CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6859: Operational Analysis of Active Traffic Management Strategies

Background

The objective of this project is to develop tools for analyzing the effectiveness of active traffic management (ATM) strategies. The Federal Highway Administration defines ATM strategies as practices that manage recurring and non-recurring sources of congestion in a dynamic manner as a function of prevailing traffic conditions. Such strategies include ramp metering, variable speed limits, and using shoulders as travel lanes during peak times. From a planning perspective, the decision to deploy ATM strategies poses two key challenges:

1. Which control strategies are best suited for a particular corridor?
2. How can a strategy's effectiveness be tested at a network level—prior to implementation—using mathematical models that capture traffic flow dynamics and driver behavior?

The tools developed in this project offer insight into these challenges: an offline hybrid microsimulation-dynamic traffic assignment (DTA) model analyzes the strategies' effectiveness and a spreadsheet tool helps decision-makers implement ATM strategies under different levels of data availability.

What the Researchers Did

The research efforts can be broadly categorized into two parts. First, the researchers performed the following work:

1. We developed a detailed microsimulation model of the I-35 corridor in Williamson County. The objective was to demonstrate the usefulness of microsimulation models in assessing the performance of different control algorithms for four different ATM strategies.
2. We also developed a DTA model of the Williamson County network (in a software called VISTA) and combined it with the microsimulation model results to build a hybrid model that can test both the detailed corridor-level and broad network-level impacts of an ATM strategy. The offline hybrid model iterated back and forth between VISSIM and VISTA until convergence.

Second, the researchers conducted several corridor and network-level simulations on toy networks to build regression models that can predict the effectiveness of ATM strategies under different levels of data availability (provided as 0-6859-P1).

What They Found

Following are the key findings:

- For the recurring congestion scenario, ramp metering, variable speed limits, and hard shoulder running are found to improve the corridor travel time and network performance for the selected testbed. Certain control algorithms and their

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parameters showed an improvement of 5–16% in the system delay. The percent changes for dynamic lane use control near ramp merge and freeway-arterial coordinated operations are found insignificant.

- Ramp metering and variable speed limits lead to a reduction in corridor travel time when combined, in comparison to the isolated use of each individual strategy. However, the overall network performance is worse when the strategies are used in combination.
- For the case of non-recurring congestion, most strategies lead to worse network performance compared to the base case (do-nothing), due to the bottleneck effects of the incident. The sensitivity analyses for hard shoulder running and ramp metering indicate that the performance under non-recurring congestion depends on the location, severity, and the duration of the incident.
- In terms of network-level impacts, the shift in route choice patterns caused by each ATM strategy is found insignificant. Ramp metering and variable speed limits increase the total system travel time for the network, with only marginal effects on corridor congestion.
- The local impacts of ATM strategies are different depending on combinations of demand and downstream bottleneck capacity. The regression models estimated in this project have a good fit to simulation results.

What This Means

The results from the analysis point have the following implications:

1. The impact of an ATM strategy is observed beyond the freeway facility. For instance, an ATM strategy that creates a significant improvement in the mainline travel time may decrease performance for the rest of the corridor, including the frontage roads. Prior to implementation, the agency deploying the ATM strategies must carefully consider the objective, scope, and choice of ATM strategy and its control algorithm.
2. To accurately evaluate the effectiveness of ATM strategies, consider both microscopic and network-level impacts, which necessitates integrating high-fidelity microsimulations and dynamic or static traffic assignment models (such as the hybrid model proposed in this research).
3. The network-level impacts of an ATM strategy beyond the corridor may or may not be significant for a given network. The propensity of travelers to change their current route depends on the attractiveness of the alternate routes. A careful analysis of travel time and capacities on all alternate routes to the selected corridor is thus recommended.
4. Generalizing the effectiveness of an ATM strategy from one simulation result to another should be treated with caution. The usefulness of an ATM strategy depends on several factors, including corridor geometry, control algorithm, demand, choice of location, and coordination between the strategies. The decisions derived from the regression models should be used only for preliminary planning purposes or for multiple scenario analysis. Before actual deployment of an ATM strategy, the research team recommends building a microsimulation model of the corridor for a full analysis of the impacts.

For More Information

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