PLATOONING TRAJECTORY AND SIGNAL PHASING OPTIMIZATION FOR CONNECTED AUTOMATED VEHICLES IN COORDINATED ARTERIALS

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Motivation

- Several studies have developed signal control algorithms using CAVs at the intersection level, but there are few such studies for arterials
- Joint optimization of CAVs trajectories and Signal Phasing and Timing (SPaT) for arterial is limited by the computation cost
- Researchers evaluate their methodologies by developing simulations on different platforms (Python, Matlab, etc). This makes it challenging to compare different methodologies
- Evaluation in well-established simulation frameworks such as VISSIM is not used when evaluating CAVs optimization strategies

Objective

- To develop a heuristic framework to jointly optimize (**I**) Connected Automated Vehicles (CAVs) trajectories, and (**II**) SPaT in coordinated arterials.
- Integrate our optimization framework into a microsimulation software to facilitate the comparison of CAVs impact in signalized intersections and different optimization strategies

I. Trajectory Optimization Methodology

A heuristic approach was developed to adjust CAVs trajectories to form platoons and ensure the arrival of CAVs during the green interval

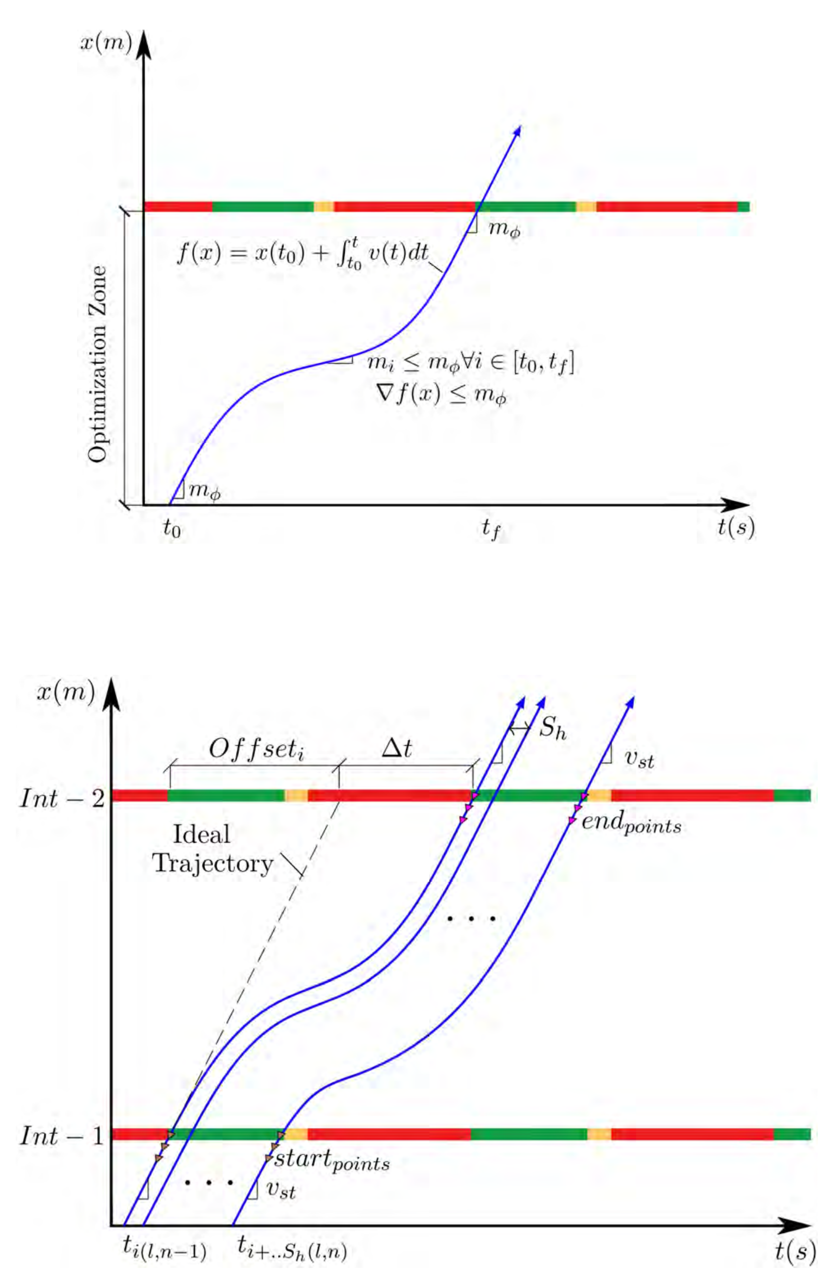

Fig. 2: Concept of trajectory optimization algorithms.

II. SPaT Optimization Methodology

A search-based algorithm is designed to optimize the SPaT. A novel Performance Index (PI) is set as the objective function. The PI represents how vehicles' trajectories deviate from their ideal trajectory.

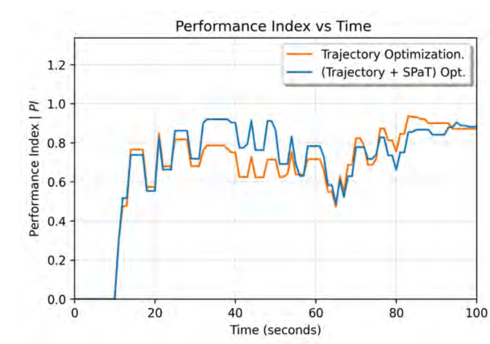

Fig. 3: Comparison of PI variation over time.

I. Simulation Experiments and Results

Simulation results showed that the trajectory optimization framework successfully form platoons at the saturation headway (S_h) without collision. The results showed that travel time and delay are reduced by (7-16%) and (23-43%), respectively.

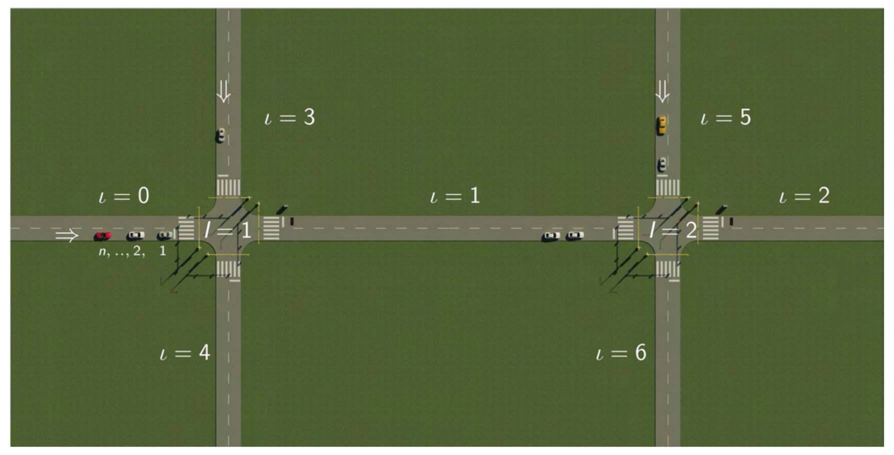

Fig. 4: Study arterial for simulation experiments.

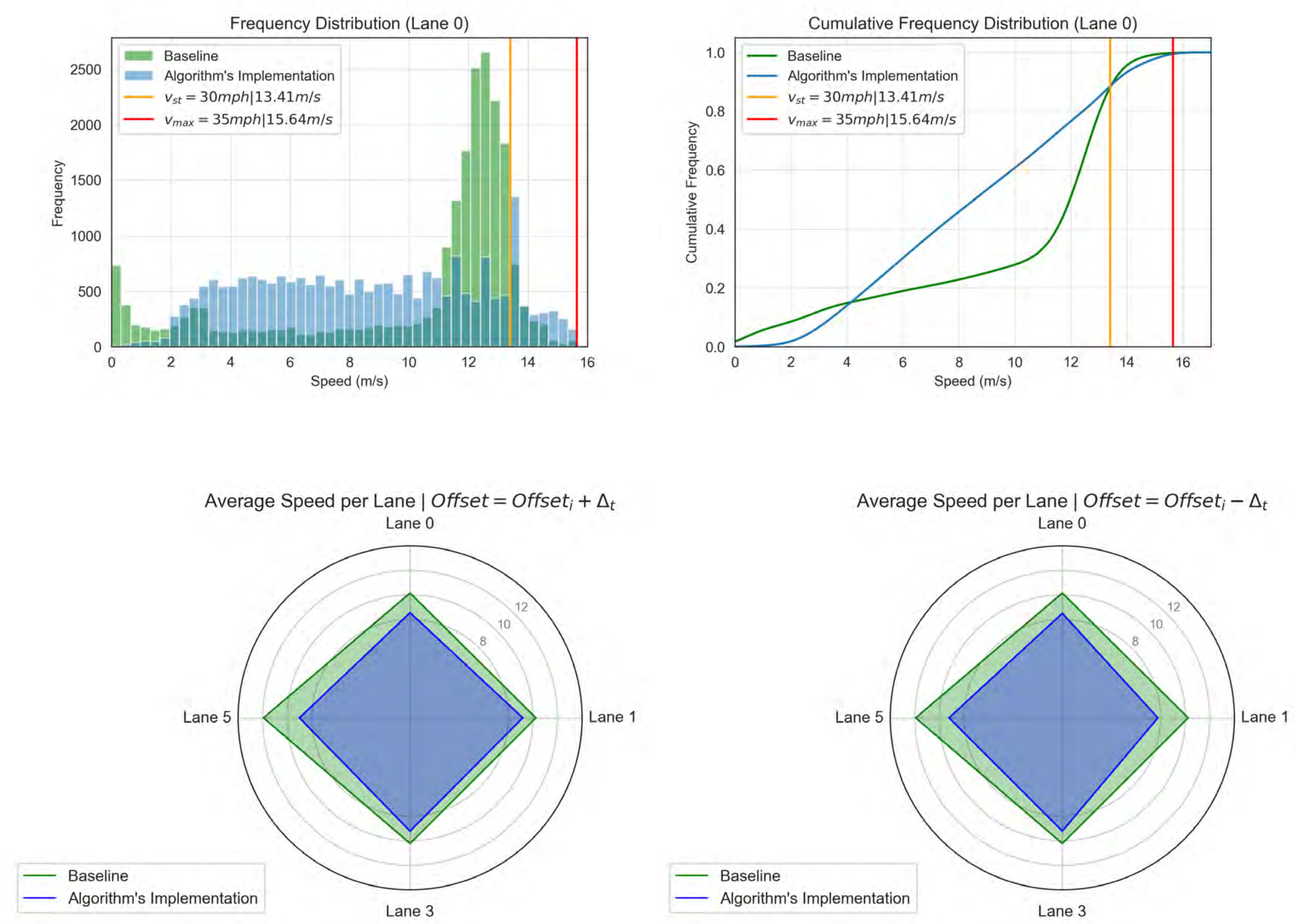

Fig. 6: Average speed distribution by approach.

II. Simulation Experiments and Results

Adding the SPaT optimization to the platoon-trajectory strategy travel time and delay are reduced by 4-9% and that the green usage is increased.

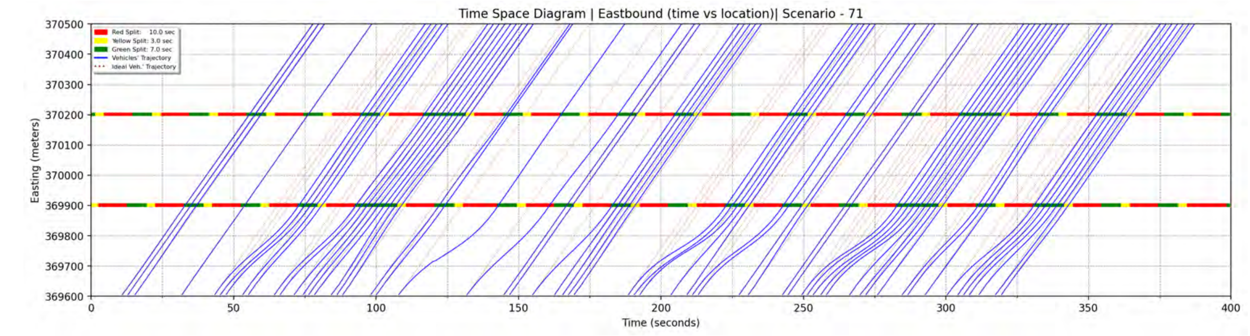

Fig. 7: Time-Space Diagram.

Algorithms - Microsimulation Integration

Carvalho et al 2022 proposed a methodology to integrate optimization strategies in PTV VISSIM.

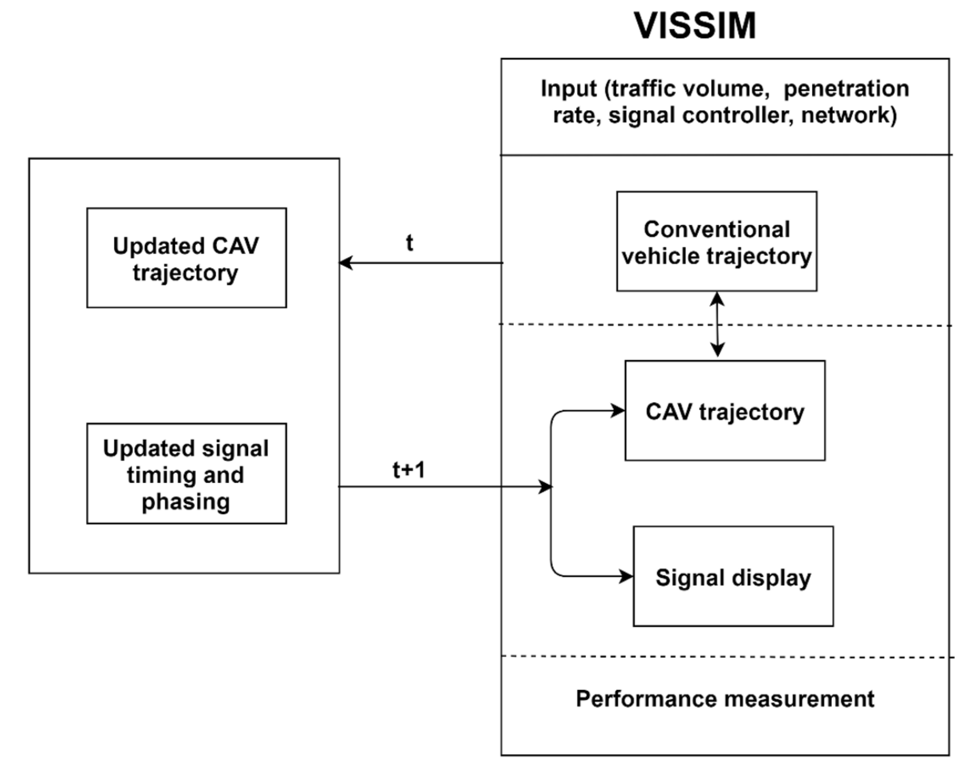

Fig. 8: Algorithm's Integration in VISSIM (Carvalho et al 2022).

Connected Vehicles Predictive Model

Connected vehicles behavior need to be model to asses the impact of mixed traffic conditions. Predictive models can be developed using high-resolution data from On-board-Units (OBU).

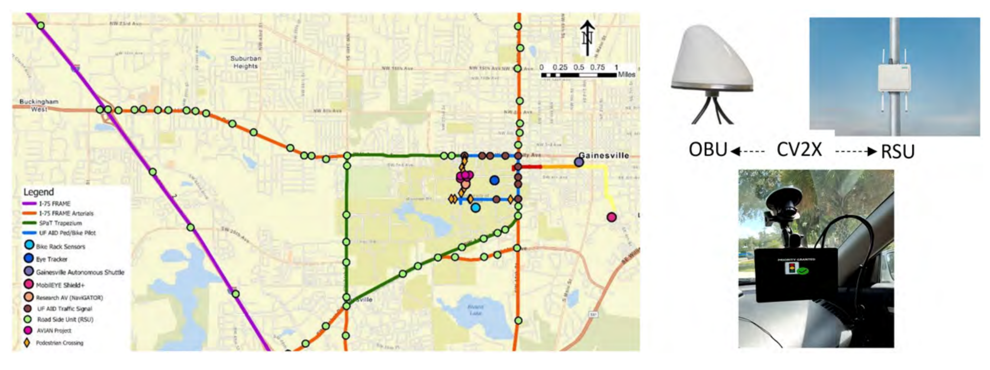

Fig. 9: Connected vehicles data collection site.