Vehicle 5.0: From Driverless Vehicles for ITS in CPS to MetaDriving for Smart Mobility in CPSS

Dear All,

I would like to share with you the following news:

- From January 1 to May 30, 2023, we have received 1214 submissions, averaging 8.09 submissions per day. Based on this SPD, we are on track to surpass our estimated 2500 submissions by November [1], [2]. This implies more work for processing and evaluation; therefore we need to speed up our effort to recruit more able and responsible Associate Editors and Reviewers. I need help from you in this task with great appreciation.
- By May 2023, our average acceptance rate is 11.9%, and our average days from submitted to accepted are 37.9, good indication of our quality and service, but we might have to publish more papers in the next and coming years.
- By the end of June 2023, we will have published 3755pages. Since our page budget is 4800, we have 1045 pages left for the next 6 issues.
- According to Elsevier's CiteScore Ranking List just released, IEEE TIV's CiteScore is 11.8 in 2022, a new record-high, ranked 3rd position or top 3% in "Control and Optimization" under Mathematics (121 journals ranked), 6th or 5% in "Automotive Engineering" under Engineering (115 journals), and 36th or top 12% in "Artificial Intelligence" under Computer Science (301 journals).
- Our current SCI's impact factor tracking is IF = 7.56 according to the Web of Science, another new record high [3]. I would like to extend my heartfelt gratitude to all contributors for their support and dedication.
- We have completed our report to IEEE ITSS Publication Board, IEEE TIV Steering Committee, and IEEE RAS Publication Board so far. On April 30, 2023, our Senior Editor Professor Lingxi Li, Vice President of IEEE ITSS, and I presented IEEE TIV's Five-Year Report to the IEEE Periodicals Review and Advisory Committee. We were pleased to receive positive feedback from the Committee. Furthermore, I proposed to revise the scope of IEEE TIV, which also got the favorable support from the Committee. I would start the deliberation on the scope revision with our AEs and SEs in July [4].

After extensive discussions and deliberations with many AEs and SEs, I would like to incorporate the following two items into our guidelines for review process [5]:

1) When a negative review report is returned, for example, reject or reject and resubmit, and other reports are overdue, our AEs and SEs are authorized to make recommendations based on the current report.
2) For submissions under the category of "Overdue Reviewer Response", "Overdue Reviewer Scores", or "Make Recommendation", EiC will look into the situations and make proper decision without prior notification to AEs and SEs.

I hope these additions to our guidelines will further improve the quality and service of our review process, we will refine our guidelines according to their outcomes and feedback from you and our contributors. This issue includes 3 letters and 15 regular papers. Four of these letters are the outcome from our decentralized and hybrid workshops (DHW): the first two letter results from our new DHW on Vehicle 5.0 and the last two from Ethics, Responsibility, and Sustainability (ERS) and Crowded Sensing Intelligence (CSI). After Scanning the Issue, I would like to address briefly the issue of Vehicle 5.0.

I. Scanning the Issue

Level-K Reasoning, Deep Reinforcement Learning, and Monte Carlo Decision Process for Fast and Safe Automated Lane Change and Speed Management

S. Karimi, A. Karimi and A.Vahidi

This paper presents a decision process model for real-time automated lane change and speed management in highway traffic. The presented algorithm is developed based on level-K game theory to model and predict the interaction between the vehicles. Using deep reinforcement learning, this algorithm encodes and memorizes the past experiences that are recurrently used to reduce the computations and speed up motion planning.

An AI-Assisted Systematic Literature Review of the Impact of Vehicle Automation on Energy Consumption

M. Noroozi, H. R. Moghaddam, A. Shah, H. Charkhgard, S. Sarkar, T. K. Das and T. Pohland

This paper examines the impacts of vehicle automation and connectivity on energy consumption from various design features and driving conditions. An AI-based methodology is developed to identify the most relevant papers to manage the high volume of literature. The papers are categorized based on how they influence energy consumption. The review highlights significant variations in study design and implementation, resulting in widely varying energy impact predictions, suggesting the need

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for more comprehensive studies to improve the precision of these predictions.

Optimization of Fuel Economy and Emissions Through Coordinated Energy Management for Connected Diesel Vehicles

L. Guo, M. Sun, Y. Hu and H. Chen

A comprehensive study of fuel economy and emissions optimization regarding both offline analysis and online strategies is proposed. Based on the detailed offline analysis result, a novel predictive eco-driving strategy with long-term connected information is proposed to realize much lower idling time, in which the traffic signal is transferred into the real-time constraints through a detailed case judgment. Simulation in real-world traffic scenarios is conducted to verify the effectiveness of the proposed controller.

Multi-Modal 3D Object Detection in Autonomous Driving: A Survey and Taxonomy

L. Wang, X. Zhang, Z. Song, J. Bi, G. Zhang, H. Wei, L. Tang, L. Yang, J. Li, C. Jia and L. Zhao

This paper comprehensively reviews the most recent and advanced progress of multi-modal 3D object detection for autonomous driving. And we propose a taxonomy for multi-modal 3D object detection that exceeds the traditional early, middle, and late fusion split and consists of three aspects: representation, alignment, and fusion. We also comprehensively compare existing methods on several publicly available datasets and provide insightful analysis.

Explaining a Machine-Learning Lane Change Model With Maximum Entropy Shapley Values

M. Li, Y. Wang, H. Sun, Z. Cui, Y. Huang and H. Chen

This paper proposes a maximum entropy-based Shapley Additive exPlanation for explaining machine learning-based lane change (LC) decisions in autonomous vehicles. The core of this method is to determine the base value of the LC decision model using the maximum entropy principle, which provides an explanation more consistent with human intuition. Statistical analysis and visualization are also developed to present intuitive explanations.

Joint Optimization of Platoon Control and Resource Scheduling in Cooperative Vehicle-Infrastructure System

P. Zhang, D. Tian, J. Zhou, X. Duan, Z. Sheng, D. Zhao and D. Cao

This paper transforms the bi-objective model into a single objective MPC model by using ϵ-constraint method. We design an efficient algorithm for solving the joint optimization model and prove the convergence. To verify the effectiveness of the proposed method, we finally evaluate the spacing error, speed error, and resource scheduling of platooning vehicles through simulation experiments in two experimental scenarios.

Adaptive Neural Control of Connected Vehicular Platoons With Actuator Faults and Constraints

J. Wei, Y.-J. Liu, H. Chen and L. Liu

This paper focuses on the adaptive neural control problem for a connected automatic vehicle platoon system with unknown disturbances, actuator fault and constraints. Then, the tangent barrier Lyapunov function is introduced into the control design to solve the time-varying position and velocity constraints in a vehicle platoon. Since the selected engine dynamics model is nonlinear, the neural network is adopted to approximate the unknown internal vehicle dynamics. Moreover, the actuator fault effect is addressed by the designed adaptive law designed based on the projection operator. It can be eventually confirmed that all the involved closed-loop signals are bounded based on the Lyapunov stability theory.

Covariance Estimation for Pose Graph Optimization in Visual-Inertial Navigation Systems

P. Shi, Z. Zhu, S. Sun, Z. Rong, X. Zhao and M. Tan

A novel covariance estimation approach that considers both sequential and loop-closing factors in pose graph optimization is proposed, and it is integrated into a visual-inertial navigation system (VINS) to better represent the true uncertainty of the system. The approach utilizes nonlinear factor recovery for sequential constraints and dynamic scale estimation for loop-closing constraints. Experiments on various datasets demonstrate that the proposed method achieves higher accuracy compared to naively-formulated pose graph optimization adopted by other state-of-the-art VINS.

Fuzzy Adaptive Fault Tolerant Time-Varying Formation Control for Nonholonomic Multirobot Systems With Range Constraints

Y. Li, S. Dong, K. Li and S. Tong

This article investigates the fault tolerant tracking problem of time-varying formation for nonholonomic multirobot systems. Unknown nonlinear dynamics and uncertain parameters are approximated by employing fuzzy logic systems and adaptive method. The prescribed performance methodology is introduced to achieve collision avoidance and connectivity maintenance. The effect from the infinite number of different actuator failures can be compensated by this scheme, and each robot can uninterruptedly track referenced time-varying trajectory generated by the leader. The effectiveness of the strategy is illustrated for nonholonomic multirobot systems.

Secure Cooperative Path Following of Autonomous Surface Vehicles Under Cyber and Physical Attacks

Z.-Q. Liu, X. Ge, Q.-L. Han, Y.-L. Wang and X.-M. Zhang

A network-based cooperative path following (CPF) error system model is established by incorporating delays and data losses, physical attacks, and cyber attacks. Then, a secure CPF control scheme has been proposed such that the multiple autonomous

surface vehicles can be driven to complete the CPF task successfully even under malicious cyber and physical attacks. The effectiveness of the proposed control scheme is verified via two case studies involving various cyber attacks and physical attacks.

Motion Planning for Autonomous Driving: The State of the Art and Future Perspectives

S. Teng, X. Hu, P. Deng, B. Li, Y. Li, Y. Ai, D. Yang, L. Li, Z. Xuanyuan, F. Zhu and L. Chen

This paper aims to review state-of-the-art planning methods. In terms of pipeline methods, a survey of selecting algorithms is provided, whereas in end-to-end methods, the training approaches and verification scenarios of driving tasks are points of concern. Experimental platforms are reviewed to facilitate readers in selecting suitable training and validation methods. Finally, the current challenges and future directions are discussed.

Semantic-Aware Video Compression for Automotive Cameras

Y. Wang, P. H. Chan and V. Donzella

How could we deal with the exploding data transmission that may exceed the bandwidth of current wired vehicle communication, especially for intelligent vehicles that require more camera sensors? This paper proposes a semantic-aware video compression framework (SAC) that compresses region-of-interest (ROI) and region-out-of-interest (non-ROI) of automotive camera video frames separately and simultaneously, enable the ROI to retain higher quality. Experimental findings and newly proposed metrics (SA-PSNR, SA-SSIM, iIoU) indicate that the SAC method outperforms other uniform compression algorithms.

Trajectory Planning for Autonomous Valet Parking in Narrow Environments With Enhanced Hybrid A$*$ Search and Nonlinear Optimization

J. Liang, W. Ren, D. Yang, L. Li and F. Yu

This paper focuses on the problem of autonomous valet parking trajectory planning in complex environments. In highly complex environments with narrow passages, it may incur high computational costs or fail to find the proper initial guess. To address this challenge, an enhanced hybrid A$*$ (EHA) algorithm is proposed. The experimental results demonstrate that the proposed method for trajectory planning is effective and robust.

STAR-RIS-Empowered Cognitive Non-Terrestrial Vehicle Network With NOMA

K. Guo, R. Liu, M. Alazab, R. J. Jhaveri, X. Li and M. Zhu

In this paper, we investigate the outage behavior of a simultaneously transmitting and reflecting reconfigurable intelligent surface (STAR-RIS)-empowered cognitive non-terrestrial vehicle network with non-orthogonal multiple access (NOMA), in which Rician fading channels and imperfect/perfect successive interference cancellation (ipSIC/pSIC) are considered. In the network, STAR-RIS is utilized to assist the transmission and reflection of the superposed signals from a secondary unmanned aerial vehicle.

GPS-Free Collaborative Elliptical Circumnavigation Control for Multiple Non-Holonomic Vehicles

X. Shao, S. Li, J. Zhang, F. Zhang, W. Zhang and Q. Zhang

This paper investigates a novel GPS-free collaborative elliptical circumnavigation control for multiple non-holonomic vehicles, where two realistic issues—achieving a higher efficiency observation and saving the energy expenditures during cooperation are involved. By defining a novel coordinated error relative to neighboring arc length, under the premise of accessible global position, a cooperative elliptical enclosing control strategy is derived for multiple vehicles connected by a digraph to enable formation behaviors with a uniform forward speed. To surmount the reliance on global position data in hostile surroundings where GPS is being attacked or disrupted, by resorting to a distance based relative position observer, a new GPS-free cooperative elliptical circling controller is formulated to force all vehicles to collaboratively evolve along the prescribed ellipse.

II. Why and What Is Vehicle 5.0?

In 2014, IEEE ITSS created a Technical Committee on Transportation 5.0 (TC Trans 5.0) at IEEE ITSC [6], and in 2015, TC Trans 5.0 organized the first week-long IEEE Summer School on Transportation 5.0 in QAII of Qingdao, China [7]. Over the last decade, many workshops and reports on Transportation 5.0 have been conducted in IEEE ITSC, IEEE IV, and other professional ITS gatherings around the worlds [8], [9], [10], [11], [12], [13], [14]. During the past three years, TC Trans 5.0 has made an intensive effort in planning and preparing its first position paper on Transportation 5.0, which is expected to be released this year.

Last March IEEE TIV launched its new DHS on Vehicle 5.0 with four DHWs on Mobility 5.0, Logistics 5.0, City 5.0, and Mining 5.0, respectively. Two letters on Mobility 5.0 and Mining 5.0 are included in this issue [15], [16], and other two on Logistics 5.0 and City 5.0 will appear in the coming issues. During those meetings, we intentionally leave the answer for the question of what is and why of Vehicle 5.0 open, we want to address first the need of new vehicles for new mobility, new logistics, new cities, and new mining operations in future smart societies. Of course, I do have my own thinking on this, after human-driven vehicles (Vehicle 1.0), remote-driven vehicles (Vehicle 2.0), networked-driven vehicles (Vehicle 3.0), unmanned-driven vehicles (Vehicle 4.0), we need digital-human driven vehicles (Vehicle 5.0) that would lead to MetaVehicles with MetaDriving and Parallel Intelligence for Smart Mobility in CPSS [17], [18]. I am ready to conduct new research on developing digital driving schools to train and provide digital drivers, including region-specific digital drivers and In Situ digital drivers specifically designed for a particular segment of a road or a lane. I am sure some people might not like my idea, so I will await and see different visions for Vehicle 5.0 in our coming DHWs.

III. Call for Participation: Decentralized Hybrid Workshops

At IEEE TIV we will continue to organize decentralized and hybrid workshops or symposia (DHW or DHS) on various issues in ITS and IVs.

Welcome to participate in our investigations on-line or off-line. Our discussions will be summarized and reported as perspectives, letters, or regular papers at IEEE TIV. The following DHWs have been organized so far:

1) Verification and Validation for IVs (V&V4IV)
2) Autonomous Mining (AM)
3) Ethics, Responsibility, and Sustainability (ERS)
4) Intelligent Vehicles for Education (IV4E)
5) Data Science for Intelligent Vehicles (DSiV)
6) Vehicle 5.0

Any suggestions or proposals for future topics of DHW/DHS are greatly appreciated. Looking forward to having you in IEEE TIV DHW/DHS.

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