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Guest Editorial: Deep Learning Techniques in Intelligent Internet of Things and 5G Communication Networks

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In the rapidly evolving digital transformation landscape, the synergy between Deep Learning (DL), the Internet of Things (IoT), and 5G communication networks heralds a new era of technological innovation. This guest editorial delves into the pivotal role of DL in enhancing the capabilities of IoT ecosystems and the performance of 5G networks, thereby paving the way for a more intelligent, more connected world. The advent of IoT has brought about a paradigm shift in how devices communicate, collect, and process data. With billions of connected devices generating vast data, DL techniques are adept at handling and interpreting the complexity and volume of IoT data, enabling advanced analytics, decision-making, and automation. In the context of IoT, DL facilitates the realization of truly intelligent systems. The integration of IoT with 5G communication networks further amplifies these benefits. 5G, known for its high speed, low latency, and massive connectivity, is a perfect match for the IoT, providing the necessary infrastructure for seamless data transmission. DL algorithms enhance 5G network management by optimizing resource allocation, improving network security, and facilitating the efficient handling of the increased data traffic by IoT devices. In conclusion, DL, IoT, and 5G convergence hold tremendous potential for transforming various industries. As we stand on the brink of this technological revolution, it is imperative to navigate the associated challenges wisely, ensuring that the benefits of these advanced technologies are realized securely and efficiently.

This special issue received 49 submissions where the corresponding authors were majorly counted by the deadline for manuscript submission with an open call-for-paper. All these submissions are considered significant in the field, but however, only one-third of them passed the pre-screening by guest editors. The qualified papers then went through double-blinded peer review based on a strict and rigorous review policy. After a totally three-round review, 13 papers were accepted for publication. A quick overview to the papers in this issue can be revealed below, and we expect the content may draw attentions from public readers, and furthermore, prompt the society development.

The first paper, titled "Implementation of Multimedia Search & Management System Based on Remote Education," by Byeongtae Ahn, addresses the need for efficient management and retrieval of video information in remote education. Highlighting the critical role of real-time processing of compressed video data, it introduces a system leveraging MPEG-4, the leading video compression standard. The paper develops a management and search solution designed explicitly for multimedia in distance learning, emphasizing the importance of MPEG-4 compression for real-time video handling. This work contributes significantly to the field by enhancing the accessibility and effectiveness of video resources in educational environments.

The second paper, titled "Automatic Voltage Stabilization System for Substation using Deep Learning," by Jiyong Moon et al., introduces an innovative solution to automate voltage regulation, which is traditionally reliant on manual intervention and prone to inefficiencies. By employing a deep learning approach with a stacked LSTM model, the system predicts the necessary input capacity for stabilization, overcoming the uncertainties of human-based regulation and enhancing operational efficiency with economic considerations. It further optimizes regulation plans and incorporates a user interface for algorithm operation visualization and model prediction communication. Tested with real substation data, the findings reveal the system's capability to significantly improve the automation of the voltage regulation process, marking a notable advancement in power facility management.

The third paper, titled "The Effects of Process Innovation and Partnership in SCM: Focusing on the Mediating Roles," by Yoonkyo Cho et al., explores the influence of supply chain management (SCM) components on organizational performance, highlighting process innovation and partnerships as essential mediators. Analyzing responses from 193 workers in smartphone manufacturing, the study identifies the positive effects of information systems, top management support, and performance management on process innovation and the fostering of partnerships. These elements, in turn, significantly enhance both the financial and non-financial outcomes for firms. The findings suggest that bolstering process innovation and partnerships is crucial for advancing a firm's SCM efficiency, offering insights into leveraging these dynamics in the context of Industry 4.0's technological shifts.

The fourth paper, titled "Navigation Control of Autonomous Ackerman Robot Using a Lidar-sensing-based Fuzzy Controller in Unknown Environments," by Cheng-Jian Lin et al., introduces a novel lidar-sensing-based navigation control system for autonomous Ackerman robots operating in uncharted territories. Utilizing a behavioral controller, this system enables effective obstacle avoidance and goal-directed movement without reliance on global map data. A Wall-Following Fuzzy Controller's core mechanism processes lidar-derived distance measurements to adjust the robot's steering angle, ensuring safe passage through diverse settings without collisions. Additionally, a

specialized escape strategy has been incorporated to circumvent potential endless looping. Experimental validation in simulated and real-world scenarios confirms the system's proficiency in guiding Ackerman robots through unfamiliar environments, highlighting its practical utility and efficiency.

The fifth paper, titled “Application of Item Response Theory and the revised Girvan–Newman Clustering for Estimating Learning Ability in Cooperative Programming Learning,” by Wen-Chih Chang, explores an innovative approach to enhance programming education through cooperative learning. Recognizing the wide range of student abilities in comprehending complex programming concepts, this study introduces a novel grouping methodology that combines item response theory with social network analysis clustering. This method strategically groups students by their learning abilities, aiming to optimize educational outcomes. The effectiveness of this approach was empirically tested in a programming course for beginners, with results indicating significant improvements in learning achievements. This paper presents a promising direction for tailoring cooperative learning experiences better to meet the diverse needs of students in programming education.

The sixth paper titled “A Study of Identity Authentication Using Blockchain Technology in a 5G Multi-Type Network Environment,” by Jui-Hung Kao, examines the application of blockchain for identity authentication within the nuanced landscape of 5G networks. Highlighting 5G's potential for facilitating rapid digital transformation through its low latency and ability to support a multitude of connections, this study addresses the challenge of limited indoor penetration by integrating 5G with Wi-Fi 6 for enhanced mobile connectivity. The paper proposes an innovative authentication framework utilizing Mobile Edge Computing and blockchain to manage access in a 5G Local Breakout network, ensuring secure and efficient user authentication across 5G and Wi-Fi 6 networks. Real-world validation confirms the effectiveness of this approach in improving user access control and network service quality, promising advancements in mobile network security and user experience through edge computing and blockchain technologies.

The seventh paper titled “An Empirical Study on Success Factors of the Game Industry,” by Jun-Ho Lee et al., explores the dynamic growth of Korea's game industry, particularly its expansion in China and Southeast Asia. This research delves into how the interplay of management, technology, market, and industry characteristics influences the success of Korean game companies both domestically and internationally. Through empirical analysis, it identifies key factors such as cutting-edge technological advancements, managerial competencies, market trends, and industry insights as pivotal to achieving growth and global market penetration. Moreover, the study highlights the critical role of intellectual property rights in sustaining performance and facilitating market expansion. Distinguishing itself from prior work that focused mainly on the external impacts of games, this study offers a holistic view of the internal workings, market dynamics, and industry strategies, underscoring the multifaceted approach needed for game companies to thrive.

The eighth paper titled “Design of TAM-based Framework for Credibility and Trend Analysis in Sharing Economy: Behavioral Intention and User Experience on Airbnb as an Instance,” by Yenjou Wang et al., investigates the pivotal role of trust in the sharing

economy, using Airbnb as a case study. Addressing the inherent uncertainties of pre-purchase conditions in such a market, this research employs the Technology Acceptance Model to identify factors influencing consumer behavior and intentions. Through a comprehensive three-year survey and data collection from Airbnb users, the study applies Partial Least Squares-Structural Equation Modeling for hypothesis testing. It further explores the effects of user experience variations on trust and purchasing intentions via Multi-Group Analysis, revealing that Airbnb's ease of use significantly shapes consumer attitudes more than any specific platform information, thereby positively affecting overall behavioral intentions. This work underscores the importance of trust in the sharing economy and highlights the critical impact of user experience on consumer engagement and platform credibility.

The ninth paper titled "Robust Compensation with Adaptive Fuzzy Hermite Neural Networks in Synchronous Reluctance Motors," by Chao-Ting Chu et al., introduces an innovative robust compensation scheme for synchronous reluctance motors (SRMs) utilizing adaptive fuzzy Hermite neural networks (RCAFHNN). Addressing the challenges posed by parameter variations, external disturbances, and nonlinear dynamics inherent in SRMs, this study leverages the adaptive neural fuzzy interface system (ANFIS) framework to refine motor control. RCAFHNN distinguishes itself through three primary advancements: incorporation of fuzzy logic and neural network-based online estimation for dynamic adjustment, the adoption of Hermite polynomial functions to expedite membership function training, and the assurance of system convergence and robustness through Lyapunov stability analysis. Experimental comparisons between RCAFHNN and traditional ANFIS approaches demonstrate RCAFHNN's enhanced performance, marking a significant step forward in precise motor control technologies.

The tenth paper titled "Machine Learning Based Approach for Exploring Online Shopping Behavior and Preferences with Eye Tracking," by Zhenyao Liu et al., investigates the evolving landscape of consumer behavior in the digital age, particularly the shift towards online shopping accelerated by the COVID-19 pandemic. This research integrates eye-tracking technology to understand better how visual stimuli influence online shopping decisions. By analyzing the eye movements of 60 participants engaged in online shopping activities, the study leverages statistical and machine learning techniques to examine the impact of visual complexity and consumer preferences on purchasing behavior. The findings reveal that when analyzed with machine learning algorithms, eye-tracking data can effectively predict consumer choices and improve e-commerce recommendation systems. The research also differentiates between hedonic and utilitarian purchasing behaviors, noting distinct patterns in visual attention. This study provides valuable insights for enhancing e-commerce platforms and tailoring marketing strategies to meet consumer needs better.

The eleventh paper, titled "A Novel Multipath QUIC Protocol with Minimized Flow Complete Time for Internet Content Distribution," by Lin Hui, addresses the challenges of scaling Internet content distribution efficiently amidst surging data flows. It critically evaluates the Quick UDP Internet Connections (QUIC) protocol, renowned for enhancing media transfer through flow-controlled streams, reduced latency in connection setup, and flexible network path migration. Despite QUIC's advancements over TCP in connection and transmission efficiency, its performance is often bottlenecked by the bandwidth limitations and variability of single network paths. This study introduces an innovative multipath QUIC strategy designed to leverage multiple

network paths concurrently to optimize bandwidth usage and circumvent congestion. Unlike previous approaches that rely on simplistic round-robin or shortest-time-first data scheduling, this method applies a sophisticated algorithm considering path delay and packet loss rate, significantly improving flow completion times. The proposed scheme demonstrates marked superiority in experimental comparisons with conventional QUIC, Lowest-RTT-First (LRF) QUIC, and Pluginized QUIC (PQUIC), offering a promising avenue for enhancing the robustness and efficiency of internet content distribution networks.

The twelfth paper titled "A study on how to augment fire data from video/image using the Similar-label and F-guessed method," by Jong-Sik Kim et al., tackles the challenge of enhancing fire detection capabilities with limited datasets. In fire detection, where data scarcity often hampers the improvement of detection rates, the research delves into semi-supervised learning as a solution, acknowledging its effectiveness yet highlighting the pitfalls of pseudo-label methods that can introduce false labels and biases. To counteract these issues, the study introduces a novel approach that generates similar-labeled data during the initial learning phase using the F-guessed method combined with the Region of Interest (ROI) expression in videos. This technique aims to maintain accuracy in label distribution, preventing the introduction of bias early on. The methodology proved substantially effective, enlarging the dataset by approximately 6.5 times, from 5,565 to 41,712 entries, and significantly enhancing the mean Average Precision (mAP@0.5) by 26.1%, from 65.9% to 92.0%, while also improving the loss from 3.347 to 1.69. This innovative approach presents a significant advancement in the field of fire detection research, offering a scalable and more accurate method for data augmentation and model training.

The thirteenth paper titled "Multi-language IoT Information Security Standard Item Matching based on Deep Learning," by Yu-Chih Wei, addresses the complexity of navigating through various information security standards applicable to IoT and other domains, such as ISO/IEC 27001 and the IEC 62443 series. With the proliferation of standards, the task of identifying and matching specific controls relevant to particular scenarios has become increasingly challenging and labor-intensive. This paper introduces a novel approach that leverages text mining and deep learning techniques to analyze and match similar control items across different security standards, regardless of language barriers. By utilizing translations of domestic and international standards as a foundation, the study aims to streamline the process of finding correspondences between controls, facilitating a more efficient implementation and research of information security standards. This method promises to significantly reduce the effort required to compare and locate applicable controls, thus enhancing the security posture of businesses and organizations in the rapidly evolving digital landscape.

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