

Editorial

## Trustworthy intelligence, sustainable systems, and resilient digital infrastructure for an AI-driven future

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ABSTRACT

This editorial introduces Volume 42, Number 2, May 2026 of the Indonesian Journal of Electrical Engineering and Computer Science (IJECS), which presents a broad collection of peer-reviewed research contributions spanning electrical engineering, electronics, computer science, artificial intelligence, cybersecurity, and information and communication technologies. The issue highlights the growing convergence of intelligent systems, sustainable engineering, trusted digital infrastructures, and data-centric innovation in addressing contemporary global challenges. The published articles demonstrate advances in renewable energy technologies, intelligent control systems, AI-enabled healthcare, cybersecurity, graph-based learning, Internet of Things (IoT) architectures, smart agriculture, educational technologies, and uncertainty-aware data management. Collectively, these contributions emphasize the importance of integrating intelligence, resilience, sustainability, and ethical considerations into next-generation engineering solutions. The issue further reflects emerging research directions focused on trustworthy artificial intelligence, secure cyber-physical systems, resource-efficient computing, and human-centered digital transformation. Through interdisciplinary innovation and practical implementation, the published works contribute to advancing technological systems capable of supporting sustainable development, economic growth, and societal well-being in an increasingly connected world.

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The IJECS, Volume 42, Number 2, May 2026, presents a diverse and forward-looking collection of research articles that reflect the continuing transformation of engineering and computing disciplines in the era

of intelligent digital systems. The contributions published in this issue illustrate how advances in artificial intelligence, sustainable energy technologies, cybersecurity, data science, and smart infrastructures are reshaping modern engineering practice and creating new opportunities for societal impact. A defining characteristic of this issue is the increasing integration of intelligent decision-making capabilities into physical, cyber, and socio-technical systems. Across multiple application domains, researchers are leveraging machine learning, deep learning, graph-based reasoning, optimization methods, and intelligent sensing technologies to improve efficiency, reliability, security, and sustainability. The resulting body of work demonstrates the growing maturity of interdisciplinary approaches that bridge traditional engineering disciplines with emerging computational paradigms.

### **The convergence of intelligence, sustainability, and resilience**

One of the defining characteristics of contemporary engineering research is the convergence of intelligence, sustainability, and resilience as complementary design objectives. Historically, electrical engineering, computer science, and information and communication technologies evolved as relatively distinct disciplines, each addressing specific technical challenges within its own domain. Today, however, advances in sensing, computation, communication, and automation are creating highly interconnected cyber-physical ecosystems in which technical performance must be balanced with sustainability, security, trustworthiness, and societal impact. This convergence is reshaping the way engineers design, deploy, and manage technological systems, requiring multidisciplinary approaches that integrate physical infrastructure, digital intelligence, and human-centered considerations.

Artificial intelligence is emerging as a foundational enabling technology within this transformation. Beyond its traditional role in automation and data analysis, AI is increasingly embedded in energy systems, healthcare platforms, industrial processes, communication networks, and educational environments. The ability of intelligent algorithms to extract insights from large volumes of heterogeneous data is enabling more adaptive, predictive, and autonomous forms of operation. At the same time, the widespread deployment of AI is raising important questions regarding transparency, fairness, accountability, privacy, and security. Consequently, contemporary engineering research is placing growing emphasis on trustworthy intelligence, where technical performance is evaluated alongside ethical responsibility, interpretability, and societal acceptance.

Sustainability has likewise evolved from a specialized concern into a fundamental engineering requirement. The growing urgency of climate change, resource constraints, and environmental degradation is motivating the development of technologies capable of supporting long-term economic growth while minimizing ecological impact. Renewable energy integration, intelligent resource management, sustainable manufacturing, precision agriculture, and energy-efficient computing are increasingly interconnected components of broader sustainability strategies. Advances in digital technologies are playing a critical role in this transition by enabling real-time monitoring, predictive optimization, and evidence-based decision-making across complex systems. As a result, sustainability is no longer viewed solely through environmental metrics but increasingly through the broader lens of resilience, efficiency, and responsible technological innovation.

Equally important is the concept of resilience, which has become a defining requirement for modern digital infrastructures and cyber-physical systems. The increasing dependence of societies on interconnected networks, cloud services, intelligent devices, and autonomous systems has created new vulnerabilities to cyberattacks, operational disruptions, misinformation, and systemic failures. Resilient systems must therefore be capable not only of preventing failures but also of adapting, recovering, and continuing operation under uncertain and rapidly changing conditions. Achieving such resilience requires the integration of cybersecurity, fault tolerance, intelligent monitoring, risk assessment, and adaptive control mechanisms throughout the system lifecycle.

The research contributions presented in this issue collectively reflect these converging priorities. Across diverse application domains, the published works demonstrate how intelligent algorithms, advanced sensing technologies, secure communication frameworks, and data-driven decision-support systems can be combined to address contemporary challenges in energy, healthcare, agriculture, education, and digital infrastructure. Although the specific applications vary considerably, a common objective unites many of the studies: the development of systems that are not only more intelligent, but also more sustainable, trustworthy, and resilient. This shared vision represents an important direction for future engineering research, where innovation is increasingly evaluated not only by technical capability but also by its capacity to support societal well-being, environmental stewardship, and long-term technological sustainability.

Viewed collectively, the articles in this issue provide a valuable snapshot of an ongoing transformation across engineering and computing disciplines. The future will likely be shaped by systems that seamlessly integrate artificial intelligence, secure connectivity, advanced analytics, and sustainable design principles into unified technological ecosystems. As these systems become more autonomous, interconnected, and influential

in everyday life, ensuring their trustworthiness, resilience, and alignment with human values will remain among the most important challenges facing researchers, practitioners, and policymakers in the coming decade.

### **Renewable energy, energy storage, and intelligent power systems**

The transition toward sustainable energy systems remains one of the most significant engineering challenges of the twenty-first century. Several articles in this issue address critical aspects of renewable energy adoption, intelligent power management, and energy system resilience. Contributions examining renewable energy technologies and energy-transition challenges provide valuable perspectives on the technical, economic, and geopolitical factors shaping the global shift toward low-carbon energy infrastructures. Beyond generation technologies, these studies emphasize the growing importance of energy storage, grid flexibility, and intelligent energy management in overcoming the intermittency and variability associated with renewable resources. As countries seek to achieve carbon neutrality and strengthen energy security, the integration of advanced forecasting, storage technologies, and digital energy platforms is becoming increasingly essential.

Research on solar-powered cable-driven robotic systems demonstrates how intelligent control methodologies can improve operational reliability under fluctuating renewable energy availability. Additional studies focusing on ferroresonance mitigation in power transformers, advanced battery charging strategies using neuro-fuzzy intelligence, and electricity load forecasting through meta-stacking deep learning architectures further illustrate the role of intelligent analytics and adaptive control in modern power systems. The incorporation of artificial intelligence into battery management and demand forecasting reflects a broader trend toward data-driven optimization of energy assets, enabling more efficient utilization of resources while enhancing system stability. Together, these works highlight the importance of combining renewable energy technologies with advanced monitoring, forecasting, and control mechanisms to support stable, efficient, and resilient energy ecosystems. They further demonstrate how the convergence of power engineering, intelligent control, and machine learning is contributing to the development of next-generation smart grids capable of supporting large-scale renewable integration and sustainable energy transitions.

### **Artificial intelligence for healthcare and biomedical engineering**

Healthcare continues to emerge as one of the most impactful application domains for artificial intelligence and intelligent sensing technologies. This issue includes several contributions that apply advanced machine learning and deep learning techniques to medical diagnosis, disease prediction, and biomedical instrumentation. These studies reflect the ongoing transformation of healthcare from reactive treatment toward predictive, preventive, and data-driven care, where intelligent systems assist clinicians in identifying risks, improving diagnostic precision, and supporting timely interventions. As healthcare data become increasingly multimodal and complex, AI-based approaches are playing an essential role in extracting clinically relevant insights from medical images, physiological signals, and patient records.

Studies on breast cancer detection using thermal imaging and convolutional neural networks demonstrate the growing effectiveness of AI-assisted diagnostic systems. Complementary research on microstrip antenna design for medical imaging applications highlights ongoing innovation in biomedical hardware technologies, where advances in sensing and electromagnetic imaging can enhance non-invasive diagnostic capabilities. Furthermore, deep learning models for diabetes prediction showcase the potential of context-aware neural architectures to support clinical decision-making and early intervention strategies. Together, these contributions illustrate how the integration of intelligent algorithms with advanced sensing technologies can facilitate more accurate, efficient, and accessible healthcare services, particularly in resource-constrained environments where early screening and automated decision support are critically needed.

Collectively, these contributions illustrate how the convergence of artificial intelligence, sensing technologies, and biomedical engineering can improve healthcare accessibility, diagnostic accuracy, and patient outcomes. They also reflect broader trends toward personalized medicine, remote health monitoring, and intelligent clinical support systems that leverage data-driven insights to deliver more targeted and adaptive healthcare solutions. As healthcare systems increasingly adopt digital technologies, ensuring transparency, robustness, clinical trustworthiness, and regulatory compliance will remain critical research priorities. Future advances are expected to focus not only on improving predictive performance but also on developing explainable, secure, and human-centered AI systems that can be safely integrated into real-world clinical workflows while maintaining patient privacy, ethical accountability, and public trust.

### **Trustworthy artificial intelligence and intelligent data analytics**

Artificial intelligence is evolving beyond predictive accuracy toward broader concerns involving explainability, fairness, accountability, and responsible deployment. Several contributions in this issue address these emerging dimensions of trustworthy AI. As AI systems increasingly influence decisions in healthcare, finance, education, public services, and digital platforms, ensuring that such systems operate transparently and equitably has become a central research priority. Contemporary AI research is therefore placing greater

emphasis on understanding not only what predictions models produce, but also how those predictions are generated, how they affect different user groups, and how uncertainty can be appropriately managed in real-world decision-making environments.

Research on hybrid large language model and graph neural network architectures for Arabic sentiment analysis demonstrates how contextual language understanding can be enhanced through relational reasoning. Studies investigating fairness dynamics in graph neural networks provide important insights into the trade-offs between predictive performance and equitable decision-making in socially sensitive applications. Additional works on sentiment analysis across multiple languages, feminist discourse analysis, report consolidation using natural language processing, and advanced machine learning for anomaly detection illustrate the expanding role of intelligent analytics in extracting actionable knowledge from increasingly complex data environments. Notably, several contributions address challenges associated with multilingual and low-resource language settings, highlighting the growing need for inclusive AI technologies that can serve diverse linguistic and cultural communities while reducing algorithmic bias and representation gaps.

These studies collectively underscore the need for AI systems that are not only accurate but also transparent, fair, interpretable, and aligned with societal expectations. They further reflect a broader shift toward human-centered artificial intelligence, where trust, accountability, and ethical considerations are integrated into the design and deployment process from the outset. As large language models, graph-based learning, and advanced analytics continue to influence decision-making processes across sectors, research on responsible and trustworthy AI will become increasingly essential. Future developments are expected to focus on explainable foundation models, fairness-aware learning algorithms, uncertainty-aware decision support systems, and governance frameworks that ensure AI technologies remain reliable, auditable, and beneficial to society while preserving privacy, security, and public trust.

### **Cybersecurity, privacy, and resilient digital infrastructures**

As digital transformation accelerates, cybersecurity has become a foundational requirement for modern information systems and critical infrastructures. This issue presents several contributions that address emerging security challenges across IoT environments, enterprise systems, and cyber-physical networks. The increasing convergence of operational technologies, cloud computing, edge intelligence, and connected devices has expanded the attack surface of digital ecosystems, making cybersecurity a strategic concern that extends beyond technical protection to encompass operational resilience, privacy preservation, and risk management. As organizations become increasingly dependent on digital services, ensuring the security and continuity of critical infrastructures is essential for maintaining trust, reliability, and societal stability.

Research on IPv6-enabled IoT security introduces innovative approaches to address generation and privacy preservation, while studies on lightweight cryptographic frameworks and blockchain-enabled IoT architectures explore security solutions tailored to resource-constrained devices. Additional contributions focus on security operations center optimization, network anomaly detection under imbalanced traffic conditions, and cybersecurity awareness among university students. Collectively, these studies highlight the importance of combining advanced cryptographic methods, intelligent threat detection, and human-centered security practices to address evolving cyber risks. The emphasis on lightweight and scalable security mechanisms is particularly significant as billions of connected devices continue to be deployed in smart cities, industrial systems, healthcare platforms, and critical infrastructure environments.

Together, these works reflect a broader transition toward adaptive, intelligence-driven cybersecurity strategies capable of protecting increasingly interconnected systems. They also reinforce emerging security paradigms such as security-by-design, zero-trust architectures, continuous monitoring, and proactive threat intelligence, where protection mechanisms are integrated throughout the system lifecycle rather than applied as afterthoughts. Future digital infrastructures will require security mechanisms that are scalable, privacy-preserving, resilient against evolving threats, and capable of responding dynamically to sophisticated attacks. As artificial intelligence becomes more deeply embedded in both defensive and adversarial cyber operations, developing trustworthy, explainable, and resilient cybersecurity solutions will remain a critical priority for safeguarding next-generation digital ecosystems and cyber-physical infrastructures.

### **Smart IoT systems, agriculture, and sustainable digital transformation**

The integration of sensing, connectivity, and intelligence continues to drive innovation across smart environments and sustainable development initiatives. This issue highlights several examples of how IoT technologies are being applied to address real-world challenges in agriculture, education, and infrastructure management. The increasing availability of low-cost sensors, edge computing platforms, and intelligent analytics is enabling the deployment of interconnected systems capable of monitoring physical environments in real time, supporting data-driven decision-making, and improving operational efficiency across diverse application domains. As societies face growing pressures related to resource constraints, environmental

sustainability, and food security, IoT-enabled solutions are becoming increasingly important for enhancing productivity while minimizing ecological impact.

Contributions on AIoT-based greenhouse irrigation systems demonstrate how intelligent monitoring and automated control can improve water efficiency and agricultural productivity. Research on pomelo maturity classification and beef spoilage assessment illustrates the growing adoption of computer vision, machine learning, and electronic sensing technologies in precision agriculture and food quality assurance. These studies highlight how advanced sensing and intelligent analytics can facilitate more accurate assessment of crop conditions, product quality, and resource requirements, enabling timely interventions and more informed decision-making throughout agricultural and food supply chains. Such capabilities are particularly valuable in addressing challenges associated with climate variability, water scarcity, and the increasing demand for sustainable and resilient food production systems.

In parallel, studies addressing localization in wireless sensor networks and scalable IoT architectures emphasize the importance of efficient communication and sensing frameworks for future smart environments. Reliable localization, low-power communication, secure data exchange, and scalable system architectures remain fundamental requirements for supporting large-scale deployments of distributed sensors and connected devices. These works collectively support the development of sustainable, data-driven ecosystems capable of improving resource utilization, operational efficiency, and environmental stewardship. They further reflect the broader evolution toward intelligent edge-enabled systems in which sensing, computation, and decision-making are increasingly performed closer to data sources, reducing latency and improving responsiveness. Looking ahead, the continued convergence of IoT, artificial intelligence, and advanced analytics is expected to accelerate the development of adaptive smart environments capable of optimizing resource consumption, strengthening resilience, and supporting sustainable digital transformation across agricultural, industrial, and urban sectors.

#### **Digital education, remote experimentation, and human-centered technologies**

The continued evolution of digital education technologies remains an important area of innovation. This issue includes contributions that advance remote experimentation platforms, adaptive e-learning systems, and intelligent educational management solutions. As educational institutions increasingly embrace digital transformation, there is a growing need for learning environments that are accessible, flexible, scalable, and capable of supporting diverse learner needs. Emerging technologies such as artificial intelligence, learning analytics, and cloud-based educational platforms are enabling more personalized and data-informed learning experiences while expanding educational opportunities beyond the constraints of traditional classrooms and laboratories.

The development of low-cost online laboratory platforms based on Raspberry Pi technology demonstrates practical approaches for expanding access to experimental learning opportunities. Complementary studies on adaptive student behavior modeling and digital application management systems further illustrate how artificial intelligence and data analytics can enhance educational effectiveness, administrative efficiency, and learner engagement. The integration of behavioral modeling, intelligent tutoring mechanisms, and adaptive learning strategies reflects a broader movement toward personalized education, where instructional content and learning pathways can be dynamically adjusted according to individual learner characteristics and performance. At the same time, digital management platforms contribute to more efficient institutional operations by streamlining workflows, improving information accessibility, and supporting evidence-based decision-making.

These contributions reinforce the importance of human-centered technology design in ensuring that digital transformation delivers meaningful benefits across educational institutions and learning communities. They also highlight the growing role of intelligent educational ecosystems that combine accessibility, adaptability, and user-centered design principles to support lifelong learning and digital inclusion. Looking ahead, advances in artificial intelligence, immersive learning technologies, and adaptive educational systems are expected to further transform teaching and learning practices, creating more engaging, equitable, and responsive educational environments for diverse populations.

#### **Data management, uncertainty modeling, and future computing paradigms**

Managing uncertainty and complexity in modern information systems remains a significant challenge. This issue includes contributions that extend relational database theory through interval probability models, enabling richer representation of uncertain information and supporting more sophisticated decision-making processes. As digital systems increasingly operate in environments characterized by incomplete, noisy, and heterogeneous data, the ability to formally model uncertainty becomes essential for maintaining the reliability and interpretability of computational outcomes. Such capabilities are particularly important in domains where decisions must be made despite ambiguity, evolving information, or conflicting data sources.

Such advances are increasingly relevant as organizations rely on heterogeneous data sources, intelligent analytics, and autonomous systems operating under uncertainty. Alongside developments in graph learning, natural language processing, and large-scale information management, these studies point toward future computing paradigms that emphasize adaptability, contextual reasoning, and probabilistic intelligence. The growing integration of machine learning, knowledge representation, and uncertainty-aware data management is enabling information systems to move beyond deterministic processing toward more flexible and resilient forms of reasoning. As data volumes continue to expand and decision environments become increasingly complex, future computing systems will likely place greater emphasis on explainability, context awareness, and robust handling of uncertainty, supporting more trustworthy and intelligent digital ecosystems across scientific, industrial, and societal applications.

### **Emerging priorities in electrical engineering and computer science for the next decade**

The research contributions presented in this issue collectively illustrate a broader transformation occurring across electrical engineering, computer science, and information and communication technologies. While addressing diverse technical challenges, the published studies reveal several priorities that are likely to shape research and innovation over the next decade. Among these priorities, the development of sustainable and intelligent energy ecosystems remains particularly important. The integration of renewable energy resources, energy storage technologies, and smart grid infrastructures will increasingly rely on advanced forecasting, adaptive control, and intelligent analytics to improve efficiency, reliability, and resilience. At the same time, the growing adoption of digital technologies across critical sectors is creating unprecedented opportunities for innovation while reinforcing the need for sustainability and long-term system resilience.

Another major priority involves the advancement of trustworthy artificial intelligence and resilient digital infrastructures. As AI systems become more deeply embedded in healthcare, education, industry, and public services, concerns regarding explainability, fairness, privacy, accountability, and security will continue to grow. The rapid emergence of foundation models, generative AI, and autonomous intelligent systems offers significant opportunities for improving decision-making and operational efficiency, while simultaneously introducing important ethical and regulatory challenges. In parallel, the continued expansion of cloud services, IoT ecosystems, and cyber-physical systems has increased the complexity and vulnerability of modern digital environments, highlighting the importance of adaptive cybersecurity mechanisms, privacy-preserving technologies, and resilient infrastructure design.

The convergence of IoT technologies, edge computing, artificial intelligence, and advanced sensing systems will further accelerate the development of intelligent cyber-physical environments across agriculture, healthcare, manufacturing, transportation, and smart cities. Equally important is the need to ensure that technological progress remains human-centered and inclusive, balancing technical innovation with accessibility, usability, and societal well-being. Taken together, these priorities suggest that the future of electrical engineering and computer science will be defined not by isolated technological breakthroughs but by the successful integration of intelligence, sustainability, resilience, and responsible innovation. The studies presented in this issue provide valuable examples of how researchers are addressing these interconnected challenges and contribute to the development of technologies capable of supporting a more sustainable, secure, and digitally connected future.

### **Conclusion and SDG-Oriented Outlook**

The articles published in this issue demonstrate how advances in electrical engineering, computer science, and information and communication technologies are increasingly contributing to sustainable development and societal resilience. Collectively, the contributions highlight the growing convergence of intelligent systems, sustainable engineering, secure digital infrastructures, and data-driven innovation in addressing challenges across energy, healthcare, agriculture, education, and industry. Through their contributions to clean energy, health and well-being, quality education, sustainable infrastructure, responsible resource utilization, and resilient institutions, these studies illustrate how technological innovation can support both economic development and societal progress while advancing several United Nations Sustainable Development Goals (SDGs).

Looking ahead, the future of electrical engineering and computer science will be increasingly shaped by the integration of artificial intelligence, intelligent sensing, secure connectivity, and sustainable system design. As emerging technologies become more autonomous, interconnected, and influential in everyday life, ensuring their trustworthiness, resilience, security, and alignment with human values will remain a central challenge. Addressing these challenges will require interdisciplinary collaboration, responsible innovation, and a long-term commitment to developing technologies that serve both society and the environment. Through the dissemination of high-quality and impactful research, IJEECS remains committed to advancing knowledge and innovation that contribute to a more intelligent, sustainable, secure, and inclusive digital future.