CPS: TTP Option: Synergy: Traffic Signal Control with Connected and Autonomous Vehicles

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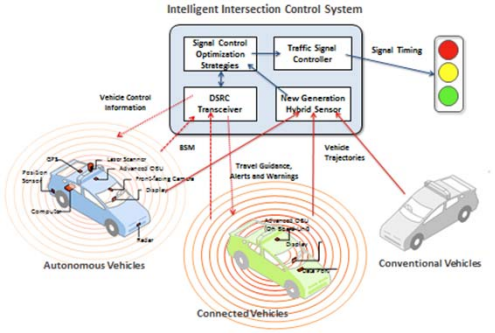
OBJECTIVES

Significant improvements in autonomous vehicle technologies as well as their connectivity and interaction with future generation traffic systems together are expected to create a perfect storm in how vehicles are going to navigate through city roads and highways.

This study develops optimization algorithms, simulation tools, and sensor capabilities for enhancing traffic signal control operations simultaneously with vehicle trajectories, when the traffic stream consists of connected vehicles, autonomous vehicles, as well as conventional vehicles. To achieve the project goals, we have secured the collaboration of two industry partners: ISS and Econolite. The first is developing algorithms for multi-sensor fusion and the latter is providing industry-standard sensors. The following are key research issues that are being investigated:

- Novel optimization algorithms for a variety of vehicle connectivity and automation and considering a broad set of intersection designs.
- Advanced simulation tools for testing the new controller, the movement of autonomous and connected vehicles, as well as the field operation of advanced sensor technologies.
- Sensor systems and sensor fusion methods to improve the functionality, range and accuracy of detection.
- Deploy and test the above methods at FHWA TFHRC, followed by field deployment during the Transition to Practice.

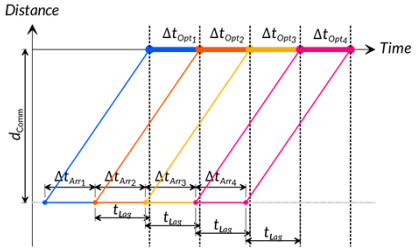


RELEVANT STUDIES

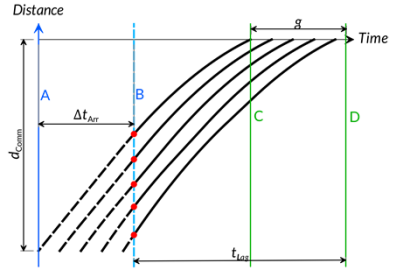
Perhaps the most researched class is the vehicle to infrastructure (V2I) communication at unsignalized intersections with fully automated vehicles demand. (Dresner & Stone, 2008) made a case where automated vehicles can communicate with a central controller requesting for a reservation to proceed the crossing maneuver. When the traffic is composed of all fully automated vehicles, and exchange of information is perfect, an algorithm can be designed to schedule the vehicle sequence. However, this approach does not address the transition period, when conventional vehicles should be served by the infrastructure. Moreover, having an intersection unsignalized can cause safety concerns.

An alternative framework can be devised that includes the presence of conventional vehicles beside automated vehicles.

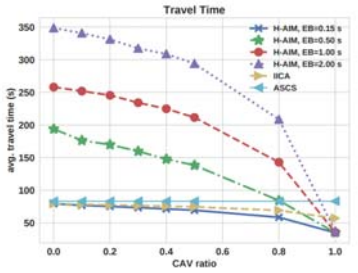
ROLLING HORIZON SCHEME

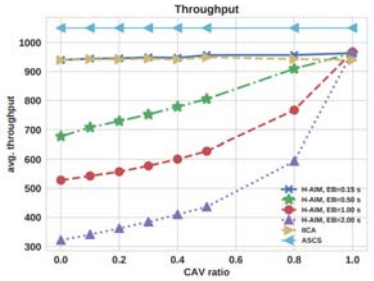


OPTIMAL TRJECTORIES

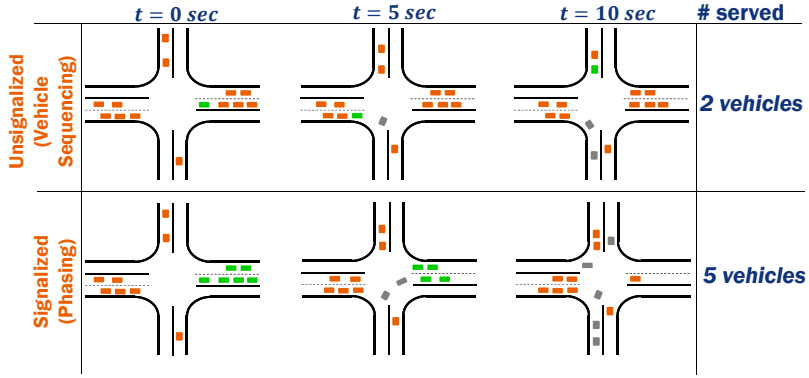


COMPARISON WITH HYBRID-AIM & ACTUATED CONTROL

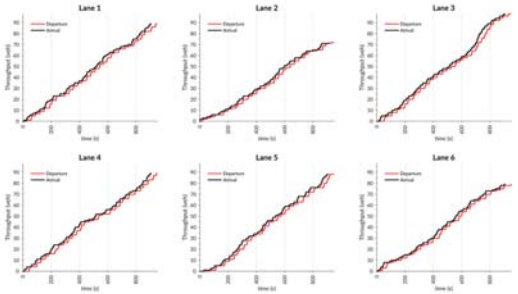




CONTROL LOGICS' PERFORMANCE



THROUGHPUT (FDOT TERL SIMULATION)



DEPLOYMENT AND TESTING AT FDOT TERL

- Six vehicles (4 AV/CVs and 2 conventional)
- Scenario run time: 15 minutes
- Max speed: 15 mph
- Detection range: 100 - 500 ft
- 1 SMS Type 29 Doppler Radar
- 4 vehicles equipped with DSRC
- Metrics included the accuracy of the multi-sensor fusion and how closely the actual trajectories driven by vehicles matched the optimal trajectories computed by IICA (root-mean-square error, or RMSE)

	Sample Size	Min RMSE (ft.)	Max RMSE (ft.)	Mean RMSE (ft.)
AV/CV	23	4.333 ± 3.507	64.856 ± 42.614	33.130 ± 18.587
Conventional	12	0.061 ± 0	75.499 ± 53.113	32.054 ± 20.923

REFERENCES

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