DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Coordination of Freeway Ramp Meters and Arterial Traffic Signals Phase IIA – Site Selection and Simulation Development

Develop and implement a control algorithm to manage the entry of vehicles on the on-ramp through signal timing changes at the intersections along adjacent arterial(s)

Transportation Safety and Mobility

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Project Title:
Coordination of Freeway Ramp Meters and Arterial Traffic Signals Phase IIA – Site Selection and Simulation Development

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WHAT IS THE NEED?

It is generally recognized that, for highly efficient and reliable traffic flow over the entire traffic network along a corridor, it is necessary to coordinate the traffic control systems between roads of different subsystems due to the strong dynamic interactions between them. Outputs of one subsystem (freeway off-ramp or arterial) is the immediate input of another subsystem (arterial or freeway onramp). The performance of the overall traffic network relies on the efficiency of traffic controls in different subsystems and an optimal coordination between them as a whole system. The objectives of this study are to develop and implement a control algorithm for coordinated operation of metered freeway on-ramps and adjacent signalized intersections.

WHAT WAS OUR GOAL?

The goals of the research are to develop and implement a control algorithm to manage the entry of vehicles on the on-ramp through signal timing changes at the intersections along adjacent arterial(s). The research effort is a continuation of a previous PATH research project that developed a control algorithm for coordinating a single freeway metered on-ramp with an adjacent isolated signalized intersection. This report describes the research performed in phase IIA of the project: development of a control algorithm, test site selection, and evaluation of a proposed algorithm on the test site through simulation. The field implementation and testing of the proposed algorithm at the selected test site will take place in the upcoming phase IIB of the project.

WHAT DID WE DO?

The project team first conducted data collection and analysis for site selection. As shown in Figure 1, the selected site is a 4 mile long section of I-680 from Alum Rock Ave. to Berryessa Rd. with five intersections in San Jose, California. There are three recurrent bottlenecks on this stretch of I-680, which are located near the onramps from Berryessa Rd., McKee Rd., and Alum Rock Ave.

Three control strategies have been developed to manage the entry of arterial traffic on the freeway on-ramp to avoid queue spillover. The first algorithm is an extension of the algorithm originally developed in the previous PATH project and adjusts both the metering rates and signal settings. The second algorithm adjusts the arterial signal settings taking into account the platoons on the arterial. The third algorithm attempts to minimize the on-ramp queues through changes of the cycle length at the adjacent signals. The third algorithm (queue length minimization) was selected for evaluation through simulation at the test site.

A field study has been conducted at one of the active bottlenecks at the selected site to field measure the changes in freeway discharge rate (capacity) due to the activation of queue override. Data were collected over ten weekdays using video cameras. Traffic flows on the freeway mainline and on-ramp were recorded an analyzed for the 7:00-9:30 AM peak period. Traffic operations at the site were simulated using the AIMSUN microscopic model. The model was calibrated to reasonably replicate existing traffic operating conditions.

WHAT WAS THE OUTCOME?

The simulation results show the proposed coordination strategy eliminated the queue spillback on the metered on-ramps that activate the queue override. This resulted in 17.9% reduction on freeway delay. The analysis of field data on bottleneck discharge flows indicate that the proposed strategy may improve the freeway capacity by 5 to 10 percent. The delay on the parallel arterial was increased on the approaches feeding the on-ramps but decreased on the rest of the signal controlled approaches. The system-wide delay was reduced by 7 percent.

The proposed control algorithm can be used with any freeway on-ramp metering algorithm. The proposed algorithm is simple and readily implementable at most freeway corridors with metered on-ramps and adjacent signalized arterials without additional instrumentation.

The next step in the ongoing research is conducting the phase IIB of the project: field implementation and testing of the control algorithm at the selected test site. This phase of the project involves the following major tasks: a) strategy software implementation and testing, b) field implementation, c) data collection on traffic performance on both freeway and arterial intersections, and d) analysis of field data to assess algorithm performance and develop guidelines for statewide implementation.

WHAT IS THE BENEFIT?

The benefit of the proposed work include the ConOps and algorithms developed for coordination and control of freeway-arterial corridors. If the field implementation and test is successful in the future phase IIB, Caltrans districts could potentially apply the developed coordination/control strategies on congested freeway-arterial corridors for traffic system performance improvement. Caltrans and the public drivers will eventually benefit from the research results

IMAGES

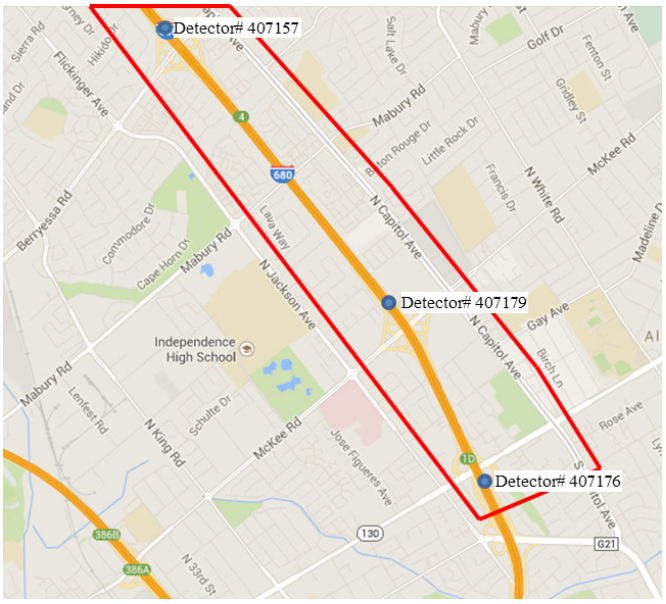

FIGURE 1: Selected Site: Freeway and Relevant Arterials