# Guest Editorial Intelligent Autonomous Transportation System With 6G—Series—Part III

WE ARE delighted to introduce the third part of the Special Section on Intelligent Autonomous Transportation Systems with 6G, which aims to provide the scientific community with a comprehensive overview of innovative technologies, advanced architectures, and potential challenges for the 6G-supported Intelligent Autonomous Transport Systems. Twenty articles were selected for publication in this issue. All the articles were rigorously evaluated according to the standard reviewing process of the IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS. The evaluation process considered originality, technical quality, presentational quality, and overall contribution. We will introduce these articles and highlight their main contributions in the following.

In [A1], Kamal et al. discuss the requirements of securing data exchange between autonomous vehicles. Securing data transfer and keeping a record of each transaction becomes necessary in IoV/IATS. Furthermore, they discusses optimized security algorithms using symmetric encryption for secure multimedia data transfer between vehicles. The main feature of these optimized algorithms is that they use a lower amount of data to generate fingerprints.

In [A2], Liu et al. present a discussion on a UAV-enabled Computing-Communications Intelligent Offloading (UAV-CCIO) scheme to offload tasks energy-efficiently. Here some nodes with a large amount of data are selected as Task Gathering Nodes (TGNs), and TGNs collect all the tasks of the left nodes. In this way, the UAV can only fly the TGNs, and so all the IoT devices' tasks can be offloaded. The distance needed for the UAV can be significantly reduced and energy is saved.

In [A3], Fang et al. discuss a new protograph-LDPC-coded modulation framework utilizing irregular mapping (IM) for the flash-memory systems. Analyses and simulations indicate that the proposed IM protograph-LDPC-coded modulation scheme can achieve very desirable performance and thus is a reliable and efficient storage solution for new-generation mobile networks, such as the Internet of Vehicles.

In [A4], Wang et al. discuss a heterogeneous Blockchain-based Hierarchical Trust Evaluation strategy, named BHTE, utilizing the federated deep learning technology for 5G-ITS. Specifically, the trust of ITS users and task distributors is evaluated using federated deep learning, and hierarchical incentive mechanisms are designed for reasonable and fair rewards and punishments. Moreover, the trusts of ITS users and task distributors are stored on heterogeneous and hierarchical blockchains for trust verification.

In [A5], Liu et al. explore Massive machine type communication (mMTC) as a core component of 6G, to fulfill the demand of massive connectivity of billions of Internet-of-Things (IoT) devices. Granting free random access is a promising technique for implementing mMTC, and the key to grant-free random access is active device detection at the base station. The article further discusses an odd-periodic total squared correlation bound, and systematic constructions of sequences achieving that bound are presented. It is demonstrated that the proposed sequences can be effectively used in massive device activity detection.

In [A6], Zhen et al. present a discussion on the uplink synchronization maintenance problem in a satellite-ground integrated vehicular network. They propose an efficient timing advance update approach by jointly designing the preamble format and fourth-order statistics-based timing metric. The proposed approach's superiority is demonstrated in class separability, the robustness of the multi-path effect and CFO, and the computational complexity through theoretical derivation and numerical investigations.

In [A7], Aloqaily et al. present a novel cooperative health emergency response system within Cooperative Intelligent Transportation Environment, namely, C-HealthIER. C-HealthIER is a cooperative health intelligent emergency response system that aims to reduce the time of receiving the first emergency treatment for passengers with abnormal health conditions. C-HealthIER continuously monitors passengers' health and conducts cooperative behavior in response to health emergencies by vehicle-to-vehicle and vehicle-to-infrastructure information sharing to find the nearest treatment provider.

In [A8], Duan et al. discuss an improved isolation forest method with data mass (MS-iForest) for data tampering attack detection, in which the data mass is used instead of the number of divisions and an anomaly score ranking to quantify the degree of anomalies is provided. This method is promising to be used as part of the intrusion detection system, like a security component in the onboard gateway, which can effectively avoid data tampering attacks.

In [A9], the authors discuss the exploration of the intrusion detection effect of urban rail transit management systems to improve the safety performance of the traffic field in urban construction. They further discuss on the deep convolution neural network model AlexNet with more network layers and

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stronger learning ability to ensure the safe operation of urban rail transit. Meanwhile, the GRU (Gate Recurrent Unit) neural network is introduced into the improved AlexNet to build an intrusion detection model for urban rail transit management systems.

In [A10], Liu et al. present a discussion on a Lightweight Trustworthy Message Exchange (LTME) scheme for UAV networks by efficiently aggregating the cryptography and trust management technologies. In the LTME scheme, a centralized Ground Control Station (GCS) periodically updates the reputation levels of registered UAVs (or UAVs for short) and securely distributes secret values to the UAVs. Based on the received secret values, each trustworthy broadcasting UAV can generate its encrypted messages so that only trustworthy receiving UAVs can decrypt them, and each trustworthy receiving UAV can accurately judge whether the received messages and the corresponding broadcasting UAVs are trustworthy in a lightweight manner.

In [A11], Gao et al. discuss the analysis of the 3-D point cloud for the 3-D scene understanding of autonomous driving. Further, a local feature transformer model and a trans-pooling model are presented, and a novel point cloud analysis framework LFT-Net is designed for 3-D point cloud analysis, which enhances the expression ability of local fine-grained characteristics of 3-D point cloud data.

In [A12], Liu et al. present an offloading scheme by exploiting multi-hop vehicle computation resources in vehicular edge computing based on mobility analysis of vehicles. In addition to the vehicles within one hop from the task vehicle that generates computation tasks, certain multi-hop vehicles that meet the given requirements in terms of link connectivity and computation capacity are also leveraged to carry out the tasks offloaded by the task vehicle.

In [A13], Li et al. discuss a cooperative Conflict Detection and Resolution (CD&R) method in the UAV IoT environment considering UAV relative motion relationships and UAV priorities. To verify the effectiveness of CD&R methods, a safety assessment method (evaluate from both conflict feature and network structure perspectives) is also proposed. A Monte Carlo Simulation with ''clone mechanism'' is designed to incorporate the effect of CD&R systems.

In [A14], He et al. analyze the security issues of the Internet of vehicles (IoV) in 5G environment from the perspective of big data. Further, an access control mechanism based on risk prediction is proposed aiming at the problems existing in the node access control process. A Wasserstein Distance-based Combined Generative Adversarial Network (WCGAN) is proposed. It modifies the loss function to solve the gradient disappearance problem, and a combination of multiple generators is designed to solve the pattern collapse.

In [A15], Yu et al. explore the construction status and prediction performance of intelligent transportation systems in the road network of smart cities based on 5G network. Aiming at the diversity and complexity of regional traffic influencing factors of road network in the construction of smart city, this research carries out resource real-time load balancing scheduling from the perspective of a 5G heterogeneous network.

In [A16], Zheng et al. discuss the challenges of spectrum scarcity, large-scale connectivity, ultra-low latency, and various security threats for the upcoming Intelligent Transportation System supported by 6G. To address these issues, the article discusses an overlay cognitive ambient backscatter communication non-orthogonal multiple access network for ITS and elaborates on the secrecy performance by deriving the secrecy outage probability.

In [A17], Zhou et al. explore the performance of short-term traffic flow prediction of the 5G Internet of Vehicles (IoV) based on edge computing (EC) for the smart city and to further improve the intelligence of the smart city. Aiming at the current emergency of traffic congestion and road congestion, the present work adds EC to the current vehicle network and integrates a deep convolution random forest neural network (DCRFNN).

In [A18], Chu et al. present a trajectory planning and tracking framework, which applies an artificial potential to obtain target trajectory and model predictive control (MPC) with PID feedback to effectively track planned trajectory. The method can reduce steady errors of the conventional MPC caused by the simplified vehicle model.

In [A19], Gao et al. discuss a spectrum sensing scheduling (SSS) scheme for communication resource management in vehicle platooning. Based on the SSS scheme and vehicle-to-vehicle (V2V) communications, a greedy algorithm for resource allocation is designed to minimize platoon delay.

In [A20], Dong et al. discuss a dependence-aware edge intelligent function offloading scheme for 6G-based Internet of Vehicles (IoV). Each edge server can provide some specific intelligent functional services. These services can receive data from cars and serve as different intelligent functions. Then, an intelligent application offloading scheme is changed into an embedding scheme of a service chain. An NP-hard objective function is constructed using a multi-winner committee selection model for this offloading service chain embedding problem.

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## APPENDIX: RELATED ARTICLES

[A1] M. Kamal, M. Tariq, G. Srivastava, and L. Malina, "Optimized security algorithms for intelligent and autonomous vehicular transportation systems," *IEEE Trans. Intell. Transp. Syst.*, early access, Nov. 2, 2021, doi: 10.1109/TITS.2021.3123188.

[A2] R. Liu, A. Liu, Z. Qu, and N. N. Xiong, "An UAV-enabled intelligent connected transportation system with 6G communications for Internet of Vehicles," *IEEE Trans. Intell. Transp. Syst.*, early access, Oct. 28, 2021, doi: 10.1109/TITS.2021.3122567.

[A3] Y. Fang, Y. Bu, P. Chen, F. C. M. Lau, and S. A. Otaibi, "Irregular-mapped protograph LDPC-coded modulation: A bandwidth-efficient solution for 6G-enabled mobile networks," *IEEE Trans. Intell. Transp. Syst.*, early access, Nov. 3, 2021, doi: 10.1109/TITS.2021.3122994.

[A4] X. Wang, S. Garg, H. Lin, G. Kaddoum, J. Hu, and M. M. Hassan, "Heterogeneous blockchain and AI-driven hierarchical trust evaluation for 5G-enabled intelligent transportation systems," *IEEE Trans. Intell. Transp. Syst.*, early access, Dec. 1, 2021, doi: 10.1109/TITS.2021.3129417.

[A5] B. Liu, Z. Zhou, Y. Yang, A. R. Adhikary, and P. Fan, "Constructions of binary signature sets with optimal odd total squared correlation and their application to device activity detection," *IEEE Trans. Intell. Transp. Syst.*, early access, Nov. 25, 2021, doi: 10.1109/TITS.2021.3128632.

[A6] L. Zhen, Y. Wang, K. Yu, G. Lu, Z. Mumtaz, and W. Wei, "Reliable uplink synchronization maintenance for satellite-ground integrated vehicular networks: A high-order statistics-based timing advance update approach," *IEEE Trans. Intell. Transp. Syst.*, early access, Dec. 10, 2021, doi: 10.1109/TITS.2021.3131816.

[A7] M. Aloqaily, H. Elayan, and M. Guizani, "C-HealthIER: A cooperative health intelligent emergency response system for C-ITS," *IEEE Trans. Intell. Transp. Syst.*, early access, Feb. 9, 2022, doi: 10.1109/TITS.2022.3141018.

[A8] X. Duan, H. Yan, D. Tian, J. Zhou, J. Su, and W. Hao, "In-vehicle CAN bus tampering attacks detection for connected and autonomous vehicles using an improved isolation forest method," *IEEE Trans. Intell. Transp. Syst.*, early access, Dec. 15, 2021, doi: 10.1109/TITS.2021.3128634.

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[A10] Z. Liu et al., "Lightweight trustworthy message exchange in unmanned aerial vehicle networks," *IEEE Trans. Intell. Transp. Syst.*, early access, Dec. 22, 2021, doi: 10.1109/TITS.2021.3136304.

[A11] Y. Gao, X. Liu, J. Li, Z. Fang, X. Jiang, and K. M. S. Huq, "LFT-Net: Local feature transformer network for point clouds analysis," *IEEE Trans. Intell. Transp. Syst.*, early access, Feb. 1, 2022, doi: 10.1109/TITS.2022.3140355.

[A12] L. Liu, M. Zhao, M. Yu, M. A. Jan, D. Lan, and A. Taherkordi, "Mobility-aware multi-hop task offloading for autonomous driving in vehicular edge computing and networks," *IEEE Trans. Intell. Transp. Syst.*, early access, Jan. 19, 2022, doi: 10.1109/TITS.2022.3142566.

[A13] S. Li, X. Cheng, X. Huang, S. A. Otaibi, and H. Wang, "Cooperative conflict detection and resolution and safety assessment for 6G enabled unmanned aerial vehicles," *IEEE Trans. Intell. Transp. Syst.*, early access, Jan. 4, 2022, doi: 10.1109/TITS.2021.3137458.

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