MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

RESEARCH SUMMARY

Design and Demonstration of an Arterial-friendly Local Ramp Metering Control System

WHAT WAS THE NEED?

Highways and arterials are highly inter-dependent but may have their own operational strategies and systems that do not necessarily synchronize, leading to spillover of queues from highways to arterials and substantial congestion that worsens the overall system performance. It is critical to develop control strategies for synchronizing ramp metering and local signalization to proactively prevent queuing stemming from either recurrent congestion or the occurrence of incidents, meanwhile ensuring a balance between highways and local arterials.

WHAT WAS THE GOAL?

This project aims to develop, assess, and optimize control strategies for ramp metering and local signal synchronization in Maryland's Transportation Systems Management and Operations (TSMO) 1 system (I-70 corridor east of Baltimore, MD). The methodology and mesoscopic simulation model can be generally applicable to other networks and TSMO systems.

WHAT DID THE RESEARCH TEAM DO?

A computationally efficient mesoscopic network simulation tool is constructed incorporating a signal control module for coordinated signalized intersections and ramp metering. The dynamic network model is calibrated by a state-of-art data-driven calibration framework using multi-source multi-class traffic data. Two control strategies, ALINEA and local signal synchronization (LSC), are implemented and tested to control metering rates at two candidate ramps along the I-70 corridor with the objectives

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of minimizing system-level congestion and ensuring equity among highways and arterials. Various scenarios with different demand levels, control strategies and incident occurrence are generated to examine the effectiveness and robustness of the proposed control methods.

WHAT WAS THE OUTCOME?

The network calibration result demonstrates the calibrated model has a satisfactory accuracy to reproduce actual traffic conditions. Tests on various scenarios of demand level and incident occurrence show that the LSC method consistently outperforms ALINEA in terms of achieving a greater reduction in average travel time, vehicle miles traveled (VMT) and vehicle hours traveled (VHT), and ensuring a good balance of vehicle delay on both ramps and immediate downstream highway segments.

The examined LSC method has a stable performance under recurrent congestion and non-recurrent traffic impacts.

HOW WILL MDOT SHA USE THE RESULTS?

The recommendation to the State Highway Administration (SHA) is to consider implementing an LSC control strategy to coordinate between ramp metering and localized signal controls to achieve the best performance and ensure equity. The LSC method *can be proactively engaged with ahead-of-the-curve traffic prediction under non-recurrent incidents that impact the immediate downstream highway segments of ramps.*

The calibrated mesoscopic network simulation model can also be quickly adopted for assessing and optimizing other intelligent transportation system (ITS) strategies to deploy in TSMO #1 System, such as traffic routing, traveler information provision, tolling, high occupancy vehicle (HOV) lanes, queue warning and incident management.

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