Adaptive control with moving actuators at motorway bottlenecks with connected and automated vehicles

Yu Du

Michail A. Makridis

Anastasios Kouvelas

STRC | **22nd Swiss Transport Research Conference**
Monte Verità / Ascona, May 18-20, 2022

Adaptive control with moving actuators at motorway bottlenecks with connected and automated vehicles

Yu Du
IVT, ETH Zürich, CH-8093 Zurich
School of Electronic and Information Engineering, Beijing Jiaotong University, Beijing, China
`yuduyu@ethz.ch`

Michail A. Makridis
IVT, ETH Zürich, CH-8093 Zurich
`mmakridis@ethz.ch`

Anastasios Kouvelas
IVT, ETH Zürich, CH-8093 Zurich
`kouvelas@ethz.ch`

February 28, 2022

Abstract

Connected and autonomous vehicles (CAVs) have great potential to improve operating effectively of future traffic systems. In this paper, we propose a control method that uses CAVs as dynamic actuators on the mainline of a freeway to maximize the throughput at motorway bottlenecks robustly, considering the dynamic fundamental diagram model of mixed traffic flow. We assume that detectors at motorway on-ramp can obtain the density in real-time. Meanwhile, assuming a certain percentage of CAVs present on the road, such vehicles can be used to perform speed coordination tasks. The main idea is to transfer the delays observed at the bottlenecks, upstream on the freeway where the conditions are more homogeneous. Specifically, when the traffic density at the bottleneck satisfies the activation condition, the CAVs will generate a new trajectory profile. Aiming to decongest the traffic at the downstream bottleneck and also smooth the upstream arrival vehicle speed, thus improving the overall throughput of the traffic. The method was evaluated through simulation experiments conducted on different traffic conditions and the market penetration of CAVs. We observe that the delays that we introduce upstream are much lower than the delays that would have occurred on the bottleneck. The results show significant improvements in reducing congestion and improving throughput.

Keywords

motorway bottleneck control, connected and automated vehicle, mixed traffic flow, fundamental diagram model