

Advancements in Future Information and Communication Engineering 2024

Yun Seop Yu ^{1,*} , Hee-Cheol Kim ² , Kwang-Baek Kim ³ , Dongsik Jo ⁴  and Jongtae Lee ⁵ 

¹ Major of ICT & Robotics Engineering, Major of Semiconductor Convergence Engineering, AISPC Laboratory, and IITC, Hankyong National University, Anseong 17579, Republic of Korea

² Institute of Digital Anti-Aging Healthcare, Inje University, Gimhae 50834, Republic of Korea; heeki@inje.ac.kr

³ Department of Artificial Intelligence, Silla University, Busan 46958, Republic of Korea; gbkim@silla.ac.kr

⁴ School of IT Convergence, University of Ulsan, Ulsan 44610, Republic of Korea; dongsikjo@ulsan.ac.kr

⁵ Department of Business Administration, Seoul Women's University, Seoul 01797, Republic of Korea; light4u@swu.ac.kr

* Correspondence: ysyu@hknu.ac.kr

1. Introduction

The field of information and communication engineering is undergoing a transformative evolution, driven by rapid advancements in artificial intelligence (AI), machine learning (ML), the Internet of Things (IoT), communication networks, and digital convergence technologies [1–3]. These innovations are no longer confined to academic exploration—they are now essential tools for addressing complex societal challenges. From urban congestion due to increasing traffic volumes to the limitations of global positioning systems (GPS) in indoor environments and the need for intelligent quality control in manufacturing processes, AI-powered solutions are increasingly in demand across various sectors.

In agriculture, labor shortages and inefficiencies necessitate smart automation. In education, there is an urgent need to deliver personalized learning experiences and foster intercultural communication. Meanwhile, in healthcare, ensuring the transparency and reliability of AI-based diagnostic models remains a critical concern. In response, research areas such as adaptive learning for AI agents in virtual environments (e.g., the metaverse), reinforcement learning for autonomous decision-making, and the integration of large language models (LLMs) are gaining prominence. Furthermore, optimization techniques aimed at improving the timeliness and reliability of communication in IoT networks are becoming foundational components of smart city infrastructure.

This Special Issue, titled Future Information and Communication Engineering 2024, brings together cutting-edge research from the fields of computer science and information and communication engineering. Featuring outstanding papers selected from the 16th International Conference on Future Information and Communication Engineering (IC-FICE) 2024—held at the Promenade Hotel Kota Kinabalu, Malaysia, from 11 to 13 January 2024—this collection offers deep insights into the application domains, methodologies, achievements, challenges, and future directions of the technologies shaping our world.

The Special Issue includes 10 regular papers and 2 review papers, focusing on a diverse range of areas: communication systems and applications, networking and services, intelligent information systems, multimedia and digital convergence, semiconductor and communication services, biomedical imaging and engineering, ubiquitous sensor networks, databases and internet applications, IoT and big data, and information technology (IT) and convergence technologies. Of the 22 papers submitted, 12 were accepted, reflecting a 54.5% acceptance rate. The selected papers are categorized into five thematic areas: review papers,



Received: 18 August 2025

Accepted: 21 August 2025

Published: 25 August 2025

Citation: Yu, Y.S.; Kim, H.-C.; Kim, K.-B.; Jo, D.; Lee, J. Advancements in Future Information and Communication Engineering 2024. *Appl. Sci.* **2025**, *15*, 9314. <https://doi.org/10.3390/app15179314>

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computer vision and intelligent systems, communication and localization technologies, healthcare and education, and AI and agent-based systems.

2. An Overview of Published Articles

The Special Issue begins with two comprehensive review papers. The first explored traffic flow prediction methods in intelligent transportation systems, classifying them into statistical, machine learning, and deep learning approaches (Contribution 1). The authors concluded that deep learning models demonstrated superior capabilities in modeling complex nonlinear relationships, significantly improving prediction accuracy and generalization. The second review focused on two-dimensional human pose estimation using deep learning. It presented a detailed analysis of task types, output strategies, and architectural designs, while identifying future research directions such as model compression and occlusion handling (Contribution 2).

The ten original research papers are grouped into four thematic categories: computer vision and intelligent systems, communication and localization technologies, healthcare and education, and AI and agent-based systems.

In the realm of computer vision and intelligent systems, one study presented a high-speed defect detection system for printed circuit boards (PCBs) using a line scan camera and real-time detection transformer (RT-DETR) deep learning model, achieving an impressive 99.5% accuracy in experiments, proving highly beneficial for precision quality management in small and medium-sized manufacturing enterprises (Contribution 3). Another proposed an AI-based smart monitoring framework for livestock farms, implementing deep learning-based intelligent monitoring to detect cattle lesions and inactive individuals (Contribution 4). By applying the RT-DETR method, the research demonstrated higher detection performance compared to traditional YOLO models, enhancing livestock management efficiency and productivity. A third contribution introduced CGADNet, a visual neural network derived from YOLOv8, designed for real-time detection of crosswalks and directional arrows in autonomous driving. It achieved a 4.1% improvement in mAP and 50.35 frames-per-second (FPS) on Jetson Orin Nano, thanks to novel modules like C2f_Van and FasterDetect (Contribution 5).

Advancements in communication and localization technologies were also well represented. One article investigated a comprehensive algorithm that combines radio measurements from Bluetooth Angle-of-Arrival (AoA) local navigation systems with indoor position estimates using particle filtering. This approach aimed to reduce estimation errors caused by multipath and non-line-of-sight (NLOS) propagation, demonstrating an average improvement in positioning accuracy of approximately 25.7% (Contribution 6). Another proposed an indoor user positioning method based on Visible Light Communication (VLC) that integrates fingerprinting with a double deep Q-Network. The simulation results showed that the proposed scheme achieved a positioning resolution of less than 13 cm and a processing time of less than 0.03 s, offering a precise and fast solution for indoor localization (Contribution 7). Additionally, a study on IoT networks addressed the critical issue of timely status updates in two-hop IoT networks by minimizing the Average Peak Age of Information (PAoI). The study jointly optimized the number of status packets for joint coding at the sink node, and the blocklengths of packets in both hops, demonstrating an approximate 8% reduction in average PAoI compared to existing methods, especially under poor wireless channel conditions (Contribution 8).

In healthcare and education, one paper addressed the early detection challenges of Alzheimer's disease (AD) using explainable AI (XAI) techniques applied to brain Magnetic Resonance Imaging (MRI) scans (Contribution 9). The model achieved 85% accuracy, effectively distinguishing between the three classes: normal cognition (NC), mild cogni-

tive impairment (MCI), and AD. It provided transparent insights into its decision-making process, particularly highlighting changes near the hippocampus for MCI. Another paper presented the Cross-Cultural Intelligent Language Learning System (CILS), an AI-driven approach to enhance cross-cultural communication through adaptive, personalized language learning experiences. Implemented on platforms such as Busuu and HelloTalk, CILS demonstrated marked improvements in linguistic proficiency and cultural understanding (Contribution 10).

Finally, in the category of AI and agent-based systems, one paper investigated the adaptability of AI agents in the Metaverse through the proposed Adaptive Learning Model for AI Agents (ALMAA) framework. The research analyzed how existing platforms align with adaptive learning principles, highlighting improvements in user interaction efficiency, contextual decision accuracy, and predictive engagement strategies in dynamic virtual environments (Contribution 11). Another method to optimize agent behavior in the Mini-Grid environment using LLMs for reinforcement learning was proposed (Contribution 12). Experimental results confirmed that LLM-based agents can effectively achieve their goals, demonstrating the potential for developing more intelligent and adaptable AI systems by maximizing the synergy between LLMs and reinforcement learning.

3. Conclusions

The papers featured in this Special Issue clearly demonstrated the transformative impact of AI and information communication technologies on solving real-world problems. From enhancing real-time detection in autonomous systems to optimizing industrial processes, improving healthcare diagnostics, and revolutionizing language education, these studies reflected a shared commitment to developing intelligent, efficient, and trustworthy solutions.

Key recurring themes include the development of lightweight, real-time AI models for resource-constrained environments, the integration of explainable AI for greater transparency, and the creation of adaptive, hybrid systems that harness diverse AI paradigms. Despite notable progress, challenges such as data acquisition, model generalization, computational demands, and ethical concerns remain active areas for research.

This collection underscores the dynamic and interdisciplinary nature of the field, paving the way for continued innovation and broad societal impact.

Author Contributions: Y.S.Y.: writing—original draft preparation; H.-C.K., K.-B.K., D.J. and J.L.: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: We would like to thank you for your sincere support from the Korea Institute of Information and Communication Engineering (KIICE) [4] for the success of this Special Issue of the ICFICE 2024.

Conflicts of Interest: The authors declare no conflicts of interest.

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