3rd International Conference on Exploring AI, IOT, Science & Technology (ICEAIST-2026)

organized by:

International Scientific Society
Sharing Knowledge & Wisdom
(An International community for Independent & academic Research Scholars)

ICEAIST-2026

ISSN : 2583-2646

ESP JETA

ESP Journal of Engineering & Technology Advancements
International Journal, Scholarly Peer-Reviewed and Published Globally

3rd International Conference on Exploring AI, IOT, Science & Technology (ICEAIST-2026)

Proceedings of

ICEAIST 2026

17th April 2025

Organized by

In Association With

VVS Arcade, 18/1, Puthur High Road,
Opposite to Aruna Theater,
Tiruchirappalli - 620017

About the Conference

The 3rd International Conference on Exploring AI, IoT, Science & Technology (ICEAIST-2026) is an international platform dedicated to bringing together researchers, academicians, industry professionals, scientists, engineers, innovators, entrepreneurs, and students to exchange ideas, present cutting-edge research, and discuss emerging trends in Artificial Intelligence (AI), the Internet of Things (IoT), and advanced scientific and technological innovations. The conference aims to foster interdisciplinary collaboration by connecting experts from diverse fields and encouraging the development of intelligent, sustainable, and technology-driven solutions to address real-world challenges.

As digital transformation continues to reshape industries and societies, the integration of AI, IoT, data science, cloud computing, robotics, cybersecurity, smart manufacturing, healthcare technologies, and intelligent automation has become increasingly significant. ICEAIST-2026 provides an excellent opportunity for participants to explore recent advancements, innovative methodologies, practical applications, and future research directions that contribute to the next generation of intelligent systems and sustainable technological development.

The conference will feature keynote speeches by renowned international experts, invited talks from leading researchers, technical paper presentations, panel discussions, workshops, and networking sessions. These activities are designed to facilitate knowledge sharing, encourage academic excellence, and promote collaborative research among universities, research institutions, industries, government organizations, and technology startups. Participants will gain valuable insights into current technological trends while establishing professional relationships that can lead to future research partnerships and innovation.

ICEAIST-2026 welcomes original, unpublished research papers covering a broad spectrum of topics including Artificial Intelligence, Machine Learning, Deep Learning, Generative AI, Internet of Things, Edge Computing, Cloud Computing, Big Data Analytics, Data Science, Robotics, Computer Vision, Natural Language Processing, Blockchain Technology, Cybersecurity, Smart Cities, Industry 5.0, Intelligent Transportation Systems, Wireless Communication, Green Computing, Sustainable Engineering, Digital Twins, Embedded Systems, Healthcare Informatics, Renewable Energy Technologies, and emerging interdisciplinary applications. The conference encourages innovative research that combines theoretical foundations with practical implementations capable of addressing industrial and societal needs.

One of the primary objectives of ICEAIST-2026 is to promote innovation and technological advancement through collaborative research. The conference serves as a bridge between academia and industry by providing opportunities for researchers to showcase their latest findings while enabling industry professionals to identify emerging technologies with practical applications. This interaction supports technology transfer, commercialization of research outcomes, and the development of future-ready engineering solutions.

Special emphasis is placed on sustainable development, ethical Artificial Intelligence, intelligent automation, digital transformation, and responsible technological innovation. The conference encourages discussions on how emerging technologies can contribute to solving global challenges in healthcare, education, agriculture, environmental sustainability, manufacturing, transportation, and public services while ensuring security, privacy, fairness, and inclusivity.

ICEAIST-2026 is committed to maintaining high academic standards through a rigorous peer-review process conducted by distinguished experts from academia and industry. Accepted papers will contribute to advancing scientific knowledge and promoting high-quality research across multiple disciplines. By providing a global forum for intellectual exchange, innovation, and collaboration, the conference aspires to inspire groundbreaking ideas, strengthen international research partnerships, and accelerate the development of intelligent technologies that create a smarter, safer, and more sustainable future for society.

Keynote Speakers / Invited Speakers

Dr. Sridhar Varadala
Electrical and Biomedical Engineering University of Nevada, Reno, USA

Dr. Latha Kiran Krishna Rajendran
Doctor/general practitioner.

Rambabu Tangirala
Senior Data Engineer & Independent Scholar,USA.

Fahad Amin
Research Scholar

Nagender Yamsani
Lead MDM Engineer, Inspire Brands

Sandeep Reddy Gantla
AI/ML Engineer & Researcher, USA

Usman Imtiaz
Research assistant

Soujanya Vummannagari
Independent Researcher, USA.

Deepika Dayalan
Senior project controls specialist, Independent Researcher, USA.

Mr. Upendra Kanuru
DevOps Engineer & Independent Researcher , USA.

Mr. Sibasis Padhi
Staff Software Engineer, Walmart Global Tech.

Mr. Shailesh Kadam
Senior Software Engineer at Saks Global, USA.

Mr. Subhojit Ghosh
Senior Manager, EY, Independent Researcher, USA.

Mr. Sai Kaushik Ponnekanti
Senior Software Engineer @ Meta & Independent Researcher, USA.

Advisory Committee

Dr. Zeinab Abbas Zaazou
Associate Professor, Department of Faculty of Management Sciences, MSA University, Egypt.

Dr. Md. Khaja Mohiddin
Associate Professor, Bhilai Institute of Technology Raipur, India.

Dr. Nadine Khair
Associate Professor-Head of Marketing Department, American University of Madaba, Jordan.

Mr. Devdutta Dasgupta
Senior Data Engineer,Research Scholar,USA.

Dr.Hedayat Omidvar
Deputy Director of Futures Studies and Foresight,Research & Technology Dept., National Iranian Gas Company

Mr. Sai Kaushik Ponnekanti
Senior Software Engineer, Meta & Independent Researcher, USA.

Dr. Dhiresh Kulshrestha
Professor & Dean -Faculty of Economics Chitkara University-Chandigarh, Punjab.

Judges / Peer Reviewers

Ms. Thilakavathi Sankaran
Senior Data Analyst, USA.

Mr. Fnu Prashant
Senior Software Engineer & Independent Researcher, USA.

Mr. Suresh Pairu Subramanayam
Mgr, Full-Stack Development,Eminent Researcher,USA.

Mr. Vasudevan Senathi Ramdoss
Senior Performance Engineer & Independent Researcher, USA.

Srinivasa Rao Seetala
Senior Data Architect , USA.

Mr. Ranjith Kumar Ramakrishnan
Senior Software Developer & Independent Researcher, USA.

Dr. Janice Toh Guat Guan
Professor, Branch Head, Penang Branch, Tunku Abdul Rahman University of Management and Technology, Malaysia.

Madhusudan Bangalore Nagaraja
Technical Delivery Manager,Research Scholar, USA.

CONTENTS

Explainable Artificial Intelligence for Trustworthy Decision-Making in Critical Systems

Dr. Harish Narayanan[1], Keerthika Raj[2]

[1]Associate Professor, Department of AI & Robotics, Indian Institute of Technology Madras, Chennai, India
[2]AI Solutions Engineer, Zoho Corporation, Chennai, India

Abstract: Artificial Intelligence (AI) has become a fundamental technology in critical domains such as healthcare, transportation, finance, manufacturing, defines, and smart infrastructure. While modern AI models, particularly deep learning algorithms, achieve remarkable predictive performance, their decision-making processes often remain opaque, creating challenges in transparency, accountability, and user trust. Explainable Artificial Intelligence (XAI) addresses this limitation by providing interpretable and understandable explanations for AI-generated decisions without significantly compromising predictive accuracy. This paper explores the principles, methodologies, and applications of XAI for trustworthy decision-making in critical systems. It reviews various explanation techniques, including feature importance analysis, saliency mapping, surrogate models, SHAP, LIME, and counterfactual explanations, highlighting their effectiveness in improving model interpretability. The study further discusses the integration of explain ability with ethical AI principles, fairness assessment, bias detection, regulatory compliance, and human-cantered decision support. Additionally, it examines the role of XAI in enhancing risk management, fault diagnosis, predictive maintenance, medical diagnosis, autonomous vehicles, and industrial automation. Emerging challenges such as balancing interpretability with model complexity, computational overhead, privacy preservation, and adversarial robustness are also analyzed. The paper proposes a conceptual framework that combines explain ability, reliability, security, and continuous learning to establish trustworthy AI ecosystems for mission-critical applications. By improving transparency and enabling informed human oversight, Explainable Artificial Intelligence enhances confidence in automated systems while supporting responsible AI deployment. The findings demonstrate that XAI is becoming an essential component of future intelligent systems, facilitating safer, more ethical, and more reliable AI-driven decision-making across diverse engineering and scientific domains.

Keywords: Explainable Artificial Intelligence, Explainable AI, Trustworthy AI, Machine Learning, Deep Learning, Model Interpretability, Decision Support Systems, Ethical Artificial Intelligence, Human-Cantered AI, Critical Systems

Federated Learning Frameworks for Privacy-Preserving Intelligent Applications

Dr. Rohan Krishnan[1], Ananya Suresh[2], Dr. Priya Raman[3]

[1]Professor, Department of Computer Science and Engineering, National Institute of Technology Tiruchirappalli, India
[2]Research Scholar, Department of Artificial Intelligence, Anna University, Chennai, India
[3]Senior Data Scientist, Tata Consultancy Services, Bengaluru, India

Abstract: The rapid expansion of Artificial Intelligence (AI) and Internet of Things (IoT) technologies has led to the generation of massive volumes of distributed data across healthcare, finance, smart cities, industrial automation, and mobile computing environments. Conventional machine learning approaches require centralized data collection, raising significant concerns regarding data privacy, security, ownership, and regulatory compliance. Federated Learning (FL) has emerged as an innovative distributed machine learning paradigm that enables collaborative model training without transferring sensitive data from local devices. This paper explores the design, implementation, and applications of federated learning frameworks for privacy-preserving intelligent applications. It examines the fundamental architecture of FL, including local model training, secure parameter aggregation, communication protocols, and decentralized optimization techniques. The study discusses advanced privacy-preserving mechanisms such as differential privacy, secure multi-party computation, holomorphic encryption, and block chain-assisted federated learning to strengthen data confidentiality and system integrity. Furthermore, the paper investigates the application of federated learning in healthcare diagnostics, autonomous vehicles, industrial Internet of Things (IoT), financial fraud detection, personalized recommendation systems, and smart city infrastructure. Key challenges including communication overhead, data heterogeneity, model convergence, client selection, scalability, adversarial attacks, and energy efficiency are critically analyzed. A comprehensive framework integrating edge computing, cloud intelligence, secure aggregation, and adaptive model optimization is proposed to improve learning efficiency while preserving user privacy. The findings indicate that federated learning represents a promising solution for developing secure, scalable, and intelligent distributed systems capable of complying with modern privacy regulations while maintaining high predictive performance. Future research directions focus on enhancing robustness, interoperability; explain ability, and sustainable AI deployment in large-scale intelligent environments.

Keywords: Federated Learning, Privacy-Preserving AI, Distributed Machine Learning, Edge Computing, Internet of Things, Differential Privacy, Secure Aggregation, Holomorphic Encryption, Block chain, Intelligent Applications

Generative AI Models for Scientific Research and Engineering Innovation

Dr. Karthik Balasubramanian[1], Meera Iyer[2]

[1]Associate Professor, Department of Information Technology, PSG College of Technology, Coimbatore, India
[2]AI Research Engineer, Infosys Ltd., Bengaluru, India

Abstract: Generative Artificial Intelligence (Generative AI) has emerged as a transformative technology capable of accelerating scientific discovery and engineering innovation through automated content generation, intelligent design assistance, and advanced data analysis. By leveraging large language models, generative adversarial networks (GANs), diffusion models, and transformer-based architectures, Generative AI enables researchers and engineers to develop novel solutions, optimize complex systems, and improve decision-making across multiple disciplines. This paper examines the role of Generative AI in advancing scientific research and engineering applications, highlighting its potential to automate literature reviews, generate simulation models, assist software development, create engineering designs, optimize manufacturing processes, and support scientific hypothesis generation. The study explores the integration of Generative AI with digital twins, cloud computing, Internet of Things (IoT), robotics, and high-performance computing to develop intelligent and adaptive engineering ecosystems. Furthermore, it discusses the application of generative models in healthcare, materials science, smart manufacturing, environmental monitoring, education, and sustainable infrastructure development. The paper also addresses critical challenges associated with model reliability, hallucination, bias, explain ability, intellectual property protection, data privacy, cybersecurity, and ethical governance. A conceptual framework is proposed that combines human expertise, responsible AI principles, continuous learning, and automated knowledge generation to ensure trustworthy and effective deployment of Generative AI in scientific and engineering domains. The findings suggest that Generative AI has the potential to significantly reduce research and development time, enhance innovation capabilities, improve design accuracy, and facilitate interdisciplinary collaboration. As the technology continues to evolve, responsible implementation, transparency, and robust validation mechanisms will be essential for maximizing its benefits while minimizing associated risks, thereby shaping the future of intelligent scientific research and sustainable engineering innovation.

Keywords: Generative Artificial Intelligence, Large Language Models, Deep Learning, Engineering Innovation, Scientific Research, Generative Adversarial Networks, Digital Twins, Intelligent Automation, Sustainable Engineering, Responsible AI

Reinforcement Learning-Based Autonomous Resource Optimization in Smart Environments

Dr. Arvind Menon[1], Sneha Nair[2], Rahul Prakash[3]

[1]Professor, School of Computing, Vellore Institute of Technology, Vellore, India
[2]Assistant Professor, Department of CSE, SRM Institute of Science and Technology, Chennai, India
[3]Research Scholar, Department of Artificial Intelligence, Amrita Vishwa Vidyapeetham, Coimbatore, India

Abstract: The increasing complexity of smart environments has created a growing demand for intelligent resource management techniques capable of adapting to dynamic and uncertain operating conditions. Reinforcement Learning (RL), a branch of Artificial Intelligence that enables autonomous agents to learn optimal actions through continuous interaction with their environment, has emerged as a powerful approach for resource optimization in modern engineering systems. This paper investigates the application of reinforcement learning for autonomous resource optimization across smart cities, industrial automation, intelligent transportation systems, cloud computing, wireless communication networks, smart grids, and Internet of Things (IoT) ecosystems. The study examines various RL techniques, including Q-learning, Deep Q Networks (DQN), Policy Gradient methods, Actor-Critic models, and Multi-Agent Reinforcement Learning, emphasizing their ability to optimize energy consumption, network bandwidth allocation, task scheduling, traffic flow, computational resources, and industrial production processes. Furthermore, the paper explores the integration of reinforcement learning with edge computing, digital twins, predictive analytics, and real-time sensing technologies to enhance system adaptability and operational efficiency. Key challenges such as large state spaces, delayed reward mechanisms, computational complexity, scalability, convergence stability, cybersecurity threats, and safe exploration are critically analyzed. A conceptual framework is proposed that combines reinforcement learning with explainable AI, edge intelligence, and adaptive control mechanisms to enable sustainable, secure, and autonomous resource management. The findings demonstrate that reinforcement learning significantly improves resource utilization, reduces operational costs, minimizes energy consumption, and enhances decision-making in complex smart environments. Future research should focus on improving sample efficiency, multi-agent coordination, transfer learning, and trustworthy AI frameworks to support the deployment of highly autonomous and sustainable intelligent systems across diverse engineering applications.

Keywords: Reinforcement Learning, Autonomous Systems, Resource Optimization, Smart Environments, Deep Reinforcement Learning, Internet of Things, Edge Computing, Intelligent Decision-Making, Sustainable Computing, Artificial Intelligence

Edge AI Architectures for Real-Time Intelligent IoT Systems

Dr. Nikhil Sharma[1], Divya Reddy[2]

[1]Associate Professor, Department of Computer Science, Indian Institute of Information Technology Hyderabad, India
[2]Software Engineer (AI), Microsoft India Development Center, Hyderabad, India

Abstract: The rapid growth of the Internet of Things (IoT) has resulted in billions of interconnected devices generating continuous streams of data that require timely processing and intelligent decision-making. Traditional cloud-centric computing architectures often experience latency, bandwidth limitations, and privacy concerns, making them less suitable for real-time IoT applications. Edge Artificial Intelligence (Edge AI) has emerged as an effective solution by enabling AI models to execute directly on edge devices, reducing response time while improving security, scalability, and operational efficiency. This paper explores the design and implementation of Edge AI architectures for real-time intelligent IoT systems across domains such as smart cities, healthcare, industrial automation, intelligent transportation, agriculture, and environmental monitoring. The study examines key architectural components, including edge devices, edge gateways, AI accelerators, cloud integration, communication protocols, and distributed intelligence frameworks. Advanced machine learning and deep learning techniques deployed at the network edge are analyzed for applications such as predictive maintenance, anomaly detection, object recognition, traffic management, and autonomous decision-making. The paper also discusses the integration of Edge AI with 5G networks, digital twins, block chain, and federated learning to enhance system performance and data privacy. Critical challenges, including limited computational resources, energy efficiency, model optimization, interoperability, cybersecurity, and real-time scalability, are thoroughly evaluated. A conceptual framework is proposed that combines lightweight AI models, adaptive resource allocation, secure communication, and continuous learning to support sustainable and intelligent IoT ecosystems. The findings indicate that Edge AI significantly enhances response speed, minimizes network congestion, reduces cloud dependency, and enables autonomous operation in distributed environments. Future research should focus on explainable Edge AI, energy-aware computing, collaborative edge intelligence, and standardized architectures to facilitate the widespread deployment of next-generation intelligent IoT systems.

Keywords: Edge AI, Internet of Things, Edge Computing, Artificial Intelligence, Real-Time Systems, Deep Learning, Smart Devices, Distributed Intelligence, Intelligent Automation, Sustainable Computing

AI-Driven Predictive Maintenance in Industrial Internet of Things (IoT)

Dr. Arvind Menon[1], Sneha Nair[2], Rahul Prakash[3]

[1]Professor, School of Computing, Vellore Institute of Technology, Vellore, India
[2]Assistant Professor, Department of CSE, SRM Institute of Science and Technology, Chennai, India
[3]Research Scholar, Department of Artificial Intelligence, Amrita Vishwa Vidyapeetham, Coimbatore, India

Abstract: The Industrial Internet of Things (IoT) has transformed modern manufacturing by connecting machines, sensors, and industrial assets to enable continuous monitoring and intelligent automation. However, unexpected equipment failures remain a significant challenge, leading to production downtime, increased maintenance costs, and reduced operational efficiency. Artificial Intelligence (AI)-driven predictive maintenance has emerged as an advanced solution that utilizes machine learning, deep learning, and real-time sensor analytics to predict equipment failures before they occur. This paper investigates AI-based predictive maintenance frameworks for Industrial Internet of Things environments, focusing on improving equipment reliability, operational efficiency, and sustainable industrial production. The study examines the integration of IoT sensors, edge computing, cloud platforms, and digital twins to collect, process, and analyze machine health data in real time. Various AI techniques, including supervised learning, unsupervised learning, neural networks, anomaly detection, and time-series forecasting, are explored for fault diagnosis, remaining useful life prediction, and maintenance scheduling. The paper also discusses the role of computer vision in automated equipment inspection and the application of reinforcement learning for maintenance optimization. Key challenges such as data quality, sensor reliability, cybersecurity threats, interoperability, computational complexity, and scalability are critically analyzed. A comprehensive framework combining intelligent sensing, predictive analytics, explainable AI, and adaptive maintenance planning is proposed to enhance industrial asset management. The findings demonstrate that AI-driven predictive maintenance significantly reduces unplanned downtime, extends equipment lifespan, lowers maintenance costs, and improves production quality while supporting sustainable manufacturing practices. Future research should focus on federated learning, autonomous maintenance systems, energy-efficient AI models, and standardized IoT architectures to enable resilient, intelligent, and self-optimizing industrial ecosystems.

Keywords: Artificial Intelligence, Predictive Maintenance, Industrial Internet of Things, Machine Learning, Deep Learning, Digital Twins, Edge Computing, Anomaly Detection, Smart Manufacturing, Industrial Automation

Energy-Efficient IoT Networks for Sustainable Smart Cities

Dr. Nikhil Sharma[1], Divya Reddy[2]

[1]Associate Professor, Department of Computer Science, Indian Institute of Information Technology Hyderabad, India
[2]Software Engineer (AI), Microsoft India Development Center, Hyderabad, India

Abstract: The rapid expansion of Internet of Things (IoT) technologies has become a cornerstone of smart city development, enabling intelligent management of transportation, energy, healthcare, public safety, environmental monitoring, and urban infrastructure. However, the increasing number of interconnected devices has significantly raised energy consumption, network congestion, and operational costs, creating challenges for sustainable urban development. This paper investigates energy-efficient IoT network architectures designed to support sustainable smart cities by optimizing resource utilization while maintaining high communication performance. The study examines advanced technologies such as low-power wireless communication protocols, edge computing, cloud computing, artificial intelligence, machine learning, and software-defined networking for intelligent energy management. Various energy optimization techniques, including adaptive routing, sleep scheduling, data aggregation, dynamic power allocation, and energy-aware task scheduling, are analyzed to improve network efficiency and extend device lifetime. The paper also explores the integration of renewable energy sources, smart grids, digital twins, and real-time environmental sensing to create intelligent and resilient urban ecosystems. Applications in smart transportation, intelligent street lighting, waste management, water distribution, environmental monitoring, and public infrastructure are discussed to demonstrate the practical benefits of energy-efficient IoT networks. Furthermore, challenges related to scalability, interoperability, cybersecurity, quality of service, latency, and data privacy are critically evaluated. A comprehensive framework is proposed that combines artificial intelligence, edge intelligence, renewable energy management, and adaptive communication protocols to enable sustainable IoT-enabled smart cities. The findings indicate that energy-efficient IoT networks can significantly reduce power consumption, improve network reliability, lower operational costs, and enhance environmental sustainability. Future research should focus on autonomous energy management, AI-driven network optimization, 6G-enabled IoT communication, and green computing technologies to support the next generation of intelligent and sustainable urban infrastructure.

Keywords: Internet of Things, Smart Cities, Energy Efficiency, Artificial Intelligence, Edge Computing, Green Computing, Smart Grid, Sustainable Development, Wireless Sensor Networks, Intelligent Infrastructure

Block chain-Enabled Secure Internet of Things Communication Frameworks

Dr. Sandeep Joshi[1], Kavya Patel[2]

[1]Professor, Department of Computer Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, India
[2]Cybersecurity Analyst, HCL Technologies, Noida, India

Abstract: The rapid growth of the Internet of Things (IoT) has enabled seamless connectivity among billions of smart devices across healthcare, transportation, manufacturing, agriculture, and smart city applications. Despite its numerous advantages, IoT environments remain vulnerable to cybersecurity threats, unauthorized access, data tampering, and privacy breaches due to their distributed and resource-constrained nature. Block chain technology has emerged as a promising solution for securing IoT communication by providing decentralized, transparent, and tamper-resistant data management without relying on centralized authorities. This paper explores block chain-enabled communication frameworks designed to improve the security, privacy, and reliability of IoT ecosystems. The study examines the integration of block chain with edge computing, cloud computing, artificial intelligence, and smart contracts to facilitate secure device authentication, decentralized identity management, trusted data sharing, and automated access control. Various consensus mechanisms, including Proof of Stake (Pops), Practical Byzantine Fault Tolerance (PBFT), and lightweight block chain protocols, are analyzed to improve scalability and reduce computational overhead in resource-limited IoT devices. The paper also investigates applications in industrial Internet of Things (IoT), healthcare monitoring, smart grids, intelligent transportation systems, supply chain management, and environmental monitoring. Critical challenges such as transaction latency, energy consumption, interoperability, storage requirements, regulatory compliance, and block chain scalability are thoroughly evaluated. A comprehensive framework combining block chain, AI-driven threat detection, edge intelligence, and secure communication protocols is proposed to establish trustworthy IoT networks. The findings indicate that block chain significantly enhances data integrity, transparency, device authentication, and resilience against cyber attacks while supporting decentralized intelligent systems. Future research should focus on lightweight block chain architectures, quantum-resistant cryptography, federated security models, and sustainable block chain solutions to facilitate the widespread adoption of secure and scalable IoT communication infrastructures.

Keywords: Block chain, Internet of Things, Cybersecurity, Smart Contracts, Edge Computing, Distributed Ledger Technology, Data Privacy, Secure Communication, Industrial Internet of Things, Artificial Intelligence

Digital Twin Technologies for Intelligent IoT-Based Infrastructure Management

Dr. Manish Gupta[1], Aditi Rao[2], Dr. Neha Kapoor[3]

[1]Associate Professor, Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai, India
[2]Research Scholar, Department of Smart Infrastructure, Indian Institute of Technology Bombay, India
[3]Senior Research Scientist, Larsen & Toubro Technology Services, Bengaluru, India

Abstract: Digital Twin technology has emerged as a transformative innovation for intelligent infrastructure management by creating dynamic virtual replicas of physical assets, systems, and processes. When integrated with the Internet of Things (IoT), Digital Twins enable continuous monitoring, predictive analytics, real-time decision-making, and lifecycle optimization of critical infrastructure. This paper explores the application of Digital Twin technologies for intelligent IoT-based infrastructure management across domains such as smart cities, transportation, energy systems, industrial facilities, water distribution networks, and healthcare infrastructure. The study examines the architecture of Digital Twin systems, including IoT sensors, communication networks, cloud and edge computing, artificial intelligence, machine learning, and data analytics platforms. These technologies facilitate the collection and analysis of real-time operational data, allowing infrastructure managers to detect anomalies, predict equipment failures, optimize maintenance schedules, and improve system resilience. The paper further investigates the role of Digital Twins in enhancing energy efficiency, asset utilization, environmental sustainability, and disaster preparedness through simulation and predictive modeling. Challenges related to data interoperability, cybersecurity, computational complexity, scalability, synchronization accuracy, and privacy protection are critically discussed. A comprehensive framework integrating Digital Twins, AI-driven analytics, edge intelligence, block chain-enabled security, and predictive maintenance is proposed to support autonomous and sustainable infrastructure management. The findings demonstrate that Digital Twin technologies significantly improve operational reliability, reduce maintenance costs, minimize downtime, and enhance infrastructure resilience while supporting data-driven decision-making. Future research directions include the development of standardized Digital Twin platforms, explainable AI integration, 6G-enabled communication, autonomous infrastructure management, and sustainable computing solutions. The adoption of Digital Twin technologies is expected to play a vital role in building resilient, intelligent, and environmentally sustainable infrastructure systems capable of meeting the evolving demands of modern society.

Keywords: Digital Twins, Internet of Things, Intelligent Infrastructure, Artificial Intelligence, Predictive Maintenance, Edge Computing, Smart Cities, Real-Time Monitoring, Sustainable Infrastructure, Data Analytics

Next-Generation Smart Agriculture Using AI and IoT Technologies

Dr. Gokul Raj[1], Nivetha Kannan[2]

[1]Professor, Department of Agricultural Engineering, Tamil Nadu Agricultural University, Coimbatore, India
[2]Research Associate, Department of Artificial Intelligence, Anna University, Chennai, India

Abstract: The increasing global demand for food production, coupled with climate change, resource scarcity, and population growth, has accelerated the adoption of intelligent technologies in modern agriculture. Artificial Intelligence (AI) and the Internet of Things (IoT) have emerged as key enablers of precision farming by providing real-time monitoring, automated decision-making, and efficient resource management. This paper explores next-generation smart agriculture systems that integrate AI and IoT technologies to enhance agricultural productivity, sustainability, and environmental conservation. The proposed framework incorporates IoT sensors, unmanned aerial vehicles (UAVs), satellite imagery, wireless sensor networks, cloud computing, edge computing, and machine learning algorithms to continuously monitor soil moisture, crop health, weather conditions, irrigation requirements, and pest infestations. AI-based predictive analytics and deep learning models are utilized to optimize irrigation scheduling, fertilizer application, crop yield prediction, disease detection, and harvest planning while minimizing resource consumption. The study also examines the role of digital twins, block chain, and intelligent automation in improving supply chain transparency, traceability, and farm management. Furthermore, the paper discusses challenges such as data quality, interoperability, cybersecurity, infrastructure limitations, energy efficiency, and technology adoption among small-scale farmers. A comprehensive architecture combining AI, IoT, edge intelligence, and sustainable farming practices is proposed to enable autonomous and data-driven agricultural operations. The findings demonstrate that intelligent agriculture systems significantly improve crop productivity, reduce water and fertilizer usage, lower operational costs, and enhance environmental sustainability. Future research should focus on explainable AI, climate-resilient farming models, autonomous agricultural robotics, 6G-enabled smart farming, and collaborative digital ecosystems to support resilient and sustainable agricultural development. The integration of AI and IoT is expected to revolutionize agricultural practices by enabling precision, efficiency, and long-term food security.

Keywords: Artificial Intelligence, Internet of Things, Smart Agriculture, Precision Farming, Machine Learning, Wireless Sensor Networks, Edge Computing, Crop Monitoring, Sustainable Agriculture, Digital Farming

Artificial Intelligence for Early Disease Prediction Using Medical Big Data

Dr. Ashwin Kumar[1], Pooja Mehta[2], Dr. Deepika Rao[3]

[1]Associate Professor, Department of Biomedical Engineering, Indian Institute of Technology Hyderabad, India
[2]Research Scholar, Department of Health Informatics, Manipal Academy of Higher Education, Manipal, India
[3]AI Healthcare Specialist, Philips Innovation Campus, Bengaluru, India

Abstract: The rapid digitization of healthcare systems has resulted in the generation of massive volumes of medical data from electronic health records, wearable devices, medical imaging, laboratory reports, and genomic databases. Effectively analyzing these heterogeneous datasets presents a significant opportunity for improving early disease detection and preventive healthcare. Artificial Intelligence (AI), supported by machine learning and deep learning techniques, has become a powerful tool for extracting meaningful insights from medical big data and enabling timely clinical decision-making. This paper explores the application of AI for early disease prediction using large-scale healthcare datasets. The proposed framework integrates medical big data, cloud computing, edge computing, and predictive analytics to develop intelligent diagnostic systems capable of identifying disease risks at an early stage. Various AI algorithms, including decision trees, support vector machines, random forests, artificial neural networks, convolutional neural networks, and recurrent neural networks, are examined for predicting chronic diseases such as diabetes, cardiovascular disorders, cancer, respiratory illnesses, and neurological conditions. The study also investigates the integration of wearable IoT devices and real-time patient monitoring systems to facilitate continuous health assessment and personalized healthcare services. Furthermore, critical challenges including data privacy, class imbalance, model interpretability, cybersecurity, regulatory compliance, and ethical AI deployment are thoroughly analyzed. A comprehensive framework combining explainable AI, federated learning, secure data sharing, and intelligent clinical decision support is proposed to improve diagnostic accuracy while preserving patient confidentiality. The findings demonstrate that AI-driven disease prediction systems significantly enhance diagnostic efficiency, reduce healthcare costs, enable early intervention, and improve patient outcomes. Future research should focus on multimodal data integration, personalized predictive medicine, trustworthy AI models, and scalable healthcare infrastructures to support the development of intelligent, accessible, and sustainable healthcare systems.

Keywords: Artificial Intelligence, Medical Big Data, Early Disease Prediction, Machine Learning, Deep Learning, Healthcare Analytics, Electronic Health Records, Clinical Decision Support, Explainable AI, Precision Medicine

Wearable IoT Devices for Continuous Healthcare Monitoring and Remote Patient Care

Dr. Naveen Chandran[1], Keerthi Das[2]

[1]Professor, Department of Electronics and Instrumentation Engineering, National Institute of Technology Calicut, India
[2]IoT Solutions Engineer, Bosch Global Software Technologies, Bengaluru, India

Abstract: The advancement of wearable Internet of Things (IoT) technologies has significantly transformed modern healthcare by enabling continuous patient monitoring, real-time health assessment, and remote medical services. Wearable IoT devices equipped with intelligent sensors can collect physiological data such as heart rate, blood pressure, body temperature, blood oxygen saturation, electrocardiogram signals, respiratory rate, and physical activity, facilitating proactive healthcare management. This paper explores the role of wearable IoT devices in continuous healthcare monitoring and remote patient care, emphasizing their contribution to improving healthcare accessibility, patient outcomes, and clinical decision-making. The proposed framework integrates wearable sensors, wireless communication technologies, edge computing, cloud computing, artificial intelligence (AI), and machine learning to process health data in real time and support predictive healthcare analytics. AI-based algorithms are employed to detect health anomalies, predict disease progression, provide personalized treatment recommendations, and generate timely alerts for healthcare professionals. The study also examines the application of wearable IoT systems in chronic disease management, elderly care, postoperative monitoring, cardiac health, diabetes management, mental health assessment, and rehabilitation services. Furthermore, the paper discusses the integration of block chain technology to ensure secure data sharing and patient privacy. Key challenges, including device interoperability, battery life, data accuracy, cybersecurity, scalability, regulatory compliance, and ethical considerations, are critically evaluated. A comprehensive architecture combining intelligent sensing, AI-driven analytics, secure communication protocols, and remote healthcare platforms is proposed to enhance the reliability and effectiveness of wearable healthcare systems. The findings demonstrate that wearable IoT devices improve early disease detection, reduce hospital admissions, support personalized healthcare, and enable efficient remote patient management. Future research should focus on energy-efficient wearable technologies, explainable AI, digital twin integration, and next-generation wireless communication to develop resilient, intelligent, and patient-cantered healthcare ecosystems.

Keywords: Wearable Internet of Things, Remote Patient Care, Continuous Health Monitoring, Artificial Intelligence, Machine Learning, Edge Computing, Cloud Computing, Healthcare Analytics, Digital Health, Smart Healthcare

Intelligent Medical Image Analysis Using Deep Learning Techniques

Dr. Rahul Iyer[1], Sanjana Rao[2]

[1]Associate Professor, Department of Artificial Intelligence, SRM Institute of Science and Technology, Chennai, India
[2]Research Scholar, Department of Medical Imaging, Vellore Institute of Technology, Vellore, India

Abstract: Medical imaging plays a vital role in the diagnosis, treatment planning, and monitoring of numerous diseases. The increasing volume and complexity of medical images generated from modalities such as X-ray, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and positron emission tomography (PET) require advanced analytical techniques to improve diagnostic accuracy and efficiency. Deep learning has emerged as a powerful branch of Artificial Intelligence (AI) capable of automatically extracting complex features from medical images, enabling accurate disease detection and clinical decision support. This paper investigates intelligent medical image analysis using deep learning techniques for improving healthcare outcomes. The proposed framework integrates convolutional neural networks (CNNs), recurrent neural networks (RNNs), vision transformers (Vitus), transfer learning, and image segmentation algorithms to perform disease classification, lesion detection, organ segmentation, tumour identification, and image enhancement. The study explores applications in diagnosing cancer, cardiovascular diseases, neurological disorders, respiratory infections, diabetic retinopathy, and musculoskeletal abnormalities. Additionally, the integration of cloud computing, edge computing, and Internet of Medical Things (IoT) technologies is examined to facilitate real-time medical image processing and remote healthcare services. The paper also addresses significant challenges, including limited annotated datasets, model interpretability, computational complexity, data privacy, cybersecurity, and regulatory compliance. A comprehensive framework combining explainable AI, federated learning, and secure medical data management is proposed to improve transparency, reliability, and clinical acceptance of deep learning models. The findings demonstrate that intelligent medical image analysis significantly enhances diagnostic accuracy, reduces interpretation time, supports early disease detection, and improves clinical decision-making. Future research should focus on multimodal medical data fusion, self-supervised learning, lightweight deep learning models, and trustworthy AI systems to develop scalable, accurate, and patient-cantered medical imaging solutions for next-generation healthcare.

Keywords: Deep Learning, Medical Image Analysis, Artificial Intelligence, Convolutional Neural Networks, Medical Imaging, Image Segmentation, Disease Detection, Healthcare Analytics, Explainable AI, Internet of Medical Things

AI-Assisted Personalized Healthcare through Digital Twin Technology

Dr. Lakshmi Narayanan[1], Aarushi Gupta[2], Dr. Vinay Kumar[3]

[1]Professor, Department of Biomedical Engineering, Indian Institute of Technology Madras, Chennai, India
[2]Research Scholar, Department of Computer Science, Anna University, Chennai, India
[3]Principal AI Scientist, GE HealthCare, Bengaluru, India

Abstract: The convergence of Artificial Intelligence (AI) and Digital Twin technology is transforming modern healthcare by enabling personalized, predictive, and preventive medical services. A Digital Twin in healthcare is a virtual representation of an individual patient that continuously synchronizes with real-time physiological, clinical, genetic, and lifestyle data collected from wearable devices, medical imaging, electronic health records, and Internet of Medical Things (IoT) sensors. This paper explores AI-assisted personalized healthcare through Digital Twin technology to improve disease prediction, treatment planning, patient monitoring, and clinical decision-making. The proposed framework integrates AI algorithms, machine learning, deep learning, cloud computing, edge computing, and IoT devices to develop intelligent Digital Twins capable of simulating patient-specific health conditions and forecasting disease progression. AI-driven predictive analytics enable healthcare professionals to evaluate treatment outcomes, optimize medication plans, identify potential health risks, and provide personalized recommendations before clinical deterioration occurs. The study investigates applications in chronic disease management, cardiovascular care, oncology, diabetes monitoring, neurological disorders, elderly care, and precision medicine. Furthermore, the paper discusses the role of block chain technology in ensuring secure data sharing, privacy preservation, and transparent healthcare information management. Critical challenges, including data interoperability, computational complexity, cybersecurity, ethical considerations, model explain ability, and regulatory compliance, are comprehensively analyzed. A conceptual architecture integrating Digital Twins, explainable AI, federated learning, and intelligent healthcare analytics is proposed to support secure, adaptive, and patient-centric healthcare ecosystems. The findings indicate that AI-assisted Digital Twin technology significantly enhances diagnostic accuracy, enables proactive disease management, reduces healthcare costs, and improves patient outcomes through continuous health monitoring and personalized treatment strategies. Future research should focus on multimodal data integration, autonomous healthcare systems, real-time Digital Twin synchronization, and sustainable AI frameworks to advance intelligent healthcare services and improve the quality of life for patients worldwide.

Keywords: Artificial Intelligence, Digital Twin, Personalized Healthcare, Precision Medicine, Internet of Medical Things, Machine Learning, Predictive Analytics, Electronic Health Records, Explainable AI, Smart Healthcare

Artificial Intelligence-Based Cyber Threat Detection in Smart Networks

Dr. Sanjay Kulkarni[1], Harsha Vardhan[2]

[1]Associate Professor, Department of Information Technology, National Institute of Technology Karnataka, Surathkal, India
[2]Cybersecurity Engineer, Cisco Systems India Pvt. Ltd., Bengaluru, India

Abstract: The rapid expansion of smart networks, including Internet of Things (IoT), cloud computing, 5G communication, industrial control systems, and smart city infrastructures, has significantly increased the complexity of cybersecurity challenges. Traditional security mechanisms often struggle to identify sophisticated cyber-attacks due to the dynamic nature of modern network environments and the growing volume of network traffic. Artificial Intelligence (AI) has emerged as a powerful technology for intelligent cyber-threat detection by enabling automated analysis, anomaly detection, and real-time response to malicious activities. This paper investigates AI-based cyber-threat detection techniques for securing smart networks against evolving cyber-threats. The proposed framework integrates machine learning, deep learning, edge computing, cloud computing, and threat intelligence platforms to continuously monitor network behavior and identify suspicious activities with high accuracy. Various AI models, including support vector machines, decision trees, random forests, convolutional neural networks, recurrent neural networks, and transformer-based architectures, are evaluated for intrusion detection, malware classification, phishing detection, ransom ware identification, distributed denial-of-service (Dodos) attack mitigation, and insider threat analysis. The study also explores the integration of explainable AI to improve transparency and support security analysts in understanding AI-generated decisions. Furthermore, block chain technology and federated learning are examined as complementary approaches for secure threat intelligence sharing and privacy-preserving collaborative learning. Critical challenges, including adversarial attacks, false-positive reduction, model scalability, data privacy, computational overhead, and regulatory compliance, are thoroughly analyzed. A comprehensive framework combining AI-driven analytics, automated incident response, adaptive learning, and zero-trust security principles is proposed to enhance network resilience. The findings demonstrate that AI significantly improves cyber-threat detection accuracy, reduces response time, minimizes security risks, and strengthens the protection of critical digital infrastructures. Future research should focus on autonomous cybersecurity systems, explainable threat detection models, quantum-resistant security mechanisms, and sustainable AI-based cyber-defines strategies.

Keywords: Artificial Intelligence, Cybersecurity, Cyber Threat Detection, Machine Learning, Deep Learning, Intrusion Detection, Smart Networks, Explainable AI, Zero Trust Security, Network Security

Privacy-Preserving Machine Learning for Internet of Things Applications

Dr. Rekha Menon[1], Vignesh Kumar[2]

[1]Professor, Department of Computer Science, Cochin University of Science and Technology, Kochi, India
[2]Research Scholar, Department of Artificial Intelligence, VIT Chennai, India

Abstract: The widespread deployment of Internet of Things (IoT) devices has resulted in the continuous generation of large volumes of sensitive data across healthcare, industrial automation, transportation, agriculture, and smart city applications. Although machine learning enables intelligent data analysis and automated decision-making, conventional centralized learning approaches raise significant concerns regarding data privacy, security, and regulatory compliance. Privacy-preserving machine learning has emerged as a promising solution by enabling intelligent model training while protecting sensitive user information. This paper explores privacy-preserving machine learning techniques for IoT applications through the integration of federated learning, differential privacy, holomorphic encryption, secure multi-party computation, and block chain technologies. The proposed framework supports decentralized model training across distributed IoT devices without exposing raw data to centralized servers. The study investigates applications in healthcare monitoring, industrial Internet of Things (IoT), autonomous transportation, environmental monitoring, and smart energy systems. Key challenges, including communication overhead, heterogeneous data distribution, model convergence, energy consumption, cybersecurity threats, and resource limitations, are critically examined. Furthermore, explainable AI is incorporated to improve model transparency and support trustworthy decision-making. The proposed architecture combines edge computing, cloud intelligence, secure aggregation protocols, and adaptive learning algorithms to improve system performance while preserving user privacy. The findings demonstrate that privacy-preserving machine learning enhances data confidentiality, improves regulatory compliance, and enables secure intelligent services across diverse IoT environments. Future research should focus on lightweight privacy-preserving algorithms, scalable decentralized learning, quantum-resistant encryption, and standardized privacy frameworks to facilitate the widespread adoption of secure and intelligent IoT systems.

Keywords: Privacy-Preserving Machine Learning, Internet of Things, Federated Learning, Differential Privacy, Holomorphic Encryption, Secure Multi-Party Computation, Edge Computing, Block chain, Explainable AI, Intelligent Systems

Zero-Trust Security Architecture for AI-Enabled Connected Systems

Dr. Abhishek Jain[1], Roshni Sharma[2], Dr. Sriram Iyer[3]

[1]Associate Professor, Department of Computer Engineering, National Institute of Technology Warangal, India
[2]Research Associate, Department of Cybersecurity, Indian Institute of Technology Kanpur, India
[3]Cloud Security Architect, IBM India Pvt. Ltd., Bengaluru, India

Abstract: The increasing adoption of Artificial Intelligence (AI), cloud computing, Internet of Things (IoT), and edge computing has significantly expanded the attack surface of modern connected systems. Traditional perimeter-based security models are insufficient for protecting distributed digital infrastructures against evolving cyber-threats. Zero-Trust Security Architecture has emerged as a modern cybersecurity paradigm based on the principle of "never trust, always verify," requiring continuous authentication, authorization, and monitoring of all users, devices, and applications. This paper investigates the implementation of Zero-Trust Security Architecture for AI-enabled connected systems. The proposed framework integrates identity and access management, multi-factor authentication, behavioural analytics, artificial intelligence, machine learning, block chain, and continuous risk assessment to establish a resilient security ecosystem. AI-driven threat detection algorithms continuously analyze network behavior to identify anomalies, insider threats, malware, ransom ware, and unauthorized access attempts. The study explores applications in smart cities, healthcare, industrial Internet of Things (IoT), financial systems, autonomous vehicles, and cloud-native environments. Critical challenges, including interoperability, policy management, scalability, latency, privacy protection, and compliance with cybersecurity regulations, are comprehensively analyzed. Furthermore, explainable AI techniques are incorporated to improve transparency in automated security decisions. The proposed architecture combines adaptive authentication, micro-segmentation, continuous monitoring, and intelligent access control to strengthen cybersecurity while maintaining system performance. The findings indicate that Zero-Trust Security Architecture significantly improves resilience against sophisticated cyber-attacks, minimizes security risks, enhances regulatory compliance, and supports secure AI-driven digital transformation. Future research should focus on autonomous zero-trust frameworks, quantum-safe authentication methods, federated cybersecurity intelligence, and sustainable security solutions for next-generation connected ecosystems.

Keywords: Zero Trust Security, Artificial Intelligence, Cybersecurity, Connected Systems, Identity and Access Management, Machine Learning, Block chain, Threat Detection, Smart Networks, Network Security

Sustainable Smart City Development Using AI, IoT, and Cloud Computing

Dr. Ramesh Babu[1], Ishita Roy[2]

[1]Professor, Department of Urban Planning, Indian Institute of Technology Kharagpur, India
[2]Research Scholar, Department of Smart Cities, Jawaharlal Nehru Technological University, Hyderabad, India

Abstract: Rapid urbanization has increased the demand for intelligent infrastructure capable of supporting sustainable economic growth, efficient public services, and environmental conservation. Smart cities utilize Artificial Intelligence (AI), Internet of Things (IoT), and cloud computing technologies to optimize urban operations through data-driven decision-making and intelligent automation. This paper explores an integrated framework for sustainable smart city development by combining AI, IoT, cloud computing, edge computing, and big data analytics. The proposed architecture enables real-time monitoring and intelligent management of transportation systems, energy distribution, waste management, water resources, environmental quality, healthcare services, and public safety. AI-based predictive analytics and machine learning algorithms optimize traffic flow, energy consumption, emergency response, and resource allocation while reducing operational costs and environmental impact. IoT sensors continuously collect data from urban infrastructure, while cloud platforms provide scalable storage, analytics, and service integration. The study also investigates the role of digital twins, block chain technology, and renewable energy integration in improving infrastructure resilience, transparency, and sustainability. Challenges related to cybersecurity, interoperability, data privacy, scalability, governance, and digital inclusion are critically discussed. A comprehensive framework integrating AI-driven automation, intelligent sensing, secure communication, and sustainable resource management is proposed to support resilient urban ecosystems. The findings demonstrate that the integration of AI, IoT, and cloud computing enhances operational efficiency, reduces carbon emissions, improves quality of life, and promotes environmentally responsible urban development. Future research should focus on autonomous city management, 6G-enabled communication, explainable AI, and climate-resilient smart infrastructure to support the next generation of sustainable smart cities.

Keywords: Smart Cities, Artificial Intelligence, Internet of Things, Cloud Computing, Sustainable Development, Edge Computing, Big Data Analytics, Intelligent Infrastructure, Renewable Energy, Urban Computing

Intelligent Traffic Management Systems Based on AI and Internet of Things

Dr. Kiran Desai[1], Megha Sinha[2], Dr. Vivek Agarwal[3]

[1]Associate Professor, Department of Transportation Engineering, Indian Institute of Technology Roorkee, India
[2]Research Scholar, Department of Artificial Intelligence, Delhi Technological University, New Delhi, India
[3]Senior AI Consultant, Accenture Technology, Gurugram, India

Abstract: The rapid growth of urban populations and vehicle ownership has intensified traffic congestion, road accidents, fuel consumption, and environmental pollution in metropolitan areas. Intelligent Traffic Management Systems (ITMS) based on Artificial Intelligence (AI) and the Internet of Things (IoT) offer an effective solution for improving transportation efficiency and urban mobility. This paper investigates AI-enabled traffic management frameworks that integrate IoT sensors, surveillance cameras, connected vehicles, edge computing, cloud computing, and machine learning algorithms for real-time traffic monitoring and optimization. The proposed architecture continuously collects traffic data from intelligent transportation infrastructure to analyze traffic density, detect incidents, predict congestion, optimize signal timing, and support dynamic route planning. Deep learning models and computer vision techniques are employed for vehicle detection, traffic flow estimation, accident identification, and pedestrian safety analysis. The study further explores the integration of vehicle-to-everything (V2X) communication, digital twins, and autonomous transportation technologies to improve transportation resilience and efficiency. Challenges such as data interoperability, cybersecurity, communication latency, privacy protection, infrastructure costs, and scalability are critically examined. A comprehensive framework combining AI-driven predictive analytics, edge intelligence, adaptive traffic control, and sustainable transportation planning is proposed to enable autonomous traffic management. The findings indicate that intelligent traffic management systems significantly reduce congestion, minimize travel time, improve road safety, lower fuel consumption, and decrease greenhouse gas emissions. Future research should focus on connected autonomous vehicles, explainable AI, 6G communication, and integrated multimodal transportation systems to develop smarter, safer, and more sustainable urban mobility solutions.

Keywords: Artificial Intelligence, Internet of Things, Intelligent Traffic Management, Smart Transportation, Machine Learning, Computer Vision, Edge Computing, Connected Vehicles, Smart Cities, Sustainable Mobility

AI-Driven Environmental Monitoring for Climate Change Mitigation

Dr. Shyam Prasad[1], Aishwarya Nair[2]

[1]Professor, Department of Environmental Engineering, Indian Institute of Technology Guwahati, India
[2]Research Scientist, Centre for Climate Studies, Anna University, Chennai, India

Abstract: Climate change has become one of the most significant global challenges, requiring advanced technologies to monitor environmental conditions, predict ecological changes, and support sustainable decision-making. Artificial Intelligence (AI) has emerged as a powerful tool for processing large-scale environmental data collected from satellites, IoT sensors, drones, weather stations, and remote sensing systems. This paper explores AI-driven environmental monitoring frameworks designed to support climate change mitigation through intelligent data analysis and predictive modeling. The proposed framework integrates machine learning, deep learning, Internet of Things (IoT), cloud computing, edge computing, and geospatial analytics to monitor air quality, water resources, forest ecosystems, biodiversity, weather patterns, carbon emissions, and natural disasters in real time. AI algorithms are utilized to predict extreme weather events, identify pollution sources, optimize renewable energy utilization, detect deforestation, and support precision environmental management. The study also investigates the integration of digital twins and Geographic Information Systems (GIS) for simulating environmental scenarios and improving policy planning. Critical challenges, including data heterogeneity, model uncertainty, cybersecurity, scalability, energy consumption, and ethical use of environmental data, are comprehensively analyzed. A sustainable framework combining AI-driven analytics, intelligent sensing, renewable energy integration, and automated environmental decision support is proposed to improve ecosystem resilience and resource conservation. The findings demonstrate that AI significantly enhances environmental monitoring accuracy, supports evidence-based climate policies, reduces ecological risks, and promotes sustainable development. Future research should focus on explainable AI, autonomous environmental monitoring systems, climate-resilient digital infrastructure, and collaborative global environmental intelligence platforms to strengthen climate change mitigation efforts.

Keywords: Artificial Intelligence, Climate Change, Environmental Monitoring, Internet of Things, Machine Learning, Remote Sensing, Geographic Information Systems, Renewable Energy, Sustainable Development, Predictive Analytics

Green Computing and Energy-Aware Artificial Intelligence Systems

Dr. Praveen Kumar[1], Neha Sharma[2]

[1]Associate Professor, Department of Computer Science and Engineering, Indian Institute of Technology Indore, India
[2]AI Research Engineer, Intel Technology India Pvt. Ltd., Bengaluru, India

Abstract: The rapid advancement of Artificial Intelligence (AI) has led to significant improvements in automation, data analytics, and intelligent decision-making across various industries. However, the growing computational demands of AI models have substantially increased energy consumption, carbon emissions, and operational costs in data centres and computing infrastructures. Green computing has emerged as a sustainable approach that focuses on minimizing the environmental impact of computing systems while maintaining high computational performance. This paper explores energy-aware Artificial Intelligence systems that integrate green computing principles to improve resource efficiency and reduce energy consumption. The proposed framework combines machine learning, cloud computing, edge computing, virtualization, workload optimization, and renewable energy integration to develop environmentally sustainable AI infrastructures. Advanced techniques such as dynamic resource allocation, energy-efficient model compression, hardware acceleration, intelligent task scheduling, and adaptive power management are examined to optimize computational efficiency. The study also investigates applications in smart cities, industrial automation, healthcare, autonomous vehicles, and high-performance computing environments. Critical challenges, including balancing computational performance with energy efficiency, carbon footprint reduction, hardware limitations, cybersecurity, and sustainable infrastructure management, are comprehensively analyzed. A conceptual architecture integrating AI-driven energy optimization, renewable energy resources, intelligent cooling systems, and lifecycle assessment is proposed to support sustainable computing ecosystems. The findings demonstrate that energy-aware AI systems significantly reduce power consumption, operational expenses, and environmental impact while maintaining reliable performance. Future research should focus on green data centres, carbon-aware AI scheduling, xeromorphic computing, and sustainable AI governance to promote environmentally responsible digital transformation and long-term technological sustainability.

Keywords: Green Computing, Artificial Intelligence, Energy Efficiency, Sustainable Computing, Cloud Computing, Edge Computing, Renewable Energy, Machine Learning, Carbon Footprint, Intelligent Resource Management

Smart Manufacturing Using AI, Robotics, and Industrial Internet of Things

Dr. Suresh Balan[1], Anjali Menon[2], Arjun Reddy[3]

[1]Professor, Department of Mechanical Engineering, National Institute of Technology Rourkela, India
[2]Assistant Professor, Department of Robotics, SRM Institute of Science and Technology, Chennai, India
[3]Automation Engineer, Siemens Technology and Services Pvt. Ltd., Bengaluru, India

Abstract: The evolution of Industry 4.0 has accelerated the adoption of Artificial Intelligence (AI), robotics, and the Industrial Internet of Things (IoT) to create intelligent manufacturing environments capable of autonomous operation and continuous optimization. Smart manufacturing integrates advanced sensing technologies, intelligent automation, predictive analytics, and interconnected production systems to improve productivity, quality, and operational efficiency. This paper explores an integrated framework for smart manufacturing using AI, robotics, and IoT technologies. The proposed architecture employs intelligent sensors, collaborative robots, edge computing, cloud computing, digital twins, and machine learning algorithms to monitor production processes, predict equipment failures, optimize resource utilization, and automate quality inspection. AI-driven predictive analytics facilitate real-time decision-making, adaptive production scheduling, and demand forecasting, while robotic systems improve manufacturing precision, workplace safety, and production flexibility. The study also investigates block chain-enabled supply chain transparency and cybersecurity mechanisms to protect industrial communication networks. Key challenges, including interoperability, cybersecurity, workforce adaptation, scalability, implementation costs, and energy efficiency, are critically examined. A comprehensive framework integrating AI, IoT, robotics, and digital twins is proposed to enable intelligent, resilient, and sustainable manufacturing ecosystems. The findings indicate that smart manufacturing significantly improves production efficiency, reduces operational costs, minimizes downtime, enhances product quality, and supports environmentally sustainable industrial practices. Future research should focus on human-cantered automation, autonomous factories, explainable AI, 6G-enabled industrial communication, and circular manufacturing models to support the transition toward Industry 5.0.

Keywords: Smart Manufacturing, Artificial Intelligence, Industrial Internet of Things, Robotics, Digital Twins, Predictive Maintenance, Edge Computing, Industry 4.0, Intelligent Automation, Sustainable Manufacturing

Human-Cantered Intelligent Automation in Industry 5.0

Dr. Mohan Raj[1], Kavitha Srinivas[2]

[1]Associate Professor, Department of Industrial Engineering, Anna University, Chennai, India
[2]Research Scholar, Department of Manufacturing Engineering, Indian Institute of Technology Madras, Chennai, India

Abstract: Industry 5.0 represents the next stage of industrial evolution by emphasizing collaboration between humans and intelligent machines rather than complete automation. Unlike Industry 4.0, which primarily focuses on efficiency and connectivity, Industry 5.0 promotes human-cantered innovation, sustainability, and resilience through the integration of Artificial Intelligence (AI), collaborative robotics, Internet of Things (IoT), and advanced digital technologies. This paper investigates human-cantered intelligent automation as a framework for developing adaptive and sustainable industrial systems. The proposed architecture combines AI-driven decision support, collaborative robots (coots), digital twins, edge computing, and real-time analytics to enhance human-machine collaboration in manufacturing and industrial operations. Intelligent automation assists workers in repetitive, hazardous, and precision-based tasks while preserving human creativity, problem-solving abilities, and ethical decision-making. The study explores applications in smart manufacturing, healthcare production, logistics, quality control, predictive maintenance, and customized product development. Challenges including workforce reskilling, cybersecurity, ethical AI, trust, interoperability, and occupational safety are critically analyzed. A comprehensive framework integrating explainable AI, collaborative robotics, intelligent sensing, and adaptive workflow management is proposed to achieve balanced cooperation between humans and intelligent machines. The findings indicate that human-cantered intelligent automation improves productivity, workplace safety, employee satisfaction, product quality, and organizational resilience while supporting sustainable industrial development. Future research should focus on cognitive robotics, personalized human-machine interfaces, digital workforce training, and responsible AI governance to facilitate the successful implementation of Industry 5.0 across diverse industrial sectors.

Keywords: Industry 5.0, Human-Cantered Automation, Artificial Intelligence, Collaborative Robots, Internet of Things, Digital Twins, Explainable AI, Smart Manufacturing, Human-Machine Collaboration, Sustainable Industry

Autonomous Quality Inspection Using Computer Vision and Deep Learning

Dr. Aditya Nair[1], Priyanka Bose[2], Dr. Rohit Sharma[3]

[1]Professor, Department of Electronics Engineering, Indian Institute of Technology BHU, Varanasi, India
[2]Research Associate, Department of Computer Vision, Vellore Institute of Technology, Vellore, India
[3]Principal Engineer, Qualcomm India Pvt. Ltd., Hyderabad, India

Abstract: Quality inspection is a critical component of modern manufacturing that directly influences product reliability, customer satisfaction, and operational efficiency. Conventional inspection methods often rely on manual evaluation, which can be time-consuming, inconsistent, and prone to human error. Recent advances in computer vision and deep learning have enabled the development of autonomous quality inspection systems capable of performing accurate, real-time defect detection and product classification. This paper explores intelligent quality inspection frameworks that integrate computer vision, deep learning, Industrial Internet of Things (IoT), edge computing, and robotics for automated manufacturing environments. The proposed framework utilizes convolutional neural networks (CNNs), vision transformers (Vitus), object detection algorithms, and image segmentation techniques to identify manufacturing defects, surface irregularities, dimensional deviations, and assembly errors with high precision. The study investigates applications across automotive manufacturing, electronics production, pharmaceutical industries, food processing, textile manufacturing, and semiconductor fabrication. Furthermore, digital twins and predictive analytics are incorporated to enable continuous quality improvement and process optimization. Critical challenges including limited training datasets, varying lighting conditions, computational complexity, explain ability, cybersecurity, and system scalability are comprehensively analyzed. A conceptual architecture combining AI-powered vision systems, edge intelligence, robotic inspection platforms, and cloud-based analytics is proposed to enhance manufacturing quality and operational efficiency. The findings demonstrate that autonomous quality inspection significantly improves detection accuracy, reduces production costs, minimizes defective products, and supports sustainable manufacturing practices. Future research should focus on multimodal inspection systems, self-supervised learning, explainable AI, and real-time adaptive vision technologies to enable next-generation intelligent manufacturing systems.

Keywords: Computer Vision, Deep Learning, Autonomous Inspection, Quality Control, Industrial Internet of Things, Convolutional Neural Networks, Edge Computing, Smart Manufacturing, Artificial Intelligence, Defect

Quantum Artificial Intelligence for Future Intelligent Computing Systems

Dr. Gautham Krishna[1], Nisha Thomas[2]

[1]Associate Professor, Department of Quantum Computing, Indian Institute of Technology Bombay, Mumbai, India
[2]Research Scholar, Department of Computer Science, Indian Institute of Science, Bengaluru, India

Abstract: The convergence of quantum computing and Artificial Intelligence (AI) has introduced a new paradigm known as Quantum Artificial Intelligence (Quantum AI), which has the potential to revolutionize intelligent computing systems by solving complex computational problems beyond the capabilities of classical computers. Quantum AI combines quantum algorithms, machine learning, and advanced optimization techniques to accelerate data processing, improve predictive analytics, and enhance decision-making across scientific and engineering domains. This paper explores the principles, architectures, and applications of Quantum AI for future intelligent computing systems. The proposed framework integrates quantum machine learning, quantum neural networks, cloud-based quantum computing platforms, and hybrid quantum-classical algorithms to improve computational efficiency in optimization, cryptography, drug discovery, financial modeling, climate simulation, and intelligent robotics. The study examines the role of quantum computing in accelerating deep learning model training, solving large-scale optimization problems, and supporting real-time intelligent analytics. Additionally, the paper discusses the integration of Quantum AI with the Internet of Things (IoT), edge computing, digital twins, and cybersecurity to develop highly efficient and secure intelligent systems. Critical challenges, including quantum hardware limitations, error correction, scalability, algorithm complexity, security concerns, and workforce readiness, are thoroughly analyzed. A comprehensive conceptual framework combining quantum computing, explainable AI, sustainable computing, and hybrid intelligence is proposed to support the next generation of intelligent technologies. The findings indicate that Quantum AI has the potential to dramatically improve computational speed, optimize complex engineering processes, strengthen cybersecurity, and accelerate scientific innovation. Future research should focus on fault-tolerant quantum architectures, scalable quantum machine learning algorithms, quantum-safe security mechanisms, and practical industrial applications to realize the full potential of Quantum AI.

Keywords: Quantum Artificial Intelligence, Quantum Computing, Quantum Machine Learning, Hybrid Intelligence, Deep Learning, Intelligent Computing, Optimization, Cybersecurity, Internet of Things, Sustainable Computing

Met averse-Enabled Smart Education Using AI, IoT, and Extended Reality

Dr. Mahesh Iyer[1], Pavan Kumar[2], Dr. Swetha R[3]

[1]Professor, Department of Educational Technology, Indian Institute of Technology Madras, Chennai, India
[2]Research Scholar, Department of Artificial Intelligence, Amrita Vishwa Vidyapeetham, Coimbatore, India
[3]Senior XR Research Engineer, Tata Elxsi Ltd., Bengaluru, India

Abstract: The rapid evolution of digital technologies has transformed traditional education into immersive, interactive, and learner-cantered environments. The Met averse, supported by Artificial Intelligence (AI), the Internet of Things (IoT), and Extended Reality (XR), offers a next-generation educational ecosystem where learners and educators can collaborate within persistent virtual environments. This paper explores the design and implementation of Met averse-enabled smart education systems that integrate virtual reality (VR), augmented reality (AR), mixed reality (MR), AI-driven learning analytics, and IoT-based smart classrooms to enhance teaching and learning experiences. The proposed framework utilizes AI for personalized learning, intelligent tutoring, adaptive assessment, and automated feedback, while IoT devices monitor classroom environments and learner engagement in real time. Extended Reality technologies provide immersive virtual laboratories, engineering simulations, collaborative learning spaces, and practical skill development without geographical constraints. Cloud and edge computing infrastructures support low-latency communication, scalable content delivery, and seamless user interaction across educational platforms. The study also examines the integration of block chain technology for secure academic credential management and digital identity verification. Critical challenges, including accessibility, cybersecurity, privacy protection, interoperability, digital equity, infrastructure costs, and ethical concerns, are comprehensively analyzed. A conceptual framework combining AI, IoT, XR, block chain, and cloud computing is proposed to establish intelligent, inclusive, and sustainable educational ecosystems. The findings demonstrate that Met averse-enabled smart education improves learner engagement, knowledge retention, collaborative learning, and practical skill acquisition while supporting personalized and lifelong learning. Future research should focus on AI-driven virtual mentors, emotion-aware learning systems, 6G-enabled immersive education, and standardized Met averse architectures to advance intelligent educational technologies and prepare learners for future digital societies.

Keywords: Met averse, Artificial Intelligence, Internet of Things, Extended Reality, Virtual Reality, Augmented Reality, Smart Education, Intelligent Tutoring Systems, Cloud Computing, Digital Learning

Brain–Computer Interface Systems for Intelligent Human–Machine Collaboration

Dr. Arun Vishwanath[1], Divya Lakshmi[2]

[1]Associate Professor, Department of Biomedical Engineering, Indian Institute of Technology Hyderabad, India
[2]Research Scholar, Department of Neuroscience and Artificial Intelligence, Manipal Academy of Higher Education, Manipal, India

Abstract: Brain–Computer Interface (BCI) technology has emerged as a ground-breaking field that enables direct communication between the human brain and external computing systems without relying on conventional physical interaction. By integrating Artificial Intelligence (AI), machine learning, neuroscience, and advanced signal processing, BCI systems facilitate intelligent human–machine collaboration across healthcare, robotics, industrial automation, education, and assistive technologies. This paper investigates the design and application of AI-enabled Brain–Computer Interface systems for enhancing communication, decision-making, and human cognitive performance. The proposed framework combines electroencephalography (EEG)-based brain signal acquisition, deep learning algorithms, edge computing, cloud computing, and intelligent control systems to decode neural signals and translate user intentions into actionable commands. The study explores applications including neurorehabilitation, prosthetic limb control, assistive communication for individuals with disabilities, cognitive workload assessment, adaptive learning environments, collaborative robotics, and autonomous vehicle interaction. Explainable AI techniques are incorporated to improve transparency and reliability in neural signal interpretation, while block chain technology is considered for secure management of sensitive neural data. Critical challenges such as signal noise, data privacy, ethical concerns, computational complexity, user adaptation, scalability, and regulatory compliance are thoroughly examined. A comprehensive framework integrating AI, BCI, IoT, digital twins, and intelligent analytics is proposed to support secure, adaptive, and efficient human–machine collaboration. The findings demonstrate that AI-powered Brain–Computer Interface systems significantly improve accessibility, human cognitive augmentation, rehabilitation outcomes, and intelligent control capabilities. Future research should focus on non-invasive high-precision BCI technologies, multimodal neural interfaces, quantum-enhanced signal processing, and responsible AI governance to enable the next generation of intelligent human-cantered computing systems.

Keywords: Brain–Computer Interface, Artificial Intelligence, Human–Machine Collaboration, Electroencephalography, Machine Learning, Deep Learning, Neural Signal Processing, Intelligent Robotics, Explainable AI, Assistive Technologies