UF Transportation Institute
UNIVERSITY of FLORIDA

Optimizing Signalized Intersection Control with Automated and Conventional Vehicles (CPS Synergy; Award 1446813)

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OBJECTIVES

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

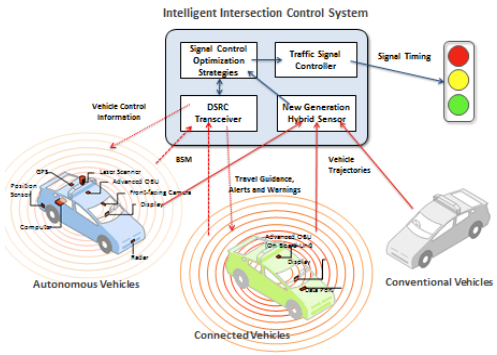
This project will develop optimization algorithms, simulation tools, and sensor capabilities for enhancing traffic signal control operations simultaneously with vehicle trajectories, when the traffic stream consists of connected vehicles, autonomous vehicles, and conventional vehicles. To achieve the project goals, we have secured the collaboration of two industry partners: ISS and Econolite. The first will develop a new sensor to be used in obtaining vehicle trajectory information for conventional and malfunctioning vehicles.

The following will be accomplished:

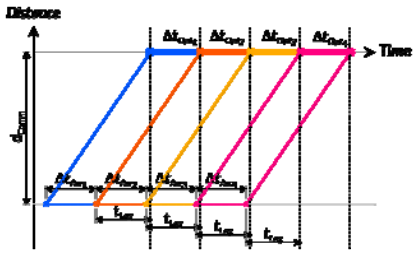
- Develop novel optimization algorithms for a variety of vehicle connectivity and automation scenarios, considering a broad set of intersection designs.
- Develop advanced simulation tools for testing the new controller, the movement of autonomous and connected vehicles, and the field operation of advanced sensor technologies.
- Develop novel 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.

FRAMEWORK

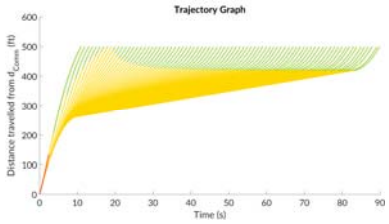
The proposed control system, shown below determines signal timings and automated vehicles' movement to optimize the overall performance of an intersection. The automated vehicles send their arrival information as they approach the intersection. Radar and video based technology is being developed to collect the same information for conventional vehicles with no communication capabilities. A fusion algorithm will be developed to synthesize all vehicle arrivals and provide them to the optimization algorithm.



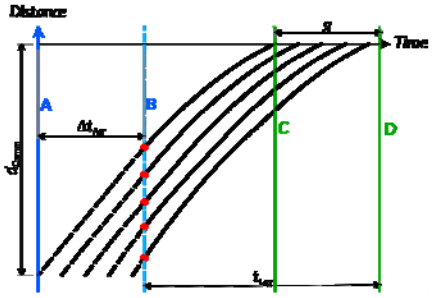
ROLLING HORIZON SCHEME



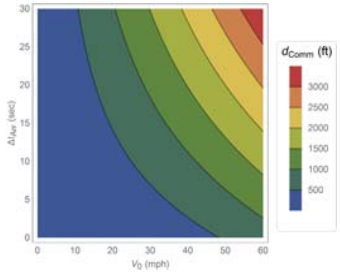
OPTIMAL TRAJECTORY DESIGN



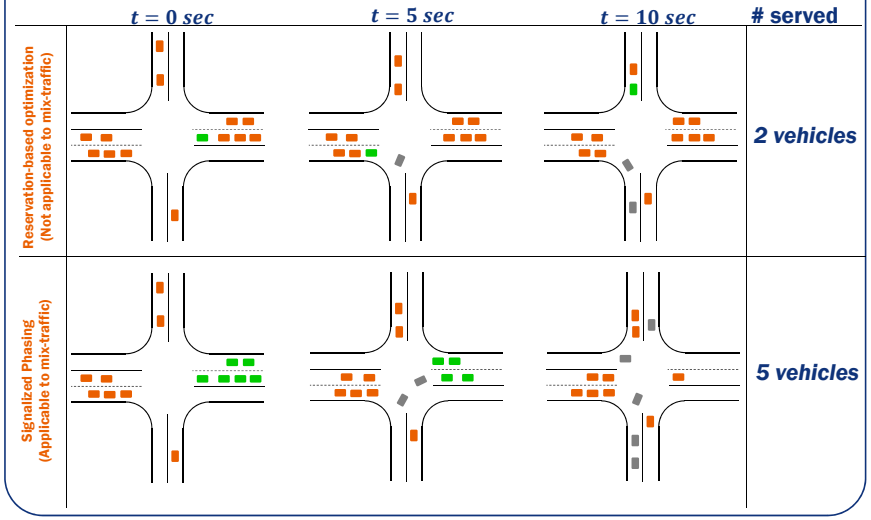
OPTIMAL TRAJECTORIES



COMMUNICATION RANGE AND OPTIMIZATION PARAMETERS

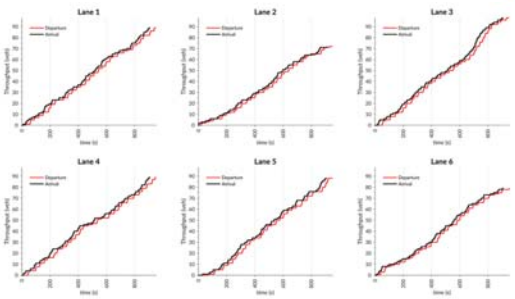


CONCEPTUAL CONTROL LOGIC

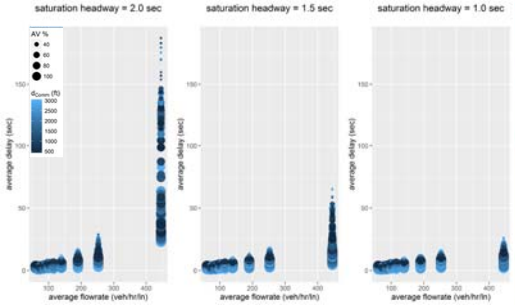


PRELIMINARY RESULTS (LOW DEMAND)

CUMULATIVE ARRIVALS/DEPARTURES



AVERAGE DELAY SENSITIVITY ANALYSIS



NEXT STEPS

- Extend the algorithm to process over-saturated conditions
  - A more systematic signal optimization is developed to address high demand conditions, and intersections with complicated channelization and phasing patterns.
  - Various optimization approaches are considered.
- Optimize considering missing data from radar and automated vehicles' sensors.
- Develop sensor fusion algorithms to integrate arrival information from several sources.
- Simulate the algorithm under a variety of scenarios considering mixed traffic.
- Develop interface between vehicles, central optimization unit and signal controller.
- Test under real-time field conditions for mixed traffic.