

Poster Title:

A Demonstration of Integrating Autonomous Vehicles into Signal Control Optimization

Authors:

Patrick Emami, Mahmoud Pourmehrab, Lily Elefteriadou, Sanjay Ranka, Carl Crane

Abstract:

In the near future, conventional, connected, and automated vehicles will be operating side by side in large numbers on roads and highways. This creates many opportunities for improving surface transportation efficiency and safety. According to the National Transportation Operations Coalition (NTOC, 2012), delays at traffic signals are estimated to be 5% to 10% of all traffic delay on major roadways and have contributed an estimated 25% to the increase in total highway traffic delay during the past 20 years. One source of delay at signals is inefficient green time utilization in response to fluctuating demand. Another source is start-up delay due to driver reaction time. New technology such as vehicle-to-infrastructure communication, as well as the availability of inexpensive albeit powerful sensors has enabled new approaches to address these problems. Specifically, controlling the trajectories of autonomous vehicles as they drive through intersections can potentially optimize the flow of traffic by a significant amount.

An optimization algorithm proposed in (Zhuofei Li, Elefteriadou, & Ranka, 2014) has been expanded upon and developed into a complete traffic intersection controller that is being demonstrated at the Florida Department of Transportation (FDOT) Traffic Engineering Research Laboratory (TERL), a closed course facility with a signalized intersection, used to evaluate various types of equipment. Our objective is to exhibit its capability to enhance traffic signal control operations at a signalized intersection when the traffic stream consists of conventional, connected, and autonomous vehicles. The traffic controller communicates directly with connected and autonomous vehicles using Dedicated Short-Range Communication (DSRC) and relies on a radar sensor to track conventional vehicles. After processing the data from all approaching vehicles, it sends back optimized trajectories for the autonomous vehicles to follow. Simultaneously, the traffic controller optimizes the signal control pattern at the intersection.

The demonstration at the TERL involves four vehicles with vehicle-to-infrastructure connectivity and two conventional vehicles. The signalized intersection used at the TERL has six approaching lanes and four departing lanes located on level terrain. There are 11 scenarios that are each run for 15 minutes; each scenario is designed to examine the operation of the system under various conditions, including varying arrival patterns, percentages of autonomous and connected vehicles in the traffic stream, and robustness to sensor and communication failures. The performance of the entire system is evaluated by assessing the effect on average travel time and average travel delay. Furthermore, the system has been evaluated in simulation with realistic traffic patterns; results show that overall delay is reduced by 38 – 52 % compared to conventional signal control.