Guest Editorial
Introduction to the Special Section on Fog/Edge Computing for Autonomous and Connected Cars

WITH advances in wireless communications, machine learning, and sensing technologies, autonomous and connected cars are becoming a reality. Many potential applications (e.g., augmented reality for information providing through a heads-up display and accident avoidance in autopilot) require significant computing power to process data generated by vehicle sensors for near-real-time responses. Upgrading on-board computers is one option at relatively high cost. Another solution is cloud computing, where the traditional centralized approach suffers from long latency and unstable connections in a vehicular environment and may congest network backhaul with a large amount of data.

Recently, fog computing (a.k.a. "edge computing"), an evolved architecture that migrates computing from the cloud to the edge of networks, has emerged for next-generation (5G) communication networks. Fog/edge computing can be a more suitable solution for enhancing computational capabilities in vehicular networks via moving the intelligence closer to vehicles. Processing can be done at road-sided units, wireless access points/base stations at the network edge, or even in other vehicles.

This goal of this special section is to publish the latest research findings in addressing key technical challenges on fog/edge computing for autonomous and connected cars. After a rigorous review process, we selected seven high-quality papers for publication, and the research topics discussed in the papers can be roughly categorized into three directions: "AI based resource allocation", "network economics", and "traffic prediction".

In the papers entitled "Adaptive Learning-Based Task Offloading for Vehicular Edge Computing Systems" by Sun *et al.* and "Smart Network Slicing for Vehicular Fog-RANs", by Xiong *et al.* the techniques of adaptive learning and Monte Carlo tree search are proposed to address the issues of task offloading and network slicing for resource allocation and quality-of-services (QoS) in vehicular fog/edge computing networks.

The edge-caching problem is investigated in the papers entitled "Twin-Timescale Artificial Intelligence Aided Mobility-Aware Edge Caching and Computing in Vehicular Networks" by Le *et al.* and "A Mobility-Aware Vehicular Caching Scheme in Content Centric Networks: Model and Optimization" by Zhang *et al*. The authors respectively adopt reinforcement learning and Lyapunov optimization to develop mobility-aware solutions for efficiently caching timely data for connected cars. In addition, there are two papers addressing network economics for vehicular edge/fog networking. In the paper entitled "Computation Resource Allocation and Task Assignment Optimization in Vehicular Fog Computing: A Contract-Matching Approach", Zhou *et al.* address the challenges on incentive design and task assignment for vehicular fog computing, and propose a solution from a contract-matching integration perspective. In the paper entitled "Parking Reservation Auction for Parked Vehicle Assistance in Vehicular Fog Computing", Zhang *et al.* develop a smart parked-vehicle-assistance system, and propose an efficient auction approach for parking reservation by exploiting the fog capability of parked vehicles.

Finally, in the paper entitled "Short-Term Traffic Prediction for Edge Computing-Enhanced Autonomous and Connected Cars", Yang *et al.* develop a semiparametric model to achieve accurate road traffic prediction by a neural network approach, which can be easily implemented in mobile edge computing servers.

We would like to thank all the authors who submitted a paper to this special section, and all the reviewers who generously offered their expertise and time to provide constructive comments that help to significantly improve the technical and presentation quality of this special section. Assistance from the editorial staff of the IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY is also appreciated. Our special thanks go to Dr. Nei Kato (Editor-in-Chief) for his valuable advice and great support throughout the preparation of this special section.

AI-CHUN PANG, *Guest Editor*
College of Electrical Engineering and Computer Science
National Taiwan University
Taipei 10617, Taiwan
e-mail: acpang@csie.ntu.edu.tw

EDWARD AU, *Guest Editor*
Huawei Technologies Co., Ltd.
Shenzhen 518129, China

BO AI, *Guest Editor*
Beijing Jiaotong University
Beijing 100044, China

WEIHUA ZHUANG, *Guest Editor*
Department of Electrical and Computer Engineering
University of Waterloo
Waterloo, ON N2L 3G1, Canada

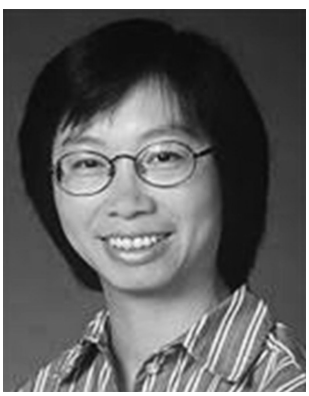
Digital Object Identifier 10.1109/TVT.2019.2907795

0018-9545 © 2019 IEEE. Personal use is permitted, but republication/redistribution requires IEEE permission.
See http://www.ieee.org/publications_standards/publications/rights/index.html for more information.

Ai-Chun Pang received the B.S., M.S., and Ph.D. degrees in computer science and information engineering from National Chiao Tung University, Hsinchu, Taiwan, in 1996, 1998, and 2002, respectively. She joined the Department of Computer Science and Information Engineering, National Taiwan University (NTU), Taipei, Taiwan, in 2002, and is currently a Professor and an Associate Dean of the College of Electrical Engineering and Computer Science, NTU. She was the Director of the Graduate Institute of Networking and Multimedia, NTU, in 2013–2016. Her research interests include wireless and mobile communications, software-defined networking, and fog/edge computing for low-latency AI and IoT services.

Edward Au is a Senior Principal Engineer with Huawei Technologies Co., Ltd., Shenzhen, China, who works on product certification, test bed development, and standardization of Wi-Fi. Prior to joining Huawei, he was a Principal Engineer in Marvell Semiconductor and worked in developing foundational technologies for Bluetooth and Wi-Fi. He has actively participated in standardization organizations and industry forums. He is the Policies and Procedures Chair of the IEEE Computer Society Standards Activity Board, and a member of the IEEE Education Activities Board/Standards Association Standards Education Committee. He is also currently the Chair of the IEEE 802.11 Task Group AY, which is aimed at developing an amendment for next-generation unlicensed millimeter wave technologies for Wi-Fi. He was also the Chair of Wi-Fi Alliance Location Technical Task Group, which developed the Wi-Fi CERTIFIED Location interoperability certification program that brought the same great user experience indoors as is expected from outdoor location-based services, and enabled the creation of new, feature-rich applications and services that benefit many markets including enterprise, retail, manufacturing, and healthcare.

Bo Ai is a Professor and Doctoral Supervisor with Beijing Jiaotong University, Beijing, China. He is also the Deputy Director with the State Key Laboratory of Rail Traffic Control and Safety. He has authored 6 Chinese academic books, 3 English books, 106 IEEE journal articles, 4 ESI highly cited papers, 1 ESI hot paper, and 1 SCOUPS Top1 highly cited paper. He is mainly engaged in the research and application of the theory and core technology of broadband mobile communication and rail transit-dedicated mobile communication systems (GSM-R, LTE-R, 5G-R, LTE-M). He has been awarded the National Science Fund for Distinguished Young Scholars, the First Outstanding Youth Science Fund, the National Central Organization Department's 10,000-Person Plan Leading Talents, the Ministry of Science and Technology's Young and Middle-Aged Science and Technology Innovation Leaders, the Ministry of Education's New Century Excellence Talent, Zhan Tianyou Railway Science and Technology Youth Award, Beijing Science and Technology Star Winner, and the Honorary Title of Beijing Excellent Teacher. He was the recipient of 9 international paper awards, 26 invention patents, 18 proposals adopted by the ITU, 3GPP, etc., and 8 Provincial and Ministerial-Level Science and Technology awards.



Weihua Zhuang has been with the Department of Electrical and Computer Engineering, University of Waterloo, Waterloo, ON, Canada, since 1993, where she is a Professor and a Tier I Canada Research Chair in Wireless Communication Networks. She is the recipient of the 2017 Technical Recognition Award from the IEEE Communications Society Ad Hoc & Sensor Networks Technical Committee, and the co-recipient of several Best Paper awards from IEEE conferences. She was an Editor-in-Chief of the IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY (2007–2013), Technical Program Chair/Co-Chair of the IEEE VTC Fall 2017 and Fall 2016, and the Technical Program Symposia Chair of the IEEE Globecom 2011. She is a Fellow of the Royal Society of Canada, the Canadian Academy of Engineering, and the Engineering Institute of Canada. She is an elected member in the Board of Governors and Vice President of Publications of the IEEE Vehicular Technology Society.