Guest Editorial Special Issue on Internet of Things for Connected Automated Driving

INTERNET OF THINGS (IoT) is becoming increasingly prevalent in transportation systems. The traffic system depends on safer, faster, and more intelligent vehicles. Vehicular networks [vehicle-to-vehicle (V2V) and vehicle-to-Infrastructure (V2I)] and automated driving technique are two of the cornerstone technologies enabling the construction of the future-generation highly functional and intelligent transportation system. The IoT-based transportation system can provide enormous connections of devices and sensors for the networked automated vehicles. The capacity of connected autonomous vehicles (CAVs) is expected to be dramatically enhanced by employing IoT techniques.

The heavy demand for IoT technologies for modern automotive systems and transportations requires novel approaches and rethinking of the design of next-generation vehicular networks, particularly for the CAVs. Therefore, it is essential to pursue research on new theories, architectures, and techniques to exploit the capability of IoT for forming a more efficient and intelligent transportation system. This special issue aims to create a platform for researchers from both academia and industry to disseminate state-of-the-art results and to advance the applications of IoT for the CAVs.

The response to our call for this special issue was overwhelming, as we received in total 68 submissions from around the world. During the review process, each article was assigned to and reviewed by at least three experts in the field, with a rigorous multiround review process. Thanks to the great support from the former Editor-in-Chief, Prof. Xuemin (Sherman) Shen, and the current Editor-in-Chief, Prof. Honggang Wang, and the dedicated work of numerous reviewers, we were able to accept 17 excellent articles covering various topics in IoT-enabled CAVs. In the following, we will introduce these articles and highlight their main contributions.

In the article "Blockchain-enabled cross-domain object detection for autonomous driving: A model sharing approach," Jiang *et al.* investigate a blockchain-enabled model sharing approach to improve the performance of object detection with cross-domain adaptation. A domain-adaptive model is trained across nodes to reduce the domain discrepancy for different object categories. A smart contract scheme can perform efficient data storage and model sharing tasks.

In the article "Deception attack detection and estimation for a local vehicle in vehicle platooning based on a modified UFIR estimator," Ju *et al.* examine a position sensor deception attack detection and estimation issue for a local vehicle in a vehicle platoon. A linearized model is presented to describe the longitudinal vehicle dynamics considering modeling uncertainties, noises, and deception attacks. Then, a modified unbiased finite-impulse response (UFIR) estimator is proposed to generate an intermediate estimated value.

The article "A p-opportunistic channel access scheme for interference mitigation between V2V and V2I communications" exploits the co-channel problem in the 2-tier architecture of vehicular networks. A p-opportunity channel access scheme (p-OCAS) for the roadside unit (RSU) is developed to solve the problem. The investigation shows that p-OCAS can substantially minimize the interference from RSU to V2V communications according to the V2V session arrival rate while maintaining a high throughput of RSU.

In the article "PAS: Prediction-based actuation system for city-scale ridesharing vehicular mobile crowdsensing," Chen *et al.* present a prediction-based actuation system for city-wide ridesharing vehicular mobile crowdsensing (MCS) to achieve optimal sensing coverage quality with a limited budget. The proposed PAS scheme achieves up to 40% more improvement in sensing coverage quality and up to 20% higher ride request matching rate than several baseline methods.

In "Parallel Internet of Vehicles: ACP-based system architecture and behavioral modeling," Wang *et al.* study the concept, architecture, and applications of Parallel Internet of Vehicles (PIoV). The PIoV identifies the cyber–physical–social features of IoV through three main components, namely, artificial IoV (digital twin of the physical IoV), computation experiments, and parallel execution (prescribe the operation of the physical IoV).

In "Intelligent reward-based data offloading in next-generation vehicular networks," Raja *et al.* focus on the design of an intelligent reward-based data offloading (IR-DON) framework. Within the IR-DON architecture, an intelligent access network discovery and selection function (I-ANDSF) module using Q-learning is designed. The IR-DON can increase the system throughput by choosing an optimal and intelligent RSU in the network selection process.

The article "Optimal eco-driving control of connected and autonomous vehicles through signalized intersections" presents the speed planning problem for CAVs to communicate with the traffic lights. The dynamic programming (DP) is employed to solve the eco-driving control problem concerning

Digital Object Identifier 10.1109/JIOT.2020.2981103

the uncertain signal timing. The proposed method can generate optimal speed reference trajectories with 40% less fuel usage.

In the article "Collective awareness for abnormality detection in connected autonomous vehicles," Thekke Kanapram *et al.* explore a novel approach to develop an initial level of collective awareness (CA) in a network of intelligent agents. A specific collective self-awareness functionality is considered, namely, agent-centered detection of abnormal situations present in the environment around any agent in the network. The agent is capable of analyzing how such the abnormalities can influence the future actions of each agent.

The article "Robust distributed consensus control of uncertain multiagents interacted by eigenvalue-bounded topologies" presents a distributed robust control method for an uncertain multiagent system with eigenvalue-bounded topologies. The linear matrix inequalities (LMIs) technique is applied to solve the distributed robust controller problem numerically. The controller is robust and stable under the condition that the topology is eigenvalue-bounded.

In "Enabling security-aware D2D spectrum resource sharing for connected autonomous vehicles," Peng *et al.* examine a security-aware dynamic device-to-device (D2D) spectrum resource sharing mechanism to enhance the security of vehicular D2D communications with the improved spectrum efficiency. A security-aware resource block and power allocation (SA-RBPA) mechanism is proposed for the small cell base station applications to realize a better spectrum efficiency and security performance.

In the article "SCMAC: A slotted-contention-based media access control protocol for cooperative safety in VANETs," Li *et al.* investigate a slotted-contention-based media access control (SCMAC). The SCMAC combines the advantages of the contention-based protocols and the contention-free protocols and can accommodate different traffic densities and channel conditions. Simulation results show that SCMAC can adapt different traffic densities and channel conditions and can provide more real-time efficient services.

The article "A cooperative driving strategy based on velocity prediction for connected vehicles with robust path-following control" presents a cooperative driving strategy for the connected vehicles by integrating vehicle velocity prediction, motion planning, and robust fuzzy path-following control. The CarSim simulation results show that the autonomous vehicle can avoid collisions with a nearby vehicle by applying the proposed driving strategy in the overtaking and lane-changing scenarios.

In the article "Modeling quality of IoT experience in autonomous vehicles," Minovski *et al.* argue for a paradigm shift in the Quality-of-Experience (QoE) area to cover the relationship between humans and intelligent machines. A novel architecture that considers Quality of Data (QoD), Quality of Network (QoN), and Quality of Context (QoC) is proposed to determine the overall Quality of IoT-experience (QoIoT) in the context of autonomous vehicles.

The article "Application-level performance of IEEE 802.11p in safety-related V2X field trials" examines the application-level performance of the safety-related communications over IEEE 802.11p. Klapez *et al.* discuss the relationship between the transmission power, antenna quality, distance, and different degrees of congestion. Then, an investigation of the hidden terminal problem, by presenting the results of field tests, is introduced and discussed.

In "A distributed adaptive triple-step nonlinear control for a connected automated vehicle platoon with dynamic uncertainty," Guo *et al.* investigate a novel control framework for CAVs platoon control. A model predictive control (MPC)-based method is proposed to obtain the optimal velocity of the whole platoon. Then, a distributed adaptive triple-step nonlinear control strategy is developed to guarantee the string stability of the CAV platoon under the premise of the existence of dynamic uncertainties.

In "A vision of C-V2X: Technologies, field testing, and challenges with Chinese development," Chen *et al.* discuss the cellular vehicle-to-everything (C-V2X) technique. The requirements of the primary road safety and advanced applications, the architecture, the key technologies, and the standards of C-V2X are presented. Then, related works and progress of the C-V2X research, field testing, and development in China are introduced.

The article "Smoothing traffic flow via control of autonomous vehicles" investigates the analytical results on the controllability, stabilizability, and reachability of a mixed traffic system consisting of human-driven vehicles and autonomous vehicles in a ring road. It shows that the mixed traffic system is not entirely controllable, but is stabilizable, indicating that autonomous vehicles can not only suppress unstable traffic waves but also guide traffic flow to a higher speed.

We would like to express our sincere thanks to all the authors for submitting their papers and to the reviewers for their valuable comments and suggestions that significantly enhanced the quality of these articles. We are also grateful to Prof. X. Shen, the former Editor-in-Chief, and Prof. H. Wang, the current Editor-in-Chief of the IEEE INTERNET OF THINGS JOURNAL, for their great support throughout the whole review and publication process of this special issue, and, of course, all the editorial staff. We hope that this special issue will serve as a useful reference for researcheres, scientists, engineers, and academics in the field of IoT-enabled connected automated driving.

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