DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Unified Framework for Stationary Arterial Network

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Design

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Project Title:
Unified Framework for Stationary Arterial Network

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WHAT IS THE NEED?

Traffic signals have been widely deployed to resolve conflicts among various traffic streams. However, signalized intersections are also major network bottlenecks, stop-and-go traffic patterns and travel delays at busy urban intersections. Most of existing signals design methods employed has a gap between method based on delay formulas and those based on traffic simulation. Existing methods for traffic signal design are either too simplistic to capture realistic traffic characteristics or too complicated to be analytically solvable, and there still lack a systematic method to analyzing the challenging design for traffic signals of a large-scale arterial network. There is a need for new unifying methodology for performance analysis and signal design in signalized networks to find optimal signal control parameters.

WHAT WAS OUR GOAL?

The goal is to develop a unified theoretical and simulation framework for analyzing and designing signals for stationary arterial networks.

WHAT DID WE DO?

In this research, we applied the link transmission model to formulate and proposed a unified framework in a signalized arterial network by:

- Analytically derived macroscopic fundamental diagrams for stationary traffic patterns with different network topologies, road conditions, driving behaviors, and signal settings;
- Quantified congestion mitigation effects of different signal settings, including cycle lengths, green splits, and offsets;
- Formulated an optimization problem with the network flow-rate as performance measure to find optimal signal control

parameters under certain demand levels.
- Developed a set of simple decision-support tools for arterial network improvement.

WHAT WAS THE OUTCOME?

For the homogeneous road network:
- We obtained a simple link transmission model for the boundary flows on a signalized ring road, which forms the foundation for solving and analyzing stationary states.
- We derived an explicit approximate macroscopic fundamental diagram, in which the average flow-rate is a function of both traffic density and signal settings.
- We derived improved formulas for the optimal signal cycle length and offset under different traffic conditions to improve arterial network performance.

Future research may include applying the method to study inhomogeneous road network to provide insight into different road length, speed limits and start-up lost time caused by different queues.

WHAT IS THE BENEFIT?

The field of traffic engineering incorporates mathematical techniques, as well as the state of-the-art traffic flow theory adopted by research programs in the Department of Transportation. These tools allow us to analyze gaps in the strategy of optimal signal control to provide solutions and knowledge to relief traffic congestion in urban networks.

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Review the complete report:
http://www.dot.ca.gov/research/researchreports/dri_reports.htm