity and advancements in speech recognition and natural language processingtechnologies offer a promising avenue foraddressing these challenges. By leveraging these technologies, it becomes possible to develop innovative solutions such as crop recommendation systems and advisory services tailored to the specific needs of farmers.

The primary motivation of this study is to bridge the gap between technological advancements and the agricultural sector by exploring the potential ofpredictive analysis and machine learning in providing actionable insights to farmers. By integrating price forecasting models with evidence- based explanations, farmers can make more informed decisions regarding storage, sales, and other aspects of agricultural management. Furthermore, by conducting a comprehensive review of existing research in this area, the study aims to identify the strengths and weaknesses of different models and propose avenues for improvement. This includes exploring the use of advanced analytics techniques, real-time data integration, and user-centric design principles to enhance the effectiveness and usability ofagricultural prediction and advisory systems.

Ultimately, the goal of this work is to empower farmers with the tools and information they need to improve productivity, mitigate risks, and enhance their livelihoods. By leveraging the latest advancements in technology and data analytics, we can contribute to the sustainable development of India's agricultural sector and ensure the well-beingof its farmers.

3. RELATED WORK

Feihu Sun et al., on agricultural price prediction has garnered attention due to its importance in sustainableagricultural development. Traditional methods like timeseries analysis and econometric models have been complemented by intelligent forecasting methods such as machine learning and deep learning techniques. Moreover, combination models that integrate variousapproaches have shown promise in enhancing predictionaccuracy. Emerging trends involve blending structured data (e.g., historical prices) with unstructured data (e.g., news and social media) for comprehensive insights. Researchers face challenges in balancing forecast accuracy and trend precision while exploring optimal model combinations. This literature review underscores the potential of hybrid models and the importance of integrating diverse data sources to improve agricultural price forecasting.

Nhat-Quang Tran., application of machine learning algorithms in agricultural price prediction has become increasingly popular due to their potential to enhance prediction accuracy and adaptability. This review explores recent research on machine learning techniques for forecasting agricultural prices. The importance of agriculture, particularly in developing countries, and the impact of crop price volatility highlight the necessity of improved prediction methods. Various machine learning approaches, such as decision trees, support vector machines, and neural networks, have been investigated for their effectiveness. While these algorithms offer significant 8 promise, challenges remain regarding data quality, model interpretability, and scalability. Further research is needed to optimize these techniques and overcome limitations for more robust and precise agricultural price forecasting.

Zhiyuan Chen., research on automated agricultural commodity price prediction systems utilizing novel machine learning techniques focuses on improving prediction accuracy and addressing challenges in forecasting historical data. Recent studies have shifted from traditional statistical methods to advanced machinelearning approaches due to large datasets and the complexity of price fluctuations. Popular algorithms such as ARIMA, SVR, Prophet, XGBoost, and LSTM have been extensively compared using historical data from Malaysia. Findings suggest that the LSTM model, with its ability to handle nonlinearity and long-term dependencies, performs best with an average mean square error of 0.304. While machine learning strategies show promise, careful selection of data and optimization of model parameters remain critical for effective predictions.

Arushi Singh., research on modern agricultural advances has focused on using machine learning algorithms for crop prediction to help farmers make informed decisions on crop cultivation based on climatic conditions and soil nutrients. Popular algorithms such as K-Nearest Neighbor (KNN), Decision Tree, and Random Forest Classifier have been compared in recent studies toevaluate their effectiveness in crop prediction. Different criteria like Gini and Entropy have been used for these evaluations. Results indicate that

Random Forest Classifier outperforms the other models, providing the highest accuracy in predictions. This approach assists farmers in selecting appropriate 9 crops, improving productivity, and adapting to environmental challenges while promoting sustainable agriculture.

Banupriya N., Recent research on crop yield prediction in India has shifted focus from complex environmental and agricultural factors to simpler, more accessible data points. This approach aims to facilitate the direct application of predictions by farmers without requiring in- depth understanding of underlying technology. By utilizing basic factors such as state, district, crop type, and season (e.g., Kharif, Rabi), researchers can efficiently gather and analyze data from the Indian Government Repository. Advanced regression techniques like Random Forest, Gradient Boosting, and Decision Tree algorithmshave been explored to predict yield, while ensemble algorithms are employed to enhance accuracy and minimize errors. This streamlined approach aids farmers in making informed decisions for improved productivity and sustainability.

4. MACHINE LEARNING ALGORITHMS

Machine learning (ML) is a branch of artificial intelligence (AI) and computer science that focuses on theusing data and algorithms to enable AI to imitate the way that humans learn, gradually improving its accuracy.

Linear Regression Model/OLS Model

- **Overview:**

Ordinary Least Squares (OLS) is a linear regression technique used to estimate the relationship between a dependent variable and one or more independent variables. The primary goal is to find the line(or hyperplane in higher dimensions) that minimizes the sum of the squared differences between the observed andpredicted values. OLS is widely employed in statistical modeling, econometrics, and machine learning.

- **MLR Equation**

The multiple linear regression (MLR) equation models the relationship between multiple independent variables(X1,X2,...,Xn)and a dependent variable (Y). The general form of the MLR equation is:

$Y = \beta 0 + \beta 1x1 + \beta 2x2 + \cdots + \beta kxk + \varepsilon$Where:

Y is the dependent variable.X1,X2,…,Xn are the independent variables.

β0 is the y-intercept (constant term). β1 ,β2,…,βn are the coefficients that represent the strength and direction of the relationship between the independent variables and the dependent variable

$$\text{F1 Score=.}\frac{2xPrecision\ Recall}{Precision+Recall}$$

ε is the error term, representing the unobserved factors that affect the dependent variable but are not included in the model. The goal of MLR is to estimate the coefficients (1,…,β0,β1,…,βn) that minimize the sum of squared differences between the observed and predicted values of the dependent variable.

1. Decision Tree Regression

Decision Tree Regression is a supervised machine learning algorithm used for predicting continuousoutcomes. Unlike decision trees in classification, which predict discrete class labels, decision tree regression predicts a numeric target variable. The algorithm works by recursively partitioning the dataset into subsets based on feature conditions, ultimately producing a tree structure where each leaf node corresponds to a predictednumerical value.

2. Evaluation Metrics in Decision Tree

In the context of Decision Trees, several evaluationmetrics are commonly used to assess the performance ofthe model. These metrics provide insights into how well the decision tree is making predictions compared to the actual outcomes. Here are some key evaluation metrics for Decision Trees:

1. Accuracy:

Definition: The ratio of correctly predicted instances to the total number of instances.Formula:

$$\text{Accuracy=}\frac{Number\ of\ correect\ prediction}{Total\ number\ of\ predictions}$$

Consideration: Accuracy is a straightforward metric but may be misleading in imbalanced datasets.

2. Precision

Definition: The ratio of correctly predicted positive observations to the total predictedpositives.Formula:

$$\text{Precision: }\frac{True\ Positive}{True\ Positive+False\ Positives}$$

Consideration: Recall emphasizescapturing as many actual positives as possible and is crucial when missing positives is costly.

3. F1 Score:

Definition: The harmonic mean of precision and recall, providing a balance between the two metrics. Formula:

Consideration: F1 Score is useful when there’s a need to balance precision and recall

4. Confusion Matrix:

Definition: A table that presents a summary of the model's predictions against the actual outcomes, showing True Positives, True Negatives, False Positives, and False Negatives**.**

Use: Provides a detailed breakdown of the model's performance and aids in calculating other metrics.

4.1. ROC-AUC (Receiver Operating Characteristic-Area Under the Curve)

Definition: A graphical representation of the trade-off between true positive rate (sensitivity) and false positive rate at various thresholds.

Use: Measures the model's ability to discriminate between positive and negative instances.

5. Gini Index (for Decision Trees):

Definition: A measure of impurity in a node. It assesses how often a randomly chosen element would be incorrectly classified.

Use: Decision Trees aim to minimize the Gini Index at each split, resulting in a tree that classifies instances more accurately.

6. Random Forest Regression

Random Forest Regression is an ensemble learning technique that extends the concept of Random Forests, originally designed for classification problems, to regression tasks. It is a powerful and flexible algorithm that leverages the strength of multiple decision trees to make more accurate and robust predictions for continuous outcomes.

7. Key Features and Concepts:

Ensemble of Decision Trees: Random Forest Regression is built on an ensemble of decision trees. Multiple decision trees are constructed independently, and their predictions are averaged to obtain a final result.

8. Bagging (Bootstrap Aggregating):

Each tree in the Random Forest is trained on a bootstrap sample (randomly selected with replacement) from the original dataset. This helps introduce diversity among the trees.

9. Random Feature Selection:

At each node of a decision tree, a random subset of features is considered for splitting. This randomness adds further diversity to the individual trees.

Prediction Aggregation:

For regression, the predictions of individual trees are averaged to produce the final output. This ensemble approach helps mitigate overfitting and improves generalization.

Handling Missing Values:

Random Forests can effectively handle missing values in the dataset, reducing the need for extensive data preprocessing.

10. Robust to overfitting:

The ensemble nature of Random Forests tends to reduce overfitting, making them less sensitive to noise and outliers in the data.

Versatility:

Random Forests can be applied to a wide range of regression tasks and are suitable for datasets with a large number of features.

5. DATA DESCRIPTION

Number of Data: 62429

Number of attributes: 11

The purpose of this is to identify the study already done in this field and find out the benefits and downsides of different models as well as the future scope of improvement. Attribute information

1.APMC (Agricultural Produce Market Committee):

Definition: The specific market committee responsible for the regulation and oversight of agricultural trade in a particular area.

Use: Identifies the market where the data was collected.

2.Commodity:

Definition: The type of agricultural commodity being traded.

Use: Specifies the particular crop or product involved in the market transactions.

3.Year:

Definition: The calendar year when the market transactions took place.

Use: Provides the temporal dimension for the data.

4.Month:

Definition: The month during which the market transactions occurred.

Use: Offers a more granular temporal reference in conjunction with the year.

5.Arrivals_in_qtl (Arrivals in Quintals):

Definition: The quantity of the commodity brought to the market, measured in quintals.

Use: Indicates the volume of the commodity traded in the market.

6.Min_price:

Definition: The minimum price at which the commodity was traded.

Use: Represents the lowest price observed for the commodity during the specified time.

7.Max_price:

Definition: The maximum price at which the commodity was traded.

Use: Represents the highest price observed for the commodity during the specified time.

8.Modal_price:

Definition: The modal (most frequently occurring) price of the commodity.

Use: Provides a measure of the central tendency of the commodity prices in the market.

9.Date:

Definition: The specific date of the market transactions.

Use: Offers a precise temporal reference for individual market events.

10.District_name:

Definition: The name of the district where the market is located.

Use: Specifies the geographical location of the market.

11.State_name:

Definition: The name of the state where the market is located.

Use: Specifies the broader geographical region in which the market operates.

6. DATA PREPROCESSING

f.isnull().sum(): this line of code provides a series where the index represents the column names of the Data Frame, and the values represent the count of null values in each column. This is useful for understanding which columns have missing data and the extent of that missing data.

df.info():the df.info() method provides a concise summary of a pandas Data Frame (df).It includes information about the Data Frame’s index and data types of each column, as well as memory usage. It also provides the number of non-null values for each column, helping you understand the data's completeness. This method is useful for quickly understanding the structure of your data, including the types of data each column contains and how much data is missing.

6.1. Feature engineering for numerical columns

When you apply MinMaxScaler from sklearn.preprocessing to normalize the numerical columns in your DataFrame (df_num) and then assign the transformed data to a new DataFrame (df_num_mn), you will end up with a DataFrame where the numerical columns have been scaled to a range of 0 to

Fit and Transform: By applying the fit_transform method, the MinMaxScaler calculates the minimum and maximum values for each column in the input DataFrame (df_num) and scales the data to a range between 0 and 1.
New DataFrame: The result of this transformation is a new DataFrame (df_num_mn) with the same column names as df_num but with the values scaled.

6.2. Feature engineering for categorical columns

When you use LabelEncoder from sklearn. preprocessing to encode categorical columns in your DataFrame (df_cat), the function transforms each categorical column into a numerical format by assigning integer labels to each unique value in the column. This process is known as label encoding.

i. Label Encoding: For each specified categorical column (e.g., 'APMC', 'Commodity', 'Month', 'district_name', 'state_name'), LabelEncoder assigns a unique integer value to each distinct category.
ii. ncoded Columns: The encoded columns replace the original categorical columns with their respective integer labels.

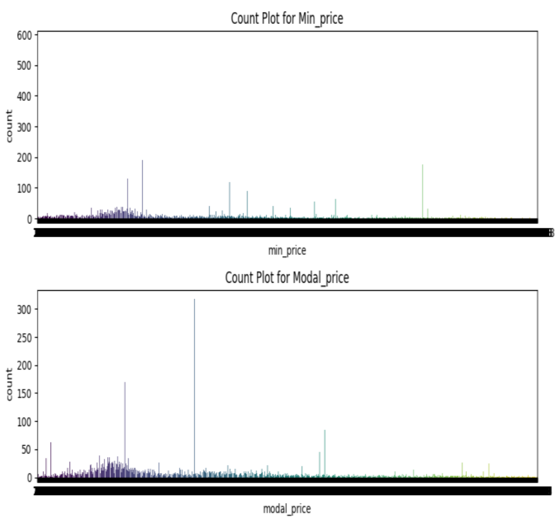

Figure.1. Count Plot

6.2.1. Model training

In the present investigation, an attempt has been made to explore efficient ML algorithms e.g., Support Vector Regression (SVR), Random Forest (RF) and Multiple Linear Regression for forecasting wholesale price of crops in 33 major markets of Maharashtra. The superiority of the models is established by means of R2-score, and other accuracy measures such as Mean Error (ME), Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and Mean Absolute Prediction Error (MAPE).

6.2.2. *Splitting-trained Models*

The training set is used to train the model, while the testing set is used to evaluate its performance on unseen data. This helps assess how well the model generalizes to new observations. Once the data is split into training and testing sets, you typically use the training set to train your model (fit the parameters) and the testing set to evaluate its performance by making predictions on the test data and comparing them to the actual values. It's crucial to ensure that the split is done randomly to avoid any biases in the data. Common ratios for splitting data include 70/30, 80/20, or 90/10, depending on the size of your dataset and the specific requirements of your analysis. The dataset has been divided into two – Training and Testing
The proportion of data allocated to each set is determined by the test_size parameter. In this case, 20% of the data is assigned to the testing set, while 80% is assigned to the training set.
Count Plot for 'min_price' and 'modal_price': It generates two subplots stacked vertically. Each subplot is a count plot that shows the distribution of values for the 'min_price' and 'modal_price' columns from the DataFrame 'df.
Scatter Plot of 'Min_price' versus 'Max_price':
It generates a scatter plot illustrating the relationship between the'min_price' and'max_price' columns in the Data Frame 'df'.

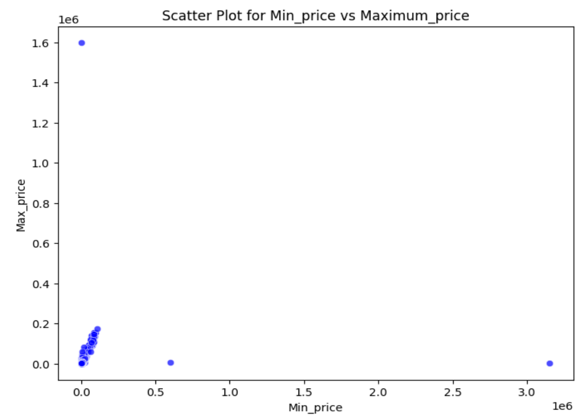

Figure.2. Scatter Plot

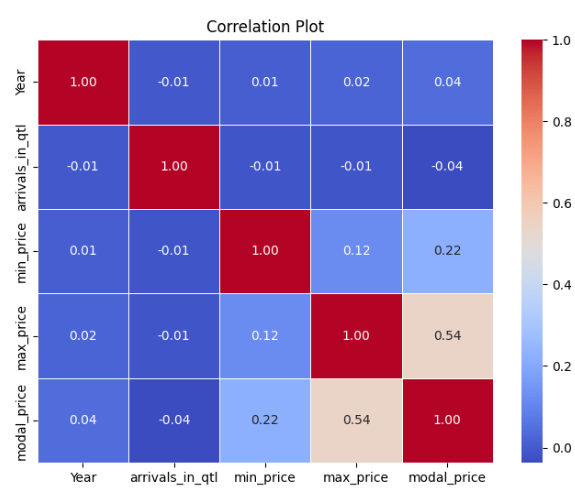

Figure.3. Correlation Plot

6.2.3. Crosstab:

It generates a cross-tabulation of the columns 'APMC' and 'Commodity' in the Data Frame 'df'. This gives a frequency distribution of the occurrences of different commodities in various APMCs.

6.2.4. Correlation Plot:

It computes the correlation matrix for each numeric column in the Data Frame 'df'. It generates a heat map visualisation of the correlation matrix, demonstrating the relationship between various numerical parameters.

6.2.5. Bar Chart for 'Month' and 'Commodity':

It generates a bar chart depicting the number of commodities for each month. The hue parameter is used to differentiate commodities based on color.

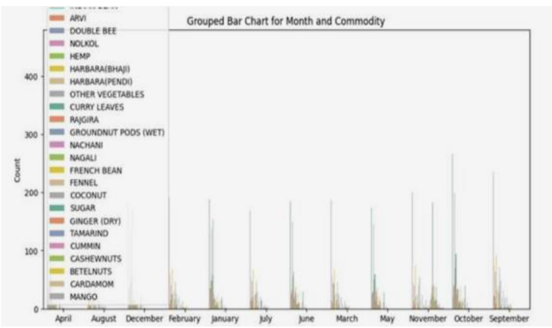

Figure.4. Bar Chart for Month and Commodity

6.2.6. Bar Chart for 'Commodity':

It generates a basic bar chart depicting the count of each commodity

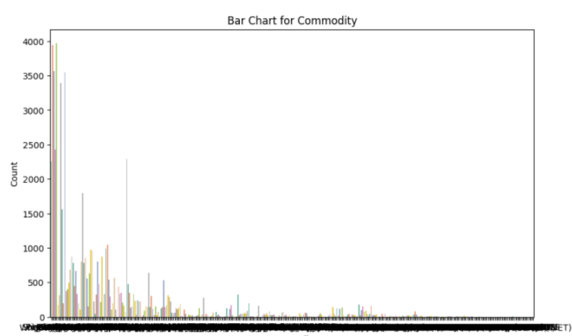

Figure.5. Bar Chart for Commodity

7. CONCLUSION AND FUTURE WORKS

In order to empower Indian farmers and improve agricultural decision-making, this research examined a large dataset containing market transactions, crop specifics, and pricing information. Exploratory data analysis provided insights that guided the creation of crop recommendation and price forecasting models, addressing important agricultural concerns. The findings highlighted geographical and temporal diversity in agricultural prices, emphasizing the need for localized knowledge. Moving forward, increasing model sophistication using advanced techniques like ensemble learning and including external elements like weather patterns and government policies would improve model accuracy. Deploying user-friendly tools and encouraging community interaction will guarantee that offered solutions are realistic and sustainable, eventually benefiting farmers and increasing agricultural prosperity.

REFERENCES

[1] https://www.india.gov.in/official-website-commission-agricultural-costs-and-pricesN. Abiwinanda, M. Hanif, S. T. Hesaputra, A. Handayani, and T. R. Mengko, ‘‘skin cancer tumor classification using convolutional neural network,’’ in Proc. World Congr. Med. Phys. Biomed. Eng., vol. 68, 2018, pp. 183–189, doi: 10.1007/978-981-10-9035-6_33.

[2] www.maths.qmul.ac.uk/ bb/TSChapter72.pdf - accessed on May,16 2019

[3] Rehman U, Bahar F, Saad A, Bhat M, Singh L, Mahdi S, Mir MS, Bashir M, Bhat TA, Palmo T (2022) Trends, challenges and prospects of underutilized food crops under temperate ecologies: a review.

[4] Liwen, L.; Shixin, C.; Dabin, Z.; Boting, Z. A Multi-Time Scales Combination Strategy for Pork Price Forecasting. J. Syst. Sci. Math. Sci. 2021, 41, 2829–2842.

[5] Zhao, L.; Zeng, G.; Wang, W.; Zhang, Z. Forecasting oil price using web-based sentiment analysis. Energies 2019, 12, 4291. [CrossRef]

[6] Asma Hasifa Nurcahyono, Fhira Nhita,Deni Saepudin and Annisa Aditsania,“Price Prediction of Chili in Bandung Regency Using Support Vector Machine (SVM) Optimized with an Adaptive Neuro- Fuzzy Inference System (ANFIS),” 7th International Conference on Information and Communication Technology (ICoICT), 2019.

[7] Dabin Zhang, Shanying Chen , Liwen Ling, And Qiang Xia “Forecasting Agricultural Commodity Prices Using Model Selection Framework With Time Series Features and Forecast Horizons,” IEEE Access February 14, 2020 .

[8] Darekar, Ashwini and B Datarkar, Snehal(December 2016),”Onion Price Forecasting on Kolhapur Market of Western Maharashtra”International Journal of Information Research and Review.

[9] V.K. Verma, P. Kumar, Singh. S.P and H. Singh(July 2016), ”Use of ARIMA modeling in forecasting coriander prices for Rajasthan,International J. Seed Spices 6(2),40-45.

[10] R. Lombardo, J. Flaherty(January 24-27 2000),”Modelling Private New Housing Starts in Australia”,Pacific-Rim Real Estate Society Conference, University of Technology Sydney(UTS)

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Transfer Learning: Concepts, Applications, Challenges and Future Directions

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ABSTRACT

Transfer learning is a powerful technique in machine learning that significantly enhances the efficiency of model training. In this technique, a model trained on one task is used as the starting point for a model trained on a second task. The paper highlights the benefits of transfer learning, including knowledge transfer across different domains, reduced training time, improved model generalization, and domain-specific adaptation. It outlines the implementation process, including obtaining a pre-trained model, creating a base model, freezing layers, adding new trainable layers, and fine-tuning the model. It also showcases the adaptability of transfer learning through computer processing, vision, speech its applications natural in language recognition, and healthcare. Each domain benefits from knowledge transfer, leading to improved performance and efficiency. Though it has potential, transfer learning faces challenges like negative transfer, domain adaptation, and data efficiency. By overcoming these challenges, Transfer Learning can be used responsibly and effectively in diverse applications, paving the way for advancements in machine learning and artificial intelligence. The paper suggests collaboration increased and research domain-specific techniques as future directions to overcome these hurdles. The paper delves into the intricacies of transfer learning, exploring its benefits, implementation strategies, applications, challenges, and future research directions.

Keywords– Transfer Learning, machine learning, knowledge transfer.

1. INTRODUCTION

Transfer learning is an approach where we improve the performance of various tasks by transferring knowledge from one domain to another [1][5]. It involves using a model that has been trained on one task as the foundation for a model on a second task. This can be useful in case of data scarcity where less data is available for the second task. One of the earliest forms of transfer learning was feature-based transfer learning, which involved using features learned from a source task to improve performance on a target task [2][5]. Another kind of Transfer Learning is fine-tuning, which involves training a pre-trained model on a task with a smaller dataset [4]. The paper is organized in the following manner, Section II Related Works is present, Section III includes Implementation, Section IV contains Benefits, Applications, Challenges and Future Directions finally Section V contains Conclusion.

2. RELATED WORKS

Ali et al. (2023) proposed a new technique for Transfer Learning and discussed how transfer learning can be utilized to improve the performance of various tasks. The paper underscored the benefits of transfer learning, including its capacity to utilize pre-trained models efficiently to save time and resources, particularly in data-scarce scenarios. The authors delved into the diverse applications of transfer learning, showcasing its adaptability and its promise to transform multiple industries. The paper concludes by contemplating the prospects that transfer learning holds. Zhu et al. (2023) conducted a comprehensive survey on transfer learning in the context of deep reinforcement learning (DRL). Their research delved into the recent progressions in transfer learning aimed at overcoming obstacles encountered in reinforcement learning, particularly in terms of learning efficiency and efficacy. Furthermore, the study examined the interconnections between transfer learning and related subject matters, along with potential hurdles and future avenues for research in this field. Huang (2020) introduced the concept of a complete special holonomy manifold defined by a global perturbation potential function. This approach allows for the study of L^2 harmonic forms under certain conditions on the global perturbation potential function, leading to vanishing theorems. The paper discusses the significance of these manifolds in mathematical physics and string theory, particularly in the construction of G2 manifolds and Spin (7)-manifolds. The results include establishing the vanishing of certain harmonic forms on these manifolds Zhuang et al. (2020) conducted a comprehensive survey on transfer learning, covering over forty approaches and emphasizing homogeneous transfer learning from data and model perspectives. The survey also included experiments demonstrating the importance of selecting suitable models for different applications, using three datasets: Amazon Reviews, Reuters-21578, and Office-31, emphasizing the need for practical application. Yosinski et al. (2014) explored the transferability of features in deep neural networks and their generality across different tasks. Their findings revealed that features found in the initial layers of neural networks trained on natural images are not specific to particular datasets or tasks but are instead general and relevant to a variety of datasets and tasks. As the layers progress from general to specific and the gap between tasks widens, the transferability of features decreases. Nevertheless, transferring features between even distant tasks proved to be more efficient than utilizing random features.

3. IMPLEMENTATION

The following steps are involved in the implementation of Transfer Learning [9]. 1. Obtaining a Pre-Trained model: In the initial step we choose the already trained model to keep as the foundation of our training, depending on our target. There should exist a strong correlation between knowledge of the Pre-Trained model and the Target Domain for them to be compatible. 2. Creating a Base model: The base model is selected as one of the architectures for our specific task. We can choose to download the network weights to save time on additional model training. Otherwise, we will have to train the model from the beginning using the network architecture. It may be necessary to enhance the final output layer of the base model in case there are additional neurons in the final output layer. 3. Freezing the Layers: Freeze the initial layers of the pre-trained model as it allows us to avoid the additional work of making the model learn basic features. If we don't do this, we will lose all the learning which has already taken place which is just like training the model from scratch thus costing us time and resources. 4. Adding and training new Layers: Feature extraction layers are the components we reuse. To predict the model's specific tasks, we need to construct additional layers on top of them. Typically, these are the layers that determine the final output. The final output of a pre-trained model is unlikely to match the desired outcome for our model. For example, models pre trained on the Image Net dataset will yield 1000 categories. However, our model needs to operate with just two classes. In this case, we must train the model with a newly incorporated output layer. 5. Fine-tuning the model: Fine-tuning is used to enhance the performance of the model. To fine-tune, part of the base model should be unfrozen, and then we can fine-tune a few top layers of the model rather than fine-tuning the whole model. Fine-tuning allows us to work with new datasets without overfitting the model or overwriting it with generic learning.

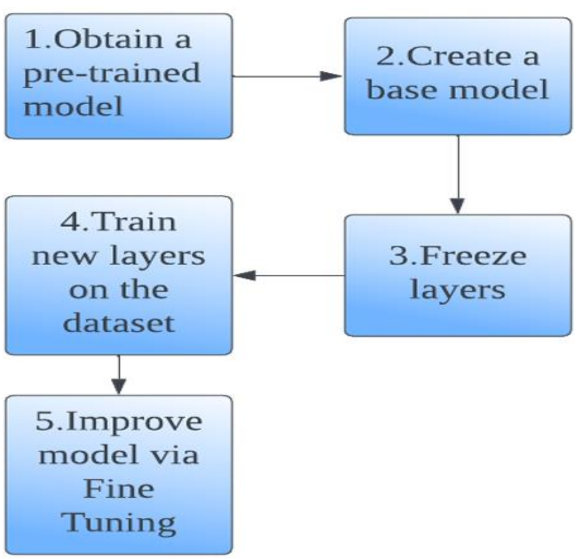

Figure.1. Implementation of Transfer Learning

IV. DISCUSSIONS We have discussed the various advantages and challenges that can be encountered during the use of Transfer Learning. Applications and Future directions of Transfer Learning are also highlighted.

4. ADVANTAGES

In the domain of deep learning and machine learning, transfer learning has many significant benefits. First of all, it makes knowledge transfer easier by enabling ideas from one problem's solution to be used for related tasks—even those in unrelated areas. This feature saves a great amount of time and resources by allowing the reuse of previously trained models and the transfer of important knowledge between tasks[6]. Second, by utilizing the acquired features from well-trained models, transfer learning significantly shortens the training period [6]. Models can rapidly converge during training when knowledge is transferred to a related job, avoiding the need to start training from the beginning and resulting in faster model creation and deployment. Moreover, transfer learning improves generalization skills, which is beneficial when working with sparse training data. Models can understand and adjust to new, unseen examples more effectively by using pre-trained knowledge, which enhances overall performance and endurance. Finally, transfer learning makes it possible for models to adapt to particular tasks or domains by expanding on previously learned features[6]. This flexibility is essential in situations where data distributions differ because it enables models to accurately represent features unique to a given domain while reducing the possibility of overfitting. Combined, these benefits make transfer learning a useful method for improving performance, speeding up model construction, and resolving issues in a variety of machine-learning applications.

5. APPLICATIONS

Computer vision: Transfer learning is essentially used in image classification tasks, and image segmentation tasks. It is also widely used in object detection since the pre-trained models help to detect and localize objects in images [7]. 2. Natural Language Processing: Transfer Learning is also utilized in text classification tasks, where the pre trained model is used to classify text into different categories [7][9]. We also use this approach in sentiment analysis to classify the sentiment of texts. 3. Speech Recognition: To identify certain keywords or commands in voice data, pre-trained models are modified via transfer learning in keyword spotting tasks. By utilizing prior knowledge from trained models, transfer learning in speech recognition makes it possible to identify speakers [9]. 4. Healthcare and Biomedical Applications: Using pre-trained models for increased accuracy, transfer learning is used in medical image analysis to help with tasks like disease diagnosis and anomaly identification [4]. Transfer learning speeds up drug development procedures in biomedical applications by making it easier to predict chemical characteristics and drug interactions.

6. LIMITATIONS

Despite all of its benefits, transfer learning has some drawbacks and difficulties. One major issue is the potential for negative transfer and overfitting. A deep learning model experiences negative transfer when its performance declines following retraining, frequently as a result of previous knowledge interfering with the process of learning something new. It is important to balance knowledge transfer without allowing the source data to have a lot of influence, as this risk of overfitting to the source domain can have negative impacts on the target domain [8]. Transferring information from one domain with significantly different data distributions to another presents another difficulty known as domain adaptation. For efficient knowledge transfer and model performance across domains, this requires precise feature representation alignment and adjustment [8]. Furthermore, data efficiency is a significant barrier in transfer learning since successful knowledge transfer usually requires a large amount of labelled data from the target domain. Insufficient data can make knowledge transfer ineffective and lead to poor model performance. To fully realize the promise of transfer learning and guarantee its successful implementation across a range of tasks and domains, it is important to address these restrictions.

7. FUTURE ASPECTS

The future of transfer learning holds promising avenues for advancement and innovation in machine learning research. Enhanced research collaboration between academic institutions and industry is a crucial element that enables the advancement of advanced transfer learning methodologies and more detailed studies [4]. It will be essential to adapt transfer learning techniques to certain industries, such as engineering, banking, and healthcare, to handle particular problems and maximize performance in a range of applications. Exploring automated techniques to streamline and improve the efficiency of the process of choosing the best pre-trained models for particular jobs is another avenue for future research. In the future of transfer learning, ethical issues will also be essential, especially in sensitive fields where data security and privacy are crucial. Addressing ethical implications and ensuring responsible implementation of transfer learning will be essential for maintaining trust and integrity in the field. All things considered, domain-specific innovation, ethical considerations, automation, and collaboration will define the future of transfer learning research and open the door to significant improvements and applications across a range of industries.

V. CONCLUSION In conclusion, transfer learning holds great potential for advancing various research domains. To move forward, there is a need for increased collaboration between researchers and industry experts to drive innovation. Additionally, the development of domain-specific transfer learning techniques will be crucial for addressing unique challenges across different fields. Furthermore, the automation of model selection and ethical considerations are key areas for future research, ensuring responsible and effective implementation of transfer learning in diverse applications.

8. REFERENCES

[1] Zhu, Z., Lin, K., Jain, A. K., and Zhou, J., “Transfer Learning in Deep Reinforcement Learning: A Survey”, <i>arXive-prints,2020 doi:10.48550/arXiv.2009.07888.

[2] J. Yosinski, J. Clune, Y. Bengio, and H. Lipson, "How transferable are features in deep neural networks? " Advances in neural information processing systems, vol. 27, 2014.

[3] T. Huang, "Global perturbation potential function on complete special holonomy manifolds," arXiv preprint arXiv:1906.05137, 2019.

[4] F. Zhuang et al., "A comprehensive survey on transfer learning," Proceedings of the IEEE, vol. 109, no. 1, pp. 43 76, 2020.

[5] Ali, Ahmed & G. Yaseen, Mohanad&Aljanabi, Mohammad & Abed, Saad& GPT, Chat. (2023). Transfer Learning: A New Promising Techniques. Mesopotamian Journal of Big Data. 2023. 31-32. 10.58496/MJBD/2023/004.

[6] Transfer learning for deep learning - IBM Developer

[7] https://www.allerin.com/blog/exploring-the-limits-of-transfer-learning.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Intelligent Wireless Management Of A Backup Generator By Using Iot

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ABSTRACT

An essential electrical system intended to provide power in the event of an outage or emergency is a backup generator. When the main power source fails, it functions as a backup power source and turns on automatically. Backup generators are necessary in many contexts, from households to crucial infrastructure, since they provide continuity by maintaining electrical systems, keeping lights on, and sustaining essential operations. Research, data, and residential facilities are protected while academic and administrative functions are carried out without interruption at institutions. They are essential for continued operation in the face of unanticipated interruptions because of their quick reaction to power outages, which increases resilience. A backup generator is crucial to the smooth operation of administrative and academic operations in a college environment. Critical infrastructure found at colleges includes communication systems, research equipment, and computer servers, all of which depend significantly on a steady power source. A backup generator makes sure that vital operations like communication networks, data storage, and online learning platforms continue to run when the power goes out. In order to prevent interruptions to courses, experiments, and research projects, continuous electricity is essential for lecture halls, labs, and libraries. If we do not have remote control of a backup generator on campus, backup generators are essential for avoiding data loss, maintaining ongoing research, and guaranteeing that instructional materials are always available. It would be beneficial to have remote control over the generator, which would allow for efficient management, a reduction in labor costs, a shorter operating duration if IOT technology was used, and the ability to provide control to a limited number of individuals who needed constant power at that particular moment. Since Zigbee-based control is expensive, switching to IOT is the best option.

Keywords: IOT, Zigbee-based control

1. INTRODUCTION

In the event of a power outage, generators serve as backup power sources. It's critical to make sure the generators run very reliably and safely. When a generator is operating perfectly, it can sustain an enormous load on a regular basis while still maintaining its designated performance rate for many years. The generators will have a long service life if they are used without going above their rated conditions. Some preventative actions against overloading and abnormal situations must be implemented in order to guarantee the generator operates safely. Regular monitoring of the generator helps reduce the likelihood of generating malfunctions. This process is made easier and requires less time and labor thanks to remote monitoring systems. Online The generator's monitoring enables the operator to regulate the load remotely and guarantee safe operation. Currently, generators are manually monitored, meaning that a human enters the generator room on a regular basis to perform maintenance and logs important parameters. Information on the generator's sporadic overloading and overheating cannot be obtained by such monitoring. When poor weather persists and when it's nighttime, this kind of monitoring gets challenging. The generator life may be considerably shortened by all of these elements. As a result, an automated monitoring system becomes necessary. The major causes of hazards in generators are overloading and poor maintenance. Thus, it becomes crucial to keep a constant eye on the generator. The existing monitoring systems have several shortcomings. A standard measuring system finds single phase characteristics like power, current, and voltage. Certain detectors have the capacity to measure many parameters, but the data transmission rate and acquisition time are both excessively slow.

Poor dependability, unstable systems, and inadequate data measurement precision are some of the drawbacks of extra measuring systems. Transformer monitoring and control systems using PLCs were designed for long term installations. These are used to keep an eye on a single unit. The central processing unit receives information from the local area network (LAN). Additionally, it grants access to a website where the transformer's settings may be seen and tracked. This system's data collecting procedure moves slowly. Three microcontrollers are used in the system-based monitoring of a 10kVA switchable transformer to measure the characteristics of each of the three phases. Temperature and a graphic LCD interface are measured by a different microprocessor. Data is sent via embedded Ethernet to at a distant place. Embedded Ethernet was used in the development of client-server applications to facilitate LAN monitoring.

The system becomes cumbersome overall when several microcontrollers are used. The system is unstable and difficult when using a wired LAN connection. For the power system to function, a dependable and high-quality power source is essential. When dealing with critical load locations such as hospitals, banks, airports, radar systems, military offices, and data centers, its significance increases. They need a consistent and dependable power source in order to function properly. In light of this, having generator backup capability in case of blackout or power outage is essential. Only when these generators are properly maintained and run will they be effective. For improved performance, issues including the generator's battery voltage, overall load, and remote fuel tank monitoring are crucial. An Arduino controller board is used in the construction of the advanced IOT-based monitoring system to avoid these issues. This system checks the fuel level using a fuel gauge, and it provides the controller with real-time analogue data by measuring the generator's load using a current transformer.

Through the use of an ADC convertor, the data is transformed into digital format, and an IDE (Integrated Development Environment) is used to program the instructions for each parameter. Additionally, this data may be seen on a laptop or Android app that uses the esp8266 WIFI module as a controller-to cloud interface. A hardware prototype is created and put on a working generator. The results demonstrate real-time remote monitoring of the generator, guaranteeing its dependable functioning and prompt repair suggestion.

2. BLOCK DIAGRAM

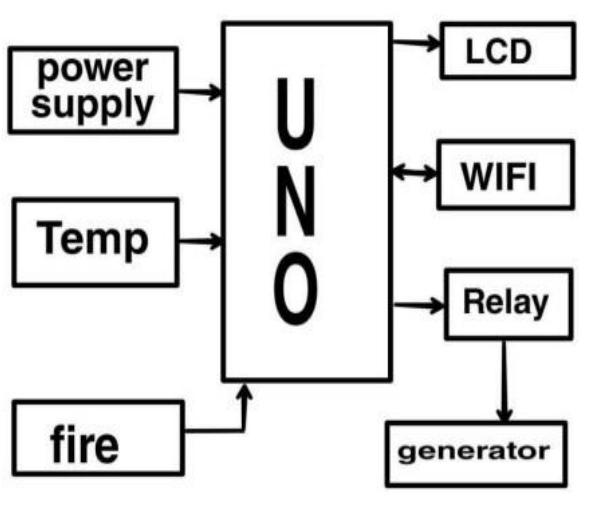

Figure.1.Block diagram

2.1. Hardware components

Regulated power supply.
8. Temperature sensor
9. Fire sensor
10. Micro controller.
11. ESP8266
12. Dht11

2.2. Software requirements:

• Arduino uno
• Embedded C

3. IMPLEMENTATION (WORKING PROCEDURE)

The electrical industry's rebuilding process necessitates the development of innovative methods for displaying massive volumes of device data and controlling the devices

In this system it consists of sensor like DHT11 sensor, relays fire sensor. These sensors take actual physical quantity and this transmitter and according to these data information is given to the microcontroller through wireless LCD display shows the quantity like fire, temperature, Humidity level low or high etc. We have another advance option to start of generator according to requirement. IoT used for transmission of this information over long distance by using IoT wireless technology. At another end IoT is used to collect this information and given to app and we develop one IOT Application to update this information on internet for public access for security purpose of nearer area.

4. RESULT

This project is well prepared and acting accordingly as per the initial specifications and requirements of our project. Because of the creative nature and design the idea of applying this project is very new, the opportunities for this project are immense. The practical representation of an experimental board is shown below

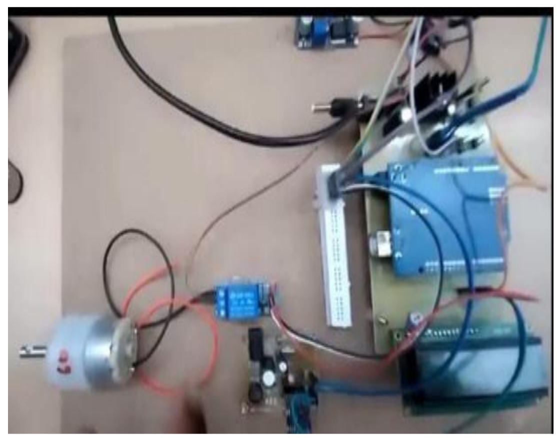

Figure 2.Project model when power supply is off

Figure.3.Project model when power supply is on

Figure.4.Project model with LCD readings

Figure.5.Project Model when humidity is detected

5. CONCLUSION

This project "Making a Control System Using IOT for Our Campus Generator," which will allow us to remotely run the generator from our smart phones in the event of a local power outage.

We can save around 20–25% of the initial cost of zigbee by using IOT instead of the more expensive zigbee. One benefit of utilizing an IOT remote control is that it allows several people to take control of it using a smart phone. This means that if one person handling the operation is unavailable or absent, others may still take charge of it. Our phones allow us to turn on and off the generator. For that, we created a prototype. We calculated the cost of our college's IOT-enabled remote generator control. Remote control is necessary while working in labs or other areas where manual OFF/ON control is not feasible. IOT-based controlling, which allows us to control it from a distance of 10 feet, is efficient and minimizes the need for human labor. Thus, we ultimately draw the conclusion that IOT-based control is a dependable and affordable method of controlling generator remote control.

REFERENCES

[1] Vrushabh G. Vyapari, Vaishnavi N. Waikar, Shweta D. Suryawanshi, Prof. S. J. Tikhe “A REVIEW ON SMART GENERATOR CONTROL USING ANDROID APPLICATION” International Research Journal of Engineering and Technology (IRJET).

[2] Shubhangi Landge, Snehal Waydande, Sanjay Sangale,Somesh Gaikwad “MONITORING OF DISTRIBUTION TRANSFORMER PARAMETERS USING PLC” International Research Journal of Engineering and Technology (IRJET).

[3] P.Mercy, N.Uma Maheswari, S.Deepika Devi, V.Dhamodharan “Wireless Protection and Monitoring of Power Transformer using PIC” International Journal of Computer Science and Mobile Computing, Vol. 4, Issue 3, March 2015.

[4] Chris Meetoo, Sanjay Bahadoorsingh, Neil Ramsamooj and Chandrabhan Sharma “Wireless Residential Power Monitoring System”, 2015.

[5] Hari Arief Dharmawan and Sam A. M. Ali, “A Compact Remote Monitoring System for a Three-Phase 10-kVA Energy-Efficient Switchable Distribution Transformer” IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, VOL. 61, NO. 3, MARCH 2012.

[6] [6] Mei -Sung Kang, Yu-Lung Ke, He-Yau Kang, “ZigBee Wireless Network for Transformer Load Monitoring and Temperature Sensitivity Analysis”, 978-1-4244- 9500-9/11/$26.00 IEEE 2011

[7] Bhargavi K Rao, Rajeshwari, Pradeep M, Ranjitha "Generator monitoring using Android Phone"MITE, Moodabidri, Karnataka, [2019]

[8] Stephan G¨obel, Ruben Jubeh, Simon-Lennert Raesch and Albert Z¨undorf “Using The Android Platform to Control Robots” Kasse University Germany,[May.15, 2013].

[9] Generac Power Systems, Inc. “Gaseous vs. Diesel Fuel Gensets” [May.15, 2013].

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Floating Solar Power Plant

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ABSTRACT

The traditional Solar Power Plant will be built on vast tracts of land since the installation will need more space. Since agricultural is the main industry in our nation, land is essential to agriculture, and we cannot utilize that land to generate the power we require. Sincesolar power plants will be installed on the surface of bodies of water like lakes and ponds, this will allow for the efficient use of solar panels. Because the panels float on the water, the rate of evaporation will be lowered andmore water will be available for agricultural needs. Thisfloating solar power plant may be installed in huge water reservoirs, water storage buildings, including lakes and ponds. By switching the installation from land to water, we can save maintenance costs and lengthen the equipment's lifespan since the water cools the panels, which are exposed to the sun's rays for twelve hours a day.

Keywords: solar photovoltaic, floating solar systems, floating solar power plants, renewable energy, and its benefits.

1. INTRODUCTION

The main problem our country is currently experiencing is the electricity crisis. Approximately 70% of the energy used to create electricity. Daily shutdowns, load shedding, and other factors affectirrigation and industry output. Thus, we need to use renewable energy sources to generate power. These days, not just in India but in many other countries as well, the use of renewable energy sources is growing rapidly. Solar energy is one plentiful, effective, and sustainable alternative energy source. Sunlight energy reduces the greenhouse impact when it is used. India is ranked ninth among all. heat and electromagnetic radiation. These electromagnetic radiations carryenergy that travels to Earth. Since solar energy is an indirect energy source, we need two main components: a storage unit since solar radiation is changeable and a collector to absorb solar radiation and convert it to electrical energy. The energy issue can be effectively solved with solar energy, but installing land-mounted solar systems requires land, which is expensive and difficult to get. India will generate 1 GW of solar power and up to 1.75 GW of solar power from renewable energy sources in the next 10 years. As per the Jawaharlal Nehru National Solar Mission, around 5000 megawatts have been installed nationwide thus far. More work and a strong commitment from all state ministries are needed if the country is to become a major worldwide user of green electricity. A floating solar system's PV concentrator is extremely light and floats on water. It is fastened to rafts and seen floating on the surface of water reservoirs, tailing ponds, irrigation canals, and quarry lakes. A number of these systems are operational in Korea, Japan, India, the United Kingdom, France, and India. The floating solar system reduces the need for costly land space by inhibiting the formation of algae and preserving drinking water that would otherwise evaporate.

The technology shows that the temperature of the solar panels is kept lower than it would be on land. All-recyclable, UV- and corrosion-resistant high-density polyethylene is used to construct the floating platforms. Floating solar is also known as "FLOTOVOLTAIC," "SOLAR ARRAY," and "FLOATING PV."

2. IDENTIFICATION OF NEEDS

There are several significant factors that indicate the need for floating solar power plants. The demand for renewable energy sources is increasing due to environmental concerns and the desire to reduce carbon emissions, which is the primary motivating driver. Additionally, the restricted land available for conventional solar farms—especially in densely populated areas—drives research into other locations, such bodies of water. The potential for higher efficiency through cooling effects on solar panels and the utilization of otherwise underutilized water surfaces further highlights the demand for floating solar power plants as a practical and sustainable optionin the evolving energy environment.

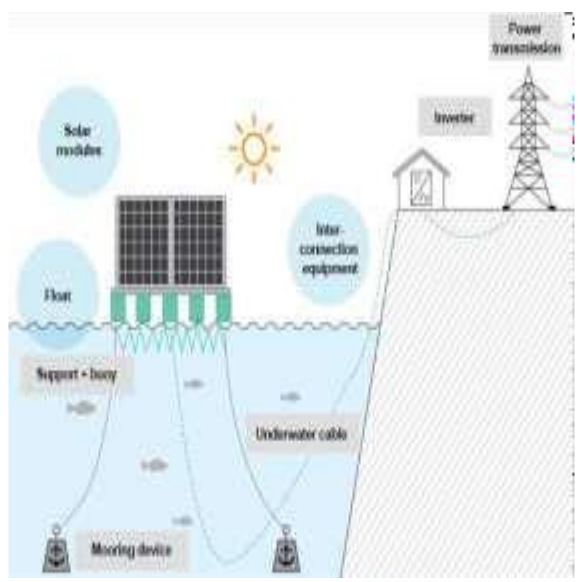

Figure.1. Floating Solar Power Plant

3. THEORY AND OVERVIEW

By carefully arranging solar panels on bodies of water, including lakes or reservoirs, a floating solar power plant transforms traditional solar energy infrastructure. This novel approach's philosophy is based on making the most use of available space and using the advantages of water cooling to raise panel efficiency. The buoyant frames holding up the solar panels have an anchoring mechanism built in to withstand outside pressures, giving them stability. When choosing solar panels, resilience to environmental changes and durability are given top priority. The water's surface underneath the panels serves as a natural cooling mechanism, and the panels'

tilt and position may be adjusted to maximize their exposure to sunlight. The energy harvesting process converts sunlight into electrical energy, regulated by a charge controller to prevent overcharging incorporating a battery system stores excess energy forperiods with limited sunlight. The inverter facilitates the conversion of direct current to alternating current, allowing integration with the electrical grid or powering local applications. Environmental considerations and economic viability are essential aspects, ensuring minimal impact on aquatic ecosystems and assessing the overall cost effectiveness of the floating solar power plant. This innovative concept underscores the fusion of sustainable energy generation with thoughtful land and resource utilization.

Situated atop dams, lakes, rivers, oceans, and other bodies of water are ces might result in reduced yields since the earth's heat affects the panels' rear surfaces. Studies show that solar panels with their rear surfaces above the water's surface will be able to cool themselves more efficiently, which will increase the panels' life span. Moreover, they can minimize evaporation by up to 70% and improve power generation by up to 16% by shading the water they float on. PV floating power

Production is produced by the integration of these floating solar power facilities. The solar panels are mounted on mooring platforms so that damage may be avoided even during severe weather. Additionally, research suggests that installing solar panels on land surface For example, the PV generation equipment, which is installed above the floating system and looks like electrical junction boxes, utilizes underwater cable to convey the electricity generated to the PV system development. PV systems, also referred to as floating solar arrays, are mounted on the surface of quarry lakes, drinking water reservoirs, irrigation canals, and ponds used for cleanup and tailings. The United States, Singapore, the United Kingdom, France, India, Japan, and South Korea are among the countries with a few of these systems.

Reportedly, the systems outperform solar plants situated on land. The cost of land is greater and there are less rules and restrictions in place when constructing on bodies of water that are not utilized for pleasure. Compared to most land-based solar power projects, floating arrays may be less visible since they are hidden from view. The panels have higher efficiency than PV panels placed on land because water cools them. The panels are coated with a special substance to prevent rust and corrosion.

4. BLOCK DIAGRAM

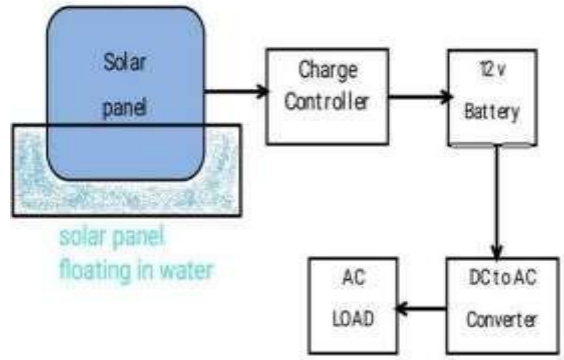

Figure.2. Block Diagram

5. WORKING

Using 20V floating solar panels, the floating solar power plant first collects sunlight. By controlling the panel output, the charge controller makes sure that the 12V lithium-ion battery is charged safely and effectively. This battery stores gathered electricity, serving as a reserve for energy. The direct current thathas been saved is converted into alternating current bythe DC to AC converter so that it can power AC loads.The technology effectively provides the AC load with renewable energy, which makes the floating solar power plant a flexible and sustainable option.

5.1. Floating solar panels

Using water surfaces like lakes or reservoirs, floating solar panels generate electricity effectively. These panels, which are installed atop buoyant structures, gain from water cooling, which raises their total effectiveness. The panels may be tilted and oriented to maximize their exposure to sunlight throughout the day. The floating design provides a sustainable approach to the production of renewable energy while maximizing land utilization and minimizing environmental effect. In addition, the water's cooling impact lengthens the panels' lifespan. All things considered, floating solar panels are a creative solutionthat satisfies both energy demands and environmental concerns.

5.2. Charge controller

By controlling the voltage and current from solar panels, a solar charge controller minimizes overcharging and maximizes battery life. It serves as an essential part of solar power systems, guaranteeingeffective energy transmission to the battery that is linked. Through oversight and regulation of the charging procedure, the controller guards against overvoltage damage to the battery. For increased dependability, it has features including temperature correction and overcharge prevention. To meet diversesystem needs, solar charge controllers are available in a variety of kinds, such as PWM (Pulse Width Modulation) and MPPT (Maximum Power Point Tracking). Their function is critical to preserving the efficiency and lifespan of solar power systems.

5.3. Lithium ion battery

Rechargeable energy storage devices, such as lithium- ion batteries, are frequently seen in electric cars and portable gadgets. During charge and discharge, lithium ions travel between the positive and negative electrodes, which is how it functions. cycles. Lithium- ion batteries, which have a high energy density, provide a portable and lightweight power source. Because of their greater cycle life than conventional batteries, they may be used in a variety of applications. A built-in protection circuit or other safety device increases their dependability. The goal of ongoing research is to increase their longevity, sustainability, and efficiency in relation to renewable energy storage.

5.4. DC TO AC Inverter

An electrical device called a DC to AC inverter changes direct current (DC) power into alternating current (AC) so that it may be used with other common electrical equipment. It makes it easier to use DC power sources for AC-powered appliances, and it is frequently employed in solar power systems and automobile applications. Typical safety features of inverters include overload protection to guard against harm to connected equipment. Waveform quality is offered by square wave, modified sine wave, and sine wave inverters. Inverters are essential components of renewable energy systems because they transform stored DC energy into AC loads or allow for grid integration.

6. AC Load

An electrical device called a DC to AC inverter changes direct current (DC) power into alternating current (AC) so that it may be used with other common electrical equipment. It makes it easier to use DC power sources for AC-powered appliances, and it is frequently employed in solar power systems and automobile applications. Typical safety features of inverters include overload protection to guard against harm to connected equipment. Waveform quality is offered by square wave, modified sine wave, and sine wave inverters. Inverters are essential components of renewable energy systems because they transform stored DC energy into AC loads or allow for grid integration.

7. RESULT

With its 18–20V solar panels, the floating solar power plant model controls the voltage of a 12V lithium-ion battery. In order to avoid overcharging, the charge controller optimizes charging. Stored energy is converted for AC loads using a DC to AC converter.

These floating power plants will decrease the rate at which water evaporation from bodies of water, such as lakes, ponds, and reservoirs, by forty percent. The water will also be

Figure.3. Solar Power Circuit

utilized to cool down installed

photovoltaic cells, extending their lifespan and improving power production efficiency.

8. MERITS OF FLOATING POWER PLANT

Because of the cooling impact of the water, floating solar power plant systems often produce more electricity than ground-mount and rooftop systems. Typhoon and storm conditions, as well as significant physical stress, are not going to affect the floating platforms because of their design and engineering. By shading the water, these facilities lessen water evaporation and algae growth.

Floating plants may be installed in any body of water, wherever in the world, as long as there is enough sunshine. Made entirely of recyclable high-density polyethylene that is resistant to corrosion and UV light, floating platforms are environmentally friendly. A comparison of the installed modules with that of the other system.

9. CONCLUSION

One viable and long-term approach to use renewable energy is the installation of a floating solar power plant. Its creative design uses water to increase energy production while also optimizing land utilization surfaces. With continuous technological development and mounting environmental concerns, floating solar has a bright future ahead of it, one that might see a shift toward a more efficient and clean energy system.

REFERENCES

[1] "Economic Assessment of Concrete and Floating Based Solar Chimney Power Plants in Bangladesh," 2020 IEEE Region 10 Symposium (TENSYMP), Dhaka, Bangladesh, 2020, pp. 638-641, M. A. Aziz Bhuiyan, M. H. Bhuiyan, M. A. Rahman, M. A. Abir, N. Mehfuz, and S. Salehin J. Energy Storage, 39 (2021), Article 102616

[2] "Floating Solar Collector for Hybrid Hydro-Solar Power Plant," 2018 International Conference on Smart City and Emerging Technology (ICSCET), Mumbai, India, 2018, pp. 1–5. R. Giri, A. Kumar, S. Mishra, and N. Shah.

[3] S. F. Hui, H. F. Ho, W. W. Chan, K. W. Chan, W. C. Lo and K. W. E. Cheng, "Floating solar cell power generation, power flow design and its connection and distribution," 2017 7th International Conference on Power Electronics Systems and Applications - Smart Mobility, Power Transfer & Security (PESA), Hong Kong, China, 2017, pp. 1-4

[4] S. F. Hui, H. F. Ho, W. W. Chan, K. W. Chan, W. C. Lo and K. W. E. Cheng, "Floating solar cell power generation, power flow design and its connection and distribution," 2017 7th International Conference on Power Electronics Systems and Applications - Smart Mobility, Power Transfer & Security (PESA), Hong Kong, China, 2017, pp. 1-4

[5] D. Mittal, B. K. Saxena and K. V. S. Rao, "Comparison of floating photovoltaic plant with solar photovoltaic plant for energy generation at Jodhpur in India," 2017 International Conference on Technological Advancements in Power and Energy (TAP Energy), Kollam, India, 2017, pp. 1-6

[6] 2023 International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM), Sochi, Russian Federation, 2023, pp. 239- 244; D. Tryakin and P. Shurkalov, "Investigation of Temperature Effect on Photovoltaic Modules of the Nizhne-Bureyskaya Floating Solar Power Plant,"

[7] "Feasibility Analysis of Floating Solar PV Project in Catchment Area of Kaptai Dam," 2022 International Conference on Energy and Power Engineering (ICEPE), Dhaka, Bangladesh, 2022, pp. 1–5, Ahmad, Al-Mahmud, andRahman

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

SIMULATION BASED HYBRID ELECTRIC VEHICLE PV PANEL AS ASECONDARY ENERGY SOURCE

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ABSTRACT

Electric cars (EVs) and hybrid electric vehicles (HEVs) offer a workable solution to reduce greenhouse gas emissions, hence research and developmenton these vehicles has gained popularity. Switched reluctance motors, also known asSRMs, are one type of motor that is promised for use in hybrid and electric car applications. EVs and HEVs may go fartherbetween charges when they havephotovoltaic (PV) panels installed on their vehicles, which lessens their reliance on vehicle batteries. Building on the phase winding properties of SRMs, a tri-port converter is presented in this study to control the energy flow between the PV panel, battery, and SRM. There are six different operating modes available: two forstationary onboard charging and four for driving particularly.

Energy decoupling management in the driving modes allows for the PV panel's maximum power point tracking (MPPT) and SRM speed control. In stationary charging modes, there's no need for extra hardware to construct a grid-connected charging topology. The PV panel increasesenergy efficiency when it charges the battery directly by using a multisection charging management strategy. The proposed tri-port converter is demonstratedto be successful based on testing and resultsfrom MATLAB/Simulink simulation. This could boost EV and HEV market acceptance and have good economic impacts.

Keywords: pv panel, EVs, HEVs, tri-port converter and srm motor.

1. INTRODUCTION

High-performance permanent-magnet(PM) motor drives are commonly utilized, but the broad use of electric vehicles (EVs) is limited by the enormous quantity of rare earth minerals required. A photovoltaic (PV) panel and a switching reluctance motor (SRM) are proposed to provide power supply and motor drive, respectively, in order to overcome these problems. First, a sustainable energy source is created by mounting the PV panel above the EV. A standard passenger automobile today has enough surface area to accommodate a 250-watt photovoltaic panel. Second, an SRM isbecoming more and more popular in EV and HEV applications since it is durable and does not require rare-earth PMs.

PV panels have low power density for traction drive but can be used for charging batteries for most of the time. In general, thestructure of the PV fed EV is similar to thatof the hybrid electric vehicle (HEV), where the ICE is replaced by a PV panel. The PV-fed EV system is shown in Fig.1. Its main features include an off-board charger, a photovoltaic (PV), batteries, power converters, etc. One way to reduce the conversion processes is by re-designing the motor to incorporate some on-board charging functions. For example, a 20-kW split-phase PM motor can be used for EV charging but suffers from high harmonics in the rear electromotive force (EMF).

1.1. History:

A 2.3-kW SRM motor, based on traditional SRM technology, incorporates onboard charging and power factor correction by utilizing machinewindings as the input filter inductor. The use of intelligent power modules (IPMs) enables a four-phase half bridge converter for driving and grid-charging. While modularization aids in mass production, the adoption of half/full bridge topology may compromise system reliability due to shoot- through issues. The paper introduces a straightforward topology for plug-in HEVsthat facilitates flexible energy flow. However, for grid-charging, connecting thegrid to the generator rectifier can enhance the energy conversion process but reduce charging efficiency. Despite this, an efficient topology and control strategy for PV-fed EVs remains undeveloped. Given the distinct characteristics of PV systems compared to ICEs, factors such as maximum power point tracking (MPPT) and solar energy utilization are crucial for PV-fed EVs and HEVs.

1.2. Operation

In order to achieve cost effective and adaptable energy flow method, a cost-effective tri-port converter isintroduced in this study to manage the PV panel, SRM, and battery. The proposed tri- port configuration includes three energy terminals: PV, battery, and SRM. These terminals are interconnected by a power converter comprising four switching devices (S0 − S3), four diodes (D0 − D3), and two relays, as depicted in Fig. 2. Through the control of relays J1 and J2, sixoperational modes are facilitated, as shown

in Fig. 3. In mode 1, PV serves as the energysource for driving the SRM and charging the battery. In mode 2, both the PV and thethe SRM.

2. MODELLING OF CASESTUDY

The proposed tri-port configuration includes three energy terminals: PV, battery, and SRM (Switched Reluctance Motor). These terminals are interconnected by a power converter comprising four switching devices (S0 to S3), four diodes (D0 to D3), and two relays, as depicted in Figure 2. Through the control of relays J1 and J2, six operation modes are facilitated, as illustrated in Figure 3. In Mode 1, PV acts as the energy source to power the SRMand charge the battery simultaneously. Mode 2 utilizes both PV and the battery as energy sources to drive the SRM. In Mode 3, PV serves as the primary source while thebattery remains inactive. Mode 4 employs the battery as the driving force with PV remaining inactive. Mode 5 involves charging the battery from a single-phase grid while PV and SRM are inactive. Mode 6 enables charging the battery using PV while the SRM remains inactive.

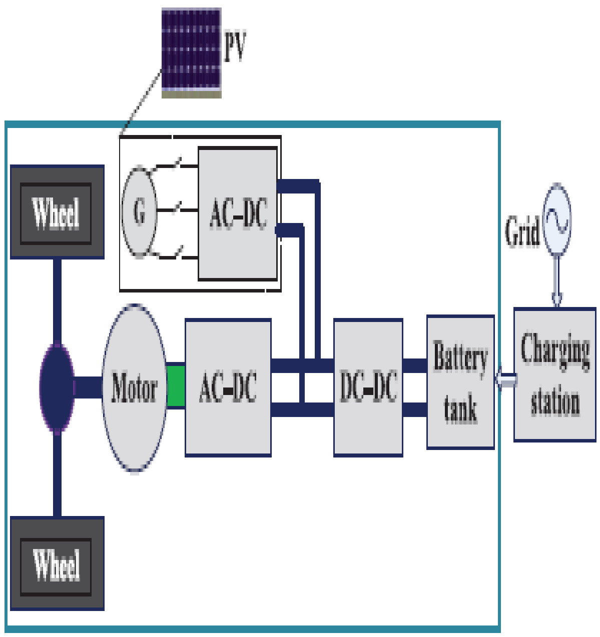

Figure.1. PV-fed HEV

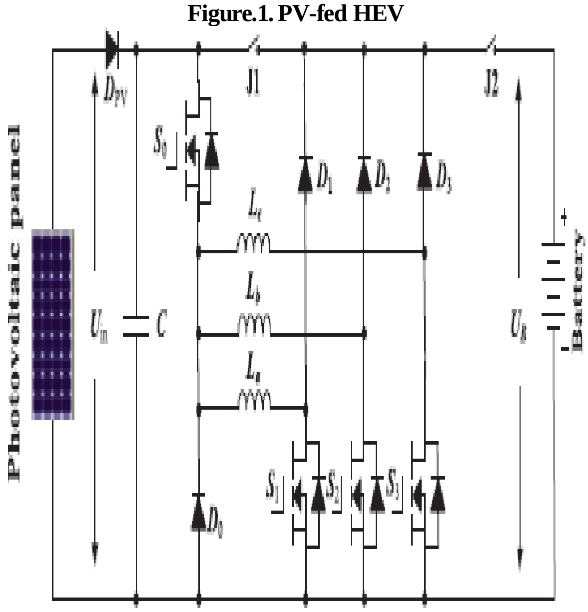

Figure. 2. Proposed tri-port topology for PV-powered SRM drive

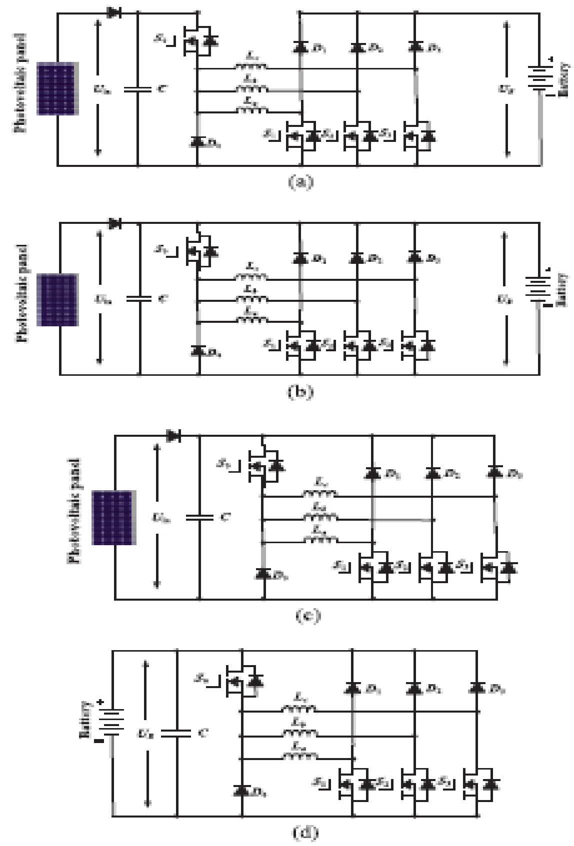

Figure.3. Equivalent circuits under drivingmodes.

- **Operation circuit under mode**
- **Operation circuit under mode**
- **Operation circuit under mode**
- **Operation circuit under mode**

3. SIMULATION RESULTS

The proposed methodology is verifiedusing a 750-W three-phase 12/8-pole SRM, as depicted in Figure A. An Agilent Technology E4360A PV array simulator isemployed as the input source. For testing charging and discharging, a 24-V lead-acid battery is utilized. An asymmetric-half bridge converter is employed to drive the motor. The operational modes of the SRM during motoring and braking with relay J1 ON are outlined in Figure 3, with ia, ib, andic representing phase currents for phases A, B, and C, respectively. During motoring, the turn-on and turn-off angles are set at 0◦ and 20◦, resulting in a stable speed transition from 300 to 800 r/min within 1.5seconds, as demonstrated in Figure 3(c).In the case of inertial braking, illustrated in Figure 3(d), the braking time extends to 2.5seconds, with no energy flowing back to thepower supply. However, in regenerative braking mode, the turn-on and turn-off angles are adjusted to 22◦ and 43◦, respectively, reducing the braking time to 300ms and enabling energy transfer duringbraking

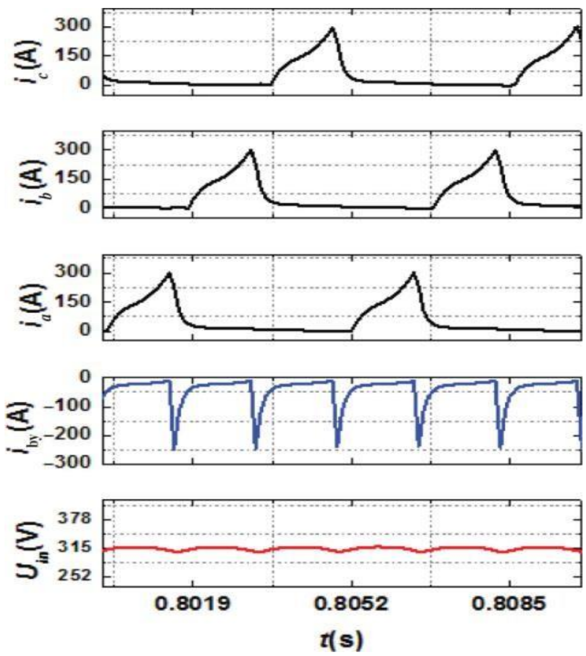

Figure.4. Simulation results of driving-charging mode

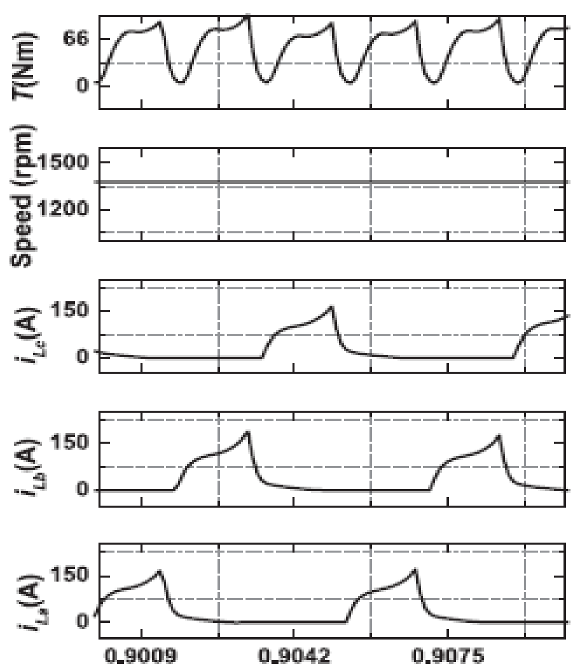

Figure.5. Simulation results of single-sourcedriving mode

4. CONCLUSION

To address the issue of range anxiety in electric vehicles (EVs) and to reduce system costs, a hybrid system combining PV panels and SRMs (Switched Reluctance Motors) is proposed for EV propulsion. This paper introduces several key contributions:

Implementation of a tri-port converter to coordinate the PV panel, battery, and SRM, enabling efficient energy management.

Development of six operational modes to facilitate flexible energy flow, catering to driving control, driving/charging hybrid control, and charging control requirements. Introduction of a PV-fed battery charging control scheme aimed at enhancing solar energy utilization and reducing reliance onconventional grid charging methods. By adopting PV-fed EVs, which are environmentally friendly and sustainable compared to internal combustion engine (ICE) vehicles, this research offers a viable solution to lower overall costs and decrease CO2 emissions from electrified vehicles. Moreover, the proposed technology isadaptable to other applications such as fuelcell-powered EVs, leveraging the higher power density of fuel cells for improved performance in EVs.

REFERENCES

[1] Emadi, L. Young-Joo, and K. Rajashekara, “Power electronics and motor drives in electric, hybrid electric, and plug- in hybrid electric vehicles,” IEEE Trans. Ind. Electron., vol. 55, no. 6, pp. 2237– 2245, Jun. 2008.

[2] L. K. Bose, “Global energy scenario andimpact of power electronics in 21st century,” IEEE Trans. Ind. Electron., vol. 60, no. 7, pp. 2638–2651, Jul. 2013.

[3] J. De Santiago et al., “Electrical motor drivelines in commercial allelectric vehicles: A review,” IEEE Trans. Veh. Technol., vol. 61, no. 2, pp. 475–484, Feb. 2012.

[4] Z. Amjadi and S. S. Williamson, “Power-electronics-based solutions for plug-in hybrid electric vehicle energy storage and management systems,” IEEE Trans. Ind. Electron., vol. 57, no. 2, pp. 608–616, Feb. 2010.

[5] Kuperman, U. Levy, J. Goren, A. Zafransky, and A. Savernin, “Battery charger for electric vehicle traction battery switch station,” IEEE Trans. Ind. Electron., vol. 60, no. 12, pp. 5391–5399, Dec. 2013.

[6] S. G. Li, S. M. Sharkh, F. C.Walsh, andN. Zhang, “Energy and battery management of a plug-in series hybrid electric vehicle using fuzzy logic,” IEEE Trans. Veh. Technol., vol. 60, no. 8, pp. 3571–3585, Oct. 2011.

[7] H. Kim, M. Y. Kim, and G. W. Moon, “A modularized charge equalizer using a battery monitoring IC for series-connected Li-ion battery strings in electric vehicles,” IEEE Trans. Power Electron., vol. 28, no. 8,pp. 3779–3787, May 2013.

[8] Z. Ping, Z. Jing, L. Ranran, T. Chengde, and W. Qian, “Magnetic characteristics investigation of an axial–axial flux compound-structure PMSM used for HEVs,” IEEE Trans. Magn., vol. 46, no. 6, pp. 2191–2194, Jun. 2010.

[9] Kolli, O. Béthoux, A. De Bernardinis, E. Labouré, and G. Coquery, "Space-vector PWM control synthesis for an H-bridge drive in electric vehicles," IEEE Trans. Veh. Technol., vol. 62, no. 6, pp. 2441–2452, Jul. 2013.

[10] Y. Hu, C. Gan, W. Cao, W. Li, and S. Finney, "Central-tapped node linked modular fault tolerance topology for SRM based EV/HEV applications," IEEE Trans. Power Electron., vol. 31, no. 2, pp. 1541– 1554, Feb. 2016.

[11] S. M. Yang and J. Y. Chen, "Controlled dynamic braking for switched reluctance motor drives with a rectifier front end," IEEE Trans. Ind. Electron., vol. 60, no. 11,pp. 4913–4919, Nov. 2013.

[12] B. Bilgin, A. Emadi, and M. Krishnamurthy, "Comprehensive evaluation of the dynamic performance of a 6/10 SRM for traction application in PHEVs," IEEE Trans. Ind. Electron., vol. 60, no. 7, pp. 2564–2575, Jul. 2013.

[13] M. Takeno, A. Chiba, N. Hoshi, S. Ogasawara, M. Takemoto, and M. A. Rahman, "Test results and torque improvement of the 50-kW switched reluctance motor designed for hybrid electric vehicles," IEEE Trans. Ind. Appl., vol. 48, no. 4, pp. 1327–1334, Jul./Aug. 2012.

Leveraging AI for Financial Management in Entrepreneurship and Innovation

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ABSTRACT

The nexus of entrepreneurship, innovation, financial management, and artificial intelligence (AI) has become a vital field for study and application in the contemporary world. AI revolutionizes financial management through process automation, trend identification, and tactic refinement. Additionally, it controls risk, fosters creativity by promptly reacting to market events, and equips business owners with the knowledge they need to make informed decisions. To promote entrepreneurship and innovation, this review article investigates the strategic integration of AI in financial management. This study explores how AI might improve risk management, operational efficiency, and financial decision-making for innovators and entrepreneurs by using a thorough examination of previous research and case studies.Personalized financial services, automated financial planning and budgeting, fraud detection and prevention, AI-powered predictive analytics for market predictions, investment strategies, and customer insights are some of the important subjects addressed. This article also explores the implications of AI-driven financial strategies for sustainable growth, increased competitiveness, and easier access to capital for entrepreneurial endeavours. This review offers useful insights for academicians, practitioners, and policymakers hoping to use AI to promote innovation, entrepreneurship, and excellent financial management in the digital age. It does this by synthesizing current knowledge and suggesting future research paths.

Keywords: Artificial intelligence, Financial Management, Entrepreneurship, Innovation

1. INTRODUCTION

Integrating artificial intelligence (AI), entrepreneurship, innovation, and financial management is a crucial area in today's business and technological landscape that propels the development of modern businesses. The term artificial intelligence, or AI in brief describes how computers, especially computer systems, can imitate human thought processes. By using these processes—learning, reasoning, and self-correction—artificial intelligence (AI) systems can comprehend enormous volumes of data and draw conclusions or predictions from it.The rapid advancement of AI technologies presents unprecedented opportunities for reshaping traditional approaches to financial management, thereby fostering entrepreneurship and driving innovation across industries.

The relationship between AI and financial management is more than just automation; it represents a fundamental change in the way companies see, evaluate, and handle financial data. With the help of artificial intelligence (AI), entrepreneurs and innovators can now navigate the complicated marketplaces of today with new skills ranging from process automation and trend recognition to risk mitigation and strategic decision-making (Brown and Smith, 2019; Silva *et al.*,2023).

As people or organizations start and run enterprises, frequently to attain growth and profitability, entrepreneurship reflects the spirit of creativity and risk-taking. The process of creating novel concepts, goods, or services that benefit consumers or society as a whole is known as innovation. Planning, organizing, directing, and regulating financial activities inside an organizationto maximise resources and reach financial objectives are all included in financial management.

2. OBJECTIVES

- Assess AI's Potential in Financial Management
- Assess How AI Affects Financial Decision-Making
- Analyse the Intersection of Financial Management, Innovation, Entrepreneurship, and AI
- Examine AI Uses in Fraud Prevention and Detection
- Talk About How AI-Powered Financial Strategies Affect Long-Term Growth

3. METHODOLOGY

A thorough literature search utilizing keywords relevant to artificial intelligence (AI) in financial management, entrepreneurship, and innovation was conducted for this review study using academic databases and reliable sources. Data are extracted from chosen studies, including important findings and techniques, using inclusion and exclusion criteria that are developed to choose pertinent literature. Finding themes and insights that are shared across the literature while critically assessing its advantages and disadvantages is known as a synthesis of findings. Insights are combined with case studies to create a coherent story, which is then examined to show true applications.

4. FINDINGS

4.1. The Potential of AI in Financial Management

Data entry, reconciliation, and reporting are just a few of the repetitive operations and workflows that AI technology may automate in financial management systems. Organizations can boost operational efficiency, decrease manual errors, and expedite regular tasks by utilizing software robots or bots driven by artificial intelligence. Finance professionals can now devote more of their important time to higher-value duties like strategy formulation, analysis, and decision-making, thanks to this automation(Marques and Oliveira, 2023). Large-scale financial data analysis is a specialty of AI-driven algorithms, which they use to find trends, patterns, and anomalies. AI can provide insightful financial decision-making by analyzing real-time and historical data from a variety of sources, such as economic indicators, customer behavior, and market patterns. AI systems, for instance, may forecast customer preferences, identify new market trends, and forecast shifts in demand, allowing companies to adjust their tactics ahead of time(Chang and White 2018; Chang and Wang 2019; Chang and White 2021).

By offering practical insights and suggestions based on data analysis, artificial intelligence (AI) facilitates strategic optimization within financial management. Predictive analytics driven by AI, for example, can optimize investment portfolios, foresee future market circumstances, and spot chances to save costs or increase income. Organizations may make better, data-driven decisions and gain a competitive edge by incorporating AI into their strategic decision-making processes. Large databases containing historical financial data, market patterns, and outside variables can be analyzed by AI-driven algorithms to produce precise forecasts and risk evaluations. Artificial Intelligence (AI) can foresee future events, including sales, cash flow, and potential dangers, by utilizing machine learning and predictive modeling approaches. To meet their financial objectives, this helps companies recognize opportunities, handle risks proactively, and allocate resources as efficiently as possible.

By streamlining financial management procedures, AI technology can be used to cut expenses and increase operational efficiency. AI-enabled hardware and software can save human labor and resource waste by automating repetitive operations, speeding up data processing, and optimizing resource allocation. AI-enabled solutions can also improve data auditability, compliance, and correctness, which improves overall operational excellence in financial departments. Organizations can improve their financial management decision-making capabilities by utilizing AI technologies. With the help of AI-powered analytics solutions, finance professionals can confidently make data-driven decisions by accessing real-time insights, scenario analysis, and predictive modeling capabilities. AI algorithms also can find hidden patterns, correlations, and dependencies in financial data, which gives decision-makers the ability to predict market trends, reduce risks, and seize opportunities.

4.2. The Impact of AI on Financial Decision-Making

The analysis of enormous volumes of data from numerous sources, including consumer behavior, market trends, and economic indicators, is made possible by AI technologies. AI systems can process this data and produce quick and accurate insights and forecasts, enabling innovators and entrepreneurs to make decisions based on current knowledge. These insights, which enable decision-makers to act proactively and intelligently, may include spotting new business opportunities, forecasting trends, or evaluating possible hazards.AI-powered automated planning tools and personalized financial services facilitate more thoughtful and strategic decision-making: Financial services and planning can be tailored by AI-powered tools to each user's preferences, objectives, and financial circumstances.AI systems can provide customized suggestions for financial products, budgeting, savings, and investment strategies through the analysis of consumer data and behavior.Through the reduction of human error and effort and the assurance of alignment with their goals and restrictions, automated planning tools can assist innovators and entrepreneurs in developing and implementing financial plans more effectively (Maple *et al.,* 2023).

AI can optimize resource allocation by directing funds towards high-potential investments or projects with the best-projected returns by utilizing machine learning and predictive analytics. AI-powered risk management solutions may also identify possible hazards, calculate their impact, and suggest risk mitigation techniques to assess and reduce financial risks. All things considered, artificial intelligence (AI) improves the efficiency of financial decision-making processes by offering actionable insights, maximizing resource allocation, and reducing risks. This eventually helps entrepreneurs and innovators achieve better financial results (Aldoseri *et al.,* 2023; Singh *et al.,*2023).

4.3. Financial Management, Innovation, Entrepreneurship, and AI Intersect

AI technologies give business owners cutting-edge instruments and solutions for data analysis, financial process optimization, and strategic decision-making. AI frees up time and resources for entrepreneurs to concentrate on creativity and innovation, fostering the creation of new goods, services, and business models. It does this by automating repetitive processes and offering real-time insights. Additionally, AI gives business owners the ability to quickly adjust to shifting market dynamics and new trends, improving their flexibility and responsiveness to client demands. Entrepreneurs can gain a competitive edge by utilizing cutting-edge technologies to optimizeoperations, differentiate their offers, and seize new market opportunities through the strategic integration of AI in financial management (Mandala *et al.* 2022).

Large data sets are analyzed by AI algorithms to find patterns, trends, and correlations. This gives business owners insightful knowledge about competition tactics, consumer behavior, and market dynamics. Through the utilization of these data, businesses can pinpoint unexplored market prospects, evaluate demand patterns, and customize their offerings to efficiently satisfy client demands.AI-powered solutions also streamline corporate procedures by lowering expenses, increasing productivity, and automating monotonous work. This frees up resources for entrepreneurs to devote more wisely to ventures aimed at expansion and assessments (Sheth *et al.,* 2022). Artificial intelligence (AI) helps business owners attain sustainable growth and profitability by streamlining financial procedures and enhancing operational effectiveness, drawing capital, and promoting expansion. Moreover, by promoting experimentation, teamwork, and constant development, the thoughtful integration of AI promotes an innovative culture within the entrepreneurial ecosystem. By testing new concepts, experimenting with various business models, and iterating quickly in response to real-time input, entrepreneurs may use AI technologies to accelerate innovation and promote long-term success in the market (Moro-Visconti *et al.* 2023).

innovation. Furthermore, AI fosters creativity by giving business owners the ability to foresee future trends, dangers, and opportunities through scenario modeling and predictive analytics. This allows them to stay ahead of the curve and create creative solutions (El Hajj and Hammoud, 2023)

AI-powered financial management solutions facilitate entrepreneurs' access to cash from lenders, investors, and financial institutions by evaluating creditworthiness, assessing investment prospects, and providing risk

4.4. AI's Applications in Fraud Detection and Prevention

AI's applications in fraud detection and prevention are multifaceted, encompassing various techniques and algorithms that leverage machine learning, data analytics, and pattern recognition to identify and mitigate fraudulent activities across different domains. Here are some key applications:

Sr.No.	**Application**	**Elucidation**	**Studies**
1	Anomaly Detection	Artificial intelligence systems can identify anomalies in transactional data by contrasting the present with the past. Unusual departures from the norm, like unexplained increases in transaction volume or strange purchasing habits, may be regarded as possible signs of fraud.	Tircovnicu and Hategan, 2023; Bassi, 2023; Al-Blooshi and Nobanee, 2020
2	Pattern Recognition	By examining big datasets and finding similar attributes amongst fraudulent transactions, AI-powered systems can detect patterns of fraudulent behavior. These technologies canrecognize new fraud cases by identifying patterns that are similar to those found in previous fraud cases	Bassi, 2023;Varma & Khan, 2013; Phulari *et al.,* 2016
3	Behavioral Analysis	AI systems examine user interaction and behaviour patterns to identify questionable activity. AI systems, for instance, can examine transaction histories, login attempts, and user navigation habits in online banking to spot irregularities that can point to account takeover or illicit access.	Darnish *et al.,* 2020; Martin *et al.,* 2021
4	Natural Language Processing (NLP)	AI systems can examine textual data, such as emails, chat transcripts, or social media posts, for indications of fraudulent activity thanks to NLP approaches. Phishing attempts, phony texts, and social engineering techniques employed by scammers to trick people or organizations can all be identified using AI-powered natural language processing models.	Bassi, 2023; Fisher *et al.,* 2016;Sood *et al.,* 2023
5	Predictive Analytics	AI-powered prediction algorithms use past data and new trends to estimate future fraud risks. Artificial Intelligence (AI) may anticipate possible fraud situations and proactively adopt preventive steps to limit risks by analyzing patterns and trends in financial transactions.	Singla and Jangir, 2020; Verma, 2022
6	Network Analysis	To identify fraudulent schemes or organized crime operations, artificial intelligence (AI) algorithms can examine networks of interconnected things, such as accounts, transactions, or consumers. Artificial intelligence (AI) can reveal intricate fraud schemes that might otherwise go unnoticed by spotting suspicious connections or odd interactions inside the network.	Nai *et al.,* 2022; Subeji *et al.,* 2011
7	Real-Time Monitoring	Real-time transaction monitoring using AI-powered systems helps identify and stop fraud before it starts. Artificial Intelligence (AI) can detect fraudulent activity in real-time and initiate prompt notifications or interventions to halt fraudulent transactions by analyzing transactional data in milliseconds.	Bassi, 2023; Farrugia *et al.,* 2021; Dong *et al.,* 2021

Overall, AI's applications in fraud detection and prevention empower organizations to combat increasingly sophisticated fraud schemes and protect their assets, customers, and reputation. By leveraging advanced machine learning algorithms and data analytics techniques, AI enables proactive and effective fraud management strategies that mitigate risks and ensure trust in financial transactions and digital interactions**.**

5. AI-POWERED FINANCE TECHNIQUES THAT IMPACT LONG-TERM GROWTH

Through the facilitation of sustainable practices, enhancement of competitiveness, and facilitation of capital access, AI-powered financial strategies are essential to the long-term growth of enterprises. By strategically incorporating AI into financial management, companies may innovate, adjust, and take advantage of new opportunities. AI-driven insights enable firms to allocate resources optimally, make well-informed decisions, and move with agility across uncertain markets. Businesses may maintain profitability, enter new markets, and develop economic resilience by utilizing predictive analytics and risk management solutions (Lin and Yu, 2023). Adopting AI-powered financial strategies positions companies for long-term success and growth in dynamic and competitive markets. It also fosters innovation and adaptation and improves the overall efficiency and efficacy of financial management procedures. AI-powered finance techniques include predictive analytics, machine learning algorithms, natural language processing, robotic process automation, credit scoring, and risk assessment (Flax, 2018; Odonkor *et al.*, 2024).

6. CONCLUSION AND FUTURE RESEARCH DIRECTION

To sum up, there is a great deal of promise for entrepreneurship, innovation, and long-term growth when artificial intelligence (AI) is included inFinancial Management. AI-driven financial strategies facilitate process optimization, improve decision-making, and reduce the risk for organizations, which in turn creates an environment that is favorable for long-term growth and sustainability. Businesses may innovate, adapt, and take advantage of new opportunities while simultaneously increasing operational effectiveness and competitiveness through the strategic application of AI technologies. In addition, AI-powered risk management and predictive analytics tools offer insightful analysis and important insights that help companies manage market turbulence and maintain long-term profitability. In general, implementing AI-powered financial strategies helps companies develop and succeed over the long term in the digital economy while also encouraging an innovative and exceptional culture.However, further research is needed to understand ethical and regulatory implications, develop advanced AI algorithms, explore AI's impact on financial inclusion, and integrate AI with emerging technologies like block chain, IoT, and quantum computing.

REFERENCES

[1] Al-Blooshi, L., & Nobanee, H. (2020). Applications of artificial intelligence in financial management decisions: a mini-review. Available at SSRN 3540140. https://dx.doi.org/10.2139/ssrn.3540140

[2] Aldoseri, A., Al-Khalifa, K., & Hamouda, A. (2023). Re-Thinking data strategy and integration for artificial intelligence: concepts, opportunities, and challenges. Applied Sciences, 13(12), 7082. DOI: 10.3390/app13127082

[3] Atadoga, A., Ike, C.U., Asuzu, O.F., Ayinla, B.S., Ndubuisi, N.L., & Adeleye, R.A. (2024). The intersection of AI and quantum computing in financial markets: a critical review.

[4] Bassi (2023).How is artificial intelligence used in fraud detection? https://cointelegraph.com/explained/how-is-artificial-intelligence-used-in-fraud-detection

[5] Chang, M. J., & Wang, Y. C. (2019). "Applications of Artificial Intelligence in Hospital Management: A Review." Health Information Science and Systems, 7(1), 1-10

[6] Chang, M. J., & White, S. T. (2018). "Ethical Considerations in AI-Driven Healthcare Financial Management." Journal of Medical Ethics, 35(1), 76-88

[7] Chang, M. J., & White, S. T. (2021). "AI-Driven Resource Allocation in Hospitals." Health Systems, 10(1), 78-87

[8] Choi, Y., Choi, D., & Hong, H. (2023). Together we turn uncertainty into action: understanding the role of artificial intelligence in supporting the financial concerns of older adults. In Companion Publication of the 2023 Conference on Computer Supported Cooperative Work and Social Computing (pp. 132-137). DOI: 10.1145/3584931.3607018

[9] Darwish, S. M. (2020). A bio-inspired credit card fraud detection model based on user behavior analysis suitable for business management in electronic banking. Journal of Ambient Intelligence and Humanized Computing, 11(11), 4873-4887.

[10] Dong, J. (2018). Application research of artificial intelligence technology in enterprise financial management. In Proceedings of the 2018 International Conference on Economics, Finance and Business Development (ICEFBD). DOI:10.25236/icefbd.18.056

[11] Dong, Y., Jiang, Z., Alazab, M., & KUMAR, P. (2021). Real-time Fraud Detection in e-Market Using Machine Learning Algorithms. Journal of Multiple-Valued Logic & Soft Computing, 36.

[12] Farrugia, D., Zerafa, C., Cini, T., Kuasney, B., & Livori, K. (2021). A real-time prescriptive solution for explainable cyber-fraud detection within the iGaming industry. Sn computer science, 2(3), 215.

[13] Fisher, I. E., Garnsey, M. R., & Hughes, M. E. (2016). Natural language processing in accounting, auditing, and finance: A synthesis of the literature with a roadmap for future research. Intelligent Systems in Accounting, Finance, and Management, 23(3), 157-214.

[14] Flax, C. (2018). Personal financial intelligence–AI and the future of money management. The WealthTech Book: The FinTech Handbook for Investors, Entrepreneurs and Finance Visionaries, 132-134. DOI: 10.1002/9781119444510.CH32

[15] G. Martín, A., Fernández-Isabel, A., Martín de Diego, I., & Beltrán, M. (2021). A survey for user behavior analysis based on machine learning techniques: current models and applications. Applied Intelligence, 51(8), 6029-6055.

[16] Hill, E. R., Mitchell, C., Brigden, T., & Hall, A. (2023). Ethical and legal considerations influencing human involvement in the implementation of artificial intelligence in a clinical pathway: A multi-stakeholder perspective. Frontiers in Digital Health, 5,1139210. DOI: 10.3389/fdgth.2023.1139210

[17] Lin, L., & Yu, S. (2023). The transformative impact of artificial intelligence on educational financial management. Accounting and Corporate Management, 5(12), 15-21. DOI:10.23977/acccm.2023.051203

[18] Mandala, G. N., Buddhi, D., Arumugam, M., Harbola, S., Othman, B., & Almashaqbeh, H. A. (2022). A critical review of applications of artificial intelligence (AI) and its powered technologies in the financial industry. In 2022 2nd International Conference on Advanced Computing and Innovative Technologies in Engineering (ICACITE) (pp. 2362-2365). IEEE. DOI: 10.1109/icacite53722.2022.9823776

[19] Maple, C., Szpruch, L., Epiphaniou, G., Staykova, K. S., Singh, S., Penwarden, W., Wen, Y., Wang, Z., Hariharan, J., & Avramović, P. (2023). The AI revolution: opportunities and challenges for the finance sector. arXiv. DOI: 10.48550/arXiv.2308.16538

[20] Mittal, A. (2019). A selective landscape of artificial intelligence in finance and banking. DOI:10.2139/ssrn.3604999

[21] Nai, R., Sulis, E., & Meo, R. (2022). Public procurement fraud detection and artificial intelligence techniques: a literature review. In Companion Proceedings of the 23rd International Conference on Knowledge Engineering and Knowledge Management (pp. 1-13). CEUR-WS.

[22] Odonkor, B., Kaggwa, S., Uwaoma, P. U., Hassan, A. O., & Farayola, O. A. (2024). The impact of AI on accounting practices: A review: Exploring how artificial intelligence is transforming traditional accounting methods and financial reporting. DOI:10.30574/wjarr.2024.21.1.2721

[23] Phulari, S. V, Lamture, U. S., Madage, S. V., & Bhandari, K. T. (2016). Pattern Analysis and Fraud Detection Using Hadoop Framework, 5(1), 92–100.

[24] Silva, B. V., Marques, J., Menezes, M. N., Oliveira, A. L., & Pinto, F. J. (2023). Artificial intelligence-based diagnosis of acute pulmonary embolism: Development of a machine learning model using 12-lead electrocardiogram. Revista Portuguesa de Cardiologia, 42(7), 643-651.

[25] Singla, A., & Jangir, H. (2020). A comparative approach to predictive analytics with machine learning for fraud detection of realtime financial data. In 2020 International Conference on Emerging Trends in Communication, Control and Computing (ICONC3) (pp. 1-4). IEEE.

[26] Sood, P., Sharma, C., Nijjer, S., & Sakhuja, S. (2023). Review the role of artificial intelligence in detecting and preventing financial fraud using natural language processing. International Journal of System Assurance Engineering and Management, 14(6), 2120-2135.

[27] Šubelj, L., Furlan, Š., & Bajec, M. (2011). An expert system for detecting automobile insurance fraud using social network analysis. Expert Systems with Applications, 38(1), 1039-1052.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Navigating the Contact Tracing Landscape:Strategies, Innovations, and Challenges

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ABSTRACT

Contact tracing plays a role, in controlling the spread of diseases by identifying and notifying individuals whomay have come into contact with a pathogen. Contact tracing has received attention and has evolved with theemergence of Corona in 2019. This process involves interviewing individuals who havetested positive to gather information about their interactions. The identified contacts are then guided on testing and self-isolation measures. This approach helps to interruptthe transmission chain, manage outbreaks effectively and safeguard health. Contact tracing, which is fundamental in disease control has seen changes due to pathogens and technological advancements. Successful contact tracing involves a strategy that combines methods with modern technologies and analytical tools. By improving these techniques public health authorities can limit the spread of diseases. Protect public well-being. However, addressing issues related to privacy, fairness, and technological constraints is crucial, for the implementation of contact tracing initiatives.

Keywords-Contact tracing, DBSCAN Clustering, Spread of Diseases, COVID 19

1. INTRODUCTION

Contact Tracing is an essential public health strategy for preventing the spread of infectious diseases such as COVID-19, Ebola, and TB. To prevent further transmission, it is necessary to identify the infected person and prevent them from spreading the disease. This process involves identifying, assessing, and managing individuals who have been exposed to a contagious disease. When a person identified as having a contagious disease public health professionals locate and alert anybody who may have had close contact with the infected person during contagious period. Close contacts are those who have had direct physical contact with the infected person for a significant amount of time. By quickly identifying and isolating cases, contact tracing helps manage infectious disease epidemics by halting furthertransmission. But in order for it to be effective, the community must coordinate, provide resources, and cooperate. Since contact tracing involves gathering and managing sensitive personal data, privacy issues and ethical considerations must also be taken into account. Global contacttracing initiatives are being carried out by a number of governmental and non- governmental organizations. In order to control epidemics and stop future transmission, these organisations collaborate to locate, track down, and manage contact of people who are afflicted with communicable illness. Contact tracing is indispensable for swiftly identifying and containing the spread of infectious diseases.

2. HISTORY OF CONTACT TRACING

The practice of contact tracing has a long history, dating back to the 19th century, when it became apparent that it was an essential instrument for preventing thespread of infectious diseases. Public health expert John Snow in order find the cause of outbreak of cholera in London in 1854 employed crude contact tracing techniques to trace the cause of the disease. At the time, cholera was a deadly and mysterious disease, causing widespread panic and claiming thousands of lives in densely populated urban areas like London. Dr. John Snow traced a contaminated water pump on Broad Street in London is the cause of cholera outbreak. He stopped the spread of the disease by mapping cases andremoving the handle of the pump. As a result, he invented contact tracing and epidemiology techniques that are still vital to our knowledge of and ability to control infectious diseases.

As public health infrastructure and monitoring techniques advanced over the 20th century, so did contact tracing. Global public health organisations developed methodical procedures to detect and track people exposed to infectious diseases like smallpox, syphilis, and tuberculosis. A major contribution to disease control effortswas made by trained contact tracers who conducted interviews, gathered data, andfollowed up with contacts to stop further transmission. Contact tracing has remained essential to the containment of infectious diseases in recent decades, especially during major outbreaks like SARS and Ebola. But the rise of extremely contagious illnesses like COVID-19 has highlightedthe need for more reliable and practicalcontact tracing methods. As a result, numerous nations have improved contact tracking capabilities by utilising digital technology and data analytics. Health authorities and the public may now identifycontacts quickly and communicate more efficiently thanks to mobile applications, wearable technology, and data-drivenalgorithms.

Contact tracing has gained attention due to the COVID-19 pandemic, which emphasises how crucial it is to control infectious diseases in a globalised society. Digital contact tracing tools present never- before-seen possibilities for monitoring andresponding in real time, but they also bring up ethical and privacy issues that need to be carefully considered. However, contact tracing's history shows that it remains relevant today as a key component of public health practice, adapting to new threats of infectious diseases while maintaining the basic principles of disease control and prevention.

The groundbreaking work of Dr John Snow laid the foundation for modern epidemiology and revolutionized our understanding of infectious disease transmission. Snow's implementation of contact tracing methods and spatial analysis to the London cholera outbreak investigation continues to be a landmark example of how data-driven methods may guide public health initiatives and save lives.

3. STRATEGIES FOR EFFECTIVE CONTACT TRACING

Effective contact tracing strategies take a multimodal approach to quickly detecting cases, tracking down their contacts, and preventing the spread of infectious diseases. Early diagnosis and rapid reaction is a crucial approach that entails promptly identifying persons afflicted with a communicable illness and tracking down their contacts to break the chain of transmission. Early detection lowers the chance of subsequent spread within communities by enabling immediate adoption of public health interventions, such as the isolation of individuals and the quarantine of contacts. In order to implement this strategy, robust surveillance technologies that can quickly identify and report cases are needed, in addition to skilled contact tracers that can quickly conduct interviews, obtain information, and alert contacts.

Another essential tactic for successful contact tracing is thorough training of tracers. In order to detect and alert people who might have been exposed to a dangerous disease, as well as to advise them on the appropriate safety measures and testing protocols, contact tracers are essential. To ensure accurate information gathering and successful communication with contacts, it is crucial to provide comprehensive training on interview tactics, data collection methodologies, and communication skills. In order to equip contact tracers with the knowledge necessary to perform their jobs efficiently, training programmers should also contain instruction on the particular disease being traced, its mode of transmission, and suggested control measures.

A key component of contact tracing initiatives that are successful is community engagement. Establishing confidence and promoting cooperation with communities can improve the efficiency of contact tracing by boosting compliance with quarantine regulations, promoting cooperation, and making contact identification easier. Involving local leaders, groups, and community health professionals can aid in the dissemination of factual information, dispel myths, and encourage adherence to public health guidelines. Furthermore, by including communities in the planning and execution of contact tracing initiatives, it is possible to guarantee that the methods used are appropriate for the given environment, culturally sensitive, and demographically responsive. The utilisation of digital tools and technologies has brought about a significant transformation in contact tracing endeavours, providing prospects for amplified efficacy, precision, and expandability. Digital platforms make it possible to collect data automatically, streamline contact notification procedures, and monitor cases and contacts in real time, all of which speed up response times and decision-making. Web-based platforms, mobile applications, and data analytics technologies can help to increase coordination among stakeholders, accelerate contact tracing operations, and offer insightful information for resource allocation and intervention planning. To preserve people's privacy and confidentiality, it is crucial to address security and privacy issues related to the use of digital technologies. To do this, strong data protection mechanisms must be put in place, and applicable laws must be followed.

Another tactic that can improve the success of contact tracing is targeted outreach, especially when it comes to contacting high-risk groups or places with poor access to medical treatment. Customized strategies, such outreach initiatives aimed at the community, mobile testing units, or collaborations with neighborhood groups, can assist in removing obstacles to access and guarantee that contact tracing initiatives cover all facets of society. Furthermore, effective communication techniques that are both linguistically and culturally sensitive can enhance cooperation and understanding among varied populations, advancing inclusivity and equity in contact tracing programmers.

Effective contact tracing necessitates coordination between multiple stakeholders, including government agencies, healthcare professionals, public health agencies, and community organizations. This involves interdisciplinary teamwork. Working together can make it easier to share information, mobilise resources, and create standardized procedures and policies for contact tracing. Interdisciplinary collaboration can increase response capabilities, strengthen contact tracing systems, and boost disease management outcomes by using the knowledge and assets of many sectors. Given the sensitive nature of the information shared and acquired during the process, data security and privacy are critical factors to take into account when tracing contacts. Ensuring the privacy, confidentiality, and security of people' data during the contact tracing process requires the implementation of strong standards and safeguards. This entails getting people's consent in writing before collecting their information, granting only authorised workers access to data, and making sure that all applicable data privacy laws and regulations are followed. The public's trust and confidence can be increased by transparency and accountability in data processing procedures, which will promote collaboration and participation in contact tracing efforts.

Optimising contact tracing tactics and taking advantage of new possibilities and challenges require constant review and adjustment. Decision-making can be aided by the regular evaluation of contact tracing performance, which includes indicators like timeliness, completeness, and efficacy. Stakeholder input, which includes opinions from contact tracers, medical professionals, and members of the community, can offer insightful opinions about the advantages and disadvantages of contact tracing initiatives, helping to improve and modify current strategies. As technology advances, community needs change, and epidemiological patterns shift, contact tracing initiatives must be flexible and adaptable to stay relevant and effective in these ever-changing situations.

To summarise, the implementation of successful contact tracing tactics necessitates a diverse strategy that incorporates technical advancements, community involvement, and cooperation between public health organisations and interested parties.

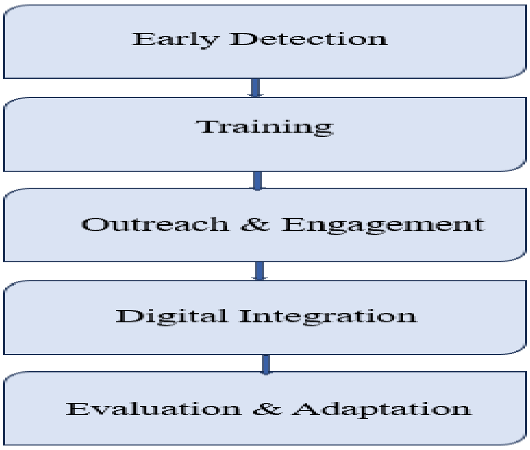

Figure 1. Contact Tracing Implementation

The efficiency and precision of contact tracing operations can be improved by making use of data-driven techniques, quick reaction teams, and scalable platforms. However, in order to guarantee fair and long-lasting results, issues like privacy concerns, resource constraints, and disparities in access must be addressed. Contact tracing may continue to be an essential component of the fight against infectious diseases and help build stronger, healthier communities all over the world by making constant adjustments to strategies in response to new information and lessons learned.

4. INNOVATIONS IN CONTACT TRACING TECHNOLOGIES

It has long been known that tracing contactsis essential for preventing the spread of infectious diseases. With the introduction of digital technologies, contact tracing has undergone a substantial evolution from its traditional methods of manual interviews and epidemiological studies. This study examines the novel technologies that are revolutionising contact tracing, as well as the possible advantages, difficulties, andpublic health ramifications of these technologies.

4.1.Mobile Contact Tracing Apps

Particularly during the COVID-19 epidemic, mobile contact tracing applications have become a widely used tool in the battle against infectious diseases. These applications employ Bluetooth technology to identify and document user proximity. Notifications are sent to those who have been in close touch with the infected person after they test positive for a contagious disease, urging them to take the appropriate precautions, such testing or self-isolation. Aarogya Setu (India), Corona-Warn-App (Germany), and COVID Alert (Canada) are a few examples.

4.2.Wearable Devices

Fitness trackers and smart watches are examples of wearable technology thatprovides an additional means of locating contacts. Real-time tracking of the users' movements and interactions by these devices yields useful information for identifying possible exposures. Certain wearable's have functions that improve on conventional contact tracing efforts andallow for more proactive responses to outbreaks such as system monitoring and and warnings for contact tracing.

4.3.QR Code Check-ins:

Systems for scanning QR codes to check in have become commonplace in a variety of places, such as eateries, shops and public transit. Businesses and authorities are able to monitor and trace possible exposures thanks to users scanning QR codes upon admission. By streamlining contact tracing procedures, this method reduces the spread of infectious diseases and allows for the quicker identification of people who are at-risk.

4.4.Automated Contact Tracing Algorithms:

Automated contact tracing technologies leverage data analytics and machine learning to better find possible contacts by analysing big datasets. These algorithms can calculate the probability of transmission by evaluating variables like distance, time, and surroundings. Machine learning algorithms such as DBSCAN are very useful in contact tracing. Public health organisations can improve resource allocation and response times, which will result in more efficient disease control, by automating some contact tracing tasks. Theresults provided by the algorithms can be converted into dashboards.

4.5.Integration with Heath Records

Healthcare providers and public health authorities can work together more easily and share data more easily when contact tracing tools are integrated with electronic health records (EHRs). With the inclusion of test results, immunisation history, and medical history, this integration enables more thorough contact tracing attempts. It is possible to improve the efficiency and coordination of contact tracing initiatives by utilising the current health infrastructure.\

5. Challenges and Ethical Considerations

Innovative contact tracing technologieshave great promise, but there are a number of issues and factors to take into account. Sensitive personal data collection and storage raises privacy issues, so in order to preserve user confidence and compliance, strong privacy safeguards and data protection procedures are required.

5.1.Privacy Concerns

Overcoming privacy issues related to gathering and retaining sensitive personal data is one of the main obstacles in contact tracing. Conventional contact tracing techniques entail conducting manual interviews and gathering data, which may give rise to worries over the privacy and security of personal data. As the data includes live locations it may put the user in danger posing threats like stalking, robbing etc. To avoid such issues such data should be handled only by the concerned authorities. The emergence of digital contact tracing technology, like wearables and mobile apps, has raised questions aboutdata privacy and monitoring. Implementing strong data protection mechanisms, anonymizing data whenever feasible, and guaranteeing transparency in data collection and usage are some strategies to address these concerns.

5.2.Equity and Accessibility

Ensuring equity and accessibility for all people, regardless of socioeconomic background or technology literacy, is a fundamental difficulty in contact tracing. Contact tracing initiatives that rely exclusively on digital tools may disproportionately impact vulnerable people, such as those without access to cell phones or internet connectivity. Adopting inclusive tactics that cater to a range of needs and offer alternate access points, like hotline services or community outreach initiatives, is crucial to addressing thesegaps.

5.3.Trust and Compliance

Establishing credibility and encouraging adherence are essential components of effective contact tracing campaigns. The public's adoption of contact tracing methods is largely dependent on their level of trust in governmental organisations, medical professionals, and technological companies. But false information, doubt, and worries about data abuse can erode confidence and make contact tracking more difficult to comply with. Clear communication, openness about data usage and privacy protections, and community involvement programmes to allay fears and boost trust in contact tracing procedures are some tactics to promote compliance and trust.

5.4.Stigmatization and Discrimination

Contact tracing initiatives could unintentionally fuel stigmatisation and discrimination, especially if people's privateinformation is revealed without their knowledge or if some populations are disproportionately the focus of surveillance. The efficacy of contact tracing initiatives may be compromised by stigmatisation, which might deter people from obtaining testing or sharing their connections. It is crucial to have non-discriminatory practices in place, safeguard people's privacy, and give impacted communities assistance and resources in order to reduce these hazards.

5.5.Technical Limitations

Contact tracing initiatives are severely hampered by technical constraints, especially in places with inadequate infrastructure or resources. The success of contact tracing programmes might be hampered by problems like imprecise proximity detection, incompatibility between various contact tracing systems,and challenges integrating data from various sources. It is crucial to make investments in a strong technical infrastructure, create standardized standards for data exchange and interoperability, and give contact tracing teams assistance and training in order to overcome these obstacles.

5.6.Ethical Considerations

When it comes to contact tracing, ethical issues play a crucial role in directing choices regarding the gathering, using, and sharing of data. Respect for each person's autonomy, beneficence (doing good), non- maleficence (avoiding harm), and justiceare important ethical precepts. Ensuring that contact tracing procedures are proportionate, transparent, and responsible requires striking a balance between the advantages of contact tracing and thedefence of people's civil liberties andprivacy.

6. Case Studies and Best Practices

Best practices and case studies give insightful information on effective contact tracing initiatives as well as direction for overcoming obstacles in the field. The 2014 Ebola outbreak response in West Africa is one noteworthy case study. Contact tracingwas crucial in halting the spread of the virusduring the Ebola outbreak, especially in themost impacted nations—Guinea, Liberia, and Sierra Leone. There were many obstacles in the way of the outbreak response, including as a deficient healthcare infrastructure, mistrust in the community, and a shortage of funding. Notwithstandingthese obstacles, successful contact tracing initiatives made a substantial contribution to the epidemic's containment. Contact tracing was essential in stopping the virus's spread and preventing more transmission during this crisis. A comprehensive study of contacts, prompt identification of patients, and focused quarantine measures were all part of an effective contact tracing strategy. Key elements of the approach included community participation and cooperation with local stakeholders, which promoted

cooperation and helped to establish confidence.

Amidst the COVID-19 pandemic, some nations have executed inventive contact tracing campaigns, albeit with differing degrees of efficacy. Best practices are frequently referenced, with examples including South Korea's intensive contact tracing and testing strategy and Singapore's TraceTogether app. By utilising digital technologies, thorough testing, and meticulous contact tracing, these initiatives expeditiously detect and isolate cases, thereby disrupting transmission chains.

7. FUTURE DIRECTION AND OPPORTUNITIES

7.1.Integration of Digital Technologies

The incorporation of digital technologies has auspicious prospects for optimising and augmenting contact tracing endeavours. Wearable technology, mobile apps, and QR code check-in systems have shown to be useful tools for streamlining contact tracing procedures, enhancing data quality, and enabling in-the-moment exposure monitoring. In the future, contact tracing data may be analysed using artificial intelligence and machine learning algorithms to spot patterns or trends that canguide resource allocation and focused actions.

7.2.Expansion of Surveillance Networks

Expanding surveillance networks can improve outbreak reaction times and early diagnosis of infectious diseases. Through the utilization of pre-existing surveillance tools, such syndromic monitoring and electronic health records, public health organizations can more efficiently identify case clusters and possible hotspots. Furthermore, the use of genome sequencing technology can offer important insights into the dynamics of disease transmission, enabling more accurate and focused contact tracing initiatives. In the future, contact tracing has the potential to significantly transform efforts to manage disease and lessen the effects of infectious disease epidemics. We can fully utilise contact tracing to safeguard public health and save lives worldwide by embracing digital technologies, growing surveillance networks, promoting international collaboration, empowering communities, addressing ethical issues, encouraging research and innovation, and bolstering preparedness and resilience.

8. CONCLUSION

In conclusion, a thorough grasp of the tactics, advancements, and difficulties present in this vital public health activity is necessary to successfully navigate the contact tracing terrain. Rapid case identification, in-depth contact tracing, and reliable data management are all necessary for effective contact tracing; these factors are bolstered by cutting-edge technology and community involvement. However, in order to guarantee the moral and just application of contact tracing initiatives, obstacles like privacy worries, equity issues, and technological limits must be overcome. We can more skilfully navigate the contact tracing landscape by adopting best practices, responsibly utilising technological advancements, and placing a high value on transparency and collaboration. Predicting the probability of another disease outbreak like COVID-19 ischallenging but taking into consideration of various factors, including zoonotic diseases,global travel and trade, urbanization and population density, antimicrobial resistance, climate change and environmental factors it is inevitable for another such outbreak to take place as the probability has always increases which canbe seen from past experience. So it is necessary to be prepared for any furtheroutbreak. Contact tracing will help to control infectious diseases and protectpublic health globally.

REFERENCES

[1] Kucharski, A. J., Klepac, P., Conlan, A. J., Kissler, S. M., Tang, M. L., Fry, H., ... & Russell, T. W. (2020). Contact Tracing for COVID-19: Current Evidence, Practical Considerations & Research Priorities. BMJ Global Health, 5(9), e002309.

[2] Salathé, M., Althaus, C. L., Neher, R., Stringhini, S., Hodcroft, E., Fellay, J., ... & Lasserre, J. A. (2020). Digital Contact Tracing: Panacea or Pandemonium? The Lancet Public Health, 5(8), e447-e448.

[3] Ferretti, L., Wymant, C., Kendall, M., Zhao, L., Nurtay, A., Abeler-Dörner, L., ... & Fraser, C. (2020). Ethical Considerations for Contact Tracing Technologies in Public Health Surveillance: A Narrative Review. The Lancet Digital Health, 2(8), e425-e434.

[4] Altmann, S., Milsom, L., Zillessen, H., Blasone, R., Gerdon, F., Bach, R., ... &Krause, G. (2020). Innovations in Digital Contact Tracing for COVID-19: A Rapid Review. BMJ Open, 10(9), e042522.

[5] Choi, S., Han, C., Lee, J., & Kim, S. I. (2020). Contact Tracing During Coronavirus Disease Outbreak, South Korea, 2020. Emerging Infectious Diseases,26(10), 2465-2468.

[6] Gostin, L. O., & Wiley, L. F. (2020). Community-Based Health Interventions: Best Practices in Contact Tracing. Journal of the American Medical Association, 323(19), 1895-1896.

[7] Morley, J., Cowls, J., Taddeo, M., & Floridi, L. (2020). The Role of Public Health Ethics in COVID-19 Contact Tracing Apps. Nature Medicine, 26(8), 1167-1170.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Challenges and Opportunities in Human Resource Management: Navigating Global Trends for Competitive Advantage

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ABSTRACT

In today's dynamic business environment, human resource management (HRM) plays a pivotal role in ensuring organizational success and maintaining a competitive edge. This article delves into the complexities of HRM, exploring global trends, methods, challenges, and opportunities in the field. However, these challenges also present opportunities for HR to leverage technology, embrace diversity and inclusion, develop agile learning structures, and cultivate a strong employer brand. By strategically navigating these trends, HR can attract, retaining, and developing top talent, ultimately leading to a sustainable competitive advantage for organizations. By navigating these dynamics effectively, organizations can leverage HRM practices to gain a competitive advantage in the ever-evolving business environment.

Keywords: ***Business Environment, Challenges, Opportunities, Technology, Strategy***

1. INTRODUCTION

Human Resource Management plays a pivotal role in shaping organizational success by effectively managing the workforce and aligning human capital strategies with business objectives. In today's dynamic and interconnected world, HRM faces unprecedented challenges and opportunities arising from global trends such as technological advancements, demographic shifts, and changing employee expectations. This article examines the key global trends impacting HRM and explores strategies for navigating these trends to achieve competitive advantage. Human resource management is a critical function within organizations, responsible for attracting, developing, and retaining talent, as well as fostering a positive work culture and ensuring compliance with legal and ethical standards. With globalization breaking down geographical barriers and technological advancements reshaping the way we work, HRM practices are evolving to meet the demands of an increasingly interconnected world.

The Human resource sector has undergone significant innovative changes in the past few years. Technological advancement and the way of working have collaborated to shape the world of human resource in many organizations. Managers and HR professionals should be aware of the Current Trends in Human Resource Management and adapt them quickly to ensure the company is at the forefront of innovation. As a result, it helps a business to be in line with upcoming changes and embrace the new technology quickly.

In recent years, the landscape of human resource management (HRM) has undergone significant transformation due to globalization, technological advancements, demographic shifts, and changing workplace dynamics. As organizations strive to remain competitive in this rapidly evolving environment, HRM professionals are facing a myriad of challenges and opportunities.

1.1. Statement of the Problem:

While Human Resource Management is essential for organizational success, it also faces numerous challenges in the face of evolving global trends. Issues such as talent shortages, skills gaps, technological disruptions, demographic changes, and cultural diversity present significant hurdles for HRM professionals. This study seeks to address these challenges and identify opportunities for organizations to enhance their HRM practices and gain a competitive edge in the global marketplace.

1.2. Objectives of the Study

1. To analyze global trends shaping the field of Human Resource Management.
2. To explore methods and approaches used in HRM to address challenges and leverage opportunities.
3. To assess the scope of HRM practices in optimizing organizational performance and competitiveness.
4. To identify the key challenges faced by HRM professionals in the current global landscape.
5. To highlight opportunities for innovation and growth within the realm of HRM.

1.3. Scope of the Study

This study focuses on the challenges and opportunities in Human Resource Management within the context of global trends. It encompasses various aspects of HRM, including talent acquisition, retention, training and development, diversity and inclusion, employee engagement, and strategic workforce planning. Additionally, the study examines how HRM practices differ across industries and regions, highlighting best practices for achieving competitive advantage.

2. GLOBAL TRENDS IN HRM

1. Technological Advancements: The integration of technology in HRM processes, such as automation, artificial intelligence, and data analytics, is reshaping traditional HR practices and enhancing efficiency and decision-making.

2. Demographic Shifts: Aging populations, generational diversity, and workforce globalization are influencing talent acquisition strategies, succession planning, and employee engagement initiatives.
3. Remote Work and Flexible Arrangements: The rise of remote work and flexible work arrangements necessitates new approaches to performance management, communication, and collaboration.
4. Skills Shortages and Talent Mobility: The war for talent intensifies as organizations compete for skilled professionals amidst talent shortages and increasing demand for specialized skills.
5. Diversity, Equity, and Inclusion (DEI): Embracing diversity, equity, and inclusion in the workplace is not only a moral imperative but also a strategic advantage for organizations aiming to foster innovation, creativity, and employee engagement.
6. Gig Economy and Contingent Workforce: The prevalence of gig workers and contingent workforce models requires HRM to adapt policies and practices to effectively manage non-traditional employment relationships.

3. METHODS

- **Emphasis on Employee Experience:**

In today's digital age, organizations are placing greater emphasis on enhancing the employee experience to attract, engage, and retain top talent. This involves creating a conducive work environment, offering opportunities for growth and development, and prioritizing employee well-being and work-life balance.

- **Adoption of HR Analytics:**

The proliferation of data analytics tools has revolutionized HRM practices, enabling organizations to make data-driven decisions regarding recruitment, performance management, training, and retention. HR analytics helps in identifying trends, predicting future workforce needs, and optimizing HR processes for greater efficiency and effectiveness.

- **Remote Work and Virtual Collaboration:**

The COVID-19 pandemic accelerated the adoption of remote work and virtual collaboration, challenging traditional notions of workplace dynamics. HRM professionals are tasked with managing geographically dispersed teams, ensuring effective communication, and fostering a sense of belonging and cohesion among remote workers.

- **Diversity, Equity, and Inclusion (DEI) Initiatives:**

Organizations are increasingly recognizing the importance of diversity, equity, and inclusion in fostering innovation, creativity, and organizational performance. HRM plays a pivotal role in implementing DEI initiatives, promoting a culture of belonging, and addressing systemic barriers to inclusion.

- **Agile HRM Practices:**

Agile methodologies, originally developed in the field of software development, are being applied to HRM practices to enhance flexibility, responsiveness, and adaptability. Agile HRM involves iterative processes, cross-functional collaboration, and a focus on delivering value to both internal and external stakeholders.

- **Work and Wellness**

As the trend shifted to employee-centric strategies, the personal well-being of employees caught the limelight. According to Gartner's 2020 Re imagine HR Employee Survey, there is a 23% increase in the number of employees reporting better mental health when employers develop deeper relationships. Also, employers who provided holistic support witnessed a 21% increase in productivity, high performers. Thus, building deeper connections eventually leads to increased employee satisfaction and productivity. The HR professionals need to motivate employers towards the same as the focus on mental health and its connection with productivity is apparent.

- **Administering Progressive Benefits**

The idea of a job rings a different bell in today's young minds. They seek an open work culture with accommodating mentors, opportunities to innovate, flexible working hours, etc. They also expect progressive benefits such as more family time, the option to choose remote working, extended vacation time, paternity leaves, etc. Inclusion of progressive work culture has become a necessity, and the focus must lie on integrating it in a way that is beneficial to both the employer and the employees.

- **Empowering Employees**

Employees are no longer liabilities, but resources that employers can invest time and money in. This "employee is an asset" mindset must be adhered to, by companies to seek the full potential of the talent pool. The HR teams must look into empowering them with skills that improve career development. Professional courses and approaches to updating their technical knowledge add value to the individual and empower them to face future challenges.

- **Globalized Talent Pool**

Another global HR strategy that became trending in 2021 is the globalization of talent acquisition. Previously, the geographic location and consent to relocate was an essential aspect of hiring. This took a major step back during remote working. Globalization enabled cross-border recruitments to unfold a vast array of talent pools to choose from. After all, hiring the top talents has always been HR's top priority.

- **Diversity**

Globalization of the talent pool enabled diversity. A wider array of people can be included irrespective of their country, race, or language.

- **Inclusion**

Another major trend in global HR is the inclusion of contractors or part-time employees. The previous annotation of preferring only full-time employees was erased due to remote working and globalization. However, care must be taken to manage distinct policies and maintain separate contracts and other norms for both types of employees.

- **Cross Border Compliance**

The inclusion of global teams is easier said than done. There are several local laws and compliances in place that differ from one country to the other. We must be well aware of and abide by them to set up a functioning team. The entire process can be streamlined and managed with EOR (Employer Of Record) tools such as Multiplier.

- **People Analytics**

Data is the new oil, an untapped valuable asset. The practice of transforming the HR data into actionable insights unleashes the potential to take more strategic and informed decisions.

- **AI in HR**

The next global HR trend is the use of AI in HR. With AI being integrated into our everyday tasks, this comes as no surprise. AI-driven process and decision automation speed up the HR tasks while improving the quality. Optimization of the human-automation combination is bound to transform the future of the HR domain.

- **Cloud-based HR Tools**

HR tools have made life easier in the remote world, for both employers and employees. The use of PEO (Professional Employer Organization) tools for the virtual on boarding of new employees has served companies to a greater extent, especially during global hiring. They declutter the entire process thereby, simplifying it.

4. LATEST HR MANAGEMENT TRENDS

- **Shift to employee's experience**

Due to a change in technology, most businesses are shifting from employee's engagement to employees experiences. This is done through an easy implementation of HR process, improving employee's careers, and a productive office atmosphere.

- **Data security**

Human resource automation allows you to use software that can back-up important data to cloud services thus protecting critical company data. It also reduces errors that may occur during manual processes. These are the Current Trends in Human Resource Management.

- **Mobile Access**

This is where employees across all divisions and sectors access different applications via mobile app. HR applications in a given company can now be accessed through the mobile thus making work easier.

- **HR innovations**

A new pace is being set based on, for example, new learning methods, new methods to reduce biases, innovative recruit approaches, training, and advanced performance management.

- **Migration to Cloud**

A Cloud-based HR is being embraced by most business today because it is making work easier and one can perform HR functions wherever they want at anytime.

- **Rise of Intelligent Self – service tools**

The existence of intelligent self –service tools has helped the HR department to conduct time-tracking, training, and reporting easily.

- **Intelligent Apps and Analytics**

HR applications are changing the nature and structure of the work-place. Similarly, they are enabling work- performance analysis, tracking and assessments, internal management, and attracting talents and enterprise management for improved better decision making.

5. CHALLENGES AND OPPORTUNITIES

1. Talent Acquisition and Retention: Competition for skilled talent poses challenges for recruitment, while effective retention strategies can drive employee engagement and reduce turnover costs.
2. Skills Development and Training: Bridging skills gaps and fostering a culture of continuous learning are critical for maintaining a competitive workforce.
3. Technology Integration: Adopting and leveraging HR technologies requires investment, training, and change management to realize their full potential.
4. Diversity and Inclusion: Overcoming biases, promoting inclusivity, and creating a diverse workforce can lead to innovation and better decision-making.
5. Remote Work Challenges: Managing remote teams effectively, maintaining communication and collaboration, and addressing work-life balance issues are key challenges in remote work environments.
6. Data Privacy and Security: Ensuring compliance with data protection regulations and safeguarding employee data privacy are essential considerations in HRM practices.

5.1. Changes required overcoming the challenges and opportunities

Achieving competitive success through people requires a fundamental change in how managers think about their employees and how they view the working relationship.
Employment Security
Employment security is a critical element of a high-performance work arrangement. The security of employment signals a longstanding commitment to its workforce. Employees will develop new ideas when their jobs are secured because they know that introducing the new system will not affect their employment stability. They will welcome the change.

- **Selective Recruiting**

Organizations serious about making a profit through people will expend the efforts needed to recruit the right people in the first place.

- **High and Lucrative Wages**

An organization can attract and retain qualified candidates if it pays a high and lucrative pay package. Higher wages tend to attract more outstanding applicants, permitting the organization to be more selective in finding people who will be committed to the organization.

- **Incentive Pay**

The pay system should be based on the performance or productivity of employees. Paying for skills acquisition encourages people to learn different jobs and become more flexible. There is a tendency to overuse money to solve organizational problems.

- **Employee Ownership**

Organizations should make an employee a mini-employer. A stock ownership plan can do this. This may increase their sense of ownership.

Employee ownership reduces conflict between labor and capital. Employee ownership puts stock in the hands of people.

- **Employee Empowerment and Participation**

Empowerment indicates many things to many experts. It refers to mutual influence, creative power distribution, and shared responsibility. It is a democratic and long-lasting process. Participation increases both satisfaction and employee productivity. Managers should encourage the decentralization of decision-making.

- **Information Sharing**

To be a source of competitive advantage, people must have the information necessary to do what is required to be successful. Information sharing is an essential element of high-performance work systems. The sharing of information on issues like budget, strategy, and financial performance conveys to an organization's people that they are trusted.

- **Training and Development of Skills**

Training is an essential component of high-performance works systems because these systems rely on front-line employees' skill and initiative to identify and resolve problems, initiate change in work methods, and take responsibility for quality.

- **Treat People with Respect and Dignity**

Dignity is a term used in moral, ethical, legal, and political discussions to signify that human being has an innate right to be valued and receive ethical treatment.

- **Wage Compression**

Pay differential among the levels of management should be lower. Wage compression between senior managers and employees will reduce status differences and develop a sense of common fate.

- **Promotion from Within**

It is of vital importance to encourage employee promotion from within the organization. This practice may boost employee morale. It encourages training and skill development because the availability of promotion opportunities within the firm binds workers to employers and vice versa.

6. CONCLUSION

Navigating global trends in Human Resource Management presents both challenges and opportunities for organizations seeking to gain a competitive advantage. By embracing technological advancements, fostering diversity and inclusion, and prioritizing employee development and well-being, organizations can optimize their HRM practices to attract, retain, and engage top talent. Strategic alignment between HRM initiatives and business objectives is paramount for achieving sustainable growth and success in the dynamic global marketplace.

REFERENCES

[1] https://www.usemultiplier.com/blog/global-trends-in-human-resource-management
[2] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4514970
[3] https://www.zimyo.com/resources/insights/trends-in-human-resource-management/
[4] https://www.myworkpay.com/blogs/current-trends-in-human-resource-management#:~:text=Some%20of%20the%20Current%20Trends,self%2Dservice%20tools%20and%20applications.
[5] https://www.iedunote.com/competitive-advantage-human-resource-management

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Heat Transfer Analysis of Fin Materials

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ABSTRACT

This paper presents a comprehensive analysis of heat transfer characteristics for 19 different materials used as in thermal applications. The study utilizes a MATLAB-based computational model to investigate temperature distribution, heat transfer rates, and fin efficiency profiles along the length of the fin for each material. The research aims to assess the suitability of these materials for various engineering applications by evaluating their heat transfer performance.

Keywords:Fin Efficiency, Heat Transfer Rate, Thermal Conductivity, Heat Transfer Analysis, Thermal Performance, Electronics Cooling, Heat Sink.

1. INTRODUCTION

Fins are essential components in heat exchangers, radiators, and cooling systems, designed to enhance heat transfer between solid surfaces and surrounding fluids. The choice of fin material significantly influences the overall efficiency of heat transfer in such systems. This paper systematically analyses the heat transfer performance of different materials used as fins, providing valuable insights for engineers and researchers seeking to optimize heat transfer in practical applications.

Heat transfer analysis of fin materials is a crucial area of research with applications spanning various industries, including thermal management systems, aerospace engineering, electronics cooling, and renewable energy systems. Common types of fins include rectangular, square, annular, cylindrical, and tapered fins. These fins are experimented with different geometrical combinations to achieve optimized heat transfer performance. Optimization can focus on either maximizing heat dissipation for a specific fin weight or minimizing the weight of the fin while maintaining effective heat dissipation. AmbarishMaji et al., provides a concise review of the heat transfer enhancement achieved through various types of fins, taking into account factors like thermophysical properties and geometric parameters. This information can be valuable for designing heat exchangers in the future, considering factors such as cost and space availability [1]. Various methods can be used to enhance heat transfer, these methods can be categorized as either active or passive, depending on whether they require external power to sustain the enhancement mechanism [2]. The wetted surface area, which influences heat transfer, can be increased to improve heat transfer rates. Additionally, optimizing the shape of extended surfaces can enhance thermal interaction between the surface and the fluid[6]. Combined use of nanofluids and extended surfaces to enhance heat transfer in modern machinery, an area receiving increased attention due to the demand for effective and efficient devices. Key factors like surfactants, nanoparticle volume concentration, and Reynolds number significantly influence heat transfer enhancement. There's a trend indicating that increasing nanoparticle volume concentration enhances heat transfer, but beyond an optimal concentration, viscosity and density effects can reduce Brownian motion, hindering heat transfer [3]. There is a great potential of convective–radiative porous heat sinks with FGM (functionally graded material) to effectively manage thermal issues in consumer electronics [4,5]. Maji et al, study the influence of perforated pin fin geometry on heat transfer and pressure drop in heat sinks. It offers valuable insights for optimizing heat sink designs to achieve maximum heat dissipation efficiency while minimizing energy losses. The study investigates the heat transfer enhancement of a heat sink using perforated pin fins arranged in linear and staggered configurations. Various pin fin shapes with different perforation geometries, including circular, diamond-shaped, and elliptical types, are analyzed. Three-dimensional Computational Fluid Dynamics (CFD) simulations are conducted to explore the effects of the number and shape of fins, as well as the geometry and dimensions of the perforations, for both arrangements. [7]

2. MATHEMATICAL MODEL

2.1. Important Parameters

The foundation of this analysis is a mathematical model that considers several critical parameters:

Table.1.Important Parameters

Parameter	Description
Cross-sectional area of the fin (A)	Determines the fin's geometrical characteristics.
Perimeter of the fin (P)	Influences the fin's efficiency in dissipating heat.
Length of the fin (L)	Affects the overall heat transfer area.
Base temperature (Tb)	Initial temperature at the fin's base.
Ambient temperature (Tinf)	Temperature of the surrounding fluid or environment.
Convective heat transfer coefficient (h)	Reflects the effectiveness of heat transfer.
Number of nodes (n)	Determines the level of discretization for modelling.
Thermal Conductivity (k)	W/m•K indicates its ability to conduct heat

2.2. Data

The study utilizes two sets of data: thermal conductivities (k) for different materials and their corresponding names.

Table.2.Thermal Conductivities (K) For Different Materials

S.no.	Material	Thermal Conductivity (k) (W/mK)
1.	Air. [8]	**0.024**
2.	Aluminium. [8]	**205.0**
3.	Brass. [8]	**109.0**
4.	Copper. [8]	**385.0**
5.	Gold. [8]	**310**
6.	Polyethylene HD. [8]	**0.5**
7.	Silver. [8]	**406.0**
8.	Steel. [8]	**50.2**
9.	Silicon carbide[9]	**270**
10.	Zinc[9]	**116**
11.	Graphite[9]	**168**
12.	Carbon Steel[10]	**45**
13.	Nickel[11]	**60.7**
14.	Beryllium[12]	**216**
15.	Tungsten[13]	**164**
16.	Mg–2Zn–Zr[14]	**132.1**
17.	Mg–0.1Mn[14]	**143.2**
18.	Aluminum 6061-T6[15]	**167**
19.	Aluminum 7075-T6[16]	**130**
20.	**Aluminum 6063[17]**	**218**

2.3. ANALYSIS

For each material, the analysis is carried out in a step-by-step manner.

2.3.1. Calculation of Fin Efficiency (η)

The fin efficiency is calculated using the formula:

$$\eta = tanh(\sqrt{\frac{hP}{kA}}L)/(\sqrt{\frac{hP}{kA}}L) \qquad \text{(i)}$$

- η is the fin efficiency.
- tanh represents the hyperbolic tangent function.
- h is the convective heat transfer coefficient (W/m²K).
- P is the perimeter of the fin (m).
- k is the thermal conductivity of the fin material (W/mK).
- A is the cross-sectional area of the fin (m²).
- L is the length of the fin (m).

2.3.2. Determination of Temperature Distribution (T)

The temperature distribution along the fin is computed using a mathematical model for heat conduction. The temperature distribution (T) along the fin is a critical aspect of understanding how heat is conducted and dissipated within the fin material. This distribution reveals how the temperature varies with position along the length of the fin, providing insight into the thermal behaviour of the fin.The mathematical model employed to determine the temperature distribution is based on heat conduction principles. It allows us to calculate the temperature at any point x along the fin's length (L). The formula for this temperature distribution is as follows:

$$T(x) = Tb + (Tinf - Tb)\frac{cosh(m(L-x))}{cosh(mL)} \qquad \text{(ii)}$$

- T(x) is the temperature at position x along the fin (°C).
- Tb is the base temperature of the fin (°C).
- Tinf is the ambient temperature or temperature of the surrounding fluid (°C).
- cosh represents the hyperbolic cosine function.
- m is the fin parameter,
- L is the length of the fin (m).

2.3.3. Computation of Heat Transfer Rate (Q)

The heat transfer rate (Q) is a fundamental parameter in heat transfer analysis, quantifying the rate at which heat is transferred between the fin and its surrounding environment.

The calculation of Q at the base of the fin involves the following formula:

$$Q = -kA\frac{T1 - Tinf}{\Delta x} \qquad \text{(iii)}$$

- Q is the heat transfer rate at the base of the fin (W).
- k is the thermal conductivity of the fin material (W/mK).
- A is the cross-sectional area of the fin (m^2).
- T1 is the temperature at the base of the fin (°C).
- Tinf is the ambient temperature or temperature of the surrounding fluid (°C).
- Δx is the length step between nodes, typically representing a small section of the fin's length (m).

2.3.4. Generation of Fin Efficiency (η profile)

Profiles of fin efficiency along the length of the fin are generated. These profiles provide detailed insights into how these parameters vary across the fin's surface. To gain a deeper understanding of the heat transfer characteristics of each material along the length of the fin, profiles of fin efficiency (ηprofile) is generated. These profiles offer a detailed view of how these crucial parameters vary across the surface of the fin, providing valuable insights for optimizing heat transfer in practical engineering applications.The fin efficiency profile (ηprofile) is a measure of how effectively the fin dissipates heat at different positions along its length. It quantifies variations in the fin's ability to transfer heat as one moves from the base to the tip of the fin. The profile is calculated using the formula:

$$\boldsymbol{\eta}\mathbf{profile} = \frac{\boldsymbol{tanh}(\boldsymbol{m}(\boldsymbol{L}-\boldsymbol{x}))}{\boldsymbol{m}(\boldsymbol{L}-\boldsymbol{x})} \qquad \text{(iv)}$$

- ηprofile is the fin efficiency at a specific position x along the fin.
- m is the fin parameter, calculated as $\sqrt{\frac{hP}{kA}}$
- L is the length of the fin.

The fin efficiency profile provides critical information on how effectively heat is transferred at different points along the fin's surface.

3. RESULTS

The analysis of 19 different materials along with air provides valuable insights into their heat transfer characteristics. Results are presented graphically for each material, showing temperature distribution and fin efficiency profile (Figure.1 to 20) along the fin.

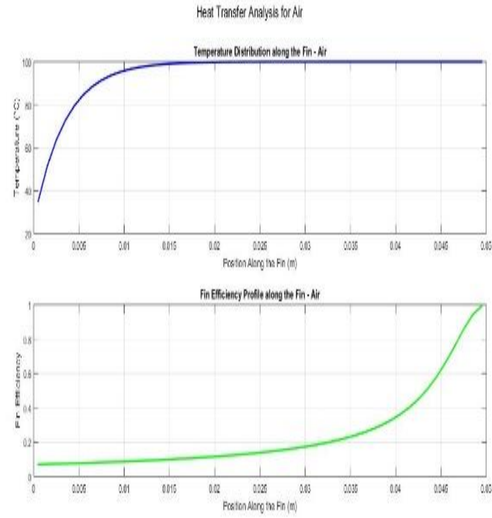

Figure.1.Heat Transfer analysis of air

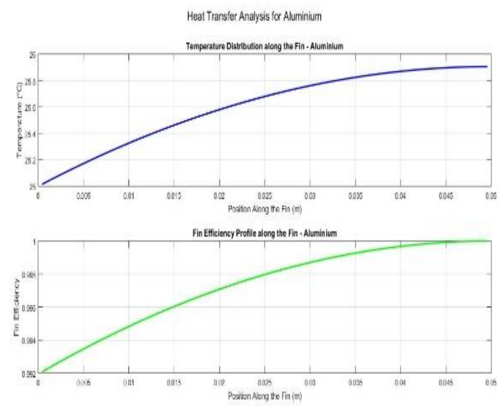

Figure.2.Heat Transfer analysis of Aluminum

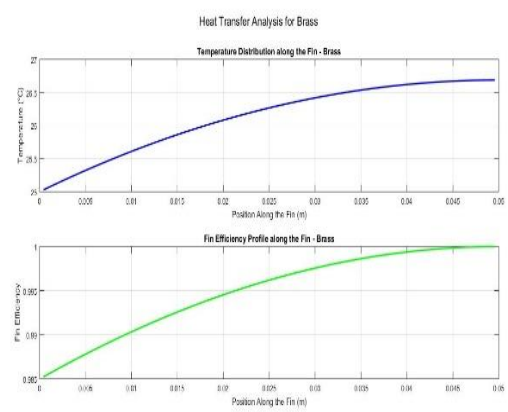

Figure.3.Heat Transfer analysis of Brass

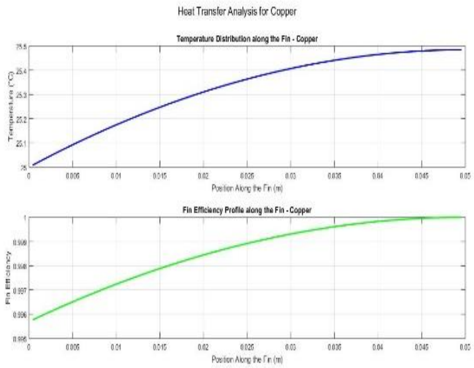

Figure.4.Heat Transfer **analysis of Copper**

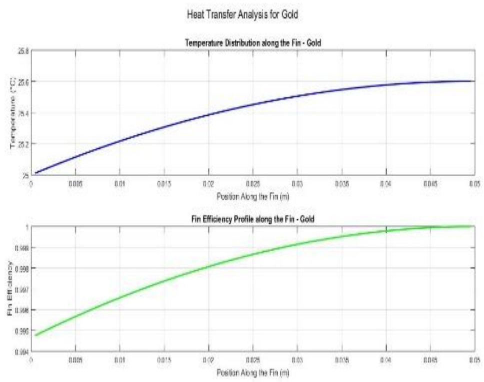

Figure.5.Heat Transfer analysis of Gold

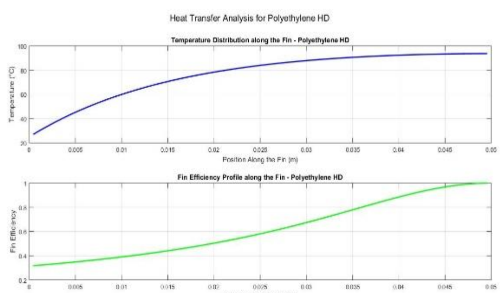

Figure.6.Heat Transfer analysis of Polyethylene HD

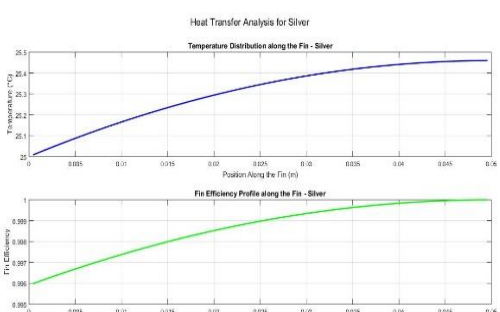

Figure.7..Heat Transfer analysis of Silver

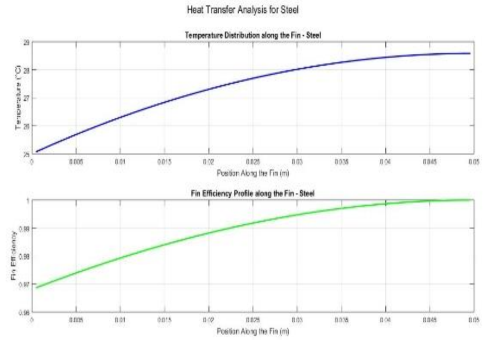

Figure.8.Heat Transfer analysis of Steel

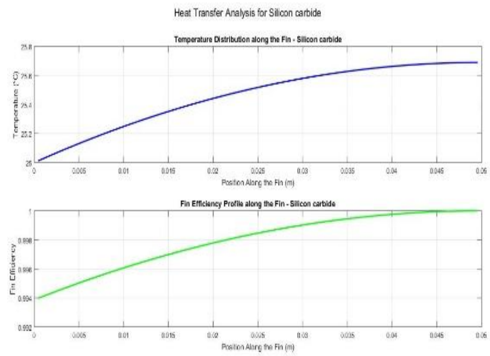

Figure.9.Heat Transfer analysis of Silicon carbide

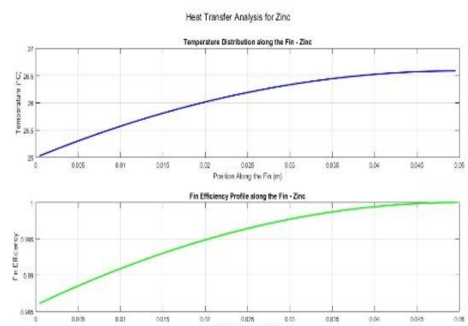

Figure.10.Heat Transfer analysis of Zinc

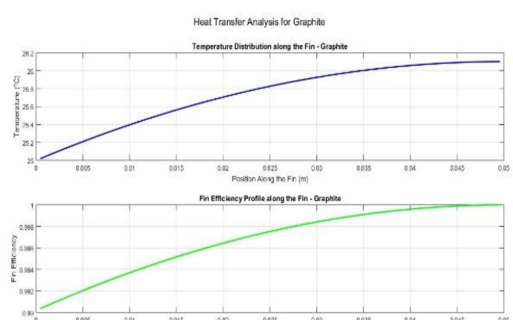

Figure.11.Heat Transfer analysis of Graphite

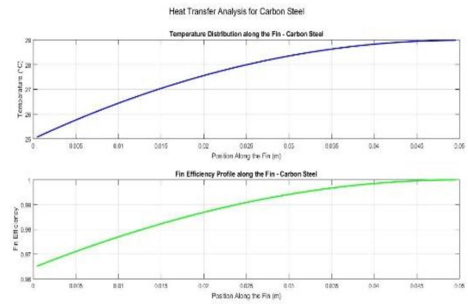

Figure.12.Heat Transfer analysis of Carbon Steel

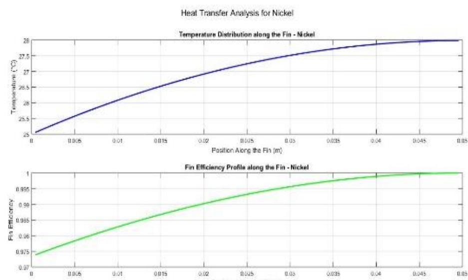

Figure.13.Heat Transfer analysis of Nickel

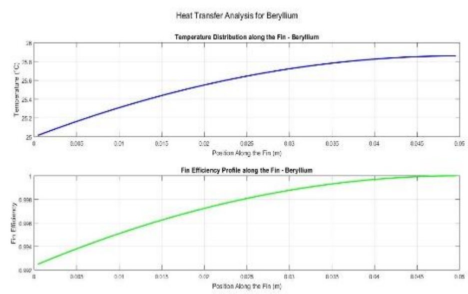

Figure.14.Heat Transfer analysis of Beryllium

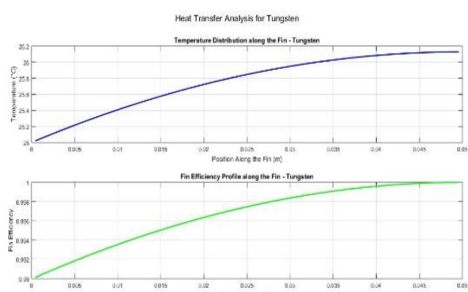

Figure.15.Heat Transfer analysis of Tungsten

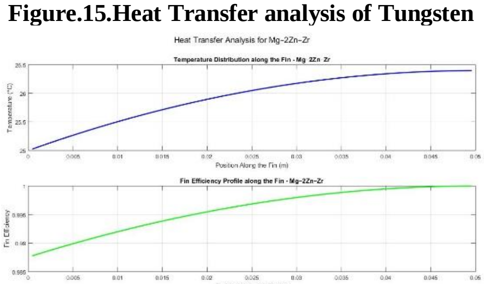

Figure.16.Heat Transfer analysis of Mg–2Zn–Zr

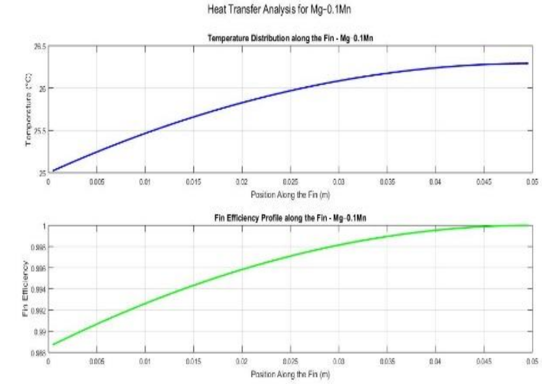

Figure.17.Heat Transfer analysis of Mg–0.1Mn

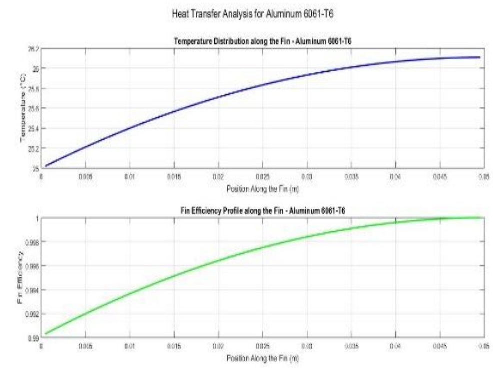

Figure.18.Heat Transfer analysis of Aluminum 6061-T6

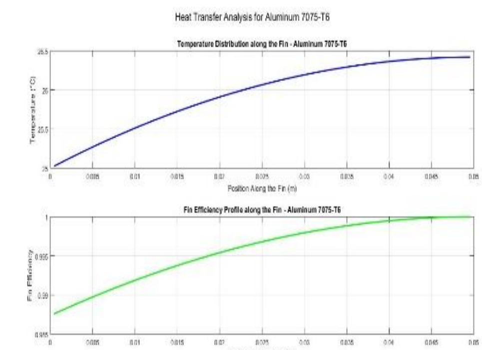

Figure.19.Heat Transfer analysis of Aluminum 7075-T6

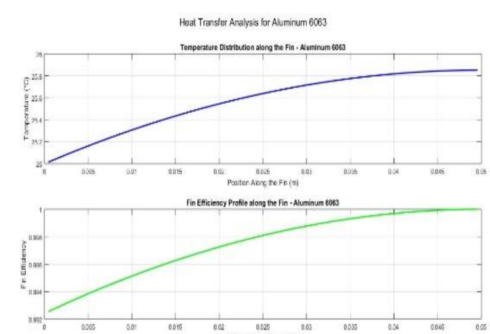

Figure.20.Heat Transfer analysis of Aluminum 6063Comparison

The first plot (Figure 21) shows the comparison of fin efficiency (η) for different materials, while the second plot (Figure 22) displays the comparison of heat transfer rates (Q). The y-axis represents the materials, and the x-axes show the corresponding values.

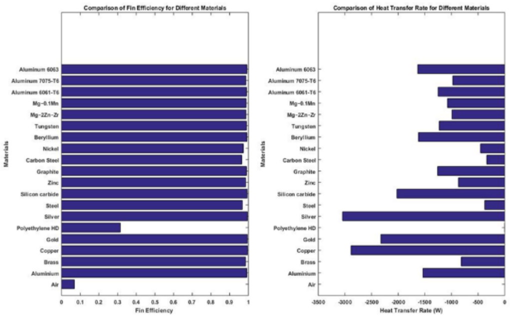

Figure.21.Comparsion of Fin Efficiency for Different Materials and Figure.22. Comparison of Heat Transfer rate for different materials

4. LIMITATIONS AND CONSIDERATIONS

It is important to note that the analysis presented here is based on idealized conditions and assumes uniform material properties. Real-world applications may involve more complex geometries, transient heat transfer, and variations in material properties. Also we are only preparing a computational model without considering its physical form. Furthermore, the selection of the most suitable material for a specific application should consider factors beyond fin efficiency and heat transfer rate, including cost, durability, and environmental considerations.

5. CONCLUSION

This paper offers a comprehensive analysis of heat transfer characteristics for 19 different materials used as fins. The computational model developed in MATLAB provides valuable insights into the performance of these materials within the context of heat transfer applications. By evaluating factors such as thermal conductivity, fin efficiency, and heat transfer rate, engineers can make informed choices when selecting fin materials, ultimately optimizing heat transfer in various engineering systems, this analysis provides valuable insights into the heat transfer performance of different materials, aiding engineers and designers in making informed decisions regarding material selection for various applications. Understanding the trade-offs between fin efficiency and heat transfer rate is essential for optimizing heat transfer systems and achieving efficient thermal management.

The results presented here serve as a starting point for further research and practical implementation in diverse fields where heat transfer plays a critical role in system performance and efficiency.

REFERENCES

[1] Maji, Ambarish, and GautamChoubey. "Improvement of heat transfer through fins: A brief review of recent developments." Heat Transfer 49.3 (2020): 1658-1685.

[2] Siddique, M., et al. "Recent advances in heat transfer enhancements: a review report." International Journal of Chemical Engineering 2010 (2010).

[3] Ho, M. L. G., et al. "A review on nanofluids coupled with extended surfaces for heat transfer enhancement." Results in Engineering 17 (2023): 100957.

[4] Oguntala, George A., et al. "Numerical study of performance of porous fin heat sink of functionally graded material for improved thermal management of consumer electronics." IEEE Transactions on Components, Packaging and Manufacturing Technology 9.7 (2019): 1271-1283.

[5] Yıldırım, Ali, DurmuşYarımpabuç, and KerimcanCelebi. "Thermal stress analysis of functionally graded annular fin." Journal of Thermal stresses 42.4 (2019): 440-451.

[6] Kashyap, Uddip, Koushik Das, and Biplab Kumar Debnath. "Effect of surface modification of a rectangular vortex generator on heat transfer rate from a surface to fluid: An extended study." International Journal of Thermal Sciences 134 (2018): 269-281.

[7] Maji, Ambarish, DipankarBhanja, and Promod Kumar Patowari. "Numerical investigation on heat transfer enhancement of heat sink using perforated pin fins with inline and staggered arrangement." Applied Thermal Engineering 125 (2017): 596-616.

[8] https://www.ndeed.org/Physics/Materials/Physical_Chemical/ThermalConductivity.xhtml

[9] https://thermtest.com/thermal-resources/top-10-resources/top-10-thermally-conductive-materials#:~:text=Zinc%20116%20W%2Fm%E2%80%A2K

[10] https://thermtest.com/thermal-conductivity-of-steel

[11] https://www.matweb.com/search/DataSheet.aspx?MatGUID=e6eb83327e534850a062dbca3bc758dc

[12] https://www.azom.com/article.aspx?ArticleID=7646

[13] https://www.plansee.com/en/materials/tungsten.html

[14] https://www.sciencedirect.com/science/article/pii/S2213956720300165

[15] https://asm.matweb.com/search/SpecificMaterial.asp?bassnum=ma6061t6

[16] https://asm.matweb.com/search/SpecificMaterial.asp?bassnum=ma7075t6

[17] https://www.matweb.com/search/DataSheet.aspx?MatGUID=bcd1abbd8d6d47b1b9896af80a3759c6.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Analysis of Sustainable addition of Non Biodegradable Waste in Geosynthetic-Reinforced Asphalt Pavements

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ABSTRACT

A viable way to combat the accumulation of Non Biodegradable waste and enhance the environmental performance of road infrastructure is the inclusion of discarded Non Biodegradable into geosynthetic-reinforced Asphalt pavements. The purpose of this study is to investigate the impact of Non Biodegradable waste integration on pavement performance and environmental sustainability in geosynthetic-reinforced Asphalt pavements. The study looks into different ways to include Non Biodegradable waste, such as using geosynthetics manufactured from recovered Non Biodegradable s, reclaimed Non Biodegradable fibers, and recycled Non Biodegradable aggregates. It looks at the long-term performance, durability, and mechanical characteristics of the pavements made of waste Non Biodegradable. The study also evaluates the advantages and disadvantages for the environment of using Non Biodegradable trash to make pavement. Important factors like compatibility of materials, best mix design, and impact of Non Biodegradable waste on pavement performance are examined. The environmental effects of integrating Non Biodegradable waste, such as carbon emissions, energy consumption, and waste reduction potential, are assessed using life cycle assessment tools.

Keywords: Sustainable, Non Biodegradable Waste, Asphalt Pavements, Geo-synthetic

1. INTRODUTION

Urgent action is required to address the environmental effects of the growing global Non Biodegradable trash epidemic and to advance sustainable alternatives. By utilizing Non Biodegradable waste materials during the pavement building process, geosynthetic-reinforced Asphalt pavements present a chance to address the issue of Non Biodegradable waste in the context of road infrastructure. This integration improves the sustainability of road infrastructure while also keeping Non Biodegradable waste out of landfills. An overview of the evaluation of the sustainable integration of Non Biodegradable waste into geosynthetic-reinforced Asphalt pavements is given in the introduction. It presents the idea of using Non Biodegradable waste materials into pavement construction, emphasizes the importance of addressing Non Biodegradable trash, and summarizes the study's value. Non Biodegradable garbage has grown to be a serious environmental issue, harming both human health and ecosystems. The building sector, which includes the development of road infrastructure, uses a lot of non-renewable resources and produces a lot of trash, which makes it a significant contribution to this problem. Therefore, in order to reduce waste and conserve resources, it is imperative to investigate sustainable methods for incorporating Non Biodegradable trash into the creation of pavement.

Non Biodegradable waste materials are perfectly integrated into geosynthetic-reinforced Asphalt pavements, which use geosynthetics like geotextiles and geomembranes to improve performance. The pavement construction process can efficiently utilize Non Biodegradable waste and lessen the need for virgin resources by using Non Biodegradable waste in the form of recycled Non Biodegradable aggregates, reclaimed Non Biodegradable fibers, or geosynthetics created from recycled Non Biodegradables.

Reducing resource consumption, improving pavement performance, and diverting waste are just a few advantages of incorporating Non Biodegradable waste sustainably into geosynthetic-reinforced Asphalt pavements. On the other hand, it also poses difficulties with regard to environmental effects, long-term performance assessment, and material compatibility. Thus, a thorough analysis is needed to determine whether using Non Biodegradable trash into pavement construction is technically feasible, financially feasible, and environmentally sustainable. The objective of this research is to evaluate the long-term performance, durability, and mechanical characteristics of geosynthetic-reinforced Asphalt pavements in relation to the sustainable integration of Non Biodegradable waste. Additionally, it assesses the effects on the environment, taking into account potential reductions in waste, energy consumption and carbon emissions. Policymakers, engineers, and decision-makers will receive direction from the evaluation's findings regarding the benefits, challenges, and best practices of using Non Biodegradable waste into pavement development. The study advances the creation of ecologically and socially conscious methods in the road building sector by evaluating the sustainable integration of Non Biodegradable waste in geosynthetic-reinforced Asphalt pavements. It opens the door for more environmentally friendly pavement building techniques and the efficient use of Non Biodegradable waste materials by offering insightful information on the technical, financial, and environmental aspects of using Non Biodegradable waste. Non Biodegradable pavement construction, sometimes referred to as Non Biodegradable roads or Non Biodegradable -modified asphalt, is a cutting-edge strategy in the field of road infrastructure that promises to provide many benefits over traditional pavement materials while addressing the problems brought about by Non Biodegradable waste. An overview of Non Biodegradable pavement construction, its benefits, and its possible influence on environmentally friendly road development are given in this introduction. In order to create Non Biodegradable pavement, waste Non Biodegradable items including bottles, bags, and packaging are mixed into the asphalt mixture that is used to create road surfaces. To make a modified asphalt mixture, the Non Biodegradable waste is treated and combined with Asphalt, the binder that keeps the asphalt mixture together.. The utilization of Non Biodegradable waste in pavement construction presents various benefits. First of all, it offers a sustainable way to dispose of Non Biodegradable waste that might otherwise contaminate the environment or wind up in landfills. Non Biodegradable pavement construction helps reduce waste and advances the circular economy by turning garbage into a useful resource by using Non Biodegradable waste. The performance qualities of Non Biodegradable -modified asphalt are superior to those of ordinary asphalt. Non Biodegradable trash is added to pavement to increase its strength and resistance to rutting, cracking, and deformation. It increases the asphalt mixture's elasticity and flexibility, making it more resilient to bad weather and high traffic volumes. Cost-effectiveness is one of the benefits of building pavement with Non Biodegradable. Utilizing Non Biodegradable trash can lower the need for virgin resources, which could lead to cost reductions in the manufacturing of asphalt. Additionally, because of its increased longevity, the new asphalt mixture requires less maintenance over time, saving road authorities money in the long run. In addition to the benefits already discussed, building with Non Biodegradable pavement can help save energy and cut greenhouse gas emissions. Because the modified asphalt mixture is produced at lower temperatures than traditional asphalt, manufacturing energy is conserved. Moreover, including Non Biodegradable trash could lessen the carbon footprint related to building roads.. There is a lot of promise for resource conservation, waste management, and sustainable road development with the use of Non Biodegradable pavement construction. The utilization of Non Biodegradable trash in the process of building road surfaces presents a pragmatic and ecologically conscious method that is consistent with the objectives of sustainable infrastructure development. Building with Non Biodegradable pavement presents a viable way to reduce Non Biodegradable waste while improving efficiency, economy, and environmental advantages. The development of sustainable road infrastructure and the promotion of the shift to a circular economy can be facilitated by more study, innovation, and application of Non Biodegradable pavement technology.

2. METHODOLOGY

One numerical method that is frequently used in the study and design of many engineering structures, including Non Biodegradable pavements, is the Finite Element Method (FEM). With the use of this potent computational tool, complex behaviors and responses of materials and structures under various loading and environmental circumstances may be simulated and predicted.

The Finite Element Method (FEM) can offer significant insights into the behavior and performance of Non Biodegradable pavements. It entails breaking up the pavement into a limited number of tiny components, each of which has certain attributes. Next, a system of equations governing the mechanical reaction of the elements and their interactions is solved in order to represent the behavior of the pavement.

The material qualities, load distribution, temperature impacts, and interactions between pavement layers are all taken into account by the FEM for Non Biodegradable pavements. It makes it possible to assess important factors including the pavement structure's deformation patterns, deflection, stress distribution, and strain accumulation. Engineers can evaluate the Non Biodegradable pavement's performance, durability, and structural integrity by examining these criteria.

Additionally, the pavement layouts can be optimized and various design scenarios can be investigated thanks to the FEM. It makes evaluating the impact of different design parameters—like layer thickness, material characteristics, where to put reinforcement, and loading conditions—easier. The best methods for building Non Biodegradable pavement may be found and the design can be improved by engineers using iterative simulations and analysis.The long-term performance and aging impacts of Non Biodegradable pavements can also be studied with the FEM. Engineers are able to forecast the deterioration and service life of pavement under practical circumstances by taking into account variables like creep, fatigue, and environmental degradation. This facilitates the creation of programs for rehabilitation and upkeep that will increase the longevity of the Non Biodegradable pavement.

3. RESULTS AND DISCUSSION

Table.1. Load and penetration values for soaked soil sample

Penetration of plunger, mm	Load dial reading, division				
	No plastic pavement	0.2 H	0.4 H	0.6 H	0.8 H
0	0	0	0	0	0
0.5	8	12	9	7	4
1.0	16	26	24	21	18
1.5	28	43	35	29	24
2.0	35	62	54	47	39
2.5	43	81	73	68	51
3.0	51	85	77	73	57
4.0	64	89	81	78	58
5.0	68	91	85	80	68
7.5	72	93	89	83	73
10.0	78	95	91	87	75
12.5	80	97	93	89	79

Table.2. Penetration vs Load dial reading

Penetration of plunger, mm	Load dial reading, divisions				
	No plastic pavement	0.2H	0.4H	0.6H	0.8H
0	0	0	0	0	0
0.5	1	10	11	5	3
1.0	2	22	23	12	8
1.5	10	38	35	17	15
2.0	17	43	47	25	19
2.5	21	66	52	39	22
3.0	26	69	57	43	28
4.0	35	73	59	48	37
5.0	40	78	63	51	39
7.5	50	81	68	59	45
10.0	58	83	72	62	49
12.5	63	89	75	66	53

Table.3. Compressive strength (MPa)

Cement (%)	Coarse Aggregate (%)	Penetration	Plasticizer %	Fine Aggregate (%)	Compressive Strength (MPA)		
					7 DAY	21 DAY	28 DAY
100	100	0	0	100%	25.9	35.89	48.11
100	99.5	0.5	5	100%	24.25	30.31	44.42
100	99.5		10	100%	25.9	31.89	45.35
100	99.5		15	100%	24.65	30.89	44.23
100	99	1	5	100%	23.5	29.18	43.54
100	99		10	100%	24.38	30.56	44.28
100	99		15	100%	24.2	29.56	43.98
100	98.5	1.5	5	100%	22.1	28.65	42.65
100	98.5		10	100%	23.15	29.65	43.63
100	98.5		15	100%	22.98	28.98	42.95
100	98	2	5	100%	20.1	27.89	40.30
100	98		10	100%	21.98	29.56	41.65
100	98		15	100%	19.15	28.36	40.97

4. The Non Biodegradable pavement construction in pavement construction have following features

An inventive method that attempts to get around the drawbacks of conventional road building materials is Non Biodegradable pavement construction. Using Non Biodegradable materials, like repurposed Non Biodegradable sheets or bottles, this technique provides a way to make durable paving surfaces. The procedure entails gathering and recycling waste Non Biodegradable materials and converting them into forms appropriate for pavement building.

There are various advantages to using Non Biodegradable materials in pavement construction, not the least of which is that it lessens the environmental impact compared to using traditional materials. The construction sector may help reduce waste and encourage the development of environmentally friendly infrastructure by utilizing recycled Non Biodegradable. Because of their increased resilience and longevity, Non Biodegradable pavement materials are less prone to deterioration and cracking from Moisture, extremes in temperature, and heavy traffic volumes. Furthermore, Non Biodegradable pavements' elasticity makes them resistant to ground vibrations, which lessens the likelihood of cracks and potholes.

The inventiveness of Non Biodegradable pavement construction and its ability to solve issues with conventional materials are emphasized in the introduction. This strategy encourages sustainability and resource saving by using recycled Non Biodegradable. Non Biodegradable pavements have several benefits, including increased flexibility, less environmental effect, and improved durability. More research and application of Non Biodegradable pavement technology may result in the creation of durable and environmentally beneficial road infrastructure.

5. CONCLUSION

In summary, the evaluation of the environmentally and socially responsible practices in the road building sector through the sustainable integration of Non Biodegradable waste into geosynthetic-reinforced Asphalt pavements provides insightful information. The worldwide Non Biodegradable waste dilemma can be addressed while improving the sustainability of road infrastructure by using Non Biodegradable waste elements into pavement development.

The study has emphasized how adding Non Biodegradable waste to geosynthetic-reinforced Asphalt pavements is technically feasible, economically feasible, and environmentally sustainable. Non Biodegradable waste can be successfully utilized to reduce landfill accumulation and promote the circular economy. Examples of such materials include recycled Non Biodegradable aggregates, reclaimed Non Biodegradable fibers, and geosynthetics constructed from recycled Non Biodegradable s. The results show that the mechanical qualities, durability, and resistance to deformation of pavement can all be enhanced by the sustainable inclusion of Non Biodegradable trash. Furthermore, compared to traditional pavement construction, life cycle assessment methodologies have shown favorable environmental benefits, such as lower carbon emissions, energy consumption, and trash generation. Nevertheless, there are obstacles that must be overcome before Non Biodegradable waste assimilation may be widely used. Assuring material compatibility, maximizing mix design parameters, assessing long-term performance, and putting in place standardized protocols and quality control procedures are some of these difficulties. In order to encourage the sustainable integration of Non Biodegradable waste in geosynthetic-reinforced Asphalt pavements, the study highlights the significance of cooperation amongst researchers, engineers, legislators, and waste management authorities. Stakeholders can create successful strategies, rules, and specifications to ensure successful implementation by exchanging expertise and working together. This study advances sustainable road infrastructure by evaluating the sustainable integration of Non Biodegradable waste into geosynthetic-reinforced Asphalt pavements. It promotes resource conservation, waste minimization, and the adoption of ecologically beneficial activities. The results can help practitioners and decision-makers make well-informed decisions about how to include Non Biodegradable trash, which will improve pavement construction sustainability and make a big difference in Non Biodegradable waste management initiatives.

REFERENCES

[1] Phoo-ngernkham T, Hanjitsuwan S, Damrongwiriyanupap N, and Chindaprasirt P, ―Effect of Sodium Hydroxide and Sodium Silicate Solutions on Strengths of Alkali Activated High Calcium Fly ash Containing Portland Cement,‖ KSCE Journal of Civil Engineering, vol. 21, no. 6, pp. 2202–2210, Oct. 2016.

[2] Prasad, D. S. V., Raju, G. V. R. P., & Kumar, M. A. (2009). Utilization of industrial waste in Asphalt pavement construction. EJGE, 13(2), 207-211.

[3] Rajasekaran, S., Vasudevan, R., &Paulraj, S. (2013). Reuse of waste Non Biodegradable s coated aggregates-Asphalt mix composite for road application—green method. American Journal of Engineering and Research, 2(11), 1-13.
[4] Rajmane, P. B., Gupta, A. K., & Desai, D. B. (2009). Effective utilization of waste Non Biodegradable in construction of Asphalt pavement for improving their performance. OSR Journal of Mechanical and Civil Engineering, 2(17), 27-30.
[5] Rajput, P. S., & Yadav, R. K. (2016). Use of Non Biodegradable waste in bituminous road construction. International Journal of Science Technology & Engineering, 2(10), 509-513.
[6] Ravindra N. Thakur and Somnath Ghosh., ―Effect of mix composition on compressive strength and microstructure of flyash based geopolymer composites‖, ARPN Journal of Engineering and Applied Sciences, 4., 68-74., 2009.
[7] Rongali, U., Singh, G., Chourasiya, A., & Jain, P. K. (2013). Laboratory investigation on use of fly ash Non Biodegradable waste composite in bituminous concrete mixtures. Procedia-Social and Behavioral Sciences, 104, 89-98.
[8] Sandeep L.Hake, Dr R. M. Damgir and Dr S.V. Patankar, ―State of Art- Investigation of Method of Curing on Geopolymer Concrete,‖ IOSR Journal of Mechanical and Civil engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 3 Ver. II (May. - Jun. 2015),
[9] Sanjay Kumar, Rakesh Kumar and S.P. Mehrotra, ―Influence of granulated balst furnace slag on the reaction, structure and properties of fly ash based geopolymer‖, Journal of Materials Science, 45(3), 607- 615., 2010.
[10] Sasidharan, M., Torbaghan, M. E., & Burrow, M. (2019). Using waste Non Biodegradable s in road construction.
[11] SatputeManesh B, WakchaureMadhukar R and PatankarSubhash V (2012) ―Effect of Duration and Temperature of Curing on Compressive Strength of Geopolymer Concrete‖, International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 5, May 2012
[12] Shankar H. Sanni, Khadiranaikar, R. B. ―Performance of Geopolymer Concrete Under Severe Environmental Conditions‖, International Journal Of Civil And Structural Engineering, 3.2., 396-407., 2012.
[13] Subhash V. Patankar , Sanjay S. Jamkar, Yuwaraj M. Ghugal, ―Effect of water-to- geopolymer binder ratio on the production of flyash based geopolymer concrete‖ ,International Journal Of Advanced Technology In Civil Engineering, 2.1., 79-83., 2013.
[14] Subramanian, R. M., &Jeyapriya, S. P. (2009). Study on effect of waste tyres in Asphalt pavement system. *Indian Geotech. Soc. Chennai*, 19-24.
[15] Tagbor, T. A., Mohammed, L., Mohammed, M., Bruce-Mensah, M. M., Tekpetey, S., Armoo,
[16] E. A., ...& Kirghiz, M. S. (2022). The utilization of palm kernel shells and waste Non Biodegradable s in asphaltic mix for sustainable pavement construction. Scientific African, 16, e01277.

Vol. 3 Issue 20 June 2024
JIIEMS ISSN: 2347-6184

Introducing Non Biodegradable Waste in Geosynthetic-Reinforced Asphalt Pavements: A Review of Sustainable Construction Practices

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ABSTRACT

There is an urgent need to reduce the impact of the accumulation of non-biodegradable garbage because it has become a major environmental concern on a global scale. The objective of this research is to investigate non-biodegradable waste management strategies through the use of sustainable building techniques for geosynthetic-reinforced Asphalt pavements. Road infrastructure frequently uses Asphalt pavements, which are known to use a lot of non-renewable resources and produce a lot of garbage when they're built and maintained. In order to limit resource consumption, reduce the accumulation of non-biodegradable waste, and improve pavement sustainability, this study explores the possibility of incorporating non-biodegradable waste materials into geosynthetic-reinforced Asphalt pavements. The review looks at current studies and real-world uses for using non-biodegradable garbage in pavement construction. The utilization of recycled non-biodegradable aggregates, recovered non-biodegradable fibers, and geosynthetics derived from recycled non-biodegradables are among the sustainable construction techniques covered. These methods preserve or enhance pavement performance while efficiently employing non-biodegradable debris, making them a promising solution.

Keywords: ***Plastic Waste, Asphalt Pavements, Geosynthetic, Non Biodegradable***

1. INTRODUCTION

The issue of non-biodegradable trash has escalated worldwide, presenting substantial obstacles to both human well-being and ecosystems. Due to the significant waste produced and the heavy use of non-renewable resources, the building industry in particular is a key contributor to this problem. Asphalt pavements are essential to transportation networks in the context of road infrastructure, but they also contribute to waste accumulation and resource depletion.

This review focuses on sustainable construction practices for geosynthetic-reinforced Asphalt pavements as a means of addressing the Non Biodegradable waste problem. Geosynthetics, such as geotextiles and geomembranes, are widely used in pavement engineering to enhance performance, stability, and durability. It is feasible to reduce resource consumption, remove non-biodegradable trash from landfills, and encourage a more sustainable method of road building by combining non-biodegradable waste materials into geosynthetic-reinforced Asphalt pavements.

The use of non-biodegradable trash in pavement construction offers a chance to address two important problems at the same time: the decrease of non-biodegradable waste and the requirement for sustainable infrastructure. Non-biodegradable waste materials can be turned into useful resources that support the circular economy by reevaluating their worth. With regard to the integration of non-biodegradable trash in Asphalt pavements reinforced with geosynthetic materials, this review attempts to present a thorough summary of current studies and real-world applications. It examines numerous suggested and applied sustainable building techniques, stressing their possible advantages and addressing the difficulties in implementing them. When using non-biodegradable garbage into pavement construction, the review also highlights how important it is to take important issues like material characterization, mechanical qualities, durability, and environmental impact into account. Comprehending these variables is vital in guaranteeing the enduring functionality and durability of the Asphalt pavements supplemented with geosynthetic materials.

The present analysis highlights the necessity of cooperative endeavors between scholars, engineers, legislators, and waste management agencies to establish uniform protocols and requirements for the sustainable application of non-biodegradable waste in transportation infrastructure. It is feasible to encourage the industry's wide adoption of sustainable construction methods by putting in place explicit frameworks.

In the end, non-biodegradable waste integration in geosynthetic-reinforced Asphalt pavements has promise for improving road infrastructure sustainability while simultaneously addressing the non-biodegradable waste challenge. This paper highlights the benefits and drawbacks of integrating non-biodegradable trash into Asphalt pavement design, making it an invaluable tool for researchers, practitioners, and policymakers involved in pavement engineering.

2. NEED OF THE STUDY

The need to address the global crisis of non-biodegradable waste and advance sustainable practices in the construction sector is the driving reason behind the study on non-biodegradable waste in geosynthetic-reinforced Asphalt pavements. Due to its high landfill content and ability to contaminate natural ecosystems, non-biodegradable trash has grown to be a serious environmental problem. The use of non-renewable resources and the production of large amounts of waste during pavement construction and maintenance are two ways that the road building industry, in particular, contributes to this problem.The possibility that Asphalt pavements reinforced with geosynthetic materials could provide a long-term solution to the non-biodegradable waste issue is what motivates this work. Pavement engineering makes extensive use of geosynthetics, such as geotextiles and geomembranes, to improve performance, stability, and longevity. The circular economy can be supported, non-biodegradable trash can be kept out of landfills, and less virgin material can be used by combining non-biodegradable waste materials into these geosynthetics. Examining the viability and efficiency of using non-biodegradable garbage in Asphalt pavements reinforced with geosynthetic materials is the goal of the project. It looks for environmentally friendly building techniques that include non-biodegradable waste products with the goal of preserving or enhancing pavement performance. In addition, the study intends to tackle the difficulties that come with incorporating non-biodegradable trash, including material compatibility, mechanical qualities, durability, and long-term performance assessment.

3. ASPHALT PAVEMENTS

Asphalt pavements, sometimes referred to as Asphalt pavements, are a common kind of road surface that have a number of benefits. These pavements are made up of several layers, each of which has a distinct function to guarantee stability and longevity. The natural soil or compacted fill material that serves as the foundation is known as the subgrade layer, and this is where Asphalt pavement construction starts. A sub-base layer is placed on top of the subgrade to give more support and disperse the weight from vehicles. The base course, which comes next, reinforces the pavement structure even more by adding a thicker layer of hardy materials like gravel or crushed stone. Next is the binder course, which is an asphalt binder and aggregate mixture. This layer serves to evenly distribute the weight and offers a durable and smooth driving surface. The top surface course, which is made of premium asphalt mixtures intended to create a long-lasting and skid-resistant driving surface, is then added. There are many advantages to Asphalt pavements. Compared to rigid pavements, they are less expensive to build, require less initial investment, and are simple to maintain and repair. Because of their adaptability, they can distribute enormous traffic loads, giving cars a smoother ride. They also demonstrate good longevity, withstanding both heavy loads and climatic fluctuations. But there are drawbacks to Asphalt pavements as well. Compared to rigid pavements, they can need more regular maintenance, and they might be more prone to deformation like cracking and rutting. In order to guarantee their long-term operation, proper design, building, and maintenance procedures are required.

4. LITERATURE REVIEW

Gawande, A. et al (2012) The increasing accumulation of Non Biodegradable waste poses a significant environmental challenge worldwide. Asphalting of roads, a crucial aspect of infrastructure development, contributes to both resource consumption and waste generation. This review aims to provide an overview of the utilization of waste Non Biodegradable in the asphalting of roads as a sustainable solution to address these issues. The review examines recent research and practical applications related to the incorporation of waste Non Biodegradable materials, such as Non Biodegradable bags, bottles, and packaging, into asphalt mixtures. These waste Non Biodegradables, when properly processed and added to asphalt, can enhance the performance and durability of road surfaces while reducing the consumption of virgin materials. Various methods, such as the dry process, wet process, and hybrid methods, are explored for integrating non-biodegradable trash into asphalt mixtures. The impacts of non-biodegradable trash on asphalt's rutting resistance, fatigue life, stability, stiffness, and potential environmental benefits are examined along with the use of non-biodegradable garbage in road building.

Gautam, P. K et al (2018) methods for managing garbage that are sustainable, like recycling, source separation, and treatment technology. It highlights how crucial it is for waste management authorities, researchers, engineers, and legislators to work together to create policies and strategies that will allow trash to be used sustainably in the creation of Asphalt pavement. There is also a discussion of the possible obstacles, like low knowledge, a lack of incentives, and market limitations, that could prevent waste materials from being widely used in Asphalt pavement. The assessment emphasizes that in order to motivate stakeholders to adopt sustainable waste management techniques, there is a need for financial incentives, awareness efforts, and supportive regulations. The construction industry may aid in waste reduction, resource conservation, and the shift to a circular economy by encouraging the sustainable use of waste materials in the creation of Asphalt pavements. This paper encourages more study and application of sustainable practices in pavement engineering by offering insightful information about the advantages, difficulties, and opportunities related to utilizing waste materials in Asphalt pavement.

G. S. Manjunath (2011) The ambient-cured geopolymer mortar was seen to demonstrate a notable increase in compressive strength over time, as per the experimental findings. Fly ash and slag are examples of industrial byproducts that can be alkali activated to promote the geopolymerization reaction, which in turn helps to build a strong and cohesive binder matrix. With increasing curing age, this matrix showed an increasing trend in compressive strength. The study emphasized how important factors affected the compressive strength of geopolymer mortar, including the kind and dosage of alkali activators, the proportion of binder to aggregates, and the curing conditions. The most effective combinations of these characteristics were found to increase the material's overall performance and strength development. The study also shown how crucial ideal curing conditions are for encouraging the growth of compressive strength. Temperature, humidity, and the length of the curing process were some of the key variables that affected the geopolymerization reaction and the ensuing strength gain. For ambient-cured geopolymer mortar to develop its strength to its full potential, proper curing protocols must be followed. In comparison to traditional cement-based materials, geopolymer mortar has a number of benefits, such as lower carbon emissions, less dependency on non-renewable resources, and the ability to use industrial byproducts as precursors.

Eze, W. U (2023) The results show that the performance and longevity of Asphalt pavement can be improved by using non-biodegradable trash, such as non-biodegradable bottles, bags, and packaging materials. Non-biodegradable waste materials can be prepared, added to asphalt mixtures, or utilized as modifiers when asphalt binders are being made. By consuming less raw materials and removing non-biodegradable trash from landfills, these measures help conserve resources. Non-biodegradable garbage has been used in Asphalt pavement, and this has increased the pavement's resilience to rutting, moisture damage, and cracking, among other attributes. Moreover, including non-biodegradable wastes may lower the energy usage and greenhouse gas emissions linked to conventional pavement building. Nevertheless, there are obstacles to overcome before non-biodegradable garbage may be widely used in Asphalt pavement. The challenges encompass the requirement for uniform rules and requirements, compatibility problems between non-biodegradable waste materials and asphalt constituents, and the assessment of non-biodegradable-modified pavements' long-term performance. To overcome these obstacles and create best practices, more study and cooperation between scientists, engineers, legislators, and waste management authorities are required.

Dutta, D (2010) This study looks into how fly ash geopolymer's porosity is affected by the addition of silica fume. Originating from industrial waste, geopolymers have become a viable and sustainable substitute for conventional cement-based materials. Nonetheless, the mechanical characteristics and durability of geopolymers may be impacted by their intrinsic porosity. Thus, there is a great deal of interest in finding ways to improve the performance of geopolymer materials while reducing porosity..The study focuses on adding silica fume, a pozzolanic substance that contains a lot of amorphous silica, to geopolymer matrices made of fly ash. The goal is to look at how silica fume additions affect the geo polymer structure's porosity properties. Fly ash geo polymer mixtures are mixed with different ratios of silica fume, and non-destructive testing methods are used to assess the resulting porosity. The experimental findings demonstrate that the porosity of the fly ash geo polymer is significantly reduced upon the addition of silica fume. During geo polymerization, the alkaline activators and amorphous silica in the silica fume combine to form a denser, more compact microstructure. The material's mechanical strength and resistance to harmful effects, like chemical and water penetration, are both improved by this reduction in porosity.

5. SIGNIFICANCE OF THE STUDY

For a number of reasons, the investigation of non-biodegradable waste in Asphalt pavements reinforced with geosynthetic materials is crucial. Impact on the Environment: Non-biodegradable garbage has a negative impact on ecosystems, wildlife, and human health, making it a significant environmental concern. The study helps to reduce the accumulation of non-biodegradable waste, minimizes the demand for landfill space, and mitigates the environmental impact of non-biodegradable pollution by investigating the inclusion of non-biodegradable waste in geosynthetic-reinforced Asphalt pavements. Resource conservation: A large portion of non-renewable resources are used by the construction sector. The study encourages resource conservation by lowering the use of virgin materials in pavement construction by exploiting non-biodegradable garbage as a resource. By recovering non-biodegradable waste as a useful resource, it aids in the shift to a more sustainable and circular economy. Sustainable Construction Techniques: The goal of the project is to determine how to construct Asphalt pavements reinforced with geosynthetic fibers in a sustainable manner. The integration of non-biodegradable waste materials is a novel strategy for augmenting pavement sustainability. This advances the building industry's overarching objective of implementing socially and environmentally conscious methods.

Performance Enhancement: The study looks at the possible advantages of adding non-biodegradable garbage to Asphalt pavements reinforced with geosynthetic materials. It seeks to preserve or enhance the performance of pavement, taking into account elements like resilience to deformation, strength, and durability. The study encourages the creation of sustainable pavements that either meet or surpass traditional pavement performance criteria by examining the components of performance enhancement. Cooperation and Exchange of Knowledge: Collaboration between researchers, engineers, legislators, and waste management authorities is encouraged by the study. It encourages the sharing of best practices, knowledge, and skills about the use of non-biodegradable garbage in Asphalt pavements reinforced with geosynthetics by bringing these stakeholders together.

By working together, it may be possible to create standardized policies, procedures, and quality assurance protocols that will make it easier to apply sustainable building techniques. The study's ability to solve the issue of non-biodegradable trash, stimulate resource conservation, support sustainable construction methods, improve pavement performance, and foster cooperation among diverse stakeholders makes it significant. The study advances knowledge and understanding in this area, which helps to make road infrastructure development more environmentally conscious and sustainable.

6. CONCLUSION

In geosynthetic-reinforced Asphalt pavements, non-biodegradable waste can be addressed with sustainable building methods, as the review emphasizes. It is feasible to cut resource consumption, limit the accumulation of non-biodegradable trash, and improve the sustainability of road infrastructure by incorporating non-biodegradable waste materials into pavement construction. In geosynthetic-reinforced Asphalt pavements, the use of non-biodegradable trash has many advantages. It gives non-biodegradable garbage an efficient way to be used, lessening the load on landfills and promoting the circular economy. Incorporating non-biodegradable garbage can also enhance the performance of pavement by improving its strength, durability, and resistance to deformation. The assessment lists a number of environmentally friendly building techniques, such as using recycled non-biodegradable aggregates, recovered non-biodegradable fibers, and geosynthetics manufactured from recycled non-biodegradables. When it comes to lowering non-biodegradable waste and preserving or enhancing pavement performance, these methods show encouraging outcomes. Nonetheless, there are obstacles in the way of putting sustainable practices into practice.

In order to guarantee the appropriate functioning and durability of the pavements, compatibility problems between non-biodegradable waste products and other pavement components must be resolved. Widespread adoption requires uniformity of criteria and long-term performance evaluation. Collaboration between waste management authorities, engineers, researchers, and legislators is essential to overcoming these obstacles. Together, we can create uniform policies, requirements, and quality assurance procedures for the long-term, sustainable use of non-biodegradable garbage in road infrastructure. In order to maximize the utilization of non-biodegradable trash in Asphalt pavements reinforced with geosynthetic reinforcement, the review highlights the necessity for more research and development. This involves researching the integrated non-biodegradable waste material's durability, long-term performance, and environmental effects.

REFERENCES

[1] Subhash V. Patankar , Sanjay S. Jamkar, Yuwaraj M. Ghugal, ―Effect of water-to-geopolymer binder ratio on the production of flyash based geopolymer concrete‖ ,International Journal Of Advanced Technology In Civil Engineering, 2.1., 79-83., 2013.

[2] Subramanian, R. M., &Jeyapriya, S. P. (2009). Study on effect of waste tyres in Asphalt pavement system. Indian Geotech. Soc. Chennai, 19-24.

[3] Tagbor, T. A., Mohammed, L., Mohammed, M., Bruce-Mensah, M. M., Tekpetey, S., Armoo,

[4] E. A., ...& Kirghiz, M. S. (2022). The utilization of palm kernel shells and waste plastics in asphaltic mix for sustainable pavement construction. Scientific African, 16, e01277.

[5] Reuse of waste plastics coated aggregates-Asphalt mix composite for road application—green method. American Journal of Engineering and Research, 2(11), 1-13.

[6] Rajmane, P. B., Gupta, A. K., & Desai, D. B. (2009). Effective utilization of waste plastic in construction of Asphalt pavement for improving their performance. OSR Journal of Mechanical and Civil Engineering, 2(17), 27-30.

[7] Rajput, P. S., & Yadav, R. K. (2016). Use of plastic waste in bituminous road construction. International Journal of Science Technology & Engineering, 2(10), 509-513.

[8] Ravindra N. Thakur and Somnath Ghosh., ―Effect of mix composition on compressive strength and microstructure of flyash based geopolymer composites‖, ARPN Journal of Engineering and Applied Sciences, 4., 68-74., 2009.

[9] Rongali, U., Singh, G., Chourasiya, A., & Jain, P. K. (2013). Laboratory investigation on use of fly ash plastic waste composite in bituminous concrete mixtures. Procedia-Social and Behavioral Sciences, 104, 89-98.

[10] Sandeep L.Hake, Dr R. M. Damgir and Dr S.V. Patankar, ―State of Art- Investigation of Method of Curing on Geopolymer Concrete,‖ IOSR Journal of Mechanical and Civil engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 3 Ver. II (May. - Jun. 2015),

[11] Sanjay Kumar, Rakesh Kumar and S.P. Mehrotra, ―Influence of granulated balst furnace slag on the reaction, structure and properties of fly ash based geopolymer‖, Journal of Materials Science, 45(3), 607- 615., 2010.

[12] Sasidharan, M., Torbaghan, M. E., & Burrow, M. (2019). Using waste plastics in road construction.

[13] SatputeManesh B, WakchaureMadhukar R and PatankarSubhash V (2012) ―Effect of Duration and Temperature of Curing on Compressive Strength of Geopolymer Concrete‖, International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 5, May 2012

[14] Shankar H. Sanni, Khadiranaikar, R. B. ―Performance of Geopolymer Concrete Under Severe Environmental Conditions‖, International Journal Of Civil And Structural Engineering, 3.2., 396-407., 2012.

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ISSN : 2347-6184

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