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The Centre for Transportation Research (CTR)

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Trajectory Planning for Autonomous Modular Vehicles Docking Operations

By

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Date: **Thursday, 5 December, 2019**

Time: **2.30 to 4:00 pm**

Venue: **EA #06-04, Block EA,**
9 Engineering Drive 1,
Singapore 117575
Faculty of Engineering,
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Abstract

Emerging autonomous modular vehicles (AMV) technology allows vehicle units to physically dock on or undock from each other en-route to form vehicles of different lengths. AMV docking can be viewed as an extreme case of autonomous vehicle platooning such that AMVs are now physically connected with zero gaps. Thus, AMV maximizes platooning benefits including mobility improvement by minimizing car following gap, riding comfort improvement by automated control and fuel consumption reduction via physical connection and aerodynamic efficiency. This presentation investigates the optimal trajectory planning for separate AMVs to dock into a longer AMV. It first formulates the investigated problem into a bi-level optimization problem. A feasible cone method is proposed to reveal theoretical properties on solution feasibility, which also leads to an analytical solution to the upper-level problem. This method also provides basics for a heuristic approach to design the corresponding trajectories specified as a small number of simple quadratic segments. Then an exact solution approach based on convex quadratic programing is proposed to optimize these AMV trajectories with a more complex convex objective function. The feasible cone method is also used to construct valid cuts to expedite the exact model solution efficiency. Numerical experiments are conducted to compare these two approaches. The results show that the heuristic approach can achieve near-optimum solutions and greatly reduce the solution time, which is appealing to real-time engineering applications. The results also show the superiority of the proposed approach in

optimizing the AMV docking trajectories compared with traditional platooning methods. Besides the macroscpic trajectory planning, this presentation will also briefly discuss relevant models and theories on macroscopic fleet operations of AMVs. Some preliminary lab experiments will be also discussed.

Speaker Biography

Dr. Xiaopeng (Shaw) Li is currently an associate professor in the Department of Civil and Environmental Engineering at the University of South Florida (USF). His major research interests include advanced network system and traffic modeling with applications in connected autonomous vehicles, shared mobility and electric vehicles. He is the first holder of Susan A. Bracken Faculty Fellowship at USF and is a recipient of a National Science Foundation (NSF) CAREER award. He has served as the PI or a co-PI for a number of federal (NSF, USDOT, USDOE), local (e.g., state DOTs, UTCs, I-4 Corridor Program) and industry grants, amounting to a total budget over $7 million. He has published 59 peer-reviewed journal papers, many of which are in top journals such as Transportation Research Part B, Transportation Science and Operations Research. He has served as a member on the Transportation Network Modeling Committee (ADB30) and the Traffic Flow Theory and Characteristics (AHB45) of the Transportation Research Board (TRB) and an Associate Department Editor for IIE Transactions Focused Issue on Operations Engineering and Analytics. Dr. Li received a B.S. degree (2006) in civil engineering with a computer engineering minor from Tsinghua University, China, a M.S. degree (2007) and a Ph.D. (2011) degree in civil engineering along with a M.S. degree (2010) in applied mathematics from the University of Illinois at Urban-Champaign, USA.

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*****Seats are limited. Please register early. All are welcome and admission is free*****

Location Map