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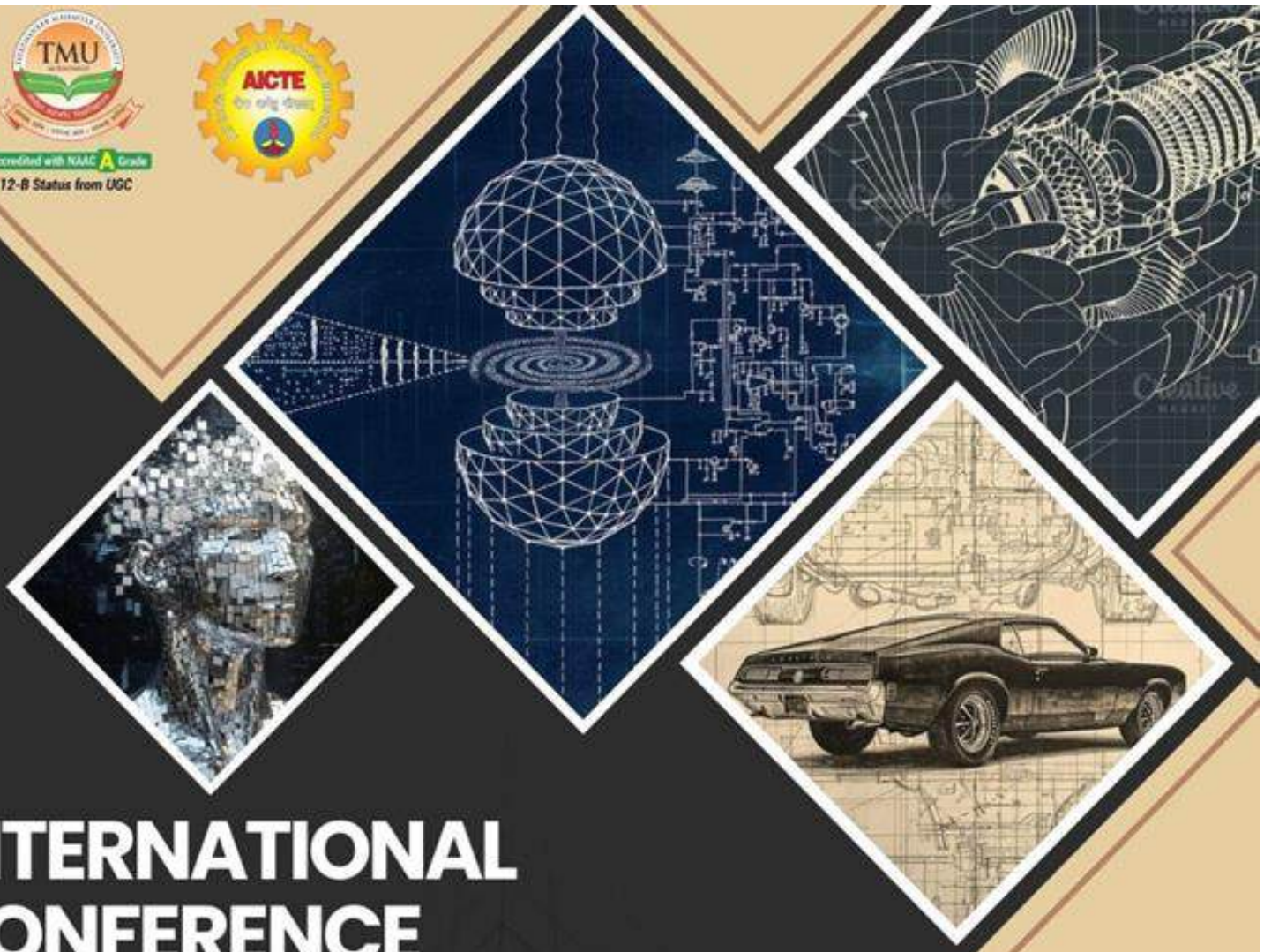

INTERNATIONAL CONFERENCE ON MODERN TRENDS IN COMPUTERS AND ELECTRONICS

ICMCE - 2025

CONFERENCE PROCEEDING

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Dr. Gulista Khan
CONVENER

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Co-Editors
Mr. Prashant Kumar
CO-CONVENER

Invention is the engine insight is the fuel.

Organized by
Teerthanker Mahaveer University
College of Engineering, Delhi Road Moradabad (UP), India
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International Conference

On

Modern Trends in Computers and Electronics

10th May, 2025

ICMCE -2025

Organized by-

TMU-College of Engineering
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India

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1st International Conference On

Modern Trends in Computers and Electronics

ICMCE -2025

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About TMU

Teerthanker Mahaveer University (TMU), Moradabad, was established by an act of the Government of Uttar Pradesh—Act No. 30 of 2008, dated 14th September 2008. The university was founded under the aegis of Teerthanker Mahaveer Institute of Management and Technology (Society), with a visionary objective to provide quality education and promote academic excellence across diverse fields.

The university is empowered by the University Grants Commission (UGC) to confer degrees under Section 22 of the UGC Act, 1956. All programs offered at TMU are duly approved by the respective regulatory authorities, ensuring that the academic framework meets national standards and global expectations.

Over the years, TMU has carved a niche for itself in the domains of Medical Sciences, Dentistry, Management, Engineering, and allied disciplines, earning widespread recognition and academic distinction. The university's commitment to quality education, research, and holistic development has attracted a diverse student population from across India and the world.
With a well-established infrastructure, experienced faculty, and industry-oriented curriculum, TMU continues to evolve as a center of excellence in higher education, fostering innovation, professional growth, and global leadership.

The university is steadfast in its mission to nurture responsible citizens and future-ready professionals equipped with the skills, knowledge, and values required to thrive in a dynamic and interconnected world.

About the College

The College of Engineering at Teerthanker Mahaveer University (TMU), Moradabad, stands as a premier constituent institution dedicated to addressing the growing demand for quality education in the domains of Engineering and Computing Sciences. Established with the vision of nurturing future-ready professionals, the college serves as a dynamic center for academic excellence, research innovation, and industry-aligned consultancy.

Over the years, the college has evolved into a hub of multi-dimensional activities, fostering an ecosystem that encourages intellectual growth, practical learning, and holistic development. Its programs are thoughtfully crafted to align with the evolving needs of the corporate world and are geared toward preparing students to navigate and excel in a competitive, technology-driven environment. The College of Engineering offers a comprehensive suite of programs at undergraduate, postgraduate, and doctoral levels, with curricula designed to meet current market and industry demands.

Emphasis is placed on blending theoretical foundations with practical training, enabling students to acquire the competencies and confidence required for success in diverse professional roles across Engineering, Management, and Computer Studies. To enhance learning outcomes and provide a global perspective, the college frequently hosts distinguished experts from national and international institutions and industries. These guest sessions, combined with the dedicated guidance of the college's experienced and highly qualified faculty, ensure that students receive a rich and transformative educational experience.

With its strong academic framework, state-of-the-art infrastructure, and industry partnerships, the College of Engineering at TMU continues to play a pivotal role in producing competent, ethical, and innovative professionals ready to lead in a rapidly changing world.

Preface of ICMCE-2025

Teerthanker Mahaveer University (TMU), Moradabad, is honored to present the proceedings of the **International Conference on Modern Trends in Computers and Electronics (ICMCE 2025)**, which took place on May 10, 2025, at the University Auditorium. This landmark event, organized by the Departments of Computer Science Engineering and Electronics & Communication Engineering, Faculty of Engineering, brought together distinguished scholars, researchers, industry professionals, and practitioners to engage in a comprehensive discussion on the latest advancements in computer science and electronics.

ICMCE 2025, held in a hybrid format, was designed to accommodate both in-person and virtual participation, offering a truly global platform for knowledge exchange. This conference served as a dynamic arena for sharing research breakthroughs, exploring new technological frontiers, and discussing future directions in the rapidly evolving fields of computing and electronics. The conference was structured around critical interdisciplinary themes, including Artificial Intelligence, Machine Learning, the Internet of Things (IoT), Embedded Systems, Robotics, Microelectronics, Cyber Security, Blockchain, Quantum Computing, and Sustainable Electronics. A key focus of the conference was on **Education 4.0**, emphasizing the role of smart technologies in transforming educational and industrial applications.

As stated by **Prof. R.K. Dwivedi**, Dean of the Faculty of Engineering, "ICMCE 2025 reflects our commitment to research and innovation in an era where technology plays a critical role in shaping society. The conference offered a much-needed opportunity for experts and young researchers alike to engage with global trends and contribute to meaningful academic discourse."

ICMCE 2025 featured keynote addresses and technical sessions delivered by eminent speakers from India and abroad, with special addresses by **Shri Rajesh Gupta**, Deputy Director General, NCA-T, DoT, Ministry of Communication, India, and **Dr. P.K. Garg**, Emeritus Fellow at IIT Roorkee and Former Vice Chancellor of UTU, as Guest of Honor. Additionally, the conference gained an international dimension with the virtual participation of **Dr. Huan Bi** from the University of Electro-Communication, Japan, and **Dr. Ivo Markovic** from the University of Belgrade, Serbia, who shared their expertise with attendees.

Over **250+ research papers** were submitted to the conference from across the globe, with **134 high-quality papers** accepted after a rigorous review process. These papers have been included in the conference proceedings, which represent a curated collection of peer-reviewed work that addresses the contemporary challenges and innovations in computing and electronics. Additionally, selected papers will be considered for publication in ISBN-registered book chapters and Scopus-indexed journals, further extending the impact of the conference.

The conference proceedings reflect the vast scope of cutting-edge research and technological advancements discussed at ICMCE 2025. These proceedings aim to serve as a valuable resource for scholars, practitioners, and students, providing insights into the present and future of technology. Moreover, the event's success has strengthened global academic and industrial networks, encouraging collaboration, innovation, and the development of new research avenues.

We extend our heartfelt gratitude to all the authors, keynote speakers, reviewers, and organizing committee members who have contributed their time and expertise to make this conference a resounding success. We also thank our participants for their active involvement and their commitment to advancing the field of computer science and electronics.

We are confident that the ICMCE 2025 conference proceedings will inspire future research, foster new collaborations, and continue to drive innovation in technology, thus playing a pivotal role in shaping the future of the digital world.

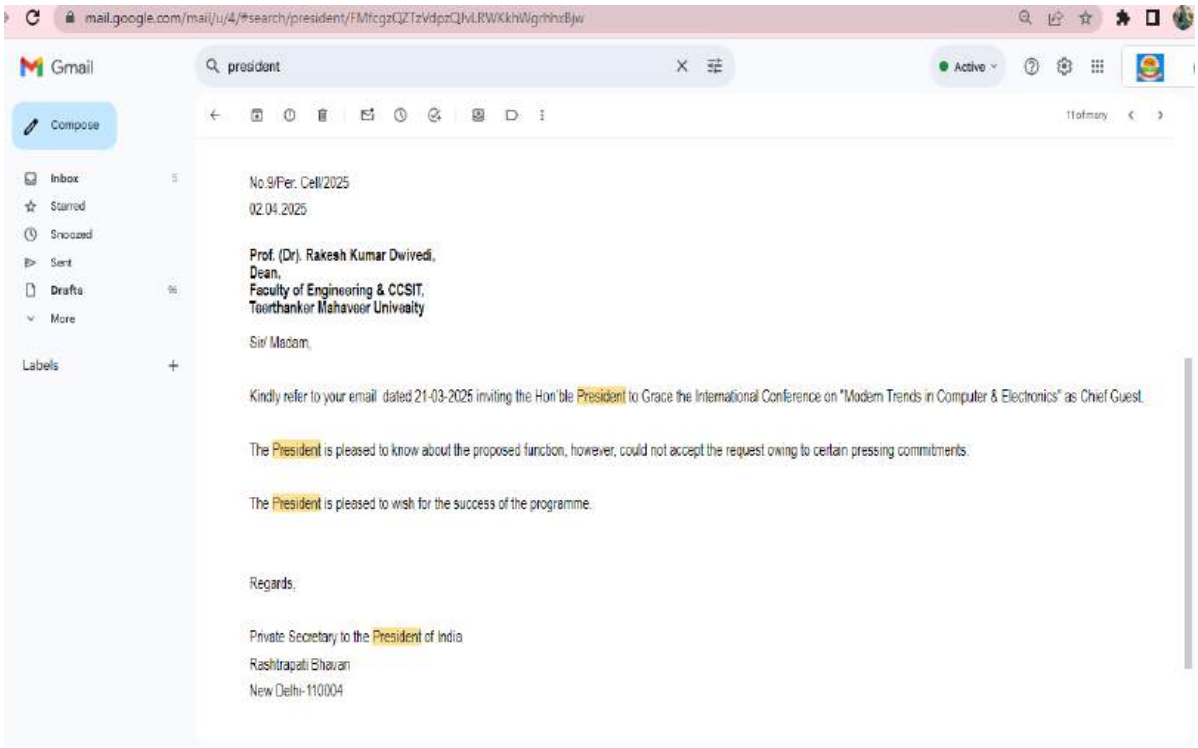
Teerthanker Mahaveer University invites all stakeholders to join hands in shaping a technology-driven future and contribute to the global dialogue on the evolving landscape of computing and electronics.

Banner of ICMCE-2025

Messages

(Honorable President of India)

The Honorable President of India has extended her best wishes for the "International Conference on Modern Trends in Computers and Electronics-ICMCE2025"jointly organized by Department of CSE and EC, Faculty of Engineering. However, due to prior commitments, she will be unable to attend as the Chief Guest.



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02.04.2025

Prof. (Dr). Rakesh Kumar Dwivedi,
Dean,
Faculty of Engineering & CCSIT,
Teerthanker Mahaveer University

Sir/ Madam,

Kindly refer to your email dated 21-03-2025 inviting the Hon'ble President to Grace the International Conference on "Modern Trends in Computer & Electronics" as Chief Guest.

The President is pleased to know about the proposed function, however, could not accept the request owing to certain pressing commitments.

The President is pleased to wish for the success of the programme.

Regards,

Private Secretary to the President of India
Rashtrapati Bhavan
New Delhi-110004

Our Patrons

Message by Mr. Suresh Jain Ji

(Hon'ble Chancellor at Teerthanker Mahaveer University in Moradabad, Uttar Pradesh)

"*I emphasize on the importance of offering courses that build both character and future prospects for students, ensuring they are well-prepared for immediate employment after graduation.*

The upcoming International Conference on Modern Trends in Computers and Electronics (ICMCE 2025) presents an excellent opportunity for students to gain hands-on experience in event management, networking, and leadership. Participation in such conferences aligns with the vision of TMU providing practical exposure and skill development to students, preparing them for successful careers in their respective fields.
Students are encouraged to actively engage in ICMCE 2025 to enhance their professional skills and broaden their academic horizons."

Message by Mr. Manish Jain Ji

(Hon'ble Group Vice Chairman and a member of the Governing Body at Teerthanker Mahaveer University in Moradabad, Uttar Pradesh)

"*It is with great pride and pleasure that I extend my warmest greetings and best wishes to all participants of the upcoming International Conference on Modern Trends in Computers and Electronics (ICMCE 2025) which stands as a testament to TMU's commitment to academic and technological advancements. I encourage the students to actively participate in such global forums, recognizing them as invaluable opportunities for networking, leadership, and professional growth.*

I emphasize the importance of organizing conferences and events that provide platforms for students and researchers to exchange innovative ideas and stay abreast of industry developments. I also believe that such initiatives are crucial for the professional growth of participants and contribute significantly to the advancement of knowledge in their respective fields. "

Esteemed Member of TMU Society: Mr. Akshat Jain

(Executive Director of Teerthanker Mahaveer University in Moradabad, Uttar Pradesh)

"*It is my distinct honor to extend my warmest greetings and best wishes to all attending the upcoming International Conference on Modern Trends in Computers and Electronics (ICMCE 2025) held at our university.*

This international gathering stands as a testament to the power of collaboration, innovation, and shared knowledge that transcends borders. We are proud to host such a diverse and distinguished group of scholars, researchers, and professionals who are committed to advancing understanding and driving progress in the domains of computing and electronics.

May this conference be a fruitful platform for meaningful dialogue, insightful discoveries, and enduring partnerships! Thank you for being part of this important event, and once again, welcome to TMU."

Message by Prof. (Dr.) V. K. Jain

(Hon'ble Vice-Chancellor, Teerthanker Mahaveer University in Moradabad, Uttar Pradesh)

"*I am delighted to extend my warmest greetings to all the esteemed researchers, academicians, industry professionals, and students participating in the International Conference on Modern Computing and Electronics (ICMCE-2025) at Teerthanker Mahaveer University. This prestigious event serves as a dynamic platform for sharing cutting-edge innovations, discussing emerging trends, and fostering collaborations in the ever-evolving fields of Computer Science and Electronics Engineering.*

With rapid advancements in Artificial Intelligence, Machine Learning, Internet of Things (IoT), Quantum Computing, VLSI, and Embedded Systems, the role of technology in shaping the future has never been more significant. ICMCE-2025 aims to bring together experts from academia and industry to address the challenges and opportunities presented by these transformative technologies.

I am pleased to acknowledge the commendable efforts of the organizing team in curating an intellectually enriching conference. I am confident that the discussions, paper presentations, and

keynote sessions will contribute to the global knowledge ecosystem and inspire groundbreaking research.

I extend my best wishes for the success of ICMCE-2025 and hope that all participants make the most of this opportunity to engage, innovate, and lead the way in technological advancements."

Message by Prof. Rakesh Kumar Dwivedi

(Hon'ble Dean FoE and Conference General Chair)

"*It is with great enthusiasm that I welcome all participants, distinguished speakers, and researchers to the International Conference on Modern Computing and Electronics (ICMCE-2025), organized by the Faculty of Engineering, Teerthanker Mahaveer University. This conference serves as a significant platform for scholars and industry experts to exchange ideas, present innovative research, and explore advancements in Computer Science and Electronics Engineering.*

In an era driven by Artificial Intelligence, Machine Learning, IoT, Cyber security, 5G Communication, and VLSI Design, the role of engineers and researchers is more crucial than ever. ICMCE-2025 aims to foster meaningful discussions on emerging trends, novel methodologies, and interdisciplinary approaches that will shape the future of technology and innovation.

I take this opportunity to appreciate the dedication of the organizing committee and the invaluable contributions of our keynote speakers, panelists, and participants. I am confident that this conference will pave the way for groundbreaking research collaborations and technological advancements that will have a lasting impact on academia and industry alike.

I extend my best wishes for a successful and insightful ICMCE-2025 and encourage all participants to engage, collaborate, and make the most of this remarkable gathering of minds."

Message by Dr. Gulista Khan

(Convener, International Conference on Modern Trends in Computer and Electronics)

"*It is an immense honor for me to welcome you all to the International Conference on Modern Trends in Computer and Electronics. As the Convener of this prestigious event, I am thrilled to see so many brilliant minds gathered here to explore and discuss the latest innovations and trends that are shaping the future of technology.*

We are witnessing an era where technological advancements in computer science, electronics, and communication are progressing at an unprecedented pace. From artificial intelligence to quantum computing, from the Internet of Things to machine learning, these innovations are not only transforming industries but also revolutionizing the way we live, work, and interact with the world around us.

This conference is a testament to the power of collaboration and knowledge sharing. It provides an invaluable platform for researchers, professionals, and thought leaders from around the globe to come together, exchange ideas, and drive forward the technological solutions that will shape the future. The interdisciplinary nature of our discussions here will help foster new collaborations and provide fresh perspectives on tackling the challenges that lie ahead.

At the heart of this gathering is the collective desire to push the boundaries of what is possible. As we explore the latest trends and developments, it is crucial that we remain mindful of the responsibility that comes with these innovations. Technology must not only be advanced but must also be inclusive, sustainable, and ethically designed to benefit society as a whole.

I extend my heartfelt thanks to all the participants, speakers, and sponsors who have made this event possible. I encourage everyone to take full advantage of the sessions, workshops, and networking opportunities that will take place over the course of this conference. Let us continue to challenge ourselves, learn from one another, and work together to pave the way for a brighter technological future.

Thank you and I look forward to the inspiring discussions and breakthroughs that will emerge from this conference."

Message from Dr. Alka Verma

(Convener, International Conference on Modern Trends in Computer and Electronics)"*It is with great pleasure and enthusiasm that I welcome you to the International Conference on Modern Trends in Computer and Electronics. As technology continues to evolve at an unprecedented pace, this conference aims to provide a platform for professionals, researchers, and students to exchange ideas, present groundbreaking research, and explore the latest trends in the fields of computer science and electronics. The rapid advancements in these domains have*

brought about transformative changes in society, industry, and everyday life. From Artificial Intelligence and Machine Learning to Internet of Things (IoT) and next-generation communication systems, the conference will focus on the innovative breakthroughs shaping the future. It is our collective responsibility to explore these innovations, understand their implications, and harness their potential for the benefit of humanity.

We are honored to host a diverse group of experts from across the globe, and I am confident that this conference will foster meaningful discussions, collaborations, and learning opportunities. Together, we can pave the way for a future powered by cutting-edge technology and sustainable solutions.
I look forward to your active participation and a successful, enriching conference experience."

Message from Prashant Kumar

(Co-convener, International Conference on Modern Trends in Computer and Electronics)

"*On behalf of the organizing committee, it is my great honor and privilege to welcome you to the International Conference on Electronics and Computers (ICMCE). As co-convener of this prestigious event, I am delighted to witness the gathering of brilliant researchers, industry leaders, and experts from around the world, all united by a common goal: to advance the fields of electronics and computer engineering.*

This conference serves as an invaluable platform for the exchange of knowledge, innovative ideas, and cutting-edge research that are shaping the future of electronics and computing. With advancements in artificial intelligence, machine learning, embedded systems, and more, the role of electronics and computers in driving societal and technological change has never been more critical.

I am confident that this conference will offer insightful discussions, foster collaborations, and inspire new solutions to the challenges we face in the evolving landscape of technology. I encourage all participants to engage, network, and share their expertise to enrich the experience of this event.

Heartfelt thanks to all the speakers, participants and partners who have made this conference possible. Together, let us embark on a journey of learning, innovation, and progress.
Best wishes for a successful and productive conference!"

Messagesfrom OurEminent Speakers

Message by Mr. Rajesh Gupta

(Chief Guest ICMCE 2025, and Dy. Director General, Department of Telecommunication, Ministry of Communication)

"*It is with great pleasure that I address you all today at the International Conference on Modern Trends in Computer and Electronics. As a representative of the Ministry of Communication, I am excited to see so many brilliant minds gathered here to discuss the latest advancements in the ever-evolving fields of computer science and electronics.*

The digital revolution has brought about profound changes to every sector, especially in communication. The intersection of communication technologies with modern trends in computer science and electronics has reshaped the way we connect, work, and innovate. Today, we are witnessing transformative breakthroughs such as 5G, artificial intelligence, IoT, and quantum computing, all of which are set to redefine industries and societies alike.

In the Ministry of Communication, we are deeply committed to driving these innovations forward, ensuring that our infrastructure is ready to support the technological advancements that will shape the future. Whether it's ensuring better connectivity across rural areas or facilitating next-generation communication systems, we understand that the role of effective, modern electronics and computing is crucial in bridging gaps and providing equitable access to technology for all.

The rapid pace of technological growth presents both opportunities and challenges. It is essential for us as engineers, policymakers, and researchers to collaborate and ensure that these trends are harnessed responsibly and for the collective benefit of society. This conference provides an invaluable platform to exchange ideas, share research, and forge partnerships that can propel us towards a future where technology is used to improve lives and foster sustainable development.

I encourage all of you to take full advantage of the diverse discussions, presentations, and networking opportunities available here. Let us continue to innovate, explore new horizons, and work together to leverage technology for the greater good.

I look forward to seeing the fruits of this conference in the exciting projects and solutions that will emerge from our shared efforts."

Message by Dr. P K Garg, Emeritus Fellow, IIT Roorkee

“It is a great honor for me to be the part of the International Conference on Modern Trends in Computer and Electronics. This is an exciting time for the field of computer science and electronics, as we stand on the threshold of new advancements that promise to shape the future in unimaginable ways.

The rapid evolution of technology has fundamentally changed our lives, from how we communicate to how we work and solve problems. The integration of artificial intelligence, machine learning, quantum computing, and the Internet of Things is creating new opportunities for innovation, and is opening doors to areas that were once only a dream. As researchers and engineers, it is our responsibility to explore these emerging trends, push the boundaries of what is possible, and ensure that the technologies we develop serve humanity in meaningful ways.

This conference serves as a crucial platform for sharing knowledge, exchanging ideas, and collaborating with experts across the globe. It is a reminder that progress in these fields is only possible through collective effort and interdisciplinary cooperation. I encourage all of you to actively engage in discussions, challenge established norms, and seek innovative solutions to the problems we face today.

The road ahead will not always be easy, but it will undoubtedly be filled with opportunities for discovery and growth. I look forward to the inspiring sessions, insightful presentations, and fruitful discussions that will take place over the course of this conference. Let us work together to shape the future of technology for the betterment of society.”

Messagesfrom International Keynote Speakers

Message by Dr. Ivo Marković

(Researcher & Engineer at Department of General Electrical Engineering, University of Belrade, Serbia)

"It gives me immense pleasure to be part of the International Conference on Modern Computing and Electronics (ICMCE-2025) hosted by Teerthanker Mahaveer University. As we navigate through an era defined by rapid digital transformation, the convergence of computing and electronics stands as a cornerstone for innovation across disciplines.

This conference arrives at a pivotal moment—where advancements in Artificial Intelligence, Cyber-Physical Systems, Quantum Technologies, and Intelligent Communication Networks are not only disrupting traditional paradigms but also opening doors to new scientific frontiers. Such progress calls for active collaboration between academia, industry, and research institutions, and ICMCE-2025 provides the ideal setting for such synergy.

What makes gatherings like this truly valuable is not just the sharing of knowledge—but the building of communities, the sparking of ideas, and the collective pursuit of solutions to global challenges. The strength of this conference lies in the diversity of perspectives it brings together—from seasoned researchers to aspiring young innovators.

I thank the organizing team for their dedication in creating this platform and commend their vision in fostering dialogue around emerging technologies. I encourage each participant to make the most of this opportunity: engage wholeheartedly, question critically, and connect meaningfully.

May ICMCE-2025 inspire new collaborations and mark the beginning of groundbreaking research journeys. Wishing you all a thought-provoking and impactful conference."

Message by Dr. HuānBì

(Professor at University of Electro-Communications, Japan)

"It is my great pleasure to extend warm greetings to all participants of this important conference on Modern Trends in Electronics and Computer Engineering. In recent years, the rapid convergence of electronics, artificial intelligence, and advanced computing systems has been reshaping the fabric of our digital society. From quantum computing and neuromorphic chips to edge AI and the Internet of Things (IoT), our field is experiencing unprecedented innovation and impact.

As researchers and professionals, we are not only witnesses but also active contributors to these transformations. This conference provides an essential platform for the exchange of ideas, collaborative discovery, and the fostering of interdisciplinary dialogue. I encourage each of you to share your insights, challenge assumptions, and explore the frontiers of what is possible.

Let us continue to push the boundaries of knowledge with integrity, curiosity, and a commitment to global progress.

With best wishes for a successful and inspiring conference,Dr. HuānBì, Department of Computer and Network Engineering, The University of Electro-Communications, Japan

Message by Dr. Milka Potrebic Ivanis

(Professor, Department of General Electrical Engineering, University of Belrade, Serbia)

"*It is an honor and privilege to be a part of the International Conference on Modern Computing and Electronics (ICMCE-2025) at Teerthanker Mahaveer University. In today's fast-evolving technological landscape, the fusion of Computer Science and Electronics Engineering plays a crucial role in shaping the future of industries, research, and society.*

ICMCE-2025 serves as a dynamic platform for global scholars, researchers, and industry professionals to exchange groundbreaking ideas, present innovative research, and collaborate on emerging technologies. With key areas such as Artificial Intelligence, IoT, Quantum Computing, Embedded Systems, and Communication Networks, this conference will undoubtedly pave the way for transformative advancements.

I extend my gratitude to the organizing committee for their efforts in bringing together such a distinguished gathering of experts. I encourage all participants to engage in fruitful discussions, explore new possibilities, and contribute to the advancement of knowledge in these vital fields.

Wishing you all an inspiring and successful conference!"

Message by Dr. Avtar Singh

(Professor at Adama Science and Technology University, Adama, Ethiopia)

"It is with sincere appreciation that I share my greetings with all participants of the International Conference on Modern Computing and Electronics (ICMCE-2025), hosted by Teerthanker Mahaveer University. In recent years, the boundaries between disciplines like computing, electronics, and intelligent systems have blurred, creating a vibrant ecosystem where innovation thrives. ICMCE-2025 stands as a testament to the spirit of collaboration and forward thinking that drives modern research.

This conference brings together a community committed not only to technical excellence but also to addressing global challenges through technology—whether in sustainable systems, resilient communication frameworks, or smarter automation.

Such academic forums remind us that knowledge exchange is the cornerstone of progress. I commend the organizers for fostering an environment that encourages bold ideas and critical engagement.

I hope each of you finds inspiration, builds lasting connections, and contributes meaningfully to the collective pursuit of knowledge. My best wishes for a successful and impactful conference."

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INTERNATIONAL INDUSTRIAL DELEGATES AND SPEAKERS
INTERNATIONAL CONFERENCE
MODERN TRENDS IN COMPUTERS AND ELECTRONICS
ICMCE-2025
DATE
10th May, Saturday, 2025
TIME
10.00 AM (IST)Onwards
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University Auditorium, TMU
ORGANIZED BY :
Department of Computer Science & Engineering and Electronics & Communication Engineering
Teerthanker Mahaveer University College of Engineering,
TMU, Moradabad (U.P.), India-244001


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Asst. Prof. (Dr.) Vijay Kumar Sharma Madan Mohan Malaviya University of Technology, Gorakhpur
International Conference on Modern Trends in Computers and Electronics
10th May (Saturday), (ICMCE-2025)
2025
Organized By
Department of Computer Science & Engineering
and
Electronics & Communication Engineering
Teerthanker Mahaveer University College of Engineering
TMU, Moradabad (U.P.), India-244001

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Keynote Talks

Reconfigurable Devices Using Memristors

[1]Ivo Marković,[2] Milka Potrebić Ivaniš,[3] Dejan Tošić

[1,2,3] School of GeneralElectrical Engineering, University of Belgrade, Serbia

The growing demand for adaptive, energy-efficient electronics continues to push the boundaries of reconfigurable device design. Emerging memristor technologies present a promising avenue to extend these boundaries even further. With features such as non-volatility, nanoscale dimensions, CMOS compatibility, and ultra-low power consumption, memristors offer a compelling platform for realizing highly compact and programmable systems.

This talk explores how memristors enable reconfigurable functionality across RF, analog, and digital domains. We review recent advancements in integrating memristors into analog and microwave circuits, demonstrating how their memory and switching capabilities enable dynamic system control while reducing footprint and power consumption. We also address circuit-level innovations and practical implementation challenges.

Ultimately, we offer a forward-looking perspective on the transformative role of memristive technologies in shaping reconfigurable electronics. The implications of these advancements for next-generation communication and sensing systems, including applications in 5G/6G, IoT, and edge AI, will also be discussed. Attendees will gain insights into emerging architectures and the potential of memristors to redefine hardware adaptability

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Digital Electronics for Societal Applications

Prof. P K Garg

Indian Institute of Technology, Roorkee

Email: pkgiitr@gmail.com

Computer science and electronics share a profound synergy, each advancing the other to drive innovation in modern technology. Electronics significantly extend the capabilities of computing systems, enabling automation, efficient communication, and data-driven decision-making across diverse domains such as healthcare, education, research, and industry.

At the heart of this technological evolution lies digital electronics—a dynamic discipline integrating hardware design with computational logic. It underpins the development of microprocessors, embedded systems, AI, robotics, and advanced communication technologies. Innovations in miniaturization, processing power, and wireless systems have revolutionized how we live, work, and interact.

This talk will highlight transformative applications of digital electronics and computational technologies in areas such as agriculture, healthcare, education, AR/VR, smart cities, and industrial automation. It will also explore the societal impact of emerging technologies like artificial intelligence, quantum computing, and the Internet of Things. Together, these advancements are shaping a more connected, intelligent, and equitable world.

International Conference on Modern Trends in Computers and Electronics

Department of Computer Science and Engineering and
Electronics & Communication Engineering
Teerthanker Mahaveer University **College of Engineering**
Date: 10th May 2025 (Saturday)

Program Schedule

Time	Event
10:30-12:00 noon	**Inaugural Function**
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9:30 am	High Tea
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11:03am -11:07am	**Welcome Dance**
11:07am-11:15 am	**Welcome Address:** **Prof. (Dr.) R.K.Dwivedi**(Convener General Chair ICMCE-2025)
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12:50-1:10pm	**Keynote Address** by International Speaker Dr. Ivo Marković (Researcher &Engineer at Department of General Electrical Engineering, University of Belrade, Serbia)
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Developing Generative AI Features for Enhancing Search Functionalities in E-commerce Platforms

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ABSTRACT

The advent of Generative Artificial Intelligence (AI) presents significant opportunities for enhancing search functionalities on e-commerce platforms. This manuscript explores the integration of generative AI models in refining product searches, personalizing user experiences, and optimizing the overall search system architecture. It presents an analysis of current challenges in e-commerce search systems, including limitations in traditional search algorithms and the potential role of AI-driven features such as natural language understanding, contextual awareness, and personalized recommendations. By leveraging advanced deep learning models, this research suggests several methodologies to implement generative AI for improving search relevance, reducing search latency, and enhancing user satisfaction. The findings suggest that generative AI models can significantly impact key metrics like click-through rates (CTR), conversion rates, and user retention. However, the approach also presents challenges related to computational efficiency, data privacy, and the need for continuous model training. The study concludes with suggestions for future work and limitations in current technological applications.

Keywords: *Generative AI, e-commerce search, machine learning, search engine optimization, natural language processing, recommendation systems, deep learning, user experience, AI in retail, personalized search.*

Cybersecurity Challenges in Deploying SAP Solutions on Cloud Platforms

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ABSTRACT

The rapid adoption of cloud computing has enabled organizations to implement SAP solutions with enhanced scalability, flexibility, and cost efficiency. However, the transition to cloud platforms introduces significant cybersecurity challenges, including data breaches, compliance risks, access management issues, and infrastructure vulnerabilities. This study investigates the key cybersecurity challenges associated with deploying SAP solutions on cloud platforms and proposes mitigation strategies. By conducting a comprehensive literature review and analyzing practical case studies, this paper highlights the critical aspects of cloud security, focusing on the shared responsibility model, encryption practices, and regulatory compliance. The findings aim to guide organizations in implementing secure and efficient SAP deployments on cloud platforms.

Keywords: *SAP solutions, cloud security, cybersecurity challenges, shared responsibility model, compliance, encryption, access management.*

Outlier Detection Systems: Enhancing E-commerce Integrity with Machine Learning

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ABSTRACT

Outlier detection systems thus play a very critical role in maintaining the integrity of e-commerce platforms by discovering anomalous patterns in transactions, user behavior, and operational data. These leverage advancements in machine learning to enhance the detection of fraudulent activities, abnormal trends, and operational inefficiencies. E-commerce platforms can therefore detect outliers in high-dimensional datasets with precision by applying supervised, unsupervised, and hybrid ML techniques that assure strong fraud prevention and operational resilience. Moreover, the scalability and adaptability of machine learning-based approaches rise to meet evolving threats and changing market dynamics. This paper will explore methodologies, challenges, and benefits involved in the implementation of ML-powered outlier detection systems in e-commerce, underlining their potential to reinforce trust, improve user experience, and optimize platform security.

Keywords: *Outlier detection systems, e-commerce integrity, machine learning, anomalous patterns, fraud detection, supervised learning, unsupervised learning, hybrid ML techniques, operational efficiency, trust, user experience.*

Cloud-Integrated Machine Learning Pipelines for Scalable Solutions

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ABSTRACT

In the era of big data and rapidly evolving digital ecosystems, the integration of cloud computing with machine learning has emerged as a transformative approach to addressing the scalability and performance challenges of modern applications. Cloud-integrated machine learning pipelines enable organizations to leverage the vast computational resources of cloud platforms, providing scalable, flexible, and cost-effective solutions for data processing, model training, and deployment. This integration simplifies complex workflows by orchestrating data ingestion, preprocessing, model optimization, and real-time inference within unified cloud ecosystems.

Such pipelines allow for seamless collaboration among data scientists, engineers, and business stakeholders to drive innovation through automation and reproducibility. In addition, cloud-integrated pipelines will decouple computational tasks and leverage either serverless architectures or containerized solutions to provide efficient utilization of resources that can scale dynamically according to workload demand. Moreover, such pipelines will further improve data governance and security through strong compliance frameworks and encryption standards native to the cloud platforms.

The application of cloud-integrated machine learning pipelines is pervasive in such diverse fields as healthcare, finance, e-commerce, and autonomous systems, where the essence of agility and scalability lies. This paper analyzes the essential elements of such pipelines, their effectiveness in practical applications, and future trends, such as the integration of edge computing, federated learning, and green AI strategies. This would help to enable the transformation of raw data into actionable insights to achieve operational excellence and drive sustainable growth by harvesting the power of cloud-integrated machine learning pipelines in an increasingly competitive digital landscape for organizations.

Keywords: *Cloud computing, machine learning pipelines, scalability, big data, serverless architecture, data processing, model training, automation, resource optimization, edge computing, federated learning, green AI, real-time inference, data governance, operational efficiency.*

Machine Learning APIs for Seamless Integration in Business Processes

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ABSTRACT

The integration of machine learning into business operations has been revolutionized by the rise of powerful Application Programming Interfaces (APIs). APIs are intermediaries that let organizations integrate potent ML features without extensive in-house knowledge or infrastructure. The vast range of uses for these APIs includes predictive analytics, natural language processing, image recognition, and process automation—all of which help to elevate decision-making and operational efficiency within a business. The adoption of ML APIs is democratizing access to advanced technologies by allowing any organization, big or small, to harness the insights from large-scale data analysis. Most of these are cloud-based, ensuring their scalability, reliability, and cost-effectiveness. Moreover, the modularity and interoperability of APIs make them easy to integrate into already existing systems, thus further speeding up their deployment and adaptability in an ever-changing business environment.

This abstract tackles the role of machine learning APIs as a transformative force in traditional business practices. It pinpoints their ability to drive innovation, improve customer experiences, and enable data-driven decision-making. Simplifying the implementation of ML solutions, APIs have become critical tools for any organization willing to remain competitive at the forefront of the digitally driven business world.

Keywords: *Machine learning APIs, business integration, predictive analytics, natural language processing, image recognition, process automation, decision-making, operational efficiency, cloud-based solutions, scalability, interoperability, modularity, data-driven decision-making, innovation, digital transformation.*

Leveraging AI for Real-Time Detection of Harmful Content

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ABSTRACT

The rise of user-generated content on digital platforms has led to the requirement of real-time systems for the detection of harmful content. Artificial Intelligence has become a game-changer with advanced capabilities in natural language processing, computer vision, and predictive analytics to detect and mitigate harmful content at scale. This manuscript will explore how AI is being applied to real-time harmful content detection, analyzing state-of-the-art techniques, challenges, and outcomes. This study, therefore, provides a framework for using AI effectively while considering ethical considerations and operational limitations.

Keywords: *Artificial Intelligence, harmful content detection, real-time systems, content moderation, ethical AI.*

Scaling KYC Processes for Global Platforms Using AI and ML

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ABSTRACT

Know Your Customer (KYC) processes are critical to maintaining compliance and reducing fraud in global platforms. However, traditional KYC systems face significant challenges in scalability and efficiency due to the diverse regulatory requirements and massive user volumes. This manuscript explores how Artificial Intelligence (AI) and Machine Learning (ML) can enhance and scale Know Your Customer processes for global platforms. With the power of advanced techniques like natural language processing, computer vision, and predictive analytics, AI and ML enable real-time identity verification and fraud detection while ensuring regional regulatory compliance. The study provides insights into current methodologies, statistical analysis, and future trends for scaling KYC processes using AI and ML.

Keywords: *KYC, artificial intelligence, machine learning, identity verification, compliance, fraud detection.*

The Role of Explainable AI in Building Trust in Automated Moderation

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ABSTRACT

The rapid development of artificial intelligence has revolutionized automated content moderation by offering efficient ways of managing the growing user-generated content across digital platforms. However, the opaqueness of AI systems instills a number of concerns regarding trust, fairness, and accountability. Explainable AI, thus, emerges as an important juncture that provides insight into the automated decision-making processes. This manuscript explores the role of explainable AI in fostering trust within automated moderation by enhancing transparency, improving user trust, and ensuring ethical governance in content moderation practices. It also goes on to discuss the present status of XAI, its applications, limitations, and future scope in engendering trust.

Keywords: *Explainable AI, trust, automated moderation, transparency, ethical AI.*

Predictive Analytics in E-commerce: Enhancing Customer Retention Through Machine Learning

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ABSTRACT

Predictive analytics has become a game-changing tool in e-commerce, where machine learning helps improve customer retention and optimize business outcomes. The predictive models, after the analysis of historical data, recognize patterns in behavior and enable a business to predict the needs of customers, provide tailored experiences, and proactively take action against the possibility of churn. This paper explores the integration of machine learning techniques such as clustering, classification, and recommendation algorithms to build specific retention strategies. It finds major applications in personalization of marketing, dynamic pricing, and prediction of churn that drive better satisfaction and long-term loyalty among customers. The research points out challenges such as data privacy and algorithmic bias and seeks solutions for ethical and efficient implementation. These insights underpin the potential of predictive analytics in redefining customer engagement and fostering sustainable growth in the competitive e-commerce landscape.

Keywords: *Predictive analytics, e-commerce, customer retention, machine learning, personalized marketing, churn prediction, dynamic pricing, data-driven insights, customer engagement, algorithmic bias.*

Machine Learning Models for Fraud Detection in Online Marketplaces

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ABSTRACT

Fraud detection in online marketplaces has become a critical area of research due to the increasing sophistication and frequency of fraudulent activities. Machine learning models are promising solutions for the identification and mitigation of fraud, as they use large datasets and advanced algorithms to identify hidden patterns and anomalies. This study will approach the application of different machine learning methods, including supervised, unsupervised, and hybrid models, in detecting fraudulent transactions and user behaviors in online platforms. The supervised models, such as decision trees, support vector machines (SVMs), and neural networks, use labeled datasets to achieve high accuracy in classifying fraudulent activities. Unsupervised techniques, such as clustering and anomaly detection, have proven to be particularly useful in identifying new and emerging patterns of fraud. Hybrid methods that combine these approaches have shown improved performance by exploiting the strengths of each technique. The integration of advanced techniques, such as deep learning, ensemble models, and reinforcement learning, further enhances the efficiency and scalability of fraud detection systems. Challenges related to imbalanced datasets, evolving fraud strategies, and data privacy are also presented, together with possible solutions. This review emphasizes the multidisciplinary nature of fraud detection, which involves the integration of technological advancements and domain-specific knowledge to effectively protect online marketplaces from fraudulent activities.

Keywords: *Fraud detection, online marketplaces, machine learning, supervised learning, unsupervised learning, hybrid models, anomaly detection, deep learning, ensemble models, reinforcement learning, data privacy, imbalanced datasets, cybersecurity.*

AI Ethics in Machine Learning: Implications for Predictive Modeling

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ABSTRACT

Rapid advancements in machine learning and artificial intelligence (AI) have revolutionized predictive modeling, offering unprecedented accuracy and utility in a wide range of domains, from healthcare to finance. However, these advances bring pressing ethical concerns that need to be addressed to ensure the responsible deployment of AI systems. Key issues here include algorithmic bias, transparency, accountability, data privacy, and the societal implications of predictive decisions. This paper explores the ethical challenges arising from machine learning in predictive modeling and considers strategies for the mitigation of potential harms through fairness-aware algorithms, interpretability, and regulatory compliance. Addressing these ethical dimensions can ensure that technological innovation aligns with societal values and that AI-driven predictive models enhance human well-being without compromising ethical principles.

Keywords: *AI ethics, machine learning, predictive modeling, algorithmic bias, transparency, accountability, data privacy, fairness-aware algorithms, interpretability, regulatory compliance, ethical AI, societal impact, responsible AI development, bias mitigation, ethical implications of AI.*

Improving Trading Strategies with Machine Learning in Commodity Markets

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ABSTRACT

Machine learning in the realm of trading strategies has managed to transform the entire process of analysis and decision-making within commodity markets. The present paper investigates how machine learning techniques enhance trading strategies, which improve predictive accuracy, risk management, and adaptive decision-making. It highlights the application of supervised learning algorithms for price forecasting, unsupervised learning for market segmentation, and reinforcement learning for optimal portfolio management. Important developments include using feature engineering for macroeconomic and market-specific indicators analysis and deep learning techniques to process high-dimensional and unstructured data. This paper also presents some major challenges of overfitting, data quality, and model interpretability and proposes solutions such as robust cross-validation and explainable AI. Leading through case studies and real-world applications, the research shows how machine learning models adapt to dynamic market changes and hence optimize the trading performance in commodity markets. The results provide actionable insights for traders, investors, and financial institutions who intend to take advantage of state-of-the-art technologies in the competitive financial landscape.

Keywords: *Machine learning, trading strategies, commodity markets, price forecasting, risk management, supervised learning, unsupervised learning, reinforcement learning, feature engineering, deep learning, market segmentation, portfolio optimization, explainable AI, adaptive decision-making, financial technology.*

Leveraging Private AI for Secure and Compliant Cloud Computing

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ABSTRACT

Private AI is an innovative means of ensuring secure and compliant cloud computing that will support complex analytics and machine learning while safeguarding sensitive data. The paper will discuss the relevance of Private AI in addressing issues of privacy, security, and regulatory concerns within the cloud environment.

An in-depth literature review, coupled with statistical analysis of adoption trends and a practical methodology, discloses how the private AI system can instill trustworthiness within cloud computing ecosystems. The results point to its ability to revolutionize industries reliant on secure data processing to make new, transformational applications possible.

Keywords: *Private AI, secure cloud computing, data privacy, compliance, machine learning*.

Comparative Analysis: Oracle SCM vs Other ERP Solutions in the Market

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ABSTRACT

The integration of Supply Chain Management (SCM) systems within Enterprise Resource Planning (ERP) frameworks is pivotal in driving operational efficiency in modern enterprises. Oracle SCM, a leading solution in this domain, offers a comprehensive suite of tools that streamline end-to-end supply chain processes. This study provides a comparative analysis of Oracle SCM with other leading ERP solutions, such as SAP S/4HANA, Microsoft Dynamics 365, and Infor CloudSuite. The analysis evaluates these platforms based on features, scalability, customization, ease of use, cost-effectiveness, and industry adoption. The findings indicate that while Oracle SCM stands out in scalability and advanced analytics, other solutions present unique strengths in affordability, integration flexibility, and niche capabilities. This paper offers actionable insights for organizations selecting the most suitable ERP solution for their specific needs.

Keywords: *Oracle SCM, SAP S/4HANA, Microsoft Dynamics 365, Infor CloudSuite, ERP, supply chain management, scalability, cost-effectiveness.*

Future of ERP Systems in Managing Multi-Channel Supply Chains

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ABSTRACT

The evolution of Enterprise Resource Planning (ERP) systems has been pivotal in managing complex supply chains, especially as businesses transition to multi-channel operations. This manuscript explores the future trajectory of ERP systems in handling multi-channel supply chains, emphasizing the integration of advanced technologies such as artificial intelligence, machine learning, and Internet of Things (IoT). Through a comprehensive literature review and empirical analysis, the study identifies key trends, challenges, and opportunities in leveraging ERP systems for enhanced supply chain efficiency, agility, and responsiveness. The findings suggest that the future of ERP systems lies in their ability to provide real-time data analytics, seamless integration across various channels, and adaptive functionalities that cater to the dynamic nature of modern supply chains. The study concludes by outlining the potential scope for further research and acknowledging the limitations inherent in the current technological landscape.

Keywords: *ERP Systems, Multi-Channel Supply Chains, Supply Chain Management, Digital Transformation, Integration, Automation, Data Analytics.*

Exploring the role of large language models (LLMs) in automated business decision-making

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ABSTRACT

Large Language Models (LLMs) have gained significant attention for their transformative potential in various sectors, including business decision-making. This paper explores the application of LLMs in automating business decisions, aiming to enhance decision accuracy, speed, and scalability. The use of natural language processing (NLP) capabilities within LLMs offers insights into market trends, customer preferences, and organizational needs, ultimately driving efficiency and innovation in business processes. This research investigates the methodologies for integrating LLMs into business systems, evaluates the results of these integrations, and outlines the future potential of these models in reshaping business operations.

Keywords: *Large Language Models, Business Decision-Making, Automation, Natural Language Processing, AI in Business, Automated Systems*

AI-Driven Chatbots for Mental Health Support: Opportunities and Challenges

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ABSTRACT

With the increasing demand for mental health services, artificial intelligence (AI)-driven chatbots have emerged as a potential tool to provide scalable and accessible mental health support. These chatbots leverage natural language processing (NLP) and machine learning (ML) algorithms to offer therapeutic conversations, cognitive behavioral therapy (CBT) exercises, and emotional support. The integration of AI in mental health support presents numerous opportunities, including cost-effectiveness, continuous availability, and reduced stigma associated with seeking help. Additionally, AI-driven chatbots can assist in early detection of mental health issues through sentiment analysis and behavioral pattern recognition.

However, significant challenges persist, such as ethical concerns, data privacy issues, and the limitations of AI in understanding human emotions. Ensuring responsible AI deployment and developing more sophisticated algorithms for emotional intelligence remain key areas for future research. This paper explores the potential of AI-driven mental health chatbots, reviews existing literature, discusses methodologies for chatbot development, presents statistical analyses and simulation results, and concludes with insights into their future development.

Keywords: *AI chatbots, mental health support, machine learning, natural language processing, cognitive behavioral therapy, ethical concerns, data privacy.*

Cybersecurity Challenges in Healthcare: Mitigating Ransomware and Data Breaches

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ABSTRACT

The healthcare industry has increasingly become a target for cyber threats, particularly ransomware attacks and data breaches. The high value of patient data, combined with outdated security systems and human errors, has made healthcare institutions a lucrative target for cybercriminals. With the integration of digital technologies, including electronic health records (EHRs) and cloud-based storage, the risks associated with cyberattacks have grown exponentially. This paper explores the primary cybersecurity challenges in healthcare, focusing on ransomware attacks and data breaches.

It examines existing literature, methodologies for mitigating threats, statistical analysis, and simulation research to evaluate the effectiveness of current cybersecurity measures. Our findings indicate that a combination of robust cybersecurity policies, advanced encryption, employee training, and AI-based security systems can significantly reduce vulnerabilities in healthcare organizations. Furthermore, the study emphasizes the importance of compliance with government regulations and the need for continuous investment in cybersecurity infrastructure.

Keywords: *Cybersecurity, Healthcare, Ransomware, Data Breach, Encryption, Artificial Intelligence, Risk Mitigation, Compliance.*

The Impact of AI on Cybersecurity Threat Landscapes

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ABSTRACT

The rapid advancements in Artificial Intelligence (AI) have significantly influenced various domains, including cybersecurity. While AI enhances cybersecurity measures by automating threat detection, mitigating attacks, and improving response mechanisms, it also empowers cybercriminals to develop sophisticated attack vectors.

This paper explores the dual role of AI in cybersecurity by analyzing recent trends, statistical data, and methodologies employed to counteract AI-driven threats. Through a comprehensive study, we evaluate the evolving threat landscape and propose future research directions to ensure a balanced and secure cyber ecosystem.

Keywords: *AI, Cybersecurity, Threat Landscapes, Cyber Attacks, Machine Learning, Cyber Defense.*

Forecasting the Future of AI in Consumer Electronics

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ABSTRACT

This study investigates the transformative role of artificial intelligence (AI) in consumer electronics and develops a forecasting framework to predict its future trends. Drawing upon current technological advancements, market dynamics, and consumer behavior patterns, the research applies a hybrid methodological approach that combines statistical analysis with simulation-based forecasting. Using historical market data and simulated scenarios via Monte Carlo techniques, the study forecasts potential adoption rates, revenue impacts, and innovation trajectories within the consumer electronics industry. The results indicate significant growth in AI-enabled devices, with substantial variability driven by technological breakthroughs and market receptivity. These findings are pivotal for industry stakeholders, policymakers, and researchers aiming to harness AI's potential in consumer electronics while mitigating associated risks and challenges.

Keywords: *AI, Consumer Electronics, Forecasting, Simulation, Market Growth, Innovation, Future Technologies.*

Enhancing Cybersecurity with AI-Driven Threat Detection Systems

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ABSTRACT

In today's digital era, the rapid evolution of cyber threats necessitates a proactive approach to cybersecurity. Traditional security mechanisms often struggle to keep pace with sophisticated attacks, resulting in significant vulnerabilities. This manuscript investigates the integration of Artificial Intelligence (AI) into threat detection systems, aiming to enhance cybersecurity through advanced machine learning (ML) and deep learning (DL) techniques. By automating threat analysis and incorporating real-time learning, AI-driven systems offer the potential to identify, predict, and mitigate attacks more effectively than conventional methods. We review current literature on AI applications in cybersecurity, describe a robust methodology that utilizes supervised and unsupervised learning algorithms to analyze network traffic and detect anomalies, and present simulated experimental results demonstrating improved detection rates and reduced false positives. The findings indicate that integrating AI into cybersecurity infrastructures can significantly bolster an organization's defense capabilities, though challenges related to data quality, interpretability, and evolving adversarial techniques remain. Future research directions include the incorporation of explainable AI (XAI) models and further optimization for large-scale real-time processing. Overall, this manuscript provides an in-depth analysis of AI-driven threat detection, highlighting its transformative potential in enhancing cybersecurity while outlining the limitations and future scope of research in this dynamic field.

Keywords: *Artificial Intelligence, Cybersecurity, Threat Detection, Machine Learning, Deep Learning, Anomaly Detection, Security Automation.*

Integrating Generative AI into E-commerce Platforms for Enhanced User Experience

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ABSTRACT

E-commerce platforms have transformed the global marketplace, offering unparalleled convenience and accessibility. However, user engagement and personalization remain key challenges. Generative AI has emerged as a revolutionary technology, enhancing e-commerce experiences by providing personalized recommendations, intelligent chatbots, and dynamic content generation. This paper explores the integration of Generative AI into e-commerce platforms, analyzing its impact on user engagement, conversion rates, and customer satisfaction. A review of existing literature is provided, followed by a discussion of methodologies used to implement AI-driven features in e-commerce. Results indicate that Generative AI significantly improves user experience, fostering higher engagement and increased sales. Finally, we discuss future prospects, challenges, and ethical considerations associated with AI integration in e-commerce.

Keywords: *Generative AI, E-commerce, Personalization, Chatbots, Machine Learning, Recommendation Systems, Customer Experience.*

Best Practices for Architecting Cloud-Native Applications

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ABSTRACT

Cloud-native applications have redefined how modern businesses build, deploy, and scale software. By leveraging microservices, containerization, and agile development methodologies, organizations can create resilient and scalable solutions that are adaptive to changing market demands. This manuscript explores best practices for architecting cloud-native applications by reviewing current literature, analyzing industry case studies, and presenting a structured methodology. Emphasis is placed on container orchestration, service mesh integration, DevOps automation, security, and scalability strategies. The results demonstrate that a well-planned cloud-native architecture can significantly reduce time-to-market, increase operational efficiency, and improve system resiliency. In addition, the study highlights the challenges of integration, the need for standardized practices, and the critical importance of continuous monitoring. Finally, the paper discusses the scope and limitations of current approaches, suggesting future research directions to address emerging issues in cloud-native architecture.

Keywords: *Cloud-Native, Microservices, Containerization, DevOps, Scalability, Resiliency, Orchestration, Security.*

The Evolution of ERP in the Cloud Era: SAP vs. Competitors (Oracle, Microsoft, Workday)

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ABSTRACT

The rapid evolution of enterprise resource planning (ERP) systems in the cloud era has redefined how businesses integrate and manage their operations. This study examines the strategic and technological evolution of ERP solutions offered by SAP, Oracle, Microsoft, and Workday. Through a comprehensive review of literature, statistical analysis, and empirical research, we compare the strengths and weaknesses of each vendor's cloud ERP offering. Our analysis focuses on market penetration, user satisfaction, integration capabilities, and innovation pace. The results demonstrate that while SAP remains a dominant force due to its deep industry roots, competitors such as Oracle, Microsoft, and Workday are rapidly advancing with flexible, cloud-native architectures that promise improved agility and cost efficiency. This manuscript provides insights into the competitive dynamics of the cloud ERP market and proposes future directions for research and practice.

Keywords: *ERP, Cloud, SAP, Oracle, Microsoft, Workday, Cloud Era, Enterprise Systems, Digital Transformation.*

Best Practices for Utilizing SQL in Complex Data Warehousing Projects

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ABSTRACT

This manuscript investigates the optimal practices for utilizing SQL in complex data warehousing projects. It discusses strategies for managing large-scale data, ensuring data quality, and optimizing query performance while addressing common challenges in enterprise-level data warehousing. Emphasis is placed on the integration of SQL with advanced ETL processes, indexing strategies, query optimization techniques, and modern data governance. The study reviews recent literature, incorporates a statistical analysis to compare performance metrics of different SQL approaches, and proposes a methodology tailored to robust data warehouse architectures. The findings indicate that adopting a combination of best practices not only enhances query performance and scalability but also significantly improves the overall efficiency of data warehousing projects.

Keywords: *SQL, Data Warehousing, Query Optimization, ETL, Data Governance, Scalability, Performance Analysis.*

Leveraging Generative AI to Simulate Retail Demand and Customer Behaviour

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ABSTRACT

The rapid evolution of artificial intelligence (AI) has revolutionized various industries, including retail. Generative AI, particularly deep learning models, provides an opportunity to simulate retail demand and customer behavior with high accuracy. This study explores how generative AI can model customer-purchasing patterns, predict demand fluctuations, and optimize inventory management. By leveraging deep neural networks such as Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs), businesses can generate synthetic yet highly realistic sales data. This data enables companies to understand complex customer behaviors, mitigate risks associated with demand volatility, and refine marketing strategies.

Keywords: *Generative AI, retail demand, customer behavior, deep learning, demand forecasting, simulation modeling, statistical analysis, machine learning, artificial intelligence, predictive analytics.*

Optimizing Fulfillment Center Capacity Planning Using Data Science

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ABSTRACT

The efficiency of fulfillment centers is critical in modern supply chain management, where demand fluctuations and operational constraints present significant challenges. This paper explores the application of data science techniques to optimize capacity planning, enhancing efficiency and reducing costs. By leveraging statistical analysis, predictive modeling, and machine learning algorithms, businesses can forecast demand, streamline inventory management, and allocate resources effectively. The study highlights the importance of real-time data integration, anomaly detection, and automated decision-making in improving operational performance. A case study is presented, illustrating the impact of these techniques on operational performance.

The findings suggest that data-driven decision-making substantially improves fulfillment center efficiency, reducing delays and operational bottlenecks. Moreover, data science enables companies to proactively manage uncertainties and enhance customer satisfaction through improved service levels.

Keywords: *Fulfillment Center, Capacity Planning, Data Science, Predictive Modeling, Machine Learning, Supply Chain Optimization, Demand Forecasting, Resource Allocation.*

The Role of Agile Methodologies in Rapid Financial Product Development

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ABSTRACT

The financial services industry is continually challenged by fast-paced market changes, regulatory shifts, and evolving customer expectations. In response, firms are increasingly adopting agile methodologies to accelerate innovation cycles while managing risk. This manuscript examines the role of agile practices in facilitating rapid financial product development. By reviewing the evolution and principles of agile within the context of finance and analyzing case studies of agile implementations, this research identifies both the benefits and challenges associated with agile transformations. The findings highlight that agile methodologies enable financial institutions to adapt swiftly, collaborate more effectively across functions, and respond to market demands, while also navigating constraints related to compliance and legacy systems. Recommendations are provided for organizations seeking to leverage agile techniques, with emphasis on tailoring agile frameworks to meet sector-specific challenges.

Keywords: *Agile methodologies, financial product development, rapid prototyping, innovation, regulatory compliance, agile transformation.*

The Benefits of Agile Methodology in Fast-Paced eCommerce Environments

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ABSTRACT

Agile methodology has redefined how organizations develop and deliver software in environments that demand rapid adaptation and innovation. This manuscript explores the benefits of employing agile methods within fast-paced eCommerce environments, where market dynamics and customer expectations necessitate continuous improvement and swift responses to change. By examining the evolution of agile practices, evaluating the interplay between agile principles and eCommerce operations, and analyzing empirical evidence from recent case studies, this study highlights how agile techniques enhance project management, foster team collaboration, and drive competitive advantage. Results indicate that agile frameworks facilitate improved product quality, accelerated time-to-market, and enhanced customer satisfaction. The findings underscore the strategic benefits of agile adoption for eCommerce companies facing intensifying market pressures and evolving technological landscapes. This manuscript provides a critical review of existing literature, outlines a practical methodology for agile implementation, and discusses insights that can guide future research and practice in agile transformation for digital commerce enterprises.

Keywords: *Agile methodology, eCommerce, project management, rapid innovation, iterative development, customer satisfaction, digital transformation.*

Design Patterns for Scalable Cloud Applications in AWS

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ABSTRACT

Scalable cloud applications on Amazon Web Services (AWS) require robust architectural design patterns to ensure performance, reliability, and maintainability under variable workloads. This manuscript examines key design patterns—such as microservices, event-driven architecture, circuit breaker, bulkhead, and strangler—applied to AWS cloud environments. Through a mixed-methods study combining quantitative performance measurements and qualitative analysis of deployment complexity, we evaluate the impact of these patterns on system scalability and resilience. A statistical comparison across three architectural variants highlights the benefits and trade-offs of each. Our findings demonstrate that combining microservices with resilience patterns (circuit breaker and bulkhead) significantly reduces error rates and maintains higher throughput under stress tests. The paper concludes with best practice recommendations for AWS architects and outlines future research directions in automated pattern selection and serverless extensions.

Keywords: *Design patterns, AWS, scalability, microservices, resilience, event-driven, circuit breaker, bulkhead.*

Leveraging Generative AI for Automated Knowledge Article Drafting in Service Now

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ABSTRACT

The rapid expansion of digital enterprises has amplified the demand for efficient knowledge management systems. ServiceNow, a leading platform for IT service management, relies heavily on structured knowledge articles to enable swift issue resolution and self-service capabilities. Traditionally, drafting these articles is labor-intensive and prone to inconsistencies in tone, structure, and completeness. This manuscript investigates the application of generative artificial intelligence (AI) to automate the drafting of ServiceNow knowledge articles. Leveraging state-of-the-art natural language generation models, we develop a pipeline that ingests ticket metadata, historical article corpora, and domain-specific taxonomies to produce first-draft articles. A mixed-methods evaluation—comprising quantitative statistical analysis and simulation-based performance testing—was conducted to compare AI-generated drafts against human-authored counterparts. Results indicate that generative AI reduces drafting time by over 70%, maintains an average readability score within professional guidelines, and achieves a user satisfaction rating comparable to manual authorship. Our findings suggest that AI-augmented knowledge article drafting can significantly enhance organizational efficiency, standardize content quality, and free subject-matter experts to focus on complex support scenarios. Future work will explore iterative human-in-the-loop refinement and broader deployment considerations.

Building upon these insights, we further delve into the nuances of AI-driven content standardization. The expanded pipeline now includes dynamic terminology mapping, contextual relevance scoring, and automated link-insertion for related knowledge base entries. By integrating feedback loops from SME reviews directly into model fine-tuning, the system continuously improves over time, reducing the need for extensive post-generation editing. Additionally, we examine ethical considerations—such as bias mitigation in model outputs and adherence to corporate security policies—ensuring that generated content aligns with regulatory and compliance requirements. This enhanced approach not only expedites the drafting process but also fortifies organizational knowledge integrity, paving the way for scalable, AI-powered knowledge management across diverse enterprise environments.

Keywords: *Generative AI; ServiceNow; Knowledge Management; Automation; Natural Language Processing.*

Strategies for Enhancing Patient Education Through Digital Health Platforms

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ABSTRACT

The evolution of digital health technologies has provided an unprecedented opportunity to enhance patient education and engagement. This manuscript explores a variety of strategies for utilizing digital health platforms to improve patient outcomes through better education. By synthesizing current research, analyzing case studies, and presenting an integrated methodology, the study identifies best practices that can be implemented across healthcare systems. Key strategies include the integration of interactive multimedia content, the use of tailored messaging and mobile applications, and the incorporation of telehealth services.

Results from a pilot implementation in a diverse clinical setting demonstrate improvements in patient comprehension, adherence to treatment plans, and overall satisfaction. The findings suggest that a strategic and evidence-based application of digital health tools can significantly empower patients to take an active role in managing their health.

Keywords: *Digital Health; Patient Education; Health Technology; eHealth; Telemedicine.*

Telemedicineasa Tool for Rural Health: Overcoming Geographical Barriers

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ABSTRACT

Rural populations often face significant challenges in accessing timely and quality healthcare due to geographical isolation, limited healthcare infrastructure, and scarcity of specialized medical professionals. Telemedicine, defined as the remote delivery of healthcare services using telecommunications technology, has emerged as a promising solution to these challenges. This manuscript explores the potential of telemedicine in transforming rural healthcare by analyzing its benefits, limitations, and impact on patient outcomes.

By reviewing current literature and presenting a mixed-methods study that combines quantitative surveys and qualitative interviews with healthcare providers and rural patients, the study demonstrates that telemedicine can reduce travel time, lower healthcare costs, and improve access to specialist consultations. However, challenges such as technological barriers, resistance to change, and issues related to data privacy persist. The paper concludes with policy recommendations aimed at optimizing telemedicine implementations to ensure sustainable and equitable healthcare delivery in rural areas.

Keywords: *Telemedicine, Rural Health, Geographical Barriers, Healthcare Access, Digital Health, Patient Outcomes, Technology Adoption.*

Role of Artificial Intelligence in Enhancing Fraud Detection Capabilities Across Financial Platforms

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ABSTRACT

The increasing sophistication of financial fraud in the modern digital economy poses significant challenges to traditional detection methods. The application of Artificial Intelligence (AI) in financial fraud detection has emerged as a critical strategy for enhancing security across financial platforms. This paper examines the role of AI technologies in identifying and mitigating fraudulent activities within financial transactions. The study explores various AI techniques, including machine learning, neural networks, and natural language processing, highlighting their efficacy in detecting anomalies, preventing fraud, and improving overall security. The research also discusses the integration of AI with existing fraud detection frameworks and its impact on reducing human error, operational costs, and response time to fraudulent activities.

Keywords: *Artificial Intelligence, Fraud Detection, Machine Learning, Financial Platforms, Anomaly Detection, Neural Networks, Security.*

Machine Learning-Driven Risk Scoring Systems for Improved Fraud Prevention in E-Commerce

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ABSTRACT

Fraud prevention in e-commerce is a critical aspect of ensuring secure transactions and maintaining consumer trust. Traditional rule-based fraud detection systems often fail to adapt to the evolving tactics of fraudsters. Machine learning (ML) offers a robust alternative by enabling the detection of hidden patterns and anomalies in transaction data. This paper explores the application of machine learning-driven risk scoring systems for fraud prevention in e-commerce. We examine various algorithms such as decision trees, random forests, and neural networks to assess their effectiveness in predicting and mitigating fraudulent activities. The study presents an approach where transactions are scored based on risk levels, allowing for a more efficient and adaptive fraud detection system. Results indicate that ML models significantly improve fraud detection rates, reduce false positives, and enhance system efficiency over traditional methods.

Keywords: *Machine Learning, Fraud Prevention, E-Commerce, Risk Scoring Systems, Anomaly Detection, Data Science, Predictive Models, Transaction Analysis.*

Adoption of Large Language Models (LLMs) for Improved Data Governance in Digital Products

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ABSTRACT

The rise of digital products has significantly increased the volume and complexity of data generated, making data governance a critical challenge for organizations. Traditional data governance frameworks struggle to keep pace with the evolving needs of digital products, leading to gaps in data quality, privacy, and compliance. In this paper, we explore the adoption of Large Language Models (LLMs) for enhancing data governance in digital products. By leveraging the natural language processing (NLP) capabilities of LLMs, organizations can automate key aspects of data governance, such as data classification, privacy compliance, and anomaly detection. We investigate the potential benefits, challenges, and methodologies for integrating LLMs into existing data governance systems, drawing on a range of case studies and recent developments in artificial intelligence. Statistical analysis is performed to evaluate the effectiveness of LLM-based approaches compared to traditional methods. Our findings suggest that LLMs can provide substantial improvements in data quality management, legal compliance, and operational efficiency, marking a significant shift in the governance of digital products.

Keywords: *Large Language Models, Data Governance, Digital Products, Automation, Artificial Intelligence, Privacy Compliance, Anomaly Detection, Statistical Analysis.*

Optimizing ETL Processes Using Adaptive Machine Learning Models

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ABSTRACT

In modern data ecosystems, the efficiency of Extract, Transform, Load (ETL) processes is critical for ensuring data quality, availability, and scalability. This study investigates the optimization of ETL processes through the integration of adaptive machine learning models. Traditional ETL methods are often static, limited in their ability to handle dynamic data flows and real-time updates. By leveraging machine learning (ML) techniques, the study explores methods to dynamically optimize ETL workflows, automate data transformation tasks, and reduce data processing time. The results demonstrate significant improvements in the performance, accuracy, and scalability of ETL systems, offering insights into the practical benefits of adaptive machine learning in data pipeline management. Future research could explore further integrations with cloud-based services and real-time analytics to drive further efficiencies.

Keywords: *ETL processes, machine learning, data optimization, adaptive models, data pipelines, automation, scalability, data transformation.*

Impact of AI and Machine Learning on Financial and Business Decision-Making

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ABSTRACT

Artificial Intelligence (AI) and Machine Learning (ML) have revolutionized various sectors, particularly in the domain of financial and business decision-making. These technologies have enabled organizations to analyze vast amounts of data, uncover hidden patterns, and make more informed, accurate decisions. The impact of AI and ML on decision-making in financial and business contexts is multifaceted, offering improvements in efficiency, risk management, and forecasting. This paper explores the integration of AI and ML in financial and business operations, assesses their benefits and challenges, and provides insights into future trends. It emphasizes how AI and ML are reshaping traditional decision-making models and enhancing the overall effectiveness of strategic planning and risk mitigation.

Keywords: *Artificial Intelligence, Machine Learning, Financial Decision-Making, Business Strategy, Risk Management, Predictive Analytics, Data-Driven Decisions, Automation, Business Intelligence.*

Comparative Analysis of AWS and Azure in Machine Learning Deployments

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ABSTRACT

Cloud computing platforms, with their scalability, flexibility, and diversity of services, have become indispensable as a means for deploying machine learning models. AWS and Microsoft Azure are among the top leaders in providing wide-ranging ecosystems for ML. The current comparative analysis delves into the features, tools, and capabilities that pertain specifically to ML deployments between the two. AWS brings together services like SageMaker and Rekognition to ease the training of models, automated workflows, and prebuilt algorithms. In contrast, Azure ML offers strong integration with the Microsoft ecosystem and more elaborate collaboration tools for enterprise-grade deployments. The key comparison points include architecture, integration, cost, user friendliness, model deployment, security, and the ability to leverage emerging ML trends like AutoML and MLOps. This paper, therefore, aims at guiding these organizations in selecting the best fit based on their needs through an emphasis on how such platforms enable fast innovation in applications that are driven by data while overcoming challenges that could arise from cloud-based machine learning workflows.

KEYWORDS: *Cloud computing, machine learning, AWS, Azure, SageMaker, Azure Machine Learning, MLOps, AutoML, model deployment, scalability, cost-effectiveness, enterprise solutions, data-driven applications, cloud-based workflows, AI innovation.*

The Future of Java: Evolving with Cloud Native Technologies

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ABSTRACT

Java has long been a cornerstone in the landscape of programming languages, renowned for its platform independence, robust ecosystem, and enterprise-grade reliability. As the computing paradigm shifts towards cloud native architectures, Java faces both significant challenges and exciting opportunities. This manuscript explores the evolution of Java within the cloud native era, examining its adaptation to containerization, microservices, and orchestration technologies. By analyzing current trends, reviewing scholarly literature, and applying empirical methodologies, this paper assesses Java's modern relevance and anticipates its trajectory in an increasingly distributed and cloud-driven environment. The findings indicate that while Java must evolve to meet the dynamic requirements of cloud native systems, its inherent strengths and continual community-driven innovation position it well for the future.

KEYWORDS: *Java, Cloud Native, Microservices, Containerization, Orchestration, Distributed Systems, Evolution*

Cybersecurity Measures for Protecting Consumer Data in Financial Applications

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ABSTRACT

Cybersecurity in financial applications is crucial to ensuring the protection of consumer data against cyber threats such as hacking, phishing, and data breaches. With the rise of digital financial services, including mobile banking, online transactions, and cryptocurrency exchanges, security challenges have become more complex. This study examines the various cybersecurity measures implemented to safeguard consumer data, including encryption, multi-factor authentication (MFA), artificial intelligence-driven fraud detection, and blockchain technology. It also explores real-world case studies and analyzes the effectiveness of these measures through statistical evaluation. The findings indicate that financial institutions adopting advanced cybersecurity solutions experience a significant reduction in fraud cases and unauthorized access attempts, leading to increased consumer trust and regulatory compliance. The study concludes that a multi-layered security approach, combined with continuous monitoring and updates, is essential for ensuring the safety of financial applications in the digital era.

KEYWORDS: *Cybersecurity, Financial Applications, Consumer Data Protection, Encryption, Multi-Factor Authentication, Artificial Intelligence, Blockchain, Fraud Prevention.*

Enhancing Solar Energy Efficiency through Dual-Axis Solar Tracking Systems: Innovations and Impacts

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Abstract

Dual-axis solar tracking technology has become a revolutionary technology in photovoltaic (PV) energy generation, providing significant improvements over fixed and single-axis systems. In this article, a controller for a solar tracker is designed that optimizes the solar panel and sunlight conditions. Create a solar controller to adjust the angle of sunlight hitting the solar panel. A model of the solar tracking mechanism can be implemented using a physical controller (using the Simulink support package for Arduino) on an inexpensive device. Take advantage of the latest developments in tracking systems, AI-enhanced controls, and adaptive weather algorithms. These innovations enable the solar panel to recover solar energy in different conditions, saving more than 40 percent of the energy. The document also shows the environmental and economic impacts of using two-axis trackers, and highlights their role in supporting the renewable energy target and promoting stable development.

***Keywords**: Dual-axis solar tracker, Photovoltaic (PV) systems, Solar positioning algorithm, Arduino Uno, Energy efficiency, PID controller, Renewable energy.*

Prognostic Model Utilizing Ensemble Machine Learning Techniques to Precisely Determine House Prices

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Abstract

Predicting home prices is a crucial task in finance, real estate, and urban planning that affects how consumers, sellers, investors, and legislators make decisions. Predictive models for home prices have drawn a lot of attention as a result of the growing availability of big data and improvements in machine learning algorithms. In order to effectively anticipate housing prices, this study investigates the application of several machine learning approaches, such as regression, decision trees, support vector machines, and neural networks. The models are trained and validated using data gathered from various sources, including location, size, amenities, economic indicators, and previous sales. Cross-validation, regularization strategies, and feature engineering are used to improve model performance and reduce overfitting. To increase prediction accuracy, ensemble techniques like gradient boosting and random forests are also included. However, most of this research works dependent on rather small datasets, which were based on the simple techniques of ML rather than deep learning techniques because of the interest of authors in those topics. The large and accurate datasets that emerge are a result of rapid digitalization both within the urban areas as well as in real estate markets. Such models need to be interpreted hence making them interpretable for a variety of applications. Assessment Model performance is evaluated using evaluation measures including R-squared, mean squared error, and mean absolute error. This study discusses the effects of precise home price prediction on different stakeholders and its recommendations for future research directions in this area round out the analysis.

Keywords*: Ensemble methods, Machine learning, Regression, Feature Engineering, House Price Prediction.*

Smart Contract Security: Auditing Procedures, Real-World Incidents, and Emerging Trends

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Abstract

Smart contracts form the foundation of decentralised finance (DeFi), non-fungible tokens (NFTs), and token ecosystems. Despite their benefits, the immutability and complexity of smart contracts introduce significant security risks, leading to substantial financial losses in various sectors. This paper delves into the challenges of securing smart contracts, focusing on manual, static, automated, and dynamic auditing procedures. Real-world security breaches such as the DAO hack and the Compound exploit are examined, alongside financial loss data from 2016 to 2023. The study emphasises the importance of comprehensive auditing tools like Slither, MythX, Foundry, and Hardhat for mitigating risks and preventing future vulnerabilities.

Keywords*: Smart Contracts, Blockchain, DeFi, NFTs, Security Audits, Manual Audits, Static Audits, Dynamic Audits, Slither, MythX, Foundry.*

The Impact of Technology on the Employability of Educators

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Abstract

With the increasing popularity of digital tools and online platforms for education, the demand for educators possessing technological skills has also increased. This paper focuses on how technology has affected the employability of educators in this digital era. It highlights how educators must equip themselves with their traditional pedagogical knowledge and technical competencies such as the use of Learning Management Systems, interactive panels, online content creation tools etc. in the ongoing era of online, hybrid and virtual classrooms. Although the use of technology in education has its advantages, many challenges are faced by educators with lack of resources to learn these skills. The paper stresses that leaders, organizational owners and educators must work together to provide equal learning opportunities to all. It also emphasizes the need to balance technological skills and teaching skills by educators.

***Keywords**: Education, Technology, Educator Employability.*

A Brief Review of Various Object Detection Machine Learning Technique

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Abstract

Object detection is an essential aspect of computer vision, with applications in autonomous driving and monitoring systems. Both traditional machine learning-based and deep learning–based object detection techniques are reviewed in this paper. The paper presents a comparison of different algorithms, as well as performance metrics, benefits, and drawbacks. The research includes experimental findings and visualizations to illustrate trends in object detection studies.

Keywords*: Object Detection, Machine Learning, CNN, Artificial Intelligence, Learning Models.*

Effect of Coal Bottom Ash on Fresh Properties of Self-Compacting Concrete

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Abstract

This research focuses on the workability of Self-Compacting Concrete (SCC) made with Coal Bottom Ash (CBA) sourced from coal thermal power plants. Four SCC mixes were created by substituting parts of the granular components- Portland Cement (PC) and natural fine aggregates (NFA) with GCBA and CBA. The Slump flow and J–ring tests were carried out to evaluate the workability of the freshly mixed SCC before casting. The findings revealed significant changes in the workability of SCC mixes with varying amounts of Grinded Coal Bottom Ash (GCBA) replacing PC and a fixed amount of CBA replacing NFA. The study suggests that replacing 10% and 30% of PC with GCBA and a portion of NFA with CBA can be successfully applied in SCC mixes. Furthermore, the workability of these CBA-based SCC mixes was found to be on par with or even better than that of the control SCC mix. This indicates that CBA can be used both as a Supplementary Cementitious Material (SCM) and as a replacement for NFA in SCC. This method also supports the more sustainable production of Portland Cement, reducing both energy consumption and CO2 emission.

Keywords*: Coal bottom ash, Grinded coal bottom ash, Self-compacting concrete, Workability.*

Fraud Detection in Online Payments with Machine Learning Approaches

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Abstract

An era of unparalleled efficiency and convenience has been brought about by the growth of online payment methods. However, a notable increase in fraudulent activity has coincided with this digital transformation, endangering both consumers and businesses. Often, traditional rule-based fraud detection systems struggle to stay up with the increasing complexity of fraudulent schemes. A strong substitute is provided by machine learning (ML), which can recognize intricate patterns and adjust to emerging fraud tendencies. This study examines the use of different machine learning algorithms for online payment fraud detection, going into common methods, difficulties, and potential future developments. We analyze several machine learning techniques, such as supervised, unsupervised, and hybrid approaches, pointing out their advantages and disadvantages in addressing the particulars of online payment fraud. In order to create reliable and efficient fraud detection systems, we finally explore the crucial factors of feature engineering, data imbalance, and model interpretability.

Keywords: *Online payment detection, ML, CNN, AI, learning model.*

A Review on Implantable Antenna Performance for Biomedical Applications

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Abstract

Implantable antennas working in the Industrial, Scientific, and Medical (ISM) band have become a vital component of recent biomedical communication systems. These antennas allow efficient wireless data transmission for applications such as medical implants, health monitoring and biosensors while ensuring minimal interference with other communication devices. The ISM band, mainly at frequencies like 2.4 GHz and 5.8 GHz, is widely used due to its global obtainability and compatibility with wireless technologies. This review paper provides the design, fabrication, and optimization of ISM band implantable antennas, focusing on key parameters such as miniaturization, biocompatibility, impedance matching, and radiation efficiency within the human body. Additionally, challenges such as tissue-induced signal attenuation, electromagnetic interference, and power management are discussed. Several biomedical applications, including wireless telemetry, neural stimulation, and real-time physiological monitoring, are also examined. By analyzing current advancements and identifying future research directions, this paper delivers valuable insights into the advancement of high-performance implantable antennas for next-generation medical technologies.

Keywords*: Implantable Antenna, Communication Systems, Biomedical devices, ISM band.*

Design and Optimization of Microstrip Patch Antenna Using Machine Learning

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Abstract

Microstrip patch antennas (MPAs) are a vital component in modern wireless communications systems due to their low profile, ease of fabrication, and compatibility with integrated circuits. However, designing efficient MPAs to meet specific performance criteria is a complex task involving trade-offs between parameters such as gain, bandwidth, return loss, and size. Traditional design methods often rely on iterative simulations and empirical models, which can be time- intensive and computationally expensive.

This paper explores the application of machine learning (ML) algorithms to streamline the MPA design process. By leveraging ML techniques, such as regression, classification, and optimization algorithms, the study demonstrates how design parameters can be predicted and optimized with high accuracy, reducing reliance on traditional trial-and-error methods. A data set comprising various antenna designs is used to train and test ML models, enabling the identification of key parameter relationships and the development of efficient, high- performance antenna configurations. The results highlight the potential of ML to revolutionize antenna design, offering faster, cost-effective, and more precise solutions for next- generation communication systems. General design procedure for microstrip antennas using artificial neural network. Mean error in detection of resonance frequencies: 0.144 GHz on train set, 0.116 GHz on test set. Enhances Microstrip Patch Antenna Array using Particle Swarm Optimization Aims for optimal performance in high-frequency wireless communication systems.

***Keywords**: Microstrip Patch Antenna (MPA), Wireless Communication Systems, Machine Learning (ML), Antenna Design, Performance Parameters.*

Textile Antenna for Biomedical Applications

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Abstract

Textile antennas have gained vital attention in recent years due to their potential for continuous incorporation into wearable and flexible communication systems. These antennas, fabricated using conductive fabrics and flexible substrates, offer benefits such as lightweight design, conformability, and ease of integration into garments. This review paper delivers a comprehensive analysis of textile antenna technology, covering key features such as design principles, fabrication methods, material choice, and performance evaluation. Furthermore, it explores the challenges associated with textile antennas, including durability, bending effects, environmental influences, and human body interactions. Various applications in healthcare monitoring, military communications, and the Internet of Things (IoT) are discussed, highlighting the growing importance of textile antennas in next-generation wireless systems. By summarizing recent developments and identifying future research directions, this review goal to provide valuable insights into the progress and optimization of textile antennas for wearable and flexible communication technologies.

Keywords*: Textile Antenna, Communication Systems, Biomedical applications, Fabrics.*

Speech Based Emotion Recognition Using Artificial Intelligence

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Abstract

One of the speediest and most natural ways for individuals to speak with one another is through voice signals. Many scholars have developed a number of techniques for recognising emotions in signals from speech. Speech characteristics are very supportive in distinguishing among distinct feelings, and if they are ambiguous, this is the reason why it is so challenging to discern a feeling from a speaker's statements. Numerous datasets are available for conversation emotions, models, and kinds that aid in identifying the speech type. The categorisation of speech emotions is a crucial step after feature extraction, therefore the study has examined and contrasted the many classifiers used to distinguish between emotions including happiness, sadness, fear, surprise, anger, disgust, and so forth. By incorporating the random forest algorithm into an autonomous emotion identification system, the study also demonstrates how the system has improved. Additionally, the accuracy of voice emotion recognition in different languages has been examined using a range of machine learning techniques.

Keyword: *Speech emotion recognition, Feature extraction, Emotion, Random Forest, Machine learning, Dataset.*

A Brief Review on Telecom Churn Prediction Using Multi-Model Voting Classifier

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Abstract

Telecom forecasting is an essential task for telecommunication providers who are aiming to reduce customer deductions and improve customer loyalty. In machine learning technology, ensemble methods such as multi-model speech classifiers have shown promising results in this field. This test compares the performance of individual models with an ensemble melody approach using key metrics such as accuracy, accuracy, Recall, F1 score, and ROC-AUC. The results show that individuals using multi-model language classifiers, particularly soft adjustments, can provide more reliable predictions and contribute to communication providers to more effectively identify endangered species customers.

Keywords*: Prediction Using Multi-Model Voting Classifier, Machine Learning, CNN, LearningModels.*

Analysis of Weather Forecasting Data Using AI

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Abstract

Accurate weather forecasting is pivotal for effective decision-making in agriculture, disaster preparedness, aviation, and numerous other sectors. Traditionally, weather predictions have relied heavily on Numerical Weather Prediction (NWP) models, which, despite their scientific rigor, are often computationally intensive and face limitations in delivering high-accuracy short-term forecasts. In recent years, the advent of Artificial Intelligence (AI)—particularly Machine Learning (ML) and Deep Learning (DL) techniques—has revolutionized the landscape of meteorological forecasting. AI-driven models are capable of learning intricate, nonlinear patterns from vast amounts of historical and real-time data, enabling faster and often more accurate forecasts with reduced computational costs. This paper delves into the transformative role of AI in modern weather forecasting, presenting a comprehensive analysis of current methodologies, comparing their performance with traditional models, and highlighting the key advantages and limitations. Furthermore, it outlines emerging trends and future directions, emphasizing the potential of AI to drive a new era of intelligent, adaptive, and highly precise weather prediction systems.

Keywords*: AI weather forecast; Machine learning; Weather forecasting.*

Study on Antenna Design and Optimization using Deep Neural Networks

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Abstract

The design and optimization of antennas play a key role in modern wireless communication systems, requiring a balance between parameters such as gain, bandwidth, efficiency, and size. Traditional antenna design methods rely on iterative simulations and empirical models, which are often computationally expensive and time-consuming. In recent years, deep neural networks (DNNs) have emerged as powerful tools for accelerating the antenna design process by learning complex relationships between design parameters and performance metrics. This review paper explores the application of DNNs in antenna design and optimization, highlighting various architectures, training methodologies, and performance evaluation techniques. Key challenges, including data generation, model interpretability, and generalization across different antenna types, are discussed. This paper also presents various innovative antenna design and optimization techniques using deep learning and advanced modeling approaches. Additionally, recent advancements in deep learning-driven inverse design, surrogate modeling, and real-time optimization are examined. By reviewing state-of-the-art techniques and identifying future research directions, this paper provides valuable insights into how DNNs can revolutionize antenna engineering, enabling faster, more efficient, and highly optimized designs for next-generation communication systems.

Keywords*: Antenna, Optimization, Deep Neural Network, Communication Systems.*

A Comprehensive Review of Machine Learning-Assisted Design for 5G mm-Wave Microstrip Antennas

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Abstract

The emergence of 5G technology has involved the development of high-efficiency, compact antennas capable to operate at millimetre wave (mm-Wave) frequencies. This journal represents a comprehensive and complete review of Machine Learning (ML)-assisted design techniques for 5G mm-Wave Microstrip Antennas (MSA), comparing them with conventional electromagnetic simulation methods. We analyze the role of ML in optimizing antenna parameters, reducing computational time, and improving accuracy. Key algos such as Artificial Neural Networks (ANN), Random Forest (RF), and Support Vector Machines (SVM) are evaluated based on performance metrics such as Mean Squared Error (MSE) and R^2 score. Additionally, we discuss challenges, ethical considerations, and future trends in AI-driven antenna design, supported by case studies and experimental results from recent literature. Abstract— The rapid evolution of 5G technology demands high-performance, compact antennas capable of operating at millimeter-wave (mm-Wave) frequencies (24–100 GHz). Microstrip patch antennas (MSAs) are widely adopted due to their low profile, lightweight design, and compatibility with integrated circuits. However, traditional electromagnetic simulation methods, such as Finite Element Method (FEM) and Finite Difference Time Domain (FDTD), suffer from high computational costs, inefficiency in parameter tuning, and limited accuracy for complex designs. This paper presents a comprehensive review of Machine Learning (ML)-assisted techniques for optimizing 5G mm-Wave MSAs, comparing their performance with conventional approaches. Key ML algorithms, including Artificial Neural Networks (ANN), Random Forest (RF), and Support Vector Machines (SVM), are evaluated based on metrics such as Mean Squared Error (MSE), R^2 score, and computational efficiency. Case studies demonstrate that ANN with Adam optimizer achieves the lowest MSE (1.107) for S11 prediction, while Random Forest excels in MIMO antenna optimization ($R^2 \approx 0.99$). The review highlights ML's advantages, such as 10–100x faster design cycles, automated parameter optimization, and real-time adaptability. Challenges, including data bias, privacy risks, and environmental impact, are also discussed. Future directions explore physics-informed ML, edge AI deployment, and quantum ML for ultra-fast optimization. This work underscores ML's transformative potential in advancing 5G antenna design, offering insights for researchers and industry practitioners.

Keywords: *5G, mm-Wave, Microstrip Antenna, Machine Learning, Optimization, ANN, Random Forest, SVM.*

Study and Investigation on 5G Technology

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Abstract

The fifth Generation (5G) technology represents the latest advancement in wireless communication, offering high-speed internet access anytime and anywhere. This paper explores the evolution of mobile communication network and the challenges faced at each stage, which were addressed through next-generation innovations. Unlike its predecessors, 5G introduces ground breaking features such as seamless connectivity between people. Smart devices, and machines. This enhanced capability is set to revolutionize user experiences and drive new business opportunities across various industries.

Understanding where and how enterprises can leverage 5G is crucial. Through extensive research and analysis, this study examines key technological advancements in 5G, including millimeter waves (mmWave), massive multiple input and multiple-output (Massive MIMO), small cell development, mobile edge computing (MEC), beamforming and advanced antenna technologies. The primary objective of this article is to highlight recent development s in 5G and outline potential future research directions in this rapidly evolving field.

Keywords: *Massive MIMO, Small Cell Development, Mobile Edge Computing.*

Simulation-Based Scaling Approach to Predict the Morphology of Thin Films Developed by Physical Process: A Short Review

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Abstract

The article reviews the basic scaling concept for the property prediction of the materials developed in thin film form mainly synthesized by different physical processes that include molecular beam epitaxy, sputtering, evaporation and other. Regarding the growth process mainly three approaches have been considered. These processes are random deposition (RD), random deposition with surface relaxation (RDSR) and ballistic deposition (BD). Not only that, effort has been made to review the recent trend in predicting material properties by considering the competitive growth model as well. Different material properties that have been addressed are mainly cluster size, roughness, water repellence, conductivity. In this review article mainly, the work published in last few years have been considered. We do believe that this work will be a valuable addition in the related literature.

Keywords*: Scaling, Thin Film, Random Deposition, Exponent, Competitive Growth.*

Advanced Gangrene Identification through Deep Learning

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Abstract

Gangrene is a serious medical disorder that arises from insufficient blood flow to tissues. It is imperative to seek immediate diagnosis and care in order to avoid potentially fatal complications. Here, we provide a thorough investigation into the identification of gangrene using the cutting-edge object detection framework YOLOv8. The robustness and generalizability of the model are ensured by the diversified dataset obtained from clinics, hospitals, and numerous medical libraries, which is the focus of our study.Using YOLOv8, our model performs admirably on several assessment criteria, including as accuracy, precision, recall, and F1 score. The model's ability to accurately diagnose patients and ensure clinical relevance is demonstrated by its excellent recall rates and precision in identifying gangrene symptoms. Furthermore, our results provide a detailed knowledge of the model's effectiveness across evaluation metrics and illuminate varied confidence thresholds.The present study not only enhances the current understanding of gangrene detection but also highlights the capacity of deep learning techniques, specifically YOLOv8, to enable prompt diagnosis and intervention in urgent medical situations. The study's conclusions have important ramifications for clinical practice since they provide doctors with a useful tool for promptly diagnosing and treating cases of gangrene, thereby preventing negative consequences and enhancing patient care.

Keywords*: Gangrene, f1-score, recall, yolov8, hospitals, clinics, deep learning.*

Comparative Study of Discrete Competitive Growth Models in 2+1 Dimensions

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Abstract

This study presents a comparative analysis of three discrete competitive growth models (CGMs) in 2+1 dimensions, simulated to explore surface evolution under competing deposition mechanisms: Random Deposition (RD) versus Random Deposition with Surface Relaxation (RDSR), RD versus Ballistic Deposition (BD), and BD versus RDSR. Using computer simulations, we investigate the scaling exponents (growth exponents β1 and β2, roughness exponent α, dynamic exponent z), critical times (tx and tsat), and morphological properties (growth velocity and fractional porosity) across varying system sizes L and competitive growth probabilities p. Each model exhibits a three-regime evolution—two growth phases and a saturation phase—deviating from traditional Edwards-Wilkinson (EW) and Kardar-Parisi-Zhang (KPZ) universality classes. RD-RDSR shows stable, compact growth; RD-BD yields porous, rough surfaces; and BD-RDSR reveals a phase transition at p = 0.90. These findings propose new scaling relations and highlight the models distinct implications for thin-film growth in material science.

Keywords*: competitive growth, random deposition, surface relaxation, ballistic deposition, scaling exponents, critical times.*

A Context-Aware Virtual Desktop Assistant for Enhanced User Productivity

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Abstract

Virtual Desktop Assistant (VDA) is progressive artificial intelligence system under expansion, directing to develop the first true Artificial General Intelligence (AGI) with revolutionary capabilities. Unlike predictable AI models, VDA is being designed to purpose with meaningfully less memory depletion and computational power while still representing exceptional intelligence and adaptability. One of the key features of VDA is its ability to control both digital (bit-based) and analog electronic devices, making it a highly adaptable and efficient solution for automation. Whether managing complex digital systems, automating industrial processes, or seamlessly integrating with IoT (Internet of Things) devices, VDA will revolutionize the way machines and intelligent systems interact.

Its core functionality includes learning, adapting, and executing complex tasks with minimal human intervention. By leveraging advanced AI models, VDA can analyze patterns, make informed decisions, and continuously improve its performance over time.

Security and privacy remain top priorities in its development. With robust encryption and secure data handling mechanisms, VDA will ensure safe and reliable interactions across multiple platforms, preventing unauthorized access and maintaining user confidentiality.

VDA represents a significant leap forward in the field of artificial intelligence and automation. As an innovative research product, it paves the way for a new era of intelligent automation, smart device control, and human-AI collaboration, making technology more accessible and efficient across various industries.

Keywords: *VDA, Artificial General Intelligence, AI models.*

Neural Vigilance: AI-Powered Misinformation Detection in the Digital Age

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Abstract

In today's fast-paced digital world, misinformation is spreading faster than ever, undermining public trust and contributing to societal instability. This research introduces the concept of Neural Vigilance—an AI-powered framework designed to detect and counteract false information online. Leveraging natural language processing (NLP), deep learning, and real-time data analysis, the study explores the development and deployment of neural network models capable of distinguishing between accurate and misleading content. A thorough examination of advanced models, such as BERT and GPT, is conducted to assess their effectiveness in identifying inconsistencies, evaluating source credibility, and detecting contextual anomalies. Critical challenges are addressed, including biases in training data, the manipulative techniques used in misinformation dissemination, and the ethical considerations of AI-driven moderation. By integrating cutting-edge technology with interdisciplinary insights, the framework aims to offer a robust and adaptable solution for combating digital misinformation and strengthening the resilience of modern information systems.

Keywords*: Neural Vigilance, digital misinformation, AI moderation, natural language processing, deep learning, real-time analysis, BERT, GPT, source credibility, bias in AI, contextual anomaly detection, ethical AI systems.*

Optimizing House Price Prediction with Deep Learning and Machine Learning Approaches

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Abstract

This report investigates the existing work on optimizing house price estimation with machine learning and deep learning techniques. Focusing on its base data types structured and then multi-modal (price, geospatial etc.) it runs through essential algorithms such as Linear Regression, XGBoost and Neural Network and compares their capabilities pros and cons. From the results, it emphasizes the ability of these methods to enhance predictive accuracy based on heterogeneous data sources, whilst challenges such as interpretability of models and integration of data persist. Promising future directions to move the field forward, such as hybrid models and multi-modal approaches, are discussed.

Keywords: *Deep learning, machine learning, house price prediction, multi-modal data, neural networks, regression analysis, feature engineering, hybrid models.*

Face Recognition Technology: Biometric Identification through Facial Analysis

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Abstract

Face recognition is among the major computer vision techniques these days. Even with limitless possibilities, face recognition is not an easy problem considering the issues with changing lighting, pose, and facial expressions. Face recognition techniques attempt to recognize or identify persons from fixed pictures or frames in video images, most likely in real-time. In this paper, we introduce an automated Face Recognition Attendance System that is meant to automate and simplify the process of taking attendance. The system applies the Viola-Jones face detection algorithm in real-time, utilizing Haar cascade classifiers to identify human faces from live video streams with precision. For identification, we utilize the Local Binary Patterns Histograms (LBPH) algorithm, which is efficient in extracting facial features to provide precise identification. Once an individual's face is identified successfully, the system captures the individual's name and a timestamp in a CSV file, thus automating attendance and reducing the level of manual input.

Keywords- *Local Binary Patterns Histograms, Face recognition, Attendance System.*

Detection and Analysis of Fake News in Social Media

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Abstract

Social media represent the new media of our time, having become the primary means of news dissemination throughout the digital revolution. Most news can be easily faked, but never before in human history has it taken so little time and been so easy for fake news to proliferate. The research proposal seeks to develop an intelligent system to detect fake news using machine learning and natural language processing to evaluate a news report as good or bad. The system uses Naïve Bayes and SVM classifiers, and works under a three-module architecture: News Suggestion System, News Authenticator, and News Aggregator—to gather, authenticate, and suggest only good news articles. The system's accuracy is significantly better than several similar indicators, producing a 93.6% accurate result, and provides a unique and reliable anti-fake news detection solution to undo the damage it does as it shapes public opinion and social coherence. This measure adds to the credibility of information on the net and enables the public to action against the manipulation of mass media.

Keywords- *News Suggestion System, SVM classifiers, Naïve Bayes, fake news detection.*

AI-Enhanced Surveillance Systems

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Abstract

AI-enhanced surveillance systems leverage machine learning, deep learning, computer vision, and the Internet of Things (IoT) to bolster security by automating video analysis, identifying threats, and recognizing suspicious behavior in real-time. In contrast to conventional CCTV systems, AI-based surveillance can recognize faces, detect weapons, monitor movements, and assess behaviors, thereby enhancing crime prevention and emergency response efforts.

These systems are extensively implemented in airports, smart cities, financial institutions, and border security to ensure public safety, deter criminal activities, and strengthen security measures. Technologies such as facial recognition, object detection, and behavioral analysis play a vital role in identifying criminals, preventing unauthorized access, and spotting unusual behaviors like loitering or aggression. Additionally, AI can work in conjunction with IoT devices to deliver automated alerts and initiate security responses.

Although AI surveillance enhances security, it also raises significant concerns regarding privacy, data protection, and ethical considerations, necessitating stringent regulations. In summary, AI-driven surveillance provides real-time monitoring, improved threat detection, and heightened public safety, establishing itself as an essential component of contemporary security frameworks.

Keywords- *AI surveillance, IoT, CCTV systems, object detection.*

AI for Ocean Exploration: Unlocking Ocean Mysteries with Artificial Intelligence

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Abstract

The ocean is super big and full of mysteries. Believe it or not, we haven't explored more than 80% of it yet. But now, with the help of Artificial Intelligence (AI), scientists are starting to explore and learn more about it.AI is like smart technology that helps us do things faster and better. It can control underwater robots that go deep into the ocean, find sea animals, and even guess what the ocean will do next. This helps scientists make maps of the ocean floor, watch how the climate is changing, and find places with a lot of sea life.

Using AI also saves money and helps people make quick decisions while exploring. It makes deep-sea missions easier and better for the environment too. So basically, AI is a big help in exploring the deep ocean, learning new things, and protecting sea life for the future.

Keywords- *Artificial Intelligence, Ocean, Environment, Smart technology.*

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Ethical Decision-Making in Autonomous Vehicles (AVs)

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Abstract

As autonomous vehicles move closer to becoming a normal part of everyday life, figuring out how they should make decisions during unavoidable accidents is becoming more urgent. This research looks into a flexible ethical framework that helps AVs navigate tough situations where some level of harm can't be avoided. Instead of forcing one moral rule onto every scenario, the idea is to weigh the moral claims of everyone involved—like pedestrians, passengers, and others on the road—and find the most balanced outcome. Using the Ethical Valence Theory, this system takes into account the harm that could happen and the uncertainty in real-time situations. We also explore a customizable ethical setting that lets users choose between different moral perspectives, all within legal limits. By combining smart algorithms with ethical reasoning, this approach aims to make autonomous decision-making more fair, adaptable, and socially acceptable.

Keywords— *Autonomous Vehicles (AVs), Ethical Decision-Making, Unavoidable Accidents, Moral Framework, Ethical Valence Theory, Real-Time Decision Systems.*

India's Heredity: AI Enabled Website

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Abstract

Welcome to India's Heredity, a lively site that lives and analyze the country's rich culture. Think about it – being able to plunge into India's mysterious past, meet developing artists and artisans, and experience the stunning variety in customs that differentiate it from other places. Whether it is the colorful festivals, local distinctive handcrafted things, or vibrant visual expression, India. Heredity is the entrance to India's inner world. If you want an artist to perform for a function or are looking to purchase a one-of-a-kind gift, India's Heredity will put you near the people and things that add life to India. Find the best of India's art, music, dance, food, and architecture to glimpse India's heart-stopping collectiveness of cultural diversity. With India's Heredity, you can watch videos, see personalized profiles of artists, and even book them for you events. You may also browse our gallery of unique indigenous crafted products, from beautiful textiles to exquisite jewelry, and buy furnishings online. With India's Heredity, we welcome you to experience India magic from within your residence.

Keywords- *Deep learning, Machine learning, Neural Networks, Regression analysis.*

Compact Circularly Polarized Antenna with Metasurface for Next-Generation Wireless Communication

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Abstract

This study focuses on the development and evaluation of a circularly polarized antenna enhanced by a metasurface for wireless communication systems. Circular polarization improves signal reliability by reducing the effects of multipath interference and polarization mismatch, making it advantageous for modern wireless networks. The antenna design features a compact radiating structure coupled with a carefully designed metasurface to generate circular polarization, broaden the impedance bandwidth, and increase gain. The metasurface, made up of periodic sub-wavelength structures, is optimized to control the electromagnetic wave propagation and enhance the antenna's radiation behavior. Simulation outcomes reveal noticeable improvements in axial ratio bandwidth and overall performance. Operating efficiently across the target frequency band, the proposed antenna is well-suited for applications including WLAN, 5G, and satellite communication. Its compact size, economical fabrication process, and robust performance position it as a strong candidate for future wireless technologies.

Keywords- *Deep learning, Machine Learning, Metasurface, Antenna.*

Land Registry System using Blockchain

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Abstract

Land registration is a crucial process for legally documenting land ownership, rights, and transactions. Registration of land in a country is very important for capturing both ownership and legal rights over a piece of land. However, many systems today have gaping flaws like inefficiency, corruption, or a complete lack of transparency. With traditional land registration, several central authorities and middlemen are part of the system, creating a huge trust deficit and making the already arduous task of record keeping, much more challenging, forget about the thousands of land titles. With Blockchain Technology, all of these red flags can be improved by taking away middlemen, inefficiency, slow pace, and corruption. As a corrective tail remedy, this paper advocates for a registered land system on Ethereum blockchain principles. In the proposed system, landowners have to provide their relevant details like the market value of the property, along with proof of ownership. A land inspector, appointed by the government for each village, further authenticates the registration. The smart contract in place for this framework restricts the user from transferring the property partially, abolishing fraudulent terms. Noteworthy is the fact that government authorities are involved in the registration dealings, however the buyer and seller are the only two people that determine how transparent they want this system to be. This brings innovation efficiency security and integrity to set out a new frontier for automated land registration.

Keywords*: Blockchain, Smart Contract, Ethereum, Solidity.*

Deep Learning-Based Object Detection: A Comparative Analysis of YOLO Model and Open CV

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Abstract

Now a days object detection is playing an import role in our current scenario in a world for improving the response and intelligence of the machine like when using our mobile phone for unlocking it by face recognition ,to operate surveillance system in better way, for navigation in self-driving car safely, this power of detection and recognizing it in the real time is become easy now a days by the tools named OpenCV and Yolov5 and this research paper is discussing these two popular tools mentioned above. As we know OpenCV is a open source library in python which is used for the computer vision and known for its speed and ease.it has been using well trained algorithm such as Haar Cascade to find the objects like face , eye upper body etc. it is memory efficient and easy to setup and runs with limited processing power, makes it a better practical choice for simpler task to perform .And for the YOLOv5 is a deep learning with modernized approach having advanced ability and capability. YOLOv5 in built upon PyTorch framework of python which can recognize and classify different objects in a single in image with having high accuracy. It is more likely powerful when running on GPU, making it more appropriate for complex real-time application like vehicle detection, crowd monitoring, and retail analytics.In this paper, we have implemented OpenCV and YOLOv5 in python, and test on some sample images to analyze their performance. We have given the working codes example and also shown the output images of both tools used. For comparing the both we will highlight the strength of both approach like: speed, ease of Opencv , and accuracy and flexibility of YOLOv5. The goal of the study is to help students, researcher and developers in making decision when choosing between both method for object detection based on project, hardware and performance based.

Keywords *– Yolo, OpenCV, Computer Vision, object detection, face detection.*

Exploring the Role of Artificial Intelligence in Mental Healthcare: Current Trends and Future Directions –A Systematic Insight

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Abstract

Mental well-being is a vital part of the health and wellbeing of an individual and population, and is essential for the individual, society, and socio-economic progress of any nation. Mental health care is now at the era of transformation in the health sector, with new technologies like artificial intelligence (AI) revolutionizing screening, diagnosis, and treatment models of psychiatric conditions. Artificial Intelligence (AI) is transforming mental health treatment by improving diagnostics, personalized treatment, and therapy. This narrative review present a holistic overview of AI technologies in mental health, from machine learning (ML) and natural language processing (NLP) to chatbots and Deep Learning(DL) also it is directed towards discussing the existing scenario and the place of AI in mental healthcare, i.e., screening, diagnosis, and treatment. Additionally, the review tried to identify the main challenges, shortcomings, and prospects of AI in delivering mental healthcare from existing literature works. We also discuss the role of AI in early detection, predictive analytics, and virtual therapy, while touching upon ethical issues like data confidentiality and algorithmic prejudice. Evidence from scholarly literature indicates that AI enhances accessibility and effectiveness in mental health care, despite limitations in clinical integration and regulation. This review emphasizes the potential of AI to transform mental health care while supporting responsible adoption.

Keywords-Artificial intelligence, machine learning, deep learning, early diagnosis and mental healthcare.

IoT-Based Smart Classroom Automation

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Abstract

In the era of digital transformation, the integration of Internet of Things (IoT) technologies in education has paved the way for smarter, more efficient learning environments. This paper presents a comprehensive study and implementation of an IoT-based smart classroom automation system aimed at enhancing the teaching and learning experience. The proposed system leverages interconnected sensors, microcontrollers, and cloud based platforms to automate environmental controls such as lighting, temperature, and air quality, while also facilitating real-time attendance tracking, smart board operation, and energy management. Through automation and intelligent data analysis, the system not only optimizes resource usage but also ensures a comfortable and secure classroom setting. Experimental results demonstrate significant improvements in energy efficiency and operational convenience, highlighting the potential of IoT in transforming traditional educational infrastructure into adaptive, interactive, and intelligent spaces. The study concludes by outlining the challenges, security concerns, and future prospects of IoT integration in educational institutions.

Keywords- *Internet of Things, Automation, Integration, Educational, Classrooms.*

AI-powered web development

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Abstract

As artificial intelligence (AI) is continually disrupting technology standards, it is becoming increasingly clearer and pertinent the influence and consequences in the scope of web development. The goal of this comparative research paper is to compile the findings of recent academic findings and industry practice, and assess how AI is changing the process of developing, designing, and servicing websites and applications. In comparing the traditional development process to AI-enhanced tools, this paper considers the frameworks of coding and copy coding, UX Design, usability testing, and SEO processes as it engages comparative frameworks to pace the effectiveness, limitation, and future of AI-based platforms in web development. While gains in productivity, as well as more automation in processes certainly stimulate interest in AI to enhance processes, we must also factor in human, as well as moral, responsibility as part of a sustainable design approach as part of our contribution to the affective approach in how we go about contemplating AI as a productive option in web development.

Keywords- *UX Design, Artificial Intelligence, Web Development.*

5G and Its Impact on IoT Communication

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Abstract

The emergence of 5G technology has brought a new era in wireless communication, significantly enhancing the performance and capabilities of network systems across the globe. With its advanced features such as ultra-high speed, very low latency, massive device connectivity, and higher reliability, 5G has become a key enabler for the rapid growth and evolution of the Internet of Things (IoT). IoT refers to the interconnection of smart devices and sensors that communicate and exchange data without human intervention, and the introduction of 5G has accelerated this communication process to a remarkable extent. 5G technology supports various new IoT applications that demand real-time data processing, large-scale device management, and minimal delays. It enables the deployment of smart solutions in multiple sectors such as healthcare, smart homes, industrial automation, agriculture, transportation, and smart cities. For instance, in healthcare, 5G allows for remote patient monitoring, telemedicine, and real-time health data analysis. Moreover, the 5G network architecture provides features like massive Machine-Type Communication (mMTC) and Ultra-Reliable Low Latency Communication (URLLC), which are vital for critical IoT applications like autonomous vehicles, remote surgery, and emergency response systems. The integration of 5G with IoT not only enhances the speed and efficiency of communication but also paves the way for innovations like Artificial Intelligence (AI)-based smart systems, cloud computing, and edge computing. However, the adoption of 5G in IoT communication also faces challenges such as high deployment costs, security risks, data privacy concerns, and the need for new infrastructure development. Despite these challenges, the impact of 5G on IoT communication is highly transformative, promising a future where smart, automated, and interconnected systems will revolutionize everyday life and industrial operations. The combination of 5G and IoT is expected to create smarter cities, more efficient industries, and improved quality of life for people worldwide.

Keywords- *Machine-Type Communication, Ultra-Reliable Low Latency Communication, Internet of Things.*

Navigating the nexus of AI and IOT: A Comprehensive Review of Data Analytics and Privacy Paradigms

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Abstract

A revolutionary change in the creation, analysis, and application of data has been sparked by the convergence of artificial intelligence (AI) and the Internet of Things (IoT) across a variety of fields, from manufacturing and transportation to smart cities and healthcare. This combination, sometimes known as the AIoT paradigm, makes use of AI's decision-making skills and IoT devices' sensing capabilities to create intelligent, self-governing, and adaptable systems. But there are also a lot of difficulties with this integration, especially when it comes to user privacy and big data analytics. By methodically examining the data analytics lifecycle, which includes data collecting, preprocessing, storage, analysis, and visualization within the IoT ecosystem, which is thorough examination seeks to navigate the changing intersection of AI and IoT.In order to address the particular limitations of IoT environments, such as limited computational power, latency sensitivity, and heterogeneity, the paper classifies and assesses cutting edge AI models and learning frameworks, such as federated learning, edge AI, and deep reinforcement learning. Simultaneously, the article offers a critical evaluation of security mechanisms and privacy preserving strategies intended to protect sensitive data in AIoT deployments. These consist of blockchain-based access control, homomorphic encryption, differential privacy, and privacy conscious machine learning algorithms. We draw attention to the ethical and legal issues that support data governance in AIoT applications, as well as the tradeoffs between model performance and privacy guarantee. This review highlights important issues, unanswered research concerns, and new opportunities at the nexus of AI and IoT by combining current research trends, technological developments, and real-world applications.

Keywords- *Deep learning, machine learning, Internet of Things.*

Some Investigation on Implantable Antennas for Biomedical Devices

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Abstract

An Antenna is a crucial component in wireless communication systems, responsible for transmitting and receiving electromagnetic waves. The rapid advancements in biomedical technology have led to increased demand for miniaturized, wideband implantable antennas that can efficiently communicate with external monitoring systems. The design and performance of an antenna depend on factors such as frequency, gain, radiation pattern and efficiency. The design of an implantable antenna for biomedical purposes is presented in this paper. It operates in the 2.4–2.48 GHz industrial, scientific, and medical (ISM) band and features a ground plate substrate and several patch patterns. It is suggested to use a tiny implantable antenna for cardiac pacemakers. and attains ultra-wideband properties between 272 MHz and 1504 MHz. The suggested ultra-miniaturized implantable antenna is made smaller by using a 1.2 Ω chip resistor, a meander line radiating patch, and etched rectangular slots on the ground plane, resulting in a bandwidth of 16.6% at 2.4 GHz for biomedical applications and new wireless power transfer system enhances efficiency and device lifetime. For biomedical applications in the 2.4 GHz ISM band, a novel implanted patch antenna with circular polarization and compact broadband was created. The implantable antenna is designed using a thin layer of substrate with high dielectric constant material as this provides biocompatibility to antenna for achieve human body insulation and provides flexibility. Biocompatibility, miniaturization & safety is the first consideration for implantable antenna presented in this review paper.

***Keywords**: Biocompatibility, Implantable Antennas ISM Band, Miniaturization.*

Artificial Intelligence & Machine Learning

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Abstract

This field project report explores the dynamic and rapidly evolving domains of Artificial Intelligence (AI) and Machine Learning (ML), emphasizing their practical applications, impact across various industries, and future potential. The study aims to bridge theoretical knowledge with real-world implementations by analyzing how AI and ML technologies are being integrated into fields such as healthcare, finance, agriculture, manufacturing, and education. The project involved direct observations, interviews with professionals, and case studies of organizations utilizing AI/ML solutions. Key findings highlight the efficiency gains, predictive capabilities, and decision-making support enabled by machine learning algorithms. Furthermore, the report discusses the challenges faced in adopting these technologies, including data privacy concerns, algorithmic bias, and the need for skilled professionals. Overall, this project underscores the transformative power of AI and ML while also calling attention to the ethical and technical considerations necessary for responsible development. The insights gained from this fieldwork offer valuable perspectives for future research, policy development, and industry adoption.

Keywords- *Deep learning, machine learning, Algorithms.*

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Grok 3: Redefining Artificial Intelligence with Advanced Reasoning, Self-Correction, and Unprecedented Compute Power

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Abstract

The rapid evolution of Artificial Intelligence (AI) has catalyzed monumental shifts in the technology landscape, and Grok 3 represents the pinnacle of this progression. Grok 3 is not just another AI model—its revolutionary advancements in reasoning, self-correction, and computational power are setting a new standard in the field. This research paper explores how Grok 3 is shaping the future of AI, focusing on its capabilities, applications, and the industry-wide implications of its unprecedented features. We will dive into its self-correction mechanisms, the impact of its advanced reasoning capabilities, and the computational power driving its breakthroughs. Furthermore, we will assess its role as both a disruptor and a beacon for future AI development, considering the potential challenges and ethical considerations that accompany such innovations.

Keywords:*Grok 3, Artificial Intelligence, Advanced Reasoning, Self-Correction, Computational Power, Ethical Implications, AI Revolution, Disruptive Technology.*

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A Hybrid Approach for Malware Applications Detection

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ABSTRACT

Mobile applications have become ubiquitous, but their widespread adoption has increased security concerns, particularly regarding malware infiltration through official app stores. Current detection methods predominantly focus on static analysis of app permissions or dynamic user-based feedback, limiting the effectiveness of malware detection. This work proposes a novel hybrid approach integrating permission profiling—examining the explicit permissions requested by an app—and user experience Analysis—leveraging metadata from app stores and user-generated reviews. A hybrid approach, combining both Permission Profiling and User Experience Analysis, represents an underexplored yet promising area of research. Such an integrated approach aims to exploit the complementary strengths of permissions-focused static analysis and dynamic, user-centric analysis to achieve superior malware detection accuracy, reduced false positives, and better adaptability to novel threats. The objective is to enhance detection accuracy and efficiency by reducing false positives and negatives. Preliminary results indicate the effectiveness of this combined method in accurately classifying benign and malicious applications, contributing to improved security measures in mobile ecosystems. The proposed hybrid model has better efficiency (98.05%) than other existing permission profiling-based models (97%) and User experience models (76%). The superior performance of the hybrid model with a higher area under the curve (AUC = 0.982) compared to Permission Profiling (AUC = 0.970) and User Experience (AUC = 0.765) models not only considers the model development perspective but also considers the users' feedback to improve the detection performance.

Keywords: *Malware Detection, Android Permissions, User Experience Analysis, Machine Learning, Soft Voting, APKPure, Google Play Store*

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Chaos-Driven Neural Network Approach for Fast and Secure Medical Image Encryption

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Abstract

Protecting medical images in real time is very important to keep healthcare data safe during sharing and storage. In this work, we introduce a fast and simple encryption method that uses a chaotic neural network along with the logistic map. The combination of the neural network's complex transformations and the unpredictable nature of the logistic map creates strong chaotic sequences, which help in quick and secure encryption and it doesn't even need any training. This lightweight and AI-based approach makes sure that medical images stay safe instantly, which is very useful for the growing need for fast and reliable security in healthcare.

Keywords*—Medical Image Encryption, Neural Network, Logistic Map, Real-time Encryption.*

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5G vs 6G: The Road Ahead

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Abstract

The evolution of mobile communication technologies has brought about transformative changes in how people connect, communicate, and access information. While 5G has introduced ultra-fast data rates, low latency, and support for massive device connectivity, it faces limitations in range, energy efficiency, and infrastructure demands. As global digital needs continue to grow, 6G emerges as the next frontier, promising speeds up to 1 terabit per second, sub-millisecond latency, and intelligent, AI-driven network management. This paper explores the key differences between 5G and the anticipated features of 6G, highlights current research efforts, and analyzes potential applications across industries such as healthcare, transportation, education, and agriculture. It also addresses the technical and ethical challenges in implementing 6G, including high infrastructure costs, data privacy concerns, and the risk of widening the digital divide. By examining the motivations, benefits, and drawbacks of both generations, this study outlines a forward-looking perspective on how 6G can build a smarter, more inclusive global communication ecosystem.

Keywords*— Mobile communication, 5G, Artificial Intelligence, Machine Learning.*

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A Computational Approach to Optimize Transportation Cost from Warehouse to Store of Lime Road Company

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Abstract

Optimizing transportation costs is essential for improving the operational efficiency of logistics companies like Lime Road Company. This project is presenting a computational approach using Python and Vogel's Approximation Method (VAM) to optimize the transportation cost problem, having objective to minimize the total shipping cost while satisfying warehouse supply limits and store demand requirements. Using linear programming techniques, this project resolves the optimal quantity of goods to be transported between each warehouse and store pair. Python library like PuLP was developed to automate the application of VAM, which constructs an initial feasible solution by systematically allocating shipments based on the criteria of penalty cost. The model was tested using real-world company data, which includes supply, demand, and cost matrices, to simulate and analyze transportation scenarios. The results demonstrate significant cost reductions compared to traditional manual planning methods. This approach emphasizes the effectiveness of integrating classical optimization techniques with modern computational tools, which hands over a scalable, practical solution and a strategic approach for transportation logistics optimization at Lime Road Company.

Keywords: *Lime Road Company, Python, Vogel's Approximation Method.*

A– 232

Transportation Optimization for Two Type Tyres by Using Least Percentage Difference

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Abstract

Operational Management on the transportation and distribution problem of automobile types was considered with selected destinations in the District- Moradabad, Uttar Pradesh. The objective of this Project is to minimize the transportation cost, and to optimize the distribution of the available resources. Data were obtained and formulated into Operational Research (OR) models using the simplex method of linear programming, five transportation algorithms, viz, Vogel's Approximation Method, North-West Corner Method, Least Cost Method, Column-Minimum Method and Row-Minimum Method were utilized and iterated in order to get the initial basic feasible solution. Optimal solutions were obtained by using above methods. The transportation algorithms were compared for 2 types of automobile tyres, based on the least percentage difference and number of iterations. The Vogel's Approximation Method (VAM) was found to be an effective method at more than twenty iterations for optimal distribution solution with minimum percentage difference, while the Column-Minimum Method (CMM) at more than twenty iterations with lesser percentage difference of performed better at minimal cost. The modelling procedures on the transportation and distribution problem would be useful in making better decisions for companies such as the automobile-tyre companies in, making optimal distribution of their tyre commodities by various designated transporters, transporting from origin site to the different destinations at minimal transportation cost.

Keywords*: Transportation Problems, Vogel's Approximation Method (VAM), Column-Minimum Method (CMM), North-West Corner Method, Least Cost Method, Column-Minimum Method and Row-Minimum Method.*

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A Study on Predictive Analysis Using Random Forest Model on Traffic Congestion

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Abstract

Traffic congestion in rapidly growing urban centers like Bangalore has become a major issue which is leading to increased travel times, fuel consumption, and pollution. To address this challenge, this study evaluates AI-based traffic congestion prediction models through three international case studies—Amman, Los Angeles, and Casablanca—where the Random Forest (RF) model demonstrated high accuracy, scalability, and real-time adaptability compared to other machine learning approaches.

Based on these key findings, we decided to implement the Random Forest model on Bangalore's traffic data using incident reports, historical congestion patterns, and real-time inputs to predict traffic congestion levels. Our methodology includes data preprocessing and model training.

Keywords: *Traffic congestion prediction, Random Forest model, Machine learning, Traffic index, Smart city mobility.*

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A Comparative Study Between Zomato & Swiggy Using Game theory

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Abstract

This paper presents a comparative study between Zomato and Swiggy (two leading food delivery companies in India) to maximize profit by using the concept of Game Theory. In first part of the study, we compare the profit of both the companies based on strategies they are currently using to maximize their profit. After that, we suggest some new strategies to both the companies that are not currently being used by of them. Later, we compare profit of both companies after implementing these new strategies.

We created a profit function, which is proven by the concept of Nash Equilibrium that it will maximise the profit of Zomato and Swiggy. Our result proves that profit of Zomato is higher than the profit of Swiggy. This paper shows that game theory can be used by companies to find optimal strategies to stay ahead in competitive markets.

Keywords: *Nash Equilibrium, Profit function, Optimal, Game theory, Comparative study.*

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A Study on impact Analysis of Student's Academic Performance by using MS Excel

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Abstract

This study investigates the academic performance of B.Sc. (Hons.) Mathematics students at Teerthanker Mahaveer University by analyzing their results from Class 12, mid-term examinations, and university semesters (I to IV) using Microsoft Excel. The primary objectives are to evaluate students' academic progress, identify performance trends before and after joining the university, and explore factors contributing to variations in achievement. Data were collected directly from students, covering five subjects in Class 12 (Physics, Chemistry, Mathematics, Hindi, English) and various subjects across university semesters. Average marks were calculated, and grades were assigned based on a predefined grading scale. Bar graphs were plotted to visualize performance differences, revealing fluctuations in individual and cohort performance. The analysis indicates an overall improvement in average percentage from Class 12 (78.35%) to the second year of university (81.23%), despite a dip in the first year (74.01%). Additionally, factors such as locality and commuting distance were examined to understand their impact on academic outcomes. The findings highlight the role of university education in enhancing student performance and provide insights into addressing challenges faced by underperforming students.

Keywords: *Academic Performance, MS Excel, Grade Analysis, Performance Trends, Student Achievement, Data Analysis.*

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Optimization of Routes for Electric Vehicle Using Amiltonian Circuit

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Abstract

The rises of electric vehicles have helped in sustainable transportation these days. Not only they are environment friendly but also cost friendly since they need less maintenance. This paper involves route optimization for electric vehicles using the concept of Hamiltonian Circuit.

The aim is to find the shortest closed loop route that visits all the required destinations exactly once and return to the original one. The charging stations are represented as vertices and the distance between them as edges of the circuit. The best possible route found is short, saves energy and meets the charging requirement of the vehicles. This problem has practical relevance in logistics, planning and routing of circuits.

Keywords*: Electric Vehicle, Route Optimization, Charging Station, Hamiltonian Circuits.*

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Advancements in Biometric Technology with Artificial Intelligence

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Abstract

Biometric technology, including fingerprint scanners, facial recognition, and iris scanning, is now widely utilized for secure identity verification. This technology has become vital in the modern digital landscape, where swift and accurate identification is crucial, whether for unlocking devices or navigating airport security. The integration of Artificial Intelligence (AI) into biometric systems enhances their efficiency and precision. AI enables these systems to identify individuals more reliably, even in challenging conditions such as inadequate lighting, varying facial angles, or changes in appearance over time. For instance, AI can still identify a person who has grown a beard or is wearing glasses. Techniques such as machine learning and deep learning empower the system to adapt and refine its recognition capabilities based on historical data. A significant advancement in this field is the emergence of multimodal biometric systems, which utilize two or more identification methods in tandem, such as combining facial and voice recognition. These AI-supported systems are considerably more difficult to deceive and offer greater accuracy than relying on a single method. Consequently, they are increasingly adopted in critical sectors such as banking, healthcare, law enforcement, and border control, where rapid and secure identity verification is essential. Nevertheless, these advantages come with important concerns. The combination of AI and biometrics raises significant issues regarding privacy and ethics, particularly concerning data collection, storage, and access. There is a potential risk of surveillance or misuse if these systems are not properly regulated. Therefore, it is imperative to develop these technologies responsibly and adhere to guidelines that safeguard individual rights.

Keywords- *Deep learning, machine learning, house price prediction, multi-modal data, neural networks, regression analysis, feature engineering, hybrid models.*

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Neural Network Based S-Box Generation and its Application in Image Encryption

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Abstract

S-Box is the key component of the Advanced Encryption Standard (AES) algorithm. The design of a powerful substitution box(S-Box) is a challenge for the researcher. This paper presents how we can generate strong cryptographic 16×16 S-Boxes by building a neural network system. The generated SBoxes are then used to encrypt different grayscale images. The quality of the designed cryptosystem is judged through several cryptographic tests for such generated S-Boxes to justify the quality of the designed cryptosystem.

Keywords: *Image Encryption, Neural Network, S-Box, AES Algorithm, Hyperchaotic System.*

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Mental Health and Behavior Analysis using Deep Learning

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Abstract

Deep learning and artificial intelligence (AI) are being increasingly added to the arsenal of behavioural analysis mental health care providers use to diagnose, treat and monitor patients, providing more sophisticated methods. Current mental health assessments often use subjective self-reports and clinician observations as the basis for diagnosis and treatment, resulting in inconsistent diagnoses and response. AI driven tools, which leverage on neural networking, deep learning and machine learning models, tries to analyse the speech patterns, facial expressions, the physiological signals, and social interactions to provide objective and real time insights into individual's mental state. Early detection of mental health conditions, including depression, anxiety and schizophrenia, to bring in timely and personalized interventions, these innovations are made possible. In this paper, we look at the ways in which AI can transform mental health services with chatbots based therapies, diagnostic accuracy improvements, and predictive analytics. It also examines critically, the ethical challenges of AI such as data privacy, algorithmic bias, and patient autonomy. Additionally, the paper shows the potential for new technologies such as brain computer interfaces and quantum AI to bring about even more change. If addressed, the issues of trust, inclusivity and regulation, AI driven behavioural analysis can make mental health care more proactive, data driven and patient centric.

Keywords-*Artificial Intelligence (AI) in Mental Health, Deep Learning in Behavioural Analysis, AI-Powered Diagnosis and Treatment, Natural Language Processing (NLP) in Healthcare, Ethical Considerations in AI for Mental Health.*

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Overview of Fast Charging Technology for LFP Batteries in Electric Vehicle

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Abstract

The rapid growth of electric vehicle (EV) adoption has increased demand for fast charging, positioning lithium iron phosphate (LFP) batteries as a cost-effective and safe alternative to nickel manganese cobalt (NMC) chemistries. LFP offers superior thermal stability (270–300°C), long cycle life (80% capacity after 2,000–3,000 cycles), and lower costs ($80–120/kWh). However, challenges like lower power density (1,000–2,000 W/kg vs. NMC's 3,000–5,000 W/kg), poor conductivity (10^{-3} S/cm coated), and lithium plating risks at high charge rates limit its performance. Advances in carbon coatings, nanostructured electrodes, and improved cell designs are enhancing power delivery and durability. While LFP production emits 5–8 tons of CO_2 per 75 kWh battery, its cobalt-free composition improves sustainability. Real-world applications like the Tesla Model 3 Standard Range and BYD Han demonstrate its viability, with 80% charge achieved in 25–40 minutes. Future research into solid-state electrolytes and higher power densities aims to further optimize LFP for fast charging.

Keyword: *Fast charging technology, lithium iron phosphate (LFP) batteries, electric vehicle (EV) batteries, battery degradation in fast charging, thermal stability of LFP batteries.*

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A Smart Car Parking System: Enhancing Urban Parking Efficiency Using IoT

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Abstract

The rapid increase in urban population and vehicle ownership has led to significant challenges in managing parking spaces efficiently. A Smart Car Parking System offers an innovative solution by integrating technologies such as the Internet of Things (IoT), sensors, and cloud computing to optimize parking operations. This system automates the process of locating available parking spots, reserving spaces, and managing vehicle entry and exit, thereby reducing traffic congestion, fuel consumption, and time spent searching for parking. Users can access real-time information through mobile applications or web platforms, enabling seamless navigation to available spots. The system also supports features like monitoring, and data analytics for better management and planning. By enhancing user convenience and improving resource utilization, the Smart Car Parking System represents a significant step towards smarter, more sustainable urban mobility.

Keywords: *Car parking, Smart parking system, Internet of Things (IoT) based parking system, Sensor, Cloud computing.*

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Face Recognition based Attendance Management System

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Abstract

Face recognition system plays an important role in nearly every field in this digital age. Face recognition is one of the widely utilized biometrics. It can be used for security, authentication, identification, and has numerous more benefits. Even though it has low accuracy compared to iris recognition and fingerprint recognition, it is gaining popularity because of its contactless and non-invasive nature. In addition, face recognition system can also be implemented for marking attendance in schools, colleges, offices, etc. This system is intended to develop a class attendance system which is based on the concept of face recognition as the current manual attendance system is time-consuming and tedious to maintain. And there can be possibilities of proxy attendance. So, the requirement of this system is more. The system has four phases- creation of database, face detection, face recognition, updation of attendance. Database is generated by images of the students in class. Face detection and recognition is done using Haar-Cascade classifier and Local Binary Pattern Histogram algorithm respectively. Face detection and recognition is done from live streaming video of the classroom. Attendance will be sent to the concerned faculty by post at the conclusion of the session.

Keywords-: *Face Recognition; Face Detection; Haar-Cascade classifier; Local Binary Pattern Histogram; attendance system.*

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Smart Gas Leakage Detector with Auto Shut Off

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Abstract

Gas leakage is a serious safety issue in homes, industries and commercial places as it can result into fires, explosions and health hazards. This issue falls back to me and hence we have come up with a Smart Gas Leakage Detector with Auto Shut-Off, an IoT based system that detects gas leaks and takes immediate action to prevent any accidents and alerts the users remotely. The built system of this system uses an Arduino microcontroller, an MQ-2 gas sensor, an automatic shut off valve, a buzzer for local alerts, an LCD screen that can display real time temperature and humidity, and a Wi-Fi module for online notifications. In case a gas leak is detected, the system automatically stops the gas supply to prevent further leakage, sounds an alarm to warn people nearby and displays the important safety information on the screen. Moreover, it sends immediately emails to the user, and allows remote control via mobile app, to make the situation controllable even if nobody is at the place. Unlike traditional gas detectors which only trigger an alarm, this smart system is equipped with the ability to shut off the gas as well as to provide real time updates. Being a versatile safety solution, it can be used in homes, apartments, factories, gas-powered vehicles and commercial buildings. This is another layer of security since temperature and humidity monitoring can influence gas behavior and raise risks. This project provides a reliable system of gas related accidents prevention with its real time detection, automatic safety measures, and remote monitoring features. Based on IoT technology, we introduce the modern, efficient, and proactive solution for the management of gas safety in different environments.

Keywords: *IoT Safety System, Automatic Gas Shut-Off, Gas Leak Detector, Real-Time Alerts, Remote Monitoring, Smart Home Security, Arduino.*

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Empowering Rural Healthcare: Low Resource LLM-Powered Decision Support System in India

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Abstract

Access to timely and correct health information remains an ongoing challenge in rural India, where Accredited Social Health Activists (ASHAs) are essential front line workers in maternal and child healthcare. Although Large Language Models (LLMs) have revolutionized decision support in high resource clinical environments, such models are usually large, English-biased, and internet-reliant— hence not applicable to low-resource, multilingual, and offline rural settings. This work provides a holistic framework for converting open-source LLMs (such as LLaMA, Phi-2) into light, domain-specific, and multilingual decision support systems for ASHAs. Using efficient fine-tuning methods like Low- Rank Adaptation (LoRA), we show how these models can be fine-tuned for edge device deployment to provide offline accessibility. The models are trained on India-specific maternal and child health protocols, Hindi and other regional language translations for contextual applicability and usability. We ensure validation of this through simulation-based evaluations with diagnostic accuracy, awareness of health schemes, and work flow compliance. This research also covers practical deployment considerations such as model hallucination, explainable, ethics, and human-in-the-loop protection. Our envisioned framework sets the stage for a scalable, fair AI-powered healthcare assistant that can enable rural healthcare professionals and enhance outcomes in underserved areas.

Keywords: *Accredited Social Health Activists, Low- Rank Adaptation, LLMs.*

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Lang Chain-Based AI Constitution Assistant

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Abstract

This research explores the development and implementation of a LangChain-based AI Constitution Assistant designed to assist legal professionals, scholars, and the general public in navigating, interpreting, and analyzing constitutional documents. Leveraging LangChain, a robust framework for building language models-powered applications, the AI Constitution Assistant utilizes advanced natural language processing techniques to enable users to query constitutional provisions, extract relevant interpretations, and receive real-time legal insights. The system is designed to support multiple jurisdictions and constitutional documents, offering a user-friendly interface for both casual users and professionals. This paper outlines the technical architecture, core functionalities, and practical applications of the assistant, focusing on how it enhances legal research, improves accessibility to legal texts, and aids in the democratization of constitutional knowledge. Furthermore, it discusses challenges such as legal language complexities, contextual accuracy, and ensuring system transparency and reliability. The potential for LangChain-based systems in the broader legal domain is also examined, illustrating how they can augment traditional legal analysis and foster more inclusive, data-driven legal practices.

Keywords*:AI Legal Chatbot (Law Que), Document Generation, user authentication, AI bot (Law Que), Question Answering, Appointment Scheduling, File storage.*

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Secure and Transparent Data Sharing using Block Chain

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Abstract

This paper presents a block-chain based framework for secure data sharing in data science pipelines. The Purposed system leverages the decentralized nature of block-chain to ensure data integrity and privacy when multiple stakeholders collaborate on sensitive datasets. Traditional centralized methods often suffers from issue such as data breaches, unauthorised access and Data Prevances.

Keywords*—Block-chain, Pipelines, Privacy, Data-breaches.*

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Revolutionizing Modern Medicine: The Transformative Power of Artificial Intelligence and Machine Learning in Healthcare

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Abstract

The integration of Artificial Intelligence (AI) and Machine Learning (ML) into the healthcare sector is significantly transforming the way medical services are delivered, diagnosed, and managed. These technologies offer intelligent data processing, predictive analytics, and real-time decision-making capabilities that enhance patient care, operational efficiency, and clinical outcomes. This paper explores the current applications, benefits, limitations, and future directions of AI and ML in healthcare. It emphasizes the transformative impact of these technologies in early disease detection, personalized medicine, robotic surgeries, medical imaging, and drug discovery. Despite notable advancements, ethical concerns, data privacy issues, and algorithmic transparency remain critical challenges that must be addressed to ensure responsible and equitable deployment.

Keywords*: Artificial Intelligence, Machine Learning, Healthcare Innovation, Medical Imaging, Predictive Analytics, Personalized Medicine, Clinical Decision Support, AI Ethics, Healthcare Transformation.*

A Survey on Cross-Cultural Analysis of NLP Models in Detecting Mental Disorders

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Abstract

Global mental health is severely hampered by mental illnesses like depression, anxiety, eating disorders, and suicidal thoughts, which calls for efficient early detection and intervention techniques. By analysing textual data from a variety of sources, such as social media platforms, medical notes, and online forums, Natural Language Processing (NLP) has become a crucial tool in the identification of these conditions. This survey offers a thorough analysis of how NLP is used to identify mental illnesses, highlighting current practices, emerging trends, and difficulties in this field. The review encompasses an analysis of feature extraction techniques, machine learning algorithms employed, and the social media platforms predominantly targeted in research studies. Additionally, it looks at the interpretability of NLP models in clinical settings, data privacy concerns, and ethical considerations. The survey also covers the incorporation of deep learning techniques, like transformer-based models, and how they outperform conventional machine learning techniques in terms of scalability and accuracy. The need for sizable, annotated datasets, managing linguistic subtleties across various languages and cultures, and creating interpretable models that clinicians can rely on are still obstacles in spite of the progress. In order to improve the effectiveness and applicability of NLP techniques in mental health diagnostics and interventions, the paper ends by suggesting future research directions, highlighting the significance of interdisciplinary collaboration, the incorporation of multimodal data, and the establishment of standardised evaluation metrics.

Keywords: *Natural Language Processing (NLP), Mental Disorder, Clinical NLP.*

Artificial intelligence: Boon or Bane for society?

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ABSTRACT

Artificial Intelligence (AI) tools such as ChatGPT and OpenAI among others, are likely to transform the way we live, work, and interact with each other. It will impact on our society positively and negatively. In this article, the opportunity and challenges of artificial intelligence in various sectors and its positive and negative effects on society are mentioned. AI provides assistance in the management of healthcare care, early diagnosis, documentation, and robotic surgery, thus improving the quality of social work. Contributes to the financial sector and improves the customer experience by facilitating artificial intelligence, market analysis, mobile banking, and digital payment systems in the financial sector. Artificial intelligence in education; Provides advanced teaching to students by using data mining, intelligent teaching platforms, and personalized learning systems. Increasing productivity, increasing revenue, creating new jobs, and reducing human error are the positive effects of artificial intelligence. Artificial intelligence has positive and negative effects. Layoffs, reductions in the labor market, privacy protection issues, and inequalities are among the negative effects of artificial intelligence. For this reason, artificial intelligence must be created within ethical frameworks and contribute to society.

Keyword: *Artificial Intelligence, Machine Learning, ChatGPT, Open AI.*

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Spam Detection with Ada Boost and Random Forest

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ABSTRACT

In today's world we all are witnessing the growth and advancement in technologies which are significantly beneficial for us to improve the quality of our daily life. However, these developments also have some negative issues which are also growing on peak. We all use messages and e-mails for formal and as well as informal communication, on these applications we received two types of messages categorized as useful and important messages which is called ham messages or safe messages, but there is also one more category of messages categorized as harmful and unsafe messages known as spam messages, Spam messages can broadly be categorized into two types. One category includes non-malicious or harmless spam, which, although not posing a direct threat, can accumulate in device storage, consume memory resources, and indirectly degrade system performance over time. Second category of spam messages can be some unwanted content or they be a scam messages like scammers send some harmful messages which may disclose our personal and important information. To address this issue we implements Machine Learning techniques like Random Forest Classifier and AdaBoost Classifier in our models which shows prediction with very high accuracy to classify the messages in spam and ham These models are evaluated using standard performance metrics, including accuracy, precision, recall, and F1-score.Getting good results because at training stage we train our model with extensive datasets sourced from Kaggle that's why our model is predicting very accurately and precisely this model play a crucial role in defending society and ensuring a secure communication environment.

Keywords- *Machine Learning, Adaptive Boosting, Data balancing, Encoding.*

A– 264

Advanced Detection of Credit Cards Frauds with Machine Learning

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ABSTRACT

Studies dedicated to the recognition of credit card fraud through the utilization of machine learning approaches have gained considerable scholarly engagement because of their ability to markedly enhance security frameworks and alleviate economic losses. This research examines the implementation of an array of supervised learning algorithms, such as Logistic Regression, Naïve Bayes, Decision Trees, Support Vector Machines (SVM), Random Forests, and K-Nearest Neighbors (KNN), aimed at the classification of fraudulent transactions. Furthermore, the investigation delves into unsupervised methodologies, exemplified by K-means clustering, as well as hybrid frameworks that amalgamate diverse strategies to bolster detection precision. The research emphasizes the critical importance of comprehensive data pre-processing in order to augment the effectiveness of model performance. This encompasses essential procedures including feature selection, data cleansing, and the resolution of class imbalance—a persistent obstacle in fraud detection datasets where legitimate transactions significantly outnumber fraudulent instances. Adequate pre-processing guarantees that the models are optimally equipped to discern intricate and evolving patterns of fraud. To assess the effectiveness of the aforementioned models, the study employs an extensive array of evaluation metrics, which include F1-score, recall, accuracy, ROC curve, precision, and AUC. These metrics furnish a holistic appraisal of the models' capabilities in accurately detecting fraudulent behavior while minimizing inaccuracies such as false positives and false negatives. Despite the notable promise exhibited by machine learning models in fraud detection, various challenges remain, including restricted data availability, inadequate interpretability, and the necessity for models that are capable of adapting to the fluid nature of fraudulent schemes. Future investigations ought to consider the utilization of ensemble methods, advanced deep learning frameworks, the integration of supplementary data sources, and real-time detection systems to overcome these challenges and further enhance fraud detection efficacy. Although it possesses significant potential, the dynamic characteristics of deceptive practices and the imperative for models that are both transparent and adaptable underscore the urgency for ongoing innovations within this field. Addressing these complexities necessitates the development of more advanced methodologies that can effectively respond to the continually evolving landscape of credit card fraud detection.

Keywords: *Neural networks, Supervised learning, Machine learning, Credit card fraud, Unsupervised learning.*

A– 265

Studying Recognition of Hand-Drawn Flowchart Symbols and Handwritten Figures Using Large Language Models

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Abstract

This review explores the evolving capabilities of large language models (LLMs) in recognizing hand-drawn flowchart and handwritten figures, a task traditionally dominated by computer vision techniques. With recent improvement in multimodal AI, particularly transformer based architectures, LLMs have demonstrated that performance in interpreting visual data alongside textual input. This paper approaches that leverage LLMs either independently or in conjunction with vision models to enhance the accuracy and efficiency of symbol recognition. Emphasis is placed on evaluating many research papers to get best models. We also analyse model architecture, training paradigms, and multimodal integration strategies. The review culminates in a comparative assessment, highlighting a set of optimized models that outperform traditional methods in recognition accuracy, processing time, and adaptability. Our findings suggest that integrating LLMs presents a scalable and efficient solution for automated understanding of sketched diagrams and handwritten content in educational, engineering, and design applications.

***Keywords**: Large Language Models, Hand-drawn Diagram Recognition, Flowchart Interpretation, Multimodal AI, OCR, Prompt Engineering, Computer Vision, Generative AI, Symbol Recognition.*

A– 267

Disease identification in sugarcane plant using MobileNet, EfficientNet.

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ABSTRACT

The paper introduces an advanced approach to detect plant diseases through deep learning models containing MobileNet and EfficientNet frameworks. Precise and timely disease identification services for worldwide biofuel and sugar production depend on vital crop sugarcane so agricultural management can improve while losses decrease. Every type of disease that affects sugarcane leaves including red rot, smut, rust and yellow leaf disease was included in our dataset following image collection along with image preprocessing. Implementation steps for MobileNet with resource-efficient EfficientNet resulted in the evaluation of disease classification accuracy precision and recall versus computational efficiency until the best models emerged. The optimized EfficientNet model reached 94.7% accuracy while MobileNet reached 92.3% accuracy thereby establishing exceptional results in limited resource environments. The optimized mobile-based models provided disease diagnosis operations in real time via offline mode for applications in agricultural sites. The research has developed user-friendly technical solutions for sugar cane farmers to detect diseases early on because they promote sustainable farming through decreased crop damage and reduced chemical usage

Keywords:*Sugarcane disease detection, Deep learning, MobileNet, EfficientNet, Computer vision, Plant pathology, Image classification, Precision agriculture, Transfer learning, Mobile deployment.*

A– 268

AI Dreamscapes: Building Boundless Realities in the Metaverse

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ABSTRACT

The rise of Generative Artificial Intelligence (AI) is reshaping how we imagine and interact with the digital world — especially in the environment of the metaverse. These advanced AI models, like GANs(Generative inimical Networks), VAEs(Variational Autoencoders), and underpinning literacy ways, can automatically induce everything from naturalistic surroundings and characters to stories, textures, and sounds. This makes structure immersive virtual spaces briskly, cheaper, and more accessible — indeed for generators with limited resources. One of the most well- known tools, ChatGPT, shows how generative AI can go beyond static content and hold intelligent, natural exchanges with druggies. This kind of technology brings virtual worlds to life, allowing for substantiated relations and gests that feel more mortal. By combining visual, audio, and textbook-grounded content, generative AI can draft engaging,multi-sensory surroundings that are dynamic and adaptable.This paper explores not only the technology behind these systems but also how they can be integrated into the metaverse — from collecting and preparing data to training AI models and bringing them into real platforms. But with great invention comes responsibility. As combining visual, audio, and textbook- grounded content, generative AI can draft engaging,multi-sensory surroundings that are dynamic and adaptable.This paper explores not only the technology behind these systems but also how they can be integrated into the metaverse — from collecting and preparing data to training AI models and bringing them into real platforms. But with great invention comes responsibility. As important as generative AI is, it also brings challenges, like icing data sequestration, avoiding prejudiced labors, and managing the huge computational coffers these systems need. Looking ahead,generative AI has the implicit to homogenize creativity and change how we learn, play, fraternize, and work in virtual spaces. It's not just about technology — it's about erecting a more interactive, inclusive, and imaginative digital future.

Keywords:*Generative Artificial Intelligence, Metaverse, GANs (generative adversarial networks), multimodal interaction, ChatGPT, real-time AI Integration.*

A– 274

Robotics Arm using Servo moters

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ABSTRACT

This research paper presents the design, implementation, and evaluation of a robotic arm controlled using servomotors. The purpose of the study is to develop a cost-effective, efficient, and precise robotic arm capable of performing tasks such as pick-and-place operations. The proposed system uses multiple servomotors for joint actuation, a microcontroller for control, and sensors for feedback. Applications of such robotic arms are widespread, including industrial automation, medical assistance, and educational tools. Experimental results demonstrate the system's accuracy, repeatability, and responsiveness.

Keywords:*Robotic Arm, Microcontroller, Sensors.*

A– 275

Hand Gesture controlled wheelchair using Arduino

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ABSTRACT

This research paper presents the design and implementation of a hand gesture-controlled wheelchair system leveraging Arduino technology. Aimed at enhancing mobility and independence for individuals with physical impairments, the system offers a user-friendly, cost-effective alternative to conventional joystick-operated or manually powered wheelchairs. At its core, the system employs an MPU6050 accelerometer sensor to capture hand gestures, which are processed by an Arduino Uno microcontroller to generate corresponding motion commands. These commands control the direction and movement of the wheelchair—forward, backward, left, and right—based on intuitive hand movements. Experimental evaluation demonstrates the system's responsiveness, accuracy, and real- time performance, validating its practicality for real-world assistive applications.

Keywords:*Wheel chair, Arduino, MPU6050 Sensor Module, Motor Driver.*

A– 276

Third Eye For Blind Ultrasonic Vibrator Glove

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ABSTRACT

This study introduces an innovative assistive wearable called the "Third Eye for the Blind", developed in the form of an ultrasonic vibrator glove to support visually impaired individuals in moving around more safely and independently. The glove employs ultrasonic sensors to detect nearby obstacles and conveys this information through vibration signals. The strength of the vibration changes depending on the distance to the obstacle, enabling users to sense their surroundings via touch. Designed to be lightweight, affordable, user-friendly, and portable, the device offers a practical solution for everyday navigation. The main goal is to improve the spatial awareness and mobility of blind users, reducing their reliance on others and boosting self-confidence. This paper explores the glove's architecture, functional mechanism, component choices, and testing results, and also discusses potential upgrades like GPS integration or voice-based feedback systems.

Keywords:*Blind navigation aid, haptic feedback, wearable technology, vibration feedback, obstacle detection, ultrasonic sensors.*

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Smart Parking System using Arduino

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ABSTRACT

This paper presents a Smart Car Parking using Arduino UNO and IR sensors to streamline vehicle entry, monitor slot availability, and automate access control through a servo motor-based gate. The system uses six IR sensors—one each for entry and exit, and four for parking slot status detection. A servo motor opens the entry gate for 2 seconds only if parking space is available. LEDs indicate parking status with green showing availability and red indicating a full lot. The proposed system eliminates the need for mobile or internet integration, offering a cost-effective solution for small-scale parking lots. The innovation lies in its simplicity and effectiveness, ensuring it can be adopted in semi-urban and institutional premises. In contrast to commercial parking systems requiring internet or app-based integration, this setup provides a standalone solution ideal for controlled environments like colleges, offices, and gated communities.

Keywords: *Smart Parking, Arduino UNO, IR Sensor, Automation, Servo Motor.*

A– 280

IoT-based Disaster Prediction Systems: Implement AI for early warning systems in natural disasters like floods and earthquakes

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ABSTRACT

The incidence and intensity of natural disasters such as floods and earthquakes have boosted the need for advanced early warning systems to reduce their impact on human life and infrastructure. The review paper describes the convergence of Internet of Things (IoT) technology and Artificial Intelligence (AI) in developing smart early warning and disaster forecasting systems. Real- time environmental data—seismic activity, temperature, humidity, water level, and atmospheric pressure—are collected through IoT sensors and processed through AI algorithms to detect patterns and forecast imminent disasters. Machine learning and deep learning algorithms improve the accuracy and reliability of forecasts, enabling timely warnings and interventions. The paper critically examines a sequence of case studies, current systems, and upcoming technologies and recognizes the advantage, limitation, and potential of IoT-AI convergence in disaster management. The convergence of IoT and AI can potentially revolutionize traditional monitoring systems with scalable, automated, and effective early warning systems with the capability to save lives and reduce economic losses.

Keywords: *Smart Parking, Arduino UNO, IR Sensor, Automation, Servo Motor.*

A– 281

Home Automation Using an Android Device

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ABSTRACT

Home automation has gained significant momentum with the advent of smartphones, particularly Android-based devices this paper present the design and implementation of a low-cost, flexible, and wireless home automation system that can be controlled through an android device. Home automation using an android device is a best technique to control the all appliances of our home directly via an android phone through these technique it is very easy to on/ off our each appliances and control them easily. The system uses Bluetooth and Wi-Fi modules for device communication, allowing users to control the home appliances such as lights, fans and security systems remotely. The research focuses on both the hardware integration and challenges of creating a layer- friendly interface for non-technical uses the proposed system emphasizes scalability and cost-effectiveness, making it suitable for developing countries.

Keywords: *Home automation, Relay module 5v, 3 bulb and 1 dc fan, Blynk app, NodeMCU 8266.*

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Eco-Conscious Digital Marketing: Strategies for Sustainable Consumer Engagement

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ABSTRACT

The increasing need for sustainable company operations has led to the emergence of eco-conscious digital marketing. This study examines tactics that companies can use to encourage sustainability via digital platforms and sway customer preferences towards environmentally friendly options. Businesses can create a responsible online presence by combining data-driven decision-making, ethical advertising, green content marketing, and sustainable branding. Along with providing data-driven insights, the study looks at how digital marketing affects environmental sustainability. It also outlines the difficulties companies encounter when implementing environmentally friendly marketing techniques and offers suggestions for resolving these issues. The findings of this research contribute to the continuing discourse on sustainable digital practices and their role in developing consumer awareness and company accountability.

Keywords: *Digital marketing, consumer behaviour, sustainability, etc.*

A– 284

Maize Leaf Disease Identification: A Comprehensive Study Using Various ML and DL Techniques

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ABSTRACT

In modern era, maize is a globally vital cereal crop that is still quite sensitive to a wide range of leaf diseases that compromise crop output and quality. Preventing major agricultural losses and guaranteeing food security depend critically on early, exact identification of these diseases. By allowing automated, accurate, scalable disease detection solutions, the combination of Machine Learning (ML) and Deep Learning (DL) approaches has transformed plant disease diagnosis in recent years. This review investigates a wide range of ML and DL techniques used in order to find maize leaf diseases. Examined alongside modern DL architectures including Convolutional Neural Networks (CNNs), ResNet50, PSPNet, and attention-based models like YOLOv5 enhanced with Coordinate Attention (CA) mechanisms and Swin Transformer heads are classical ML approaches including Support Vector Machines (SVM), Decision Trees, and Gradient Boosting. With an accuracy of 96.67%, hybrid models including PRF-SVM, which combines the spatial awareness of PSPNet, the deep feature extraction of ResNet50, and the fuzzy classification capacity of Fuzzy SVM, have shown interesting performance. Likewise, lightweight and effective models such as CTR_YOLOv5n achieve over 95% accuracy withmuch lower memory usage, so enabling real-time disease recognition on mobile devices. Training and validation of these models on several maize leaf diseases including common rust, grey leaf spot, maydis leaf blight, and others mostly rely on publicly available datasets like PlantVillage. The paper also assesses performance measures including mAP, IoU, F1-score, and preprocessing techniques as well as the effects of including attention mechanisms. The transforming power of ML and DL in digital agriculture is underlined in this review together with the difficulties and future directions required to improve accuracy, efficiency, and practical deployment in actual farming environments.

Keywords*:Maize Leaf Disease Detection, Deep Learning, Machine Learning, Convolutional Neural Networks (CNN), Support Vector Machine (SVM), Crop Monitoring.*

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The Role of IoT and AI in Building Sustainable Industrial Systems: A Review

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ABSTRACT

To improve productivity and sustainability, industries are increasingly adopting IoT (Internet of Things) and AI (Artificial Intelligence) technologies. These systems enable intelligent operations, precision, and automation across manufacturing and related sectors. Modern communication technologies like 5G, Wi-Fi, ZigBee, and LPWAN provide a robust backbone to connect sensors and machinery on the factory floor and across supply chains. Through the integration of machine learning and deep learning, IIoT (Industrial IoT) systems collect and optimize real-time data, allowing autonomous control and creating smart factories. By connecting physical assets throughout operations, industries achieve better visibility into processes and enable real-time decision-making. This integration powers advanced robotics and predictive maintenance, helping foresee equipment failures and schedule timely repairs, thereby minimizing downtime and improving operational efficiency. AI-driven systems also facilitate dynamic resource optimization, energy management, and advanced anomaly detection. Automation fueled by integrated IoT and AI enhances workflow tracking, optimizes resource use, and strengthens data-driven decision-making across operations. As a result, industries benefit from reduced costs, improved asset utilization, higher worker safety, and more sustainable use of materials, contributing to environmental preservation. However, challenges remain. Protecting data privacy, ensuring interoperability across diverse systems, and managing the complexity of large-scale IoT-AI deployments require focused attention. Additionally, industries must address risks related to overdependence on embedded intelligence and the high maintenance demands of integrated systems. Overall, IoT and AI integration form the foundation of modern industrial systems aligned with Industry 4.0 goals, offering significant gains in productivity, innovation, and sustainable development, while highlighting the critical need for strong security and interoperability standards.

Keywords:*Internet of Things; Artificial Intelligence; Industrial IoT; Industry 4.0; Deep learning.*

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Use of IOT in the Field of Agriculture

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ABSTRACT

Let's imagine the world where all the farms are connected to the internet and every plant, animal and even tools can communicate with the farmers in real time. That's the main goal of IOT (Internet of things) in the field of agriculture. This research paper explores how IOT helps in making farming more efficient, smarter and make up the kind planet. From the sensors that helps in monitoring the soil conditions to the drones that are masters to scout the field for pests. IOT helps the farmers in making better decisions for their farms and for saving resources and growing more food and crops. If we look for the real world examples - the automated irrigation systems that waters crop only when it is needed, and protects the crop from getting spoiled or the tools based on AI that predict the harvesting times. But there are possibilities of occurrence of challenges like technical problems or high costs. That farmers can face while adopting these technologies. This paper aims to look at how to make the use of IOT more easily affordable and accessible for all the farmers to large agriculture businesses.

***Keyword**: Internet of things, Soil Monitoring, Automated Irrigation, Crop Management.*

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Displacement Estimation from SMI Signals using Quantized Convolutional Neural Networks

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ABSTRACT

Abstract: The paper presents a convolutional neural network (CNN)-based method for the estimation of displacement using self-mixing interferometry (SMI). A deep neural network tailored for a limited resource system was developed and quantized to reduce inference latency and memory footprint. Experimental results demonstrate that the memory footprint was kept below 10%, and the signal reconstruction achieved a correlation of 0.8556 with the ground truth. While the current implementation does not meet real-time requirements due to high inference latency, the presented work paves the way for new applications of AI-powered self-mixing sensors for flow cytometry, microfluidics, and environmental condition classification.

Keywords:*Self-Mixing Interferometry (SMI), displacement measurement, Convolutional Neural Network (CNN), quantization, signal processing.*

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Machine Learning Frameworks for Urban Traffic Forecasting: A Real-Time Case Evaluation

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ABSTRACT

This paper introduces the Long-term Traffic Prediction Network (LTPN), a novel machine learning model engineered for real-time urban traffic forecasting. LTPN consistently outperforms conventional predictive approaches across several evaluation criteria by combining convolutional and recurrent neural network components. The model shows high reliability and accuracy with notable reductions in forecasting errors for both short and long horizons. Its performance remains robust under varied traffic scenarios, making it an effective asset for intelligent transportation systems (ITS). This study outlines the model design, training procedures, and a comprehensive performance comparison with standard methods, establishing LTPN's practical advantages. The results demonstrate significant error reduction, particularly in high-density urban areas, which can directly support traffic control centers in planning signal timings and emergency responses. This model shows strong potential for integration into smart city infrastructures by translating predictive intelligence into actionable insights. The findings also demonstrate the model's capacity to adapt to dynamic and heterogeneous traffic environments, providing deeper insight into how advanced neural networks can be deployed to improve urban mobility strategies.

Keywords*: Real-time traffic forecasting, Intelligent transportation systems, LSTM, GRU, ConvLSTM, CNN.*

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Cyber Security in Financial Systems: A Review of Threats, Vulnerabilities, and Evolving Defences

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ABSTRACT

The global financial industry is rapidly digitizing, a process that, while increasing operational effectiveness, has also exposed institutions to unprecedented cyber security vulnerabilities. The paper offers a holistic analysis of the cyber security threats, system vulnerabilities, and defence mechanisms that affect financial systems. From the peer-reviewed literature, regulatory guidelines, and empirical case studies, the paper examines how the threats of cybercrime such as phishing, ransom ware, insider attack, and data breaches have developed to affect banks, fintech companies, and financial intermediaries. The paper assesses the latest technological countermeasures such as artificial intelligence, Block chain, biometrics, and cryptography technologies that are more widely used to secure digital financial environments. Further, the study discusses regulatory compliance, governance practices, and risk management templates that inform the institution's sense of durability. Despite the high levels of investment in cyber security infrastructure, vulnerabilities persist—as in the case of insider compliance, legacy infrastructure, and attack discovery. The paper concludes with strategic propositions and directions of study based on the adoption of collaborative security paradigms, regulation harmonization, and the codification of quantum-resistant technology. As a review, its main aim is to establish a baseline of knowledge for policymakers, IT pioneers, as well as researchers dealing with the task of reinforcing the digital frontiers of the financial sector.

Keywords:*Cyber security, Financial Systems, Biometrics, Artificial Intelligence, FinTech, Cyber Threats, Risk Management, Regulatory Compliance.*

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Natural Language Processing Preprocessing Techniques in Healthcare Applications

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ABSTRACT

Natural language processing (NLP) has emerged as a transformative technology in healthcare. The abundance of unstructured text from sources like clinical notes and EHRs demands efficient Preprocessing techniques. This paper examines four key NLP Preprocessing methods—tokenization, normalization, stopword removal, and stemming—used to prepare healthcare data. The study further explores their application to the MIMIC-III dataset, outlining methodology, algorithm selection, and performance evaluation. Results highlight improvements in accuracy and relevance for healthcare NLP tasks, indicating potential for clinical integration.

Keyword:*Natural language processing, tokenization, normalization, stop word removal, stemming, MIMIC-III, healthcare data.*

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Topological Advancements and Control Techniques in Three-Phase PWM Rectifiers: A Review

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ABSTRACT

Three-phase Pulse Width Modulation (PWM) rectifiers have emerged as a critical component in modern power conversion systems, offering significant advantages such as improved power quality, controllable DC output voltage, and bidirectional power flow capability. This review paper provides a comprehensive analysis of various topologies and control strategies employed in three-phase PWM rectifiers. The discussion begins with a classification of rectifier topologies, including voltage source and current source configurations, along with advanced hybrid architectures. Key performance criteria such as power factor correction, harmonic reduction, and efficiency are examined in the context of each topology. Subsequently, the paper explores control methodologies ranging from classical Proportional-Integral (PI) control to more sophisticated techniques such as predictive control, model-based control, and artificial intelligence-based approaches. The review highlights the trade-offs between complexity, dynamic performance, and implementation cost. Finally, emerging trends and future research directions in topology optimization and adaptive control for three-phase PWM rectifiers are discussed, aiming to support the development of high-performance, grid-friendly power conversion systems..

Keyword:*PWM rectifier, Topologies, control strategies, modulation techniques, power factor improvement*

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Unlocking peak performance: A Novel Approach to Boosting Employee Productivity

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ABSTRACT

Staff members represent the organization's most valuable and distinctive resources. There is often confusion between the concepts of 'happy' and 'motivated' employees. This document aims to explore various methods of motivating employees and their positive impact on organizational productivity. It will delve into strategies for imbuing employees with a sense of purpose in their work. Motivating employees can take many forms. Managers seeking to foster productivity should ensure that employees feel valued and are rewarded for their hard work. This study draws on a substantial body of literature, primarily from recent journal publications, to examine issues related to employee motivation. Previous research has focused on specific aspects of motivation to elucidate various motivational theories that directly influence employee engagement. The unique aspect of this study lies in its theoretical framework, which attempts to establish a construct comprising dimensions that directly or indirectly impact employee motivation.

***Keywords**: Motivational, Strategies, Dimensions, Primarily*

A– 300

WEB 4.0: The future architecture of Internet

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ABSTRACT

This research work envisions Web 4.0 as the coming phase in web evolution—a smart, networked, and context-aware ecosystem. In contrast to Web 3.0's emphasis on machine-readability and decentralization with blockchain and semantic technologies, Web 4.0 will possess the vision of constructing a harmonious web where human and machine go hand in hand. This fourth-generation

Architecture will integrate fourth-generation artificial intelligence, pervasive computing, IoT, and immersive technologies such as AR and VR. The focus is not on decentralization but on hyper personalization, real-time response, and emotional intelligence with digital interactions. Its proponents are convinced that Web 4.0 will usher in proactive services, more automation, and more user intelligence, transforming industries and lifestyles.

And this change with it come also the essential issues of data overdependence, threat to surveillance,

Morality of the employment of AI, and biasness in the algorithm. With distinctions between the real and digital space dissolving, there is all the more a need to push back the technology, moral, and societal implications of Web 4.0.

Keywords:*Web 4.0, Blockchain, AR and VR.*

A– 301

Model for disease detection in Rice and Wheat using Machine Learning

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ABSTRACT

Rice and Wheat, both being prominent staple food crops in India, are susceptible to diseases that can cause severe damage to the quality and yield. Ensuring its optimum production is must for food security of the population of India and world. Since ancient times, the crops has been monitored by farmers through naked eyes and diseases were detected but precision and early detection of diseases was always a challenge. Modern technology can offer a solution which can detect diseases early and precisely using Machine Learning. This work presents two CNN models based on VGG19 architecture to detect disease with some filters which uses agricultural techniques. A blend of scientific approach-based filters; using data provided from NASA Power Project's Data Access Viewer, Growing Degree Days (GDD) values are calculated through its standard formula which helps to detect the phonological stage of the crop and the diseases associated to that phonological stage; disease-resistant varieties and VGG19 Architecture based CNN Models can help to detect disease with a better accuracy by using an Android app which helps farmer to upload image and send to a Django Server, where filters are applied and prediction through ingesting the image into CNN model helps to get the accurate cure of the disease(s).

Keywords: *Rice, Wheat, VGG19, CNN, Django.*

A– 302

Advancing E-Commerce Recommendation Systems Integrating NLP and Machine Learning for Enhanced Accuracy

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ABSTRACT

As the availability of data increased, E-commerce websites rely on recommendation systems not only to enhance user experience but also to drive the purchase of items aligned with user preferences. The most commonly used recommendation techniques are collaborative filtering and content-based filtering and hybrid of both; however, they have been ineffective to a degree in the past and fail to comprehend unstructured data—like customer reviews or product features—which limits their ability to acknowledge the breadth of user needs. This research plans to evaluate a comprehensive use of Natural Language Processing (NLP) and Machine Learning (ML) to bridge the gap and promote the accuracy and customization of recommendations.

Keywords:*Recommendation Systems, E-Commerce, Natural Language Processing (NLP), Sentiment analysis, Machine Learning, Deep Learning, BERT, Content Filtering, Collaborative Filtering, Hybrid Filtering, Precision, Recall, NDCG.*

A– 303

Enriching Raw Corpus for Developing TTS Datasets in Low-Resource Languages without a G2P Model: A Case Study of Kashmiri Language

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ABSTRACT

Creating a high-quality Text-to-Speech (TTS) system for low-resource languages is challenging because of the scarcity of well-organised text corpora. A significant bottleneck in corpus preparation is the presence of redundant sentences, which can affect phonetic, lexical, and prosodic diversity. This paper explores different approaches to refining a raw corpus of the Kashmiri language with the absence of grapheme-to-phoneme (G2P) models for text-to-speech dataset development by filtering redundant sentences through different entropy and similarity-based metrics, ensuring the preservation of linguistic richness essential for natural speech synthesis. Without a grapheme-to-phoneme (G2P) model, we explore data-driven phoneme discovery by calculating bi-gram and tri-gram entropies. Additionally, we emphasise prosodic diversity by leveraging punctuation-based and syntactic complexity measures. Experimental results demonstrate that our comprehensive refinement approach significantly enhances corpus quality by effectively eliminating redundancy, enriching phonetic and prosodic coverage, and consequently improving the naturalness and intelligibility of TTS outputs.

Keywords: *Low-resource languages, Text-to-Speech (TTS), speech synthesis, corpus enrichment, Kashmiri Language.*

A– 304

A Study for Multi-Class Traffic Flow Congestion Prediction using Machine Learning

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ABSTRACT

Traffic congestion is a persistent urban challenge that significantly affects travel time, fuel consumption, and environmental sustainability. Accurate and timely prediction of traffic congestion levels is essential for efficient traffic management and planning. In this paper we will discuss the different machine learning-based approach for multi-class traffic flow congestion prediction, categorizing congestion into distinct levels.

Keywords*: Traffic congestion, ML Models,Support Vector Machines.*

A– 305

Multimodal Text Summarization Using T5 Transformer Model: A Hybrid Approach for Text and Image Data Extraction from PDFs

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ABSTRACT

Text summarization is a critical task in Natural Language Processing (NLP), traditionally focusing on summarizing text-based documents. However, with the proliferation of documents in mixed formats, such as PDFs containing both machine-readable text and images with embedded text, traditional summarization techniques face significant limitations. This paper proposes a novel approach that leverages the T5 (Text-to-Text Transfer Transformer) model for text summarization by incorporating both textual data and text extracted from images in PDFs. We introduce a hybrid system where Optical Character Recognition (OCR) is employed to extract text from images within the PDF, which is then combined with the original text to form a comprehensive input for the T5 model. The system is designed to process both image-based text and machine-readable text seamlessly, generating an abstractive summary that captures the most relevant and contextually rich information. The results of our experiments demonstrate that the proposed method improves summarization quality by addressing the challenges posed by multimodal document formats.

***Keywords**: Text Summarization, T5 Model, Optical Character Recognition (OCR), Natural Language Processing, Transformer Model, PDF Document Summarization, Multimodal Data, Text and Image Integration, Abstractive Summarization.*

A– 306

Face Swapping And Morphing Application

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ABSTRACT

Abstract:-Face image processing capabilities have been greatly improved by the quick development of computer vision, which has been fueled by developments in deep learning, machine learning, and the availability of large-scale datasets. The three main areas of facial image processing that are the subject of this study are face detection, face swapping, and face morphing. These three areas are fundamental to contemporary digital applications in the fields of entertainment, security, and social media. The study investigates the technological underpinnings of these procedures, namely with the aid of OpenCV and Dlib, and looks at their practical applications, including their capacity for both innovation and possible abuse.

Keyword:-Face swap, face morph, face detection, deepfake technology, real-time processing.

A– 307

A Review based on AI Enabled Water Well Predictor

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ABSTRACT

Water scarcity is one of the major global challenge, particularly affecting semi-arid and arid regions. This work introduces an AI-enabled predictor system of water well drills, designed to optimize the identification of groundwater reserves and enhance the decision-making process on drilling water wells. The system integrates geospatial data, environmental parameters, such as the nature of soil, topography, and rainfall pattern; it also integrates historical well performance into advanced machine learning models for prediction, such as neural networks or decision trees, into this process to predict locations to be drilled. So early results from field tests yield impressive improvements in the effectiveness of drilling success as more accuracy in groundwater location over the traditional methods applied was obtained. It is supplemented with an intuitive interface by which even non-experts and policymakers can draw information for making decisions. Hence, the present work, through the demonstration of capability of AI in handling any water resource issue, contributes to opening doors to much-needed improvement, like scaling and upscaling of real-time inferences.

Keywords- *AI, Groundwater Prediction, Machine Learning, Sustainable water management*

A– 308

A Microcontroller-Based Firefighting Robot with Real-Time Sensing and Obstacle Avoidance

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ABSTRACT

Fire incidents present critical risks to human life, infrastructure and the environment often exacerbated by delayed human response and hazardous operating conditions. This study proposes the design and implementation of an autonomous Fire fighting Robot capable of detecting and suppressing fires in high-risk environments. The system integrates a suite of environmental sensors—flame detectors, temperature sensors and gas analysers, for multi-modal fire detection. A microcontroller-based control architecture processes sensor inputs in real-time and executes autonomous navigation using obstacle-avoidance algorithms to locate fire sources efficiently. The robot is equipped with a water- or foam-based suppression mechanism, enabling it to extinguish small to medium-scale fires effectively. Its structure ensures mobility in complex environments, while an on-board rechargeable power system supports extended operational autonomy. Additionally a wireless communication interface allows for remote monitoring and manual override, enhancing adaptability and user control in dynamic scenarios. Experimental validation in controlled environments demonstrates the system's reliability in detecting and responding to fire hazards. This work contributes to the development of intelligent robotic platforms for disaster response and establishes a scalable foundation for future research in autonomous firefighting systems within smart safety infrastructures.

Keywords*: Firefighting Robot, Fire Detection, Flame Sensor, Temperature Sensor, Gas Detector, Microcontroller, Wireless Control, Robotics and Automation.*

A– 309

Driver Drowsiness Detection with Alarm System

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ABSTRACT

Drowsiness is the primary cause of road accidents. To solve this problem, we suggest implementing a Driver Drowsiness Detection and Alert System (DDDAS), which is intended to lower the risk of drowsy driving. The DDDAS uses a variety of sensors, including cameras for eye recognition and infrared sensing, to track driver behaviour in real-time. Machine learning algorithms will be used to evaluate the gathered data and identify indicators of drowsiness, such as yawning, head position, and eye closure. In order to lower the chance of an accident, the system immediately notifies the driver if it detects drowsiness. Extensive tests have proven the DDDAS system's efficacy in identifying drowsiness and promptly warning drivers. Boost traffic safety and stop fatigued drivers from causing collisions.

Keywords*: Driver drowsiness detection, alarm system, sensor, DDDAS, machine learning, facial recognition, infrared sensors, microphone.*

A– 310

Implementation of Electrical Device Surveillance and Control System based on IoT

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ABSTRACT

This paper presents a cost-effective IoT-based system for remote monitoring and control of electrical devices via smartphones and laptops. The setup includes sensors for temperature, humidity, gas, current, and voltage, with data collected by a NodeMCU and sent to the Think Speak cloud. Users can access real-time data through HTTP and JSON requests from anywhere. The system enhances smart home functionality by improving energy efficiency, safety, and remote accessibility

Keywords*: IoT, sensor, infrared sensors, efficiency.*

A-311

Exploration of Various Design Techniques for Biomedical Antennas

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ABSTRACT

Antennas are essential for communication and widely used across various fields. Their performance depends on patch shape and parameters like directivity, S11, and VSWR. This paper reviews implantable antenna designs operating in the 2.4–2.48 GHz ISM band for biomedical applications. These antennas use high-dielectric, biocompatible substrates to ensure insulation and flexibility within the human body. Key design considerations include biocompatibility, miniaturization, and safety.

Keywords*: Biomedical, Antennas, Directivity, Return loss, Miniiaturiation*

Zinc Oxide Field Emitter an Important Component of Modern Electronics

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Abstract— With the advent of nanotechnology Zinc Oxide (ZnO) has proven to be one of the most promising materials to be used in different application of versatilities. The applications include UV resistant cosmetics, optoelectronics, solar cell, hydrophobic coating, field effect transistor and many others. The material has unique features in the sense that due to crystal anisotropy it has inherent tendency to form in definite shape (preferably one dimensional) which is extremely important specially in the nanoregime.

Among all the applications mentioned above this article review the cold emission properties of ZnO and related hybrid. The applications of ZnO as cold emitter have numerous utilities especially in electronics. In larger scale the property found application as cold emitter gun in electron microscope, or in X-ray generator or in low dimension it works as effective component in different ICs as FET. The importance of cold emission over conventional thermal emission stands on the fact that due to the associated phenomenon of tunnelling it is much energy saving.

Keeping these growing importances of the material in mind this article reviews the basic structure and synthesis process of ZnO and related hybrids and also the article has main focus into cold emission properties of the material.

It is believed that this article will be an effective contribution to the related literature.

Keywords— Zinc Oxide, Sol-Gel process, Field Emission, Tunnelling, Work Function

I. Introduction:

In today's fast-paced technological world, the demand for energy-efficient, high-performance materials is ever-growing, particularly in fields like consumer electronics and medical imaging. Zinc Oxide (ZnO), a versatile material with unique properties, has emerged as a key player in nanotechnology, especially for its potential as a cold emitter [1,2]. Cold Field Emission (CFE) allows electrons to be emitted from a material without the need for heating, offering significant energy savings and enhanced device performance. Unlike traditional thermal emission, which requires high energy input, CFE leverages quantum tunnelling to enable electron emission at much lower energy values [3].

ZnO, a wide-bandgap semiconductor, is known for its exceptional versatility across various applications, including UV-resistant cosmetics, optoelectronics, solar cells, medicines, food preservation, and field-effect transistors (FETs). Its ability to form one-dimensional nanostructures, like nanowires and nanorods, further enhances its properties, particularly in the Nano regime, where size and shape dictate Performance [4]. The crystal anisotropy of ZnO also gives rise to unique electrical and optical characteristics, improving surface area, charge transport, and energy efficiency [5]. Doping with various materials can significantly enhance different intrinsic properties of ZnO, such as electrical conductivity, optical performance, and catalytic efficiency. By introducing specific dopants, such as transition metals or non-metals, the material's band gap, charge carrier mobility, and photocatalytic activity can be tailored for advanced applications. This process not only improves ZnO's overall functionality but also opens new avenues for its use in electronics, sensors, and energy conversion technologies. These features make ZnO particularly promising for cold emission applications in devices like electron microscopes, X-ray generators, and integrated circuits, where energy efficiency and faster operation are critical. For instance, in 2017, L. Zhao et al. [6] reported gate-structure ZnO nanowire field-emitter arrays with improved field emission performance and effective emission current modulation, demonstrating their potential for large-area vacuum electronic devices. The next year, Z. Zhang et al. [7] presents a sensitive broadband flat panel photodetector, integrating a

ZnS photoconductor and ZnO nanowire field emitters, offering high responsivity and fast response times for applications in indirect-conversion X-ray imaging. In the same year, Y. Liu et al. [8] demonstrated ZnO nanowire field-emitter arrays with a co-planar focus electrode, achieving improved electron focusing and line-addressing capabilities for large-area vacuum microelectronics. However, Z. Samsonova et al. [9] investigates the enhanced hard X-ray emission and fast electron flux from nanowire zinc oxide targets compared to flat surfaces when irradiated by ultrafast laser pulses, suggesting potential applications in high energy density physics. After that, Y.Zhao et al. [10] explores the fabrication and field emission properties of large-area indium-doped ZnO nanowire arrays, demonstrating their potential for use in flat-panel X-ray sources and detectors. Currently, M. M. Idris et al. [11] investigated the X-ray radiation effects on the I-V characteristics of zinc oxide-doped tellurium dioxide thin films, demonstrating their potential as dosimetric materials for miniaturized radiation sensors in smart devices.

Considering the increasing significance of ZnO in modern technological applications, this article provides an in-depth review of the material's fundamental structure and synthesis processes, along with its related hybrids. The primary focus of the article is on the cold emission properties of ZnO, emphasizing its potential in energy-efficient, high-performance devices. It is anticipated that this work will serve as a valuable contribution to the existing literature on ZnO and its various applications.

2. Crystal Structure and Basic Properties:

Zinc oxide has chemical formula ZnO and generally available in the form of white powder that is insoluble in water. The majority of zinc oxide is synthesised, even though the mineral zincite can be found in nature. When heated in air, crystalline zinc oxide behaves thermochromic, turning from white to yellow and then back to white when cooled [12].

There are two primary types of zinc oxide crystallization: hexagonal wurtzite and cubic zinc blende as shown in **Fig.1.** (a, b). Due of its stability at ambient temperatures, the wurtzite structure is the most prevalent. ZnO has surface energy towards c axis lesser compared to the other and thus shows a tendency of 1 dimensional growth [13].

In the II-VI semiconductor family, Wide-band gap semiconductors include ZnO. The presence of oxygen vacancies or zinc interstitials causes the semiconductor to be naturally doped in an n-type manner. The advantages of this semiconductor include good transparency, high electron mobility, a wide band gap, and strong room-temperature luminescence. [14]. These characteristics are useful in new applications for electronics including thin-film transistors and light-emitting diodes, transparent electrodes for liquid crystal displays, energy-efficient or heat-protecting windows, and more.

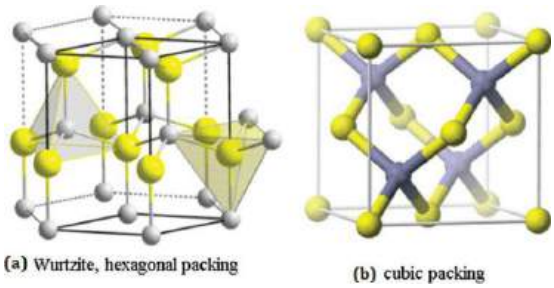

Fig.1: Basic crystal structure of ZnO

3. Synthesis Process

One of the primary challenges in the field of nanotechnology is the ability of effective creation and manipulation of nanomaterials and nanostructures. This capability is crucial for exploring the unique physical properties and phenomena exhibited by nanomaterials, as well as for translating these properties into practical, real-world applications. The synthesis of metal oxide nanostructures is a cornerstone of nanotechnology research and has led to the development of several distinct fabrication techniques. These methods can be broadly categorized into two main approaches: physical and chemical processes, which are further divided into top-down and bottom-up strategies [15]. A schematic overview of these approaches is depicted in **Fig. 2**.

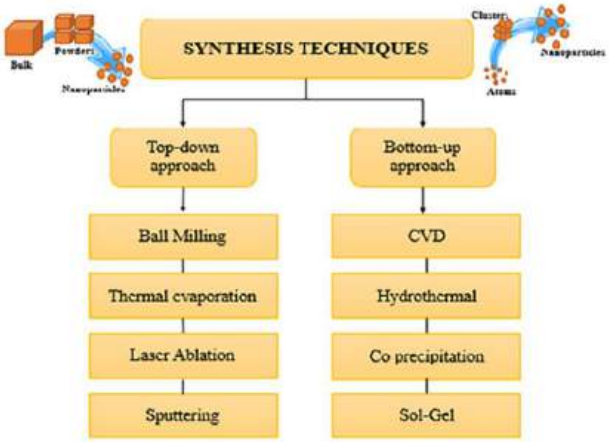

Fig.2: Schematic diagram of different synthesis approaches of nanomaterials [15]

- **Top-Down Processes:** Involve breaking down bulk materials into smaller nanostructures

using high-energy methods, easier to scale but less precise.

- **Bottom-Up Processes:** Assemble nanostructures from atomic or molecular building blocks, offering greater precision but harder to scale.
- **Common Synthesis Methods:**

a. **Ball Milling:** A mechanical process for creating fine powders, cost-effective but less precise.

b. **Sputtering:** A physical vapor deposition (PVD) method for creating thin metal oxide films with controlled thickness.

c. **Evaporation:** Deposits evaporated material onto substrates to form thin films, commonly used in semiconductor fabrication.

d. **Chemical Vapor Deposition (CVD):** Produces high-quality thin films with precise control over thickness, composition, and crystallinity.

e. **Wet Chemical Process:** A bottom-up technique for producing nanoparticles or nanowires using chemical reactions in solution, scalable and tunable.

Each synthesis method offers distinct advantages depending on the desired material properties and application, from electronics to energy and medicine

However, from all the synthesis procedure in laboratory-based work sol-gel approach is one of the most widely opted technique for low-cost, large-area growth of ZnO where the material may be grown at low temperature or even at room temperature.

On the other hand, for the device development physical processes like thermal evaporation or sputtering or other epitaxial growth processes are the key approaches for the material growth

4. ZnO Nanostructures as Cold Emitters:

Though ZnO nanostructures have found applications in numbers of fields mentioned in the previous section this article revisits and assembles information about the use of ZnO nanostructures and hybrids as cold emitters emphasizing its advantages over traditional thermal emission. Regarding this, the work reported by **T.H. Wang** and group is mention-worthy [16]. They have developed tetrapod like ZnO structure that was able to give an emission current density 18 mA/cm^2. The samples showed an excellent cold emission characteristic with ultra-long stability of more than 72 hours with less than 2 % fluctuation in the current density. The report clearly suggests that the material with specific nanostructure has very high potential to be used as cold emitter.

The similar nanostructured ZnO can give much better emission characteristics when wrapped by graphene sheet developed via PECVD as confirmed by **W.T. Zheng et.al.** [17]. This was mainly because wrinkled shape graphene sheet could act as excess emission sites as well as sites where the applied field can be enhanced couple of thousand times. Thus, it is established that the hybrid ZnO-graphene hybrid has the potential for being used as a candidate for field emission devices.

To improve the FE performance of the ZnO nanorod argon etching has also been proven to be useful and shown by **Ji et.al.** [18]. Apart from Ar plasma etching the ZnO was also subjected to coating with AlN to have favourable band bending and electron transfer. The turn on field which was set at corresponding value of current density 10 $\mu A\ cm^{-2}$ was shown a 42 % reduction to 6.8 V μm^{-1} with a highest current density value 4.1 mA cm^{-2}. Sharp tip due to etching, reduced work function and favourable band bending were assumed to be the collective reasons behind the FE enhancement.

A new X-ray tube using a ring-shaped field emission electron source has been developed by H. Kato [19] in 2016, allowing X-rays to be extracted along the axial direction. The tube operates at over 100 kV and 4 mA, with no stand-by time, and demonstrated stable electron emission during a 560-hour continuous test, making it suitable for irradiation experiments ranging from mGy to kGy.

Another report of FE from graphene wrapped ZnO came from **X. Wang et.al.** [20]. It was seen that the wrapping of wrinkled graphene structure enhances the FE characteristic of ZnO significantly giving E_{TO} and threshold field respectively 1.63 and 3.12 V/μm. The favourable band bending, electron transfer and higher conductivity was assumed to be the main reasons for excellent cold emission characteristics.

Similar kind of approach was taken by **Jun Chen** and group to enhance the FE characteristics of ZnO by aluminium doping through electron beam evaporation [21]. The system gave the best emission characteristics with turn on field as low as 6.21 Vmm^{-1} when the thickness of the Al layer reached 120 nm. The sample generated the current density 2.15 mA with an excellent stability.

Field emission from hydrothermally synthesized Ag doped ZnO was reported by **Young et.al.** [22]. When the sample was irradiated with UV light the Ag doped ZnO gave the lowest turn on field with value 2 V/μm associated with a current density of 1 mA/cm^2.

The field emission characteristics can be enhanced through three factors: (i) Generation of electron-hole pairs under UV light, leading to electron movement to the conduction band. (ii) Creation of

a heterostructure between ZnO and Ag nanoparticles on the surface of ZnO nanosheets, resulting in an increased quantum well. (iii) Enhanced electrical conductivity due to the presence of Ag nanoparticles. X. Cao et al. [23] were designed and fabricated Coaxis-gated ZnO nanowire field-emitter arrays (FEAs) with in-plane focusing gate electrodes to improve integration and addressability in vacuum microelectronic devices. The device demonstrated effective emission control and electron beam focusing, with a simplified fabrication process requiring one fewer mask than traditional designs, showing promising potential for large-area, addressable FEAs.

E_{TO} value of 4.7 V/μm was obtained from ZnO rod deposited over silicon pre-patterned by Au through CVD technique [24]. It was assumed that morphology, growth direction, catalyst layer thickness, conductivity are the key factors that governed the emission characteristics. The enhancement factor came out to be 1686. For their case it was seen that introduction of Mo nanoparticle in the ZnO system negatively influenced the emission characteristics giving the turn on field value 7.3 V/μm and enhancement factor 807.

A. Kumar et.al. employed the sol-gel method for the synthesis of zinc oxide nanoparticles [25]. The geometry of the flower-like structure of ZnO is responsible for its high current density, low E_{TO} and high β values field enhancement factor. Here each petal of nanoflowers functions as an independent field emitter to increase the current density.

ZnO doped with Cu and Al synthesized by hydrothermal method with varying dopant concentration was synthesized by **Liu et.al.** [26] When further composite was developed with grapheme sheet and FE characteristic was tested it was seen that 6 % Al doped and 4 % Cu doped sample gave the FE result with E_{TO} values 1.51 V/mm**,** 1.80 V/mm respectively.

A system of Pd nanoparticle decorated on 0 dimansional and one dimensional ZnO was developed by **S.J. Young and Y.L. Chu** [27]. When the FE properties of the system were studied it was seen that after Pd nanoparticle decoration there is very little change in E_{TO} from 6.6 to 6.4 V/μm. However, there is considerable increase in the enhancement factor from 2546 and 5947, respectively for the pure and nanoparticle decorated system. These findings indicate that Pd-ZnO samples demonstrated improved FE performance, suggesting their potential as emitters for FE-based devices.

A very high emission current of 20 mA is obtained from Indium doped ZnO and reported by **Jun Chen et.al.** [28]. The sample was deposited by thermal oxidation technique on ITO coated glass**.** It was speculated that the structure was formed by self-catalytic VLS technique. The cold emission characteristic was taken under high vacuum condition from a sample having dimensions 4.8 × 4.8 cm^2. The emission current was attributed to the high crystallinity and conductivity of the doped sample. Recently in 2023, A. M. A. Ali et al. [29] explored the use of aluminum-doped zinc oxide (AZO) thick films and bulk disk forms in extended gate field-effect transistors (EGFETs) for low-dose X-ray dosimetry. Devices were fabricated via chemical bath deposition, and results showed that the bulk disk form exhibited higher sensitivity to X-rays compared to the thick film, with sensitivity increasing with bias voltage. The findings highlight the potential of AZO-based EGFETs for low-cost, real-time X-ray dosimetry. In previous year, an extended-gate field-effect transistor (EG-FET) based on one-dimensional ZnO nanorod arrays, enhanced with silver nanoparticles (Ag NPs), was developed by Y-L Chu et al. [30] as a pH sensor. The sensor demonstrated excellent pH sensitivity (59.06 mV/pH), high repeatability, and minimal hysteresis (1.49 mV), with promising applications in industrial, agricultural, medical, and military fields, particularly in Internet-of-Things integration.

Recently, the authors have published FE properties of sol-gel synthesized ZnO nanorod and it has also been shown that nickel or europium doping can significantly enhance cold emission characteristics of the as-synthesized ZnO nanostructures [31, 32]. The microstructures and FE characteristics of the system are shown in **Fig.3** (a, b) and **Fig.4**.

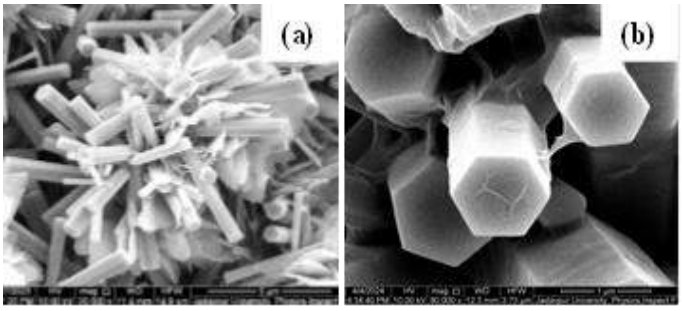

Fig.3: FESEM image of (a) Ni doped and (b) Eu doped ZnO

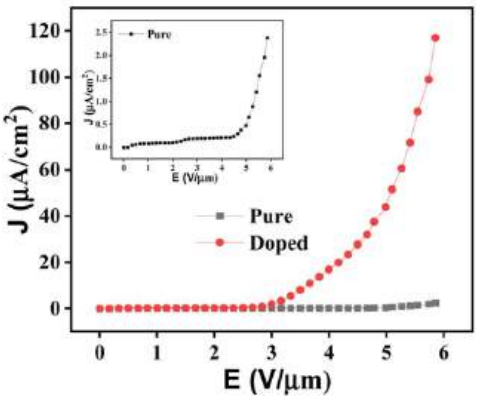

Fig.4: Field emission J–E curves of Ni doped ZnO (inset the same of pure ZnO in low field region [31]

5. Future Scopes and Challenges:

ZnO and its hybrid structures show great potential as cold emitters, offering advancements in energy-efficient technologies for fields like electronics, medical imaging, and environmental sensing. Future research could focus on scaling up ZnO-based field emission devices (FEDs) for large-area applications, enhancing emission performance through doping and hybrid materials, and optimizing synthesis methods for high-performance nanostructures. ZnO's integration with metals and graphene may further improve conductivity and emission characteristics. However, challenges remain in ensuring long-term stability, controlling emission thresholds, reducing production costs, understanding quantum tunneling effects, and addressing environmental and health concerns. Overcoming these hurdles through innovation and interdisciplinary collaboration could establish ZnO as a key material in next-generation technologies.

6. Conclusions:

ZnO has demonstrated immense potential as a cold emitter due to its unique properties, such as its ability to form one-dimensional nanostructures and its efficient energy-saving capabilities through quantum tunneling. The material's application in energy-efficient devices, particularly in electron microscopes, X-ray generators, and field-effect transistors, has garnered significant attention for its advantages over conventional thermal emission. Recent advancements in ZnO's synthesis, including doping and hybridization with materials like graphene and nanoparticles, have further enhanced its field emission characteristics, offering improved current density, reduced turn-on voltage, and greater stability. The versatility of ZnO, demonstrated through its integration in various devices like pH sensors and X-ray dosimeters, highlights its broad applicability across different fields. However, challenges remain in optimizing ZnO's performance for large-scale applications, including the control of work function, durability, and scalability. Overall, continued research and innovation in ZnO synthesis and hybridization will likely cement its role as a key material in the development of next-generation, energy-efficient technologies.

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Carbon Nanotube Cold Emitter: A Useful Component of Vacuum Microelectronics and Semiconductor Technologies

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Abstract— In the technological development, vacuum microelectronics came as a milestone where semiconductor materials like silicon, germanium and other established themselves as key components. Afterwards when technological growth entered in the era of nanotechnology apart from the conventional semiconductor materials other new systems in low dimensions also established themselves as key material in this field. Carbon nanotube (CNT), a one-dimensional sp^2 hybridized allotrope of carbon is one of the most noteworthy additions in this list.

Keeping this in mind this article reviewed the high vacuum tunnelling phenomena shown by CNT under the application of high electric field which is called the cold field emission property.

Apart from the basic properties and synthesis process of CNT, the article also reviews the basic characteristics of cold emission and its mathematical formulation using Fowler-Nordheim equation.

Lastly the current work reviews the articles as well as patents published in the last 5 years that deals the cold emission properties and related applications of CNT and related hybrids. The applications include cold emission electron gun, target in X-ray generator, electron source in microscopes and other. It is believed that the article will be an effective addition in the related literature.

Keywords— CNT, Field Emission, Tunnelling, Work Function, Fowler-Nordheim plot

1. INTRODUCTION

Spindt cathode was always at the centre of discussion in the field of vacuum electronics as it is the first report of field emission array (FEA) from a multi-tip system proposed by Spindt where in the actual system sharp molybdenum emitters with density 10^6 / cm^2 were developed which were separated by distance around 1 μm [1].

Spindt and Brodie and co-workers developed the FEAs uniformly over an area of 140 cm^2 or more and such large area helps getting output free from spatial fluctuation of the emission current [2, 3]. A considerable higher current densities of 1000 A/cm^2 was achieved for emitter set.

Idea of incorporating Spindt's FEAs to develop flat panel display was first proposed by Crost et al. in the year of 1970 [4]. With the advancement of material science silicon came as one of the most promising materials in the field of cold emission and not only that the vacuum electronics gained further popularity when the emitter was started being developed in various shapes and structures that influenced the emission characteristics. Almost one and half decade later, in the year of 1986, another group led by Gray first developed silicon emitter based efficient vacuum transistor which had numbers of advantages over conventional semiconductor transistor [5]. Though between 1970 to 1986 the related works were constantly being carried out by Brodie and Spindt or Lally and group. In this technological advancement the year 1987 has a significant mark as in this year first high-resolution color display dedicatedly addressed emitter was introduced [6]. Few companies like PixTech, Motorola, Micron Display Technologies, FED Corporation, SIDT, Honeywell, Silicon Video, Raytheon,

Futaba, and Samsung took the lead in materializing the concept of low voltage FED.

Apart from the FED development systematic parallel effort were put in using the pointed single cold emitter to be used as electron sources in electron microscopy or electron holography. Apart from those mentioned above different other devices like semiconductor LASER, mass spectrometer was started being developed by utilizing this phenomenon of FE [7-11].

LETI and SRI were the two separate research groups that contributed significantly in development of field emitter [12]. Both the groups have separately shown that the phenomenon of FE has tremendous potential when used in numbers of applications mentioned above.

After the discovery of carbon nanotubes (CNTs) by Iijima in the year of 1991 [13] most of the FE related works have focussed on the field emission properties of the material. Though there are lots of reports regarding FE properties of CNTs and related hybrids this article mainly focus on the related works published in last 5 years.

2. SYNTHESIS SCHEMES AND BASIC PROPERTIES OF CNT

CNT can be considered as rolled-up graphene sheets (graphene is an individual graphite layer). There are three distinct ways in which a carbon sheet can be rolled into a tube, as shown in the **Fig.1** below. The first two of these, known as "armchair" (b) and "zig-zag" (c) have a high degree of symmetry. The terms "armchair" and "zig-zag" refer to the arrangement of hexagons around the circumference. The third class of tube, which in practice is the most common, is known as chiral, meaning that it can exist in two mirror-related forms. An example of a chiral nanotube is shown at the bottom left (d).

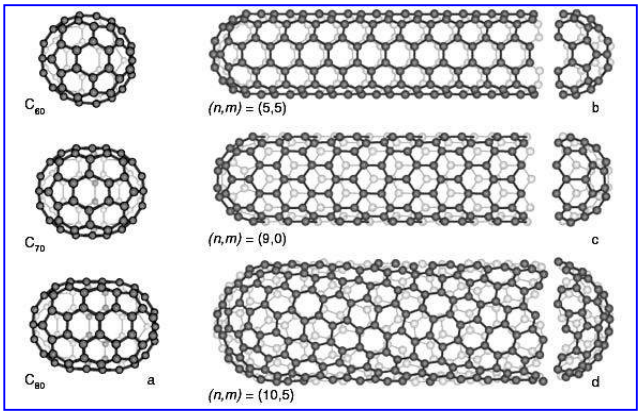

Fig.1: Types of caron nanotubes

The diameter of CNT can be determined from the chiral vector and integer values n and m from the equation below and **Fig.2**:

$$d = 0.078\sqrt{n^2 + nm + m^2}\ \text{nm} \qquad 1a$$

$$\text{and } \theta = \tan^{-1}\left[\frac{\sqrt{3}m}{m+2n}\right] \qquad 1b$$

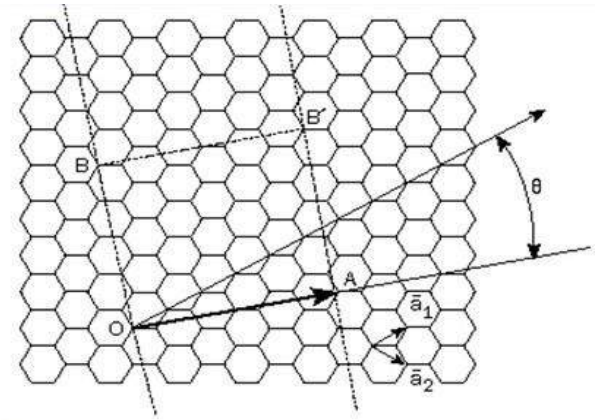

Fig.2: chiral vector and chiral angle in CNTs

The basic properties of CNT have been summarized in **Table 1**

Properties	Value
Young's Modulus: SWCNT	~ 1 TPa
MWCNT	0.3- 1 TPa
Maximum Tensile Strength	~ 63 GPa
Band Gap: For Metallic	0 eV
For Semi-Conducting	0.18 – 1.8 eV
Thermal Conductivity	3000 W/mK
Carrier mobility	10^5 cm^2/Vsec
Maximum Current Density	10^9 A/m^2
Turn-on field (V/μm)	1.5 – 7.5
Threshold field (V/μm)	1.5 – 9.5

There are various synthesis processes of Carbon Nanostructures, some of them are as following and will be explained later in LR section:

a. Electric arc discharge
b. Laser Vaporization
c. Chemical Vapour Deposition (Thermal/Plasma enhanced)
d. Pyrolysis
e. Hydrothermal
f. Solid state reaction

Few mention-worthy reports are given below:

After the discovery of CNT by Ijima in the year of 1991 there are numbers of report came related to the synthesis of CNT by different methods few of which would be mentioned here. For instance, **Bera et al.** reported the synthesis of CNT by arc discharge in water [14]. They have used two graphite electrodes

each having radius approximately 1.5 mm. The arc was generated by applying a DC voltage of 28 V while the inter-electrode distance was kept 1 mm. The CNT thus generated was in clustered form and multi-walled.

Kumar et al. used Laser ablation to synthesis CNT. In this process, a target material containing graphite and catalytic metals is heated in a tubular furnace and then exposed to a high-energy laser [15]. The laser vaporizes the target material, creating a carbon vapor that condenses and forms nanotubes on a cooled copper collector. The properties of the nanotubes, such as their diameter and length, can be influenced by the choice of laser type, target material, and atmospheric conditions. Here the reaction temperature was fixed at 700 to 1500 K.

In CNT synthesis by CVD process **Mohammed et al.** used acetylene gas as carbon precursor before which CVD chamber was flushed by argon gas [16]. The reaction was continued for 35 minutes at working temperature of 700 ^{o}C. The CNTs frown in this process was multiwalled with diameter around 50 nm with high yield.

In the PECVD induced synthesis of CNT as reported by **Gupta et al.** the authors used the same combination of C_2H_2 and NH_3 as reactive and etching gasses [17]. The base and final chamber pressure was fixed at 3.5×10^{-7}, 4 to 6.5 respectively and deposition temperature was fixed at 900°C and biasing voltage was kept at -300 V

Apart from that there are reports of CNT synthesis using spray pyrolysis [18], hydrothermal [19], solvothermal [20], solid state reaction [21] and other methods [22]

3. BASIC OF FIELD EMISSION AND ITS ANALYSIS

It is well established that though even in a conductor electron can roam around the material surface they cannot escape from the surface as they see a very large potential barrier at the material vacuum interface. So an external force is necessary in order to knock the electrons out of the surface. Depending upon the nature of external energy the phenomena of electron emission can be divided into four categories: They are 1) field induced electron emission- where the applied electric field energize the electrons and knocked out of the surface, 2) secondary electron emission- where the fast moving primary electrons get collided with secondary electrons in order to impart energy from the former into the later, 3) photo induced electron emission- where the incident photon gives electron the required energy for getting emitted and finally 4) thermionic emission- in this last form of electron emission the energy was supplied in form of heat. Out of these four the field induced electron emission got the much attention due to the fact that the efficiency of electron emission here is almost millions of times higher than in other known emission processes. It is also called cold emission because being a complete quantum mechanical phenomenon here instead of jumping over the potential barrier here the electron ejection takes place through the potential barrier by the process called quantum mechanical tunnelling as shown in **Fig.3.**

The simplest mathematical expression that can best describe this tunnelling runs as:

$$\mathbf{I = CV^k exp^{-\frac{B}{V}}} \qquad (1)$$

having B, C, and k as constants and K is taken to be 2 for the most well-known Fowler-Nordheim (F-N) equation.

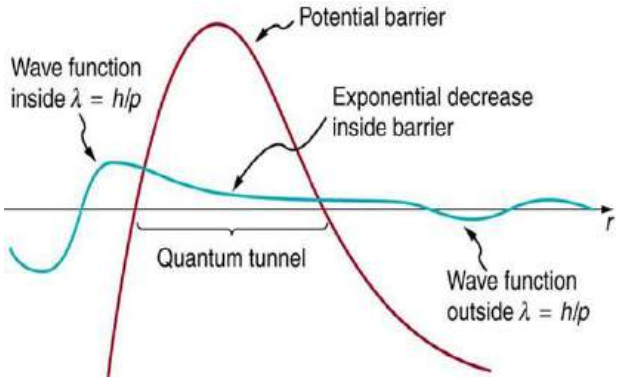

Fig.3: Schematic of quantum tunnelling

The F-N equation after incorporating several correction factors relates emission current (I) and electric field (E) as [23]:

$$\boldsymbol{I = Aat_F^{-2}\varphi^{-1}(\beta E)^2 exp\{-bv_F\varphi^{3/2}/\beta E\}} \quad (2)$$

Where A is the effective emission area, ß is the enhancement factor, t_F , v_F are the values of special field emission elliptic function for a particular barrier height ϕ [25], a and b are respectively the first and second Fowler–Nordheim (F-N) constants having values $a=1.541434\times10^{-6}$AeV V^{-2} and $b=6.830890\times10^{9}eV^{-3/2}V\ m^{-1}$. The F-N equation when simplified takes the form as

$$\boldsymbol{ln\{J/E^2\} = ln\{t_F^{-2}a\varphi^{-1}\beta^2\} - [\{v_F b\varphi^{3/2}\beta^{-1}\}/E]} \quad (3)$$

where J= I/A is the macroscopic current density Hence plot of $\ln\{J/E^2\}$ vs. 1/E should be a straight line and its slope and intercept give the valuable information about the enhancement factor, local work function etc.

4. RECENT WORKS ON FIELD EMISSION PROPERTIES OF CNT

Though there are plenty of articles addressing the excellent field emission properties of CNTs and related hybrids it is relatively new that researchers are focussing to incorporate this useful material and its field emission properties as important components in different sophisticate devices.

In the couple of day's back Fairchild et al. reported the development of knitted CNT fabric cathodes

[24]. They showed 8 times higher emission current compared to the normal CNT film. Not only that the system also showed 2 times higher pulsed emission than CNT films, with excellent durability over 5000 pulses, making them ideal for robust vacuum electronics.

In the year of 2022 MMH Raza's group reported excellent field emission properties of silver particle decorated CNTs with considerably lower turn-on (1.7 V/μm) and threshold fields (3.4 V/μm), higher current density (~7 mA/cm²), and stable emission over 2800 minutes, indicating strong potential for cold-cathode applications [25].

In another work Jiupeng Li et al. [26] developed convex shaped cold emitter from highly dense CNT films by mechanical polishing treatment. The emitter showed ability of overcoming the edge emission effect and improve the distribution uniformity.

CNT cold emitter gun was incorporated suitably in X-ray generation tube J S Han et al. [27]. The emitter produced an exceptionally high current density of 152 A/cm^2 with beam transmittance over 95 %. In addition, the system offered very stable emission with small focal spot size (FSS) of 0.5 mm during 100 000 shots.

Similar application of CNT based cold emitter in X-ray tube was also reported by Lai et al. [28] who developed screen-printed CNT cold cathode and obtained efficient field emission with respective values of turn on and threshold field 2.5 and 3.81 V/μm. The work also confirmed the F–N behaviour of current – voltage characteristics and suitability of the system for high-frequency pulse applications.

Also Sergey V. Filippov's group [29] found through simulations that for 1 nm radius SWCNTs, field enhancement increases nonlinearly with height, but the peak emission current stays constant at f = 0.45. Emission mainly comes from sharp areas with the highest field concentration.

In the separate work Lee et al. [30] showed aligned CNT based cold cathode emitters can be used as a tool of scanning electron imaging tool. Also, the work showed CNT emitters having a 50 nm tip diameter provided high brightness (9.26 × 10¹□ A·sr□¹·m□²·V□¹) and 10 μm spatial resolution at 1000 V.

Also, Ashish V. Avachat's team [31] validated a compact X-ray tube with a CNT-based cold cathode, showing controllable focal spot size, tenable X-ray energy, and comparable X-ray spectra to conventional anodes, suitable for compact imaging systems.

Another, noteworthy reports came from the group of Thomas Cole's who optimized a terahertz electron-optical system with a CNT cold cathode, achieving 7.65 A/cm² emission current density, highlighting CNT emitters' suitability for advanced terahertz radiation sources [32].

In the work reported by H R Lee and group showed the usefulness of CNT based cold cathode in secondary electron imaging used in scanning electron microscopy [33]. The schematic and actual system developed by the group has been shown in **Fig.4.**

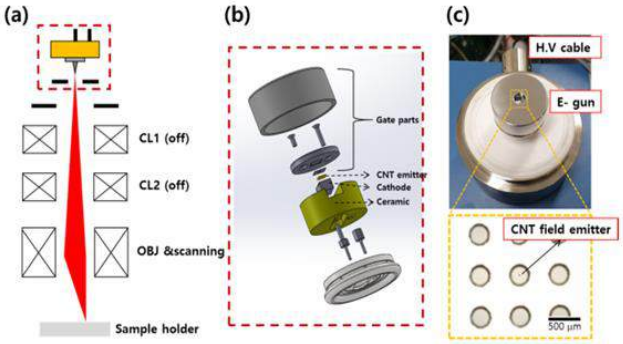

Fig.4: (a) Schematic SEM set up (b) CNT electron gun cartridge. (c) Captured image of gun part and alignment with gate electrode and single CNT emitter [33]

FE characteristics of the system developed by the group along with the corresponding F-N plot has been shown in **Fig.5.**

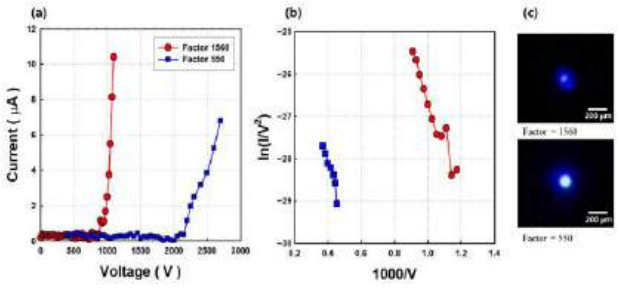

Fig.5: Comparison of field emission properties. (a) Field emission properties; (b) F–N plot; (c) captured image of field emission patterns on phosphor screen at 1 μA of emission current. (c) captured image of field emission patterns on phosphor screen at 1 A of emission current [33].

5. CHALLENGES AND FUTURE SCOPES

Though CNTs and related hybrids has shown significant promises regarding cold field emission properties still there are lots of challenges to be overcome before its successful implication in the real industry scale applications. Few of the main issues are mentioned below:

a. Synthesis: Normal synthesis processes of CNT that involve PECVD, arc discharge, laser

ablation etc requires very high temperature, suitable catalysts, inert atmosphere which are not very cost-friendly.

b. Yield: Even if the ideal synthesis condition is achieved the yield is not very high and thus industry scale application is still a challenge to overcome

c. Inertness: The cold emission characteristics of pure CNT is rather a saturated topic and so requirement is there to develop different CNT-based hybrids for optimized CFE performance. However, CNT being extremely inert in nature due well-known steric hindrance force developed in bundle form. So to make an effective hybrid an intermediate treatment called the acid functionalization is necessary. This creates additional challenges for cost-effectiveness and time friendliness of the process.

d. Field emission current stability: From the view point of device performance stability in the field emission current is one of the major challenges. The stability mainly gets effected due to the sample self-degradation during emission and the vacuum instability.

e. Uncontrolled crystal face dependence of emission current: It is seen that when emission current is recorded different characteristic is obtained from the different crystal planes of the same material. Same is applicable for CNTs with different chirality.

6. CONCLUSIONS

CNT has demonstrated immense potential as a cold emitter due to its unique properties, such as its one-dimensional structure, high thermal and mechanical strength, tuneable band gap by hybridization engineering and other. The article reviews the basic concept of field emission phenomenon and its usefulness in the field of electronics over conventional thermal emission. It has been shown that when synthesis process is concerned CNT can be developed by both physical and chemical process both generally requires high temperature. However, high yield synthesis is still a challenge and not only that the inertness of the CNTs hinder themselves from real industry application.

Regarding the application part It has been shown that CNT has shown excellent promises regarding its use as cold field emitters. However, the lack of long-time stability in field emission current is the main challenge in applying the material as electron gun. Still after optimization the CNT based cold emitter found applications in **X-ray sources, electron microscopes, field emission display, space propulsion system, nano lithography, mass spectrometer, microwave devices and other.**

In the last 5 years the device applications of field emission phenomena have found significant boom which has been reviewed in detailed. The article is believed to be working as authentic source for the future researchers describing the current scenario related to the cold emission properties of CNTs and its various applications.

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