



Caltrans Division of Research,
Innovation and System Information

Research

Notes

Transportation
Safety and
Mobility

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Project Title:
Testing of Combined Variable
Speed Advisory (VSA) and
Coordinated Ramp Metering (CRM)
for Freeway Traffic Control

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Graphical User Interface Development for Coordinated Ramp Metering System

Develop a user-friendly Graphical User Interface software for Caltrans to manage freeway corridors traffic in California.

WHAT IS THE NEED?

Although freeway ramp metering (RM) has been widely used for California highways for traffic management and control, they are mostly Local Responsive Ramp Metering (LRRM). LRRM determines RM rate only based on the information from its immediate upstream mainline traffic detectors. Therefore, the traffic throughput along the freeway corridor is not optimized.

A previous project funded by California Department of Transportation (Caltrans) Division of Research, Innovation and System Information, focused on field test of Coordinated Ramp Metering (CRM) on the State Route (SR) 99 North Bound (NB) section near Sacramento. The overall corridor traffic efficiency (or average speed) was improved by 7.25% in morning peak hours.

After the project was completed, Caltrans District 3 Regional Traffic Management Center's traffic engineers made the following request:

- To continue using the CRM control as the daily operation for the SR99 NB corridor; and
- To develop a Graphical User Interface (GUI) for the CRM algorithm so that Caltrans freeway traffic engineers can easily apply it to other freeway corridors.

WHAT ARE WE DOING?

The project team will build a user-friendly GUI capable of hiding all the complications of the mathematical algorithms. With this GUI, Caltrans Freeway Ramp Metering traffic engineers can set up the system to control a freeway corridor using the CRM strategy by simply inputting a set of traffic parameters manually or from a file, which include:



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- Freeway name
- Start post mile and end post mile
- Total number of lanes of each freeway section
- Number of high-occupancy vehicle (HOV) lanes of each freeway section
- Number of onramps in sequence and their locations and lengths
- Onramps total number of lanes and number of HOV lane
- Number of off-ramps in sequence and their locations and lengths
- Traffic (or loop) detector locations
- Internet protocol (IP) addresses of all the detectors in mainline, onramps and offramps

The project will include the following tasks:

- Determine the Real-time Operating System for GUI
- Build the GUI module for freeway corridor modeling for CRM
- Build the GUI module for data link and data mapping between field 2070 controllers IP addresses and CRM algorithm
- Build the GUI module for traffic data processing and traffic state parameter estimation
- Build the GUI module for link with new data types such as connected vehicle data
- Develop the GUI module for control parameter tuning with CRM deactivation capability; after the deactivation, the RM will go back to LRRM by default
- Develop the GUI module for fault detection and warning capability which can handle most common CRM system faults
- Implement CRM GUI System integration
- Test and validate the CRM GUI developed on SR99 NB corridor and a US50 corridor
- Write an Operation Manual and train Caltrans District 3 freeway traffic engineers for CRM GUI operation
- Write Final Report to document all the algorithms, lessons learned, and experiences gained in the project and make recommendations

WHAT IS OUR GOAL?

The goal of the proposed project is to develop a user-friendly GUI software, e.g. a Linux or Windows-based application that the Caltrans district freeway traffic engineers can easily use to control freeway corridors traffic in California.

WHAT IS THE BENEFIT?

The immediate benefit of CRM with GUI tool capability is that it is a convenient way for Caltrans traffic engineers to apply the CRM traffic control strategy to any freeway corridor.

The CRM algorithm used in the GUI uses a simplified optimal control approach that determines the RM rate at each onramp by considering the overall traffic along the freeway corridor. The traffic improvement benefit should be more significant than the LRRM currently in operation in almost all Caltrans Districts. Therefore, wide use of the CRM for freeway corridor traffic control will lead to direct benefits in freeway throughput improvement and congestion reduction. This will reduce Total Travel Time which match with the Mobility Improvement of the Caltrans Strategic Goal. Indirect benefits will include but not limit to energy and emission reduction and safety improvement.

WHAT IS THE PROGRESS TO DATE?

Continue working with PATH on developing GUI for the Coordinated Ramp Metering on State Route 99 so that other Caltrans districts may adapt the CRM algorithm to control similar freeway corridors in California. PATH team has further revised algorithms and has started to link the GUI code with the CRM algorithm. Specifically, team is working on the two codes: the previous hard-coded CRM code, and the new integrated GUI and CRM code. This is an iterative process for debugging and refining for further improvement. PATH team is also waiting for the operation to start after the road construction project is accomplished.