IV 2021 Workshop Proposal: Cooperative Driving in Mixed Traffic

Organizers

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Scope and Topics

With the advancement of vehicle-to-everything (V2X) communications, the concept of cooperative driving has been attracting increasing attention from both academia and industry. Connected vehicles, either driven by human drivers or automated controllers, are able to coordinate with each other or infrastructures through V2X communications in certain traffic scenarios to improve the overall performance. Cooperative Adaptive Cruise Control (CACC), cooperative ramp merging, connected eco-driving at signalized intersections, automated coordination at non-signalized intersections, among other cooperative driving applications of connected vehicles, have the potential to benefit the transportation system in terms of safety, mobility, resilience, and/or environmental sustainability.

However, the market penetration rate of connected vehicles is expected to evolve gradually. There will certainly be a transition period where only a portion of the vehicles traveling in the traffic environment are connected (and potentially automated), while others have no V2X capabilities – either automated vehicles equipped with on-board sensors or legacy vehicles driven by human drivers. How to perform cooperative driving maneuvers in mixed traffic environments to allow the coordinations among all these vehicle types remains an open research question.

This workshop focuses on sharing the state-of-the-art design, modeling, algorithms, simulation, and field implementation of cooperative driving in mixed traffic, and identifies challenges as well as research needs, aiming to encourage cross-disciplinary cooperation. The specific topics of interest are listed below:

- Cooperative perception or situation awareness enabled by sensors on multi-vehicles or sensor fusion between vehicles and infrastructure
- Driving behaviour modelling and driver intention inference
- V2X-based cooperative motion planning and motion control
- Cooperative driving methodologies for modelling the interaction between human-driven vehicles and automated vehicles
- Application of advanced machine learning techniques to cooperative driving
- Cyber security of cooperative driving systems
- Communication standard (including messaging) to enable cooperative driving
- Interaction between vehicles and vulnerable road users
- Advanced simulation of cooperative driving applications in mixed traffic
- Field implementation of cooperative driving in mixed traffic

Rationale

- **Why is the topic current and important?**

The market penetration rate of connected vehicles is expected to envolve gradually. There will certainly be a transition period that, only a portion of the vehicles traveling in the traffic environment are connected (and potentially automated) vehicles, while others are either automated vehicles equipped with on-board perception sensors but without any V2X capability, or legacy vehicles driven by human drivers without any V2X capability. How to perform cooperative driving maneuvers in mixed traffic environments to allow the coordinations among all these vehicle types remains an open research question.

- **Why will the workshop attract a significant number of submissions of good quality?**

The title of the workshop itself is an emerging topic being investigated by many researchers around the world. The workshop scope covers multiple aspects of this topic, which can attract good submissions from all backgrounds (computer science, electrical engineering, mechanical engineering, and traffic engineering). Additionally, the organizers of this workshop will also solicit their students and colleagues to submit papers to this workshop.

- **Why will the workshop attract a large number of attendees, in addition to the authors?**

Cooperative driving in mixed traffic is a crucial topic in both academia and industry, where researchers and practioners are looking forward to learning more cutting-edge methodologies, and to applying the knowledge to their research or product development. Additionally, the organizers of this workshop will also advertise this workshop within their professional networks, aiming to get enough exposure in the research community.

- **How does the workshop differ from others, i.e. related workshops & conferences of similar topic?**

This workshop will focus on the cooperative driving topic from the perspectives of both academia and industry. Not only theoretical progress on cooperative driving models and algorithms from academia will be discussed, experimental progress on applying such methodologies to real-world field test will also be covered. The goal of this workshop is to identify the gaps between theory and experiment, between academia and industry, and to encourage cross-disciplinary cooperation.

Biography of the Organizers

- **Ziran Wang**

Ziran Wang is currently a Researcher Scientist at Toyota Motor North America R&D - InfoTech Labs. He received the Ph.D. in Mechanical Engineering from the University of California, Riverside in June 2019, and the bachelor degree in Mechanical Engineering and Automation from Beijing University of Posts and Telecommunications. His research interests include motion planning and control / driver behavior / digital twin of connected and automated vehicles.

Dr. Wang is the recipient of the National Center for Sustainable Transportation Dissertation Award, issued by U.S. Department of Transportation. He also received the Vincent Bendix Automotive Electronics Engineering Award (i.e., best paper in 2019) from SAE International. Dr. Wang is serving various roles in multiple academic organizations, including Associate Editor of SAE International Journal of Connected and Automated Vehicles, Committee Member in the IEEE

Control Systems Society-Technical Committee on Smart Cities, Committee Member in the IEEE Industrial Electronics Society-Technical Committee on Industrial Cyber-Physical Systems. He also organized three IEEE workshops in 2020, on ITSC, IV, and CCTA, respectively.

- **Guoyuan Wu**

Guoyuan Wu received his Ph.D. degree in Mechanical Engineering from University of California at Berkeley, and is currently an Associate Research Faculty with the Center for Environmental Research and Technology (CE-CERT) and Associate Adjunct Professor in the Department of Electrical and Computer Engineering at University of California, Riverside. He has been conducting research on development and evaluation of sustainable and intelligent transportation systems (SITS), connected and automated vehicle (CAV) application, traffic flow modeling and simulation, and vehicle emissions and powertrain modeling.

Dr. Wu serves as an Associate Editor of SAE Journal – Connected and Automated Vehicles, and Associate Editor of IEEE Open Journal – Intelligent Transportation Systems. He is a senior member of the Institute of Electrical and Electronics Engineers (IEEE) and a member of the Vehicle-Highway Automation Standing Committee (AHB30) of the Transportation Research Board (TRB). He has authored or co-authored more than 180 publications, including book chapters, journal articles, conference papers, patents, and technical reports.

- **Shuo Feng**

Shuo Feng received his B.S. abd Ph.D. degrees from the Department of Automation, Tsinghua University, China, in 2014 and 2019, respectively. He was a visiting Ph.D. student in the Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, from 2017 to 2019, where he is currently a Post-Doctoral Researcher, working with Dr. Henry X. Liu. He received the Best Dissertation Award from the IEEE Intelligent Transportation Systems Society in 2020. He also serves as a member in the SAE On-Road Automated Driving Verification and Validation Committee. His research interests include platoon control, testing and evaluation of connected and automated vehicles.

- **Zhaojian Li**

Zhaojian Li is an Assistant Professor in the Department of Mechanical Engineering at Michigan State University. He obtained M.S. (2013) and Ph.D. (2015) in Aerospace Engineering (flight dynamics and control) at the University of Michigan, Ann Arbor. As an undergraduate, Dr. Li studied at Nanjing University of Aeronautics and Astronautics, Department of Civil Aviation, in China. Dr. Li worked as an algorithm engineer at General Motors from January 2016 to July 2017. His research interests include Learning-based Control, Nonlinear and Complex Systems, and Robotics and Automated Vehicles. He is the author of more than 20 top journal articles and several patents. He is currently the Associate Editor for Journal of Evolving Systems, American Control Conference and ASME Dynamics and Control Conference.

- **Jia Hu**

Jia Hu works as a ZhongTe Distinguished Chair in Cooperative Automation in the College of Transportation Engineering at Tongji University. Before joining Tongji, he was a research associate at the Federal Highway Administration, USA (FHWA). He is an Associate Editor of the American Society of Civil Engineers Journal of Transportation Engineering, IEEE Open Journal in Intelligent Transportation Systems and an assistant editor of the Journal of Intelligent Transportation Systems. Furthermore, he is a member of TRB (a division of the National

Academies) Vehicle Highway Automation Committee, Freeway Operation Committee and Simulation subcommittee of Traffic Signal Systems Committee, and a member of Sustainable Transportation Committee and Artificial Intelligence Committee of ASCE Transportation and Development Institute.

- **Meng Wang**

Dr. Meng Wang received his PhD from Delft Univesity of Technology (TU Delft) in 2014. He is currently Assistant Professor at the Department of Transport & Planning, TU Delft and Co-Director of the Electric and Automated Transport Lab. His main research interests are modeling, control design & impact assessment of Cooperative ITS systems for safe and efficient traffic operations. He has won several awards including the IEEE ITSS Best PhD Dissertation Award and IEEE ITSC Best Paper Award. He is an Associate Editor of IEEE Transactions on ITS, IET Intelligent Transport Systems, Transportmetrica B, and editorial board member of Transportation Research Part C. He is the Program Chair of IEEE Forum ISTS 2020 and has been the IPC Members of the annual IEEE ITSS's flagship conferences of ITSC since 2013 and IV' since 2016. He serves as a member of IEEE ITSS Technical Committee on Cooperative and Automated Vehicles and plays an active role in several projects under the Dutch Automated Vehicle Initiative and the European Horizon2020 programme.

Potential Invited Speakers

Christos G. Cassandras, Distinguished Professor, Boston University
Andreas Malikoupolos, Associate Professor, University of Deleware
Gabor Orosz, Associate Professor, University of Michigan
Li Li, Associate Professor, Tsinghua University
Yang Zheng, Assistant Professor, University of California, San Diego
Onur Altintas, Executive Engineer, Toyota Motor North America
Rui Guo, Principal Researcher, Toyota Motor North America
Brian Park, Professor, University of Virginia
Zhiying Shang, Research Engineer, Continental
Xianhong Zhang, Executive Engineer, SAIC Motors

Workshop Duration

Half day

Important Dates

Paper submission deadline: Mar. 15th, 2021
Notification of acceptance/rejection: Apr. 25th, 2021
Camera-ready version due: May 31st, 2021
Workshop day: Jul. 11th, 2021