Guest Editorial Special Issue on Enabling a Smart City: Internet of Things Meets AI

FUTURE cities are to be not only an intelligent and green living environment but also provide human-centered public services at a lower cost. The Internet of Things (IoT) and artificial intelligence (AI) are two cornerstone technologies enabling the smart city concept, which are fusing into an organic whole in recent years. Some particular joint points where IoT meets AI are intelligent IoT devices, smart sensing boosted by AI, and IoT big data mining with AI. Such "IoT meets AI" trend is already casting significant impact to enable a smart city. Some examples are: smartphones are able to learn the touching pattern of users; home Wi-Fi router can intelligently detect and locate an intruder; vehicles locations and movement information can be exploited for traffic control; video cameras installed in the street can perform face recognition locally.

Many technical challenges are yet to be resolved before we can genuinely integrate IoT with AI. For example, how to efficiently deploy and maintain the large number of IoT devices in a large city occupying tens of thousands of area? How to store the avalanche big data generated from IoT devices and extract the useful information from it? How to apply AI techniques, such as machine learning or neural network to the resource-constrained IoT devices? To fully exploit this mutually promoting trend of IoT and AI to materialize the smart city concept, academia and industry need to make joint efforts to resolve many scientific and engineering challenges.

The response to our Call for Papers on this special issue was satisfactory, with 85 articles from 15 countries and regions around the world. During the review process, each paper was assigned to and reviewed by at least three experts in the relevant areas, with a rigorous two-round review process. Thanks to the great support of the Editor-in-Chief of IEEE INTERNET OF THINGS JOURNAL, Xuemin (Sherman) Shen, we are able to accept 27 excellent articles covering various aspects of IoT Meets AI.

We accepted papers on IT infrastructure design for smart city. In "Energy-Efficient Fair Cooperation Fog Computing in Mobile Edge Networks for Smart City," the authors first build up a cooperative fog computing system to process offloading workload on the entire Fog layer by data forwarding and design a fairness cooperation algorithm (FCA) to obtain the optimal fairness cooperation policy of all fog nodes. In "Experiences With IoT and AI in a Smart Campus for Optimizing Classroom Usage," the authors undertake an evaluation of several IoT sensing approaches for measuring class occupancy, instrument nine lecture halls of varying capacity, and use AI techniques for predicting classroom attendance, applying them to real data, and accurately predicting future attendance with an RMSE error as low as 0.16. "AI-Enabled Massive Devices Multiple Access for Smart City" proposes an innovative and flexible scheduling method under the channel field multiple access (CFMA) framework to meet these requirements. It is proved that the proposed AI-based scheduling method can obtain better performance than the existing methods.

As for the event alert and prediction in smart city, "Energy Theft Detection with Energy Privacy Preservation in the Smart Grid" proposes an energy theft detection scheme with energy privacy preservation in the smart grid using combined convolutional neural networks (CNNs) and Paillier algorithm. The experimental results illustrate that the modified CNN model can effectively detect abnormal behaviors at an accuracy up to 92.67%. "An Efficient Passenger-Hunting Recommendation Framework with Multitask Deep Learning" uses a large-scale GPS trajectory dataset generated by over 12 000 taxis in a period of three months in Shanghai, China, and presents an efficient passenger-hunting recommendation framework with the multitask deep learning paradigm. In "Mobile Social Data Learning for User-Centric Location Prediction With Application in Mobile Edge Service Migration," the authors propose a factor graph learning model that integrates not only user's social and network information but also the correlations between a user's locations into a unified framework.

On smart city applications, "Real-Time Fine-Grained Air Quality Sensing Networks in Smart City: Design, Implementation, and Optimization" presents the architecture, implementation, and optimization of the air quality sensing system, which provides real-time and fine-grained air quality map of the monitored area. In "Deep Learning-Based Video System for Accurate and Real-Time Parking Measurement," the authors propose an accurate and real-time video system for future IoT and smart cities applications, which shows significant potential in its scalability to a city-wide scale and also in the richness of its output that goes beyond traditional binary occupancy statistics. In addition, the paper "Energy Scheduling for Networked Microgrids With Co-Generation and Energy Storage" proposes an online algorithm for energy storage management in networked microgrids (MGs) with co-generation based on the concept of quality-of-service in electricity (QoSE).

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With respect to Intelligent IoT sensing, the article "AirMouse: Turning a Pair of Glasses Into a Mouse in the Air" introduces a novel hand-free human–computer interaction (HCI) system called AirMouse, which turns a common pair of glasses into a mouse to enable the interaction between computers and humans, especially for disabled people. In "Improving Pedestrian Safety in Cities Using Intelligent Wearable Systems," the authors build a wearable system that uses multichannel audio sensors embedded in a headset to help detect and locate cars from their honks, engine and tire noises, and warn pedestrians of imminent dangers of approaching cars. In "RAMTEL: Robust Acoustic Motion Tracking Using Extreme Learning Machine for Smart Cities," a new parameter called multipath dispersion vector is proposed to estimate and mitigate the impact of multipath fading on received signals using extreme learning machine. The paper "Multiple Kernel Semi-Representation Learning With Its Application to Device-Free Human Activity Recognition" proposes SmartSense, a device-free human activity recognition system that only leverages existing commercial off-the-shelf (COTS) WiFi routers.

About crowdsensing, "Smart City-Wide Package Distribution Using Crowdsourced Public Transportation Systems" presents the city-wide package distribution problem using crowdsourced public transportation systems (CPTSs). In the work "CrowdTracking: Real-Time Vehicle Tracking Through Mobile Crowdsensing," the authors develop a crowd tracking system that people can use to collaboratively keep track of moving vehicles by taking photographs, especially in areas where video cameras are deficient. Additionally, "A Context-Aware Multiarmed Bandit Incentive Mechanism for Mobile Crowd Sensing Systems" proposes a context-aware multi-armed bandit (C-MAB) incentive mechanism to facilitate quality-based worker selection in an MCS system. And "Optimal Contract-Based Mechanisms for Online Data Trading Markets" utilizes contract theory to design optimal contract trading mechanisms for both complete and incomplete information markets.

For the topic of super large-scale multiagent systems, the article "Cloud-Assisted Stabilization of Large Scale Multiagent Systems by Over-the-Air-Fusion of IoT Sensors" proposes a novel cloud-assisted information sharing solution for the mission-critical IoT control applications. In the proposed design, the sensors and controllers communicate with the cloud network using modulation-free transmissions.

Respecting human, IoT and AI communication protocols, "Capsule Network Assisted IoT Traffic Classification Mechanism for Smart Cities" proposes an end-to-end IoT traffic classification method relying on a deep learning-aided capsule network for the sake of forming an efficient classification mechanism that integrates feature extraction, feature selection, and classification model. In "Intelligent Latency-Aware Virtual Network Embedding for Industrial Wireless Networks," an intelligent latency-aware VNE scheme is proposed to provide deadline guarantee for various industrial virtual networks (IVNs), which involves both static embedding and dynamic forwarding. In "RNN-Assisted Network Coding for Secure Heterogeneous Internet of Things With Unreliable Storage," the authors derive the relation between security level and storage in heterogeneous IoT systems, exploit recurrent neural network (RNN) for the storage failure prediction. Furthermore, the work "Deep Learning Empowered Task Offloading for Mobile Edge Computing in Urban Informatics" proposes an efficient redundant offloading algorithm to improve task offloading reliability in the case of vehicular data transmission failure.

For the topic of privacy protection in IoT applications, the paper "Deep Q-Network-Based Route Scheduling for TNC Vehicles with Passengers' Location Differential Privacy" proposes a deep reinforcement learning-based TNC route scheduling approach, which allows the TNC service center to learn about the dynamic TNC service environment and schedule the routes for the vacant TNC vehicles. The article "Privacy-Preserving Support Vector Machine Training Over Blockchain-Based Encrypted IoT Data in Smart Cities" proposes a privacy-preserving SVM training scheme over blockchain-based encrypted IoT data, utilizing the blockchain techniques to build a secure and reliable data sharing platform among multiple data providers. In "Privacy-Preserving Online Task Allocation in Edge-Computing-Enabled Massive Crowdsensing," the authors propose a novel context-aware task allocation framework for mobile crowdsensing in the scenario of edge computing to enable the crowdsensing platform effectively and in real time handle large-scale crowdsensing tasks in smart city. In the paper "Pystin: Enabling Secure LBS in Smart Cities With Privacy-Preserving Top-k Spatial-Textual Query," the authors present a new privacy preserving top-k spatio-textual keyword query scheme, called Pystin, which is performed over outsourced cloud and can enable secure LBS in smart cities.

To conclude, we would like to express our gratitude to the authors for their excellent contributions in IoT and AI. We also appreciate all reviewers dedicating their efforts in reviewing these papers, and for their valuable comments and suggestions that significantly improve the quality of the articles. We hope that this special issue will serve as a good reference for researches, scientists, engineers, and academicians in the field of IoT and AI.

XIAOHUA TIAN
School of Electronic Information and Electrical Engineering
Shanghai Jiao Tong University
Shanghai, China

YU CHENG
Department of Electrical and Computer Engineering
Illinois Institute of Technology
Chicago, IL 60616 USA

DEVU MANIKANTAN SHILA
United Technologies Research Center
East Hartford, CT 06108 USA

ADAM WOLISZ
Technische Universität Berlin
10623 Berlin, Germany

Xiaohua Tian received the B.E. and M.E. degrees in communication engineering from Northwestern Polytechnical University, Xi'an, China, in 2003 and 2006, respectively, and the Ph.D. degree from the Department of Electrical and Computer Engineering, Illinois Institute of Technology, Chicago, IL, USA, in December 2010.

Since March 2011, he has been with the School of Electronic Information and Electrical Engineering, Shanghai Jiao Tong University, Shanghai, China, where he is currently an Associate Professor.

Dr. Tian is one of the two winners of the ACM China Rising Star Award in 2017. He has been serving as the Column Editor for IEEE NETWORK MAGAZINE since 2016. He has also served as the TPC Member for IEEE INFOCOM 2014–2018, the Best Demo/Poster Award Committee Member for IEEE INFOCOM 2014, the Symposium Co-Chair for IEEE ICCC 2015 and the 9th International Conference on Wireless Algorithms, Systems and Applications 2014, and the TPC Member for IEEE GLOBECOM 2011–2016 and IEEE ICC 2013-2016.

Yu Cheng (SM'09) received the B.E. and M.E. degrees in electronic engineering from Tsinghua University, Beijing, China, in 1995 and 1998, respectively, and the Ph.D. degree in electrical and computer engineering from the University of Waterloo, Waterloo, ON, Canada, in 2003.

He is currently a Full Professor with the Department of Electrical and Computer Engineering, Illinois Institute of Technology, Chicago, IL, USA. His current research interests include wireless network performance analysis, network security, big data, and cloud computing.

Prof. Cheng was a recipient of the Best Paper Award at QShine 2007 and IEEE ICC 2011, the Runner-Up Best Paper Award at ACM MobiHoc 2014, the National Science Foundation CAREER Award in 2011, and the IIT Sigma Xi Research Award in the Junior Faculty Division in 2013. He has served as the Symposium Co-Chair for IEEE ICC and IEEE GLOBECOM, and the Technical Program Committee Co-Chair for WASA 2011 and ICNC 2015. He was a Founding Vice Chair of the IEEE ComSoc Technical Subcommittee on Green Communications and Computing. He is an Associate Editor of the IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY. He is an IEEE ComSoc Distinguished Lecturer.

Devu Manikantan Shila received the M.S. and Ph.D. degrees in computer engineering from the Illinois Institute of Technology, Chicago, IL, USA.

She was the Associate Director of Research and Innovation with United Technologies Research Center [the central research and development of United Technologies Corporation (UTC)], East Hartford, CT, USA, where she has extensive expertise applying big data mining, extraction and analysis techniques, machine learning and natural language processing and understanding (NLP/U) techniques to build secure, context-aware and user-friendly solutions for DoD and UTC. She has been extensively funded (∼16M) by DoD, DOE, and DHS in the area of mobile/wearable sensing, advanced machine learning for cyber security and health care applications. She is a co-founder and the CEO of Unknot.id. She is a seasoned leader in building and transitioning mobile/wearable-based identity and biosensing products. She has authored over 50 peer-reviewed journal and conference papers and is the inventor of over 10 U.S. patents in the area of usable and context-aware secure access control systems. A trained hacker and software engineer, she served as the Cyber Security Subject Matter Expert/Advisor for various business units with UTC.

Dr. Manikantan Shila was recognized as the 2017 Connecticut Women of Innovation. She has been a recipient of numerous accolades, multiple best paper awards, research grant awards (IEEE MILCOM'08, IEEE ICDCS'10 ACM Mobihoc'14, and NSS'15) and CEO recognized outstanding achievement awards at UTC.

Adam Wolisz (SM'99) received the M.S., Ph.D., and Habilitation degrees from the Silesian University of Technology, Gliwice, Poland, in 1972, 1976, and 1983, respectively.

From 1972 to 1989, he was with the Institute of Complex Control Systems, Polish Academy of Sciences, Warsaw, Poland, and from 1990 to 1993, he was with the Research Institute GMD-Fokus, Berlin, Germany, heading activities on quantitative aspects of high-speed networks and multimedia systems. Since 1993, he has been a Chair Professor of electrical engineering and computer science with Technical University Berlin, Berlin, where he has established and has been leading until 2018 the Telecommunication Networks Group (TKN). From 2001 to 2018, he was an Executive Director of the Institute for Telecommunication Systems, grouping the activities in Communications, Networking, and Distributed Systems. From 2001 to 2003, he was the first Dean of the newly established Faculty of Electrical Engineering and Computer Science with TUB. From 2005 to 2017, he was an Adjunct Professor with the Department of Electrical Engineering and Computer Science, Berkeley Wireless Research Center, University of California at Berkeley, Berkeley, CA, USA, where he is currently a Visiting Researcher. Since October 2018, he has been an Einstein Center Digital Future Fellow. His current research interests include architectures and protocols of communication networks as well as in protocol engineering with impact on performance and QoS aspects.