Computer-Aided Testing and Evaluation of Adaptive Ramp Control Strategies

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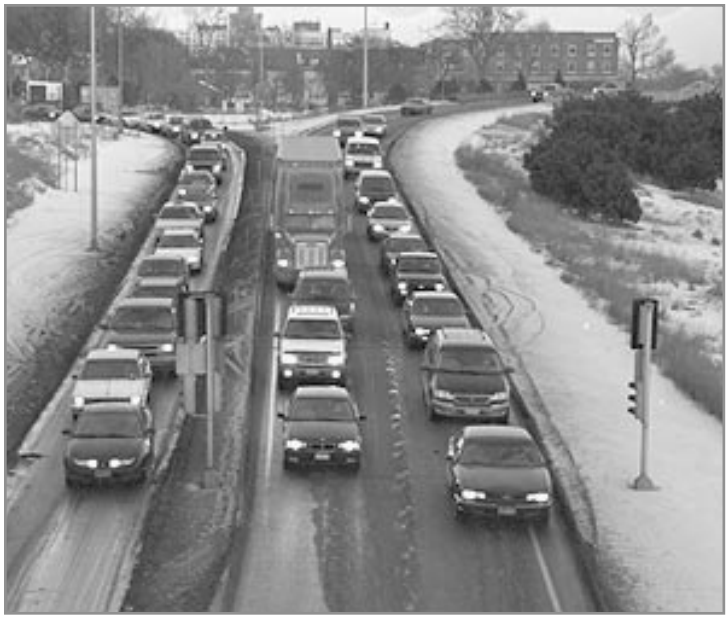
Why This Research is Needed

Researchers and professionals must rely on simulation models to test and evaluate new traffic management strategies, such as those for ramp control. Current simulation models, however, are designed to implement only a particular control strategy. Also, simulation results are often hard to interpret because of the large amounts of data that must be analyzed before a user can judge the effectiveness of a traffic management strategy, especially when comparing several different strategies.

Research Objective

To develop a computer-aided simulation method that can adapt to the unique characteristics of individual freeways and situations.



Traffic waits at a ramp meter before entering I-35W in Minneapolis.

Methodology

The researchers used a versatile microscopic simulator enhanced to include an interface that allowed the integration of any user-specified ramp control scheme and that automatically collected and fed demand patterns to the simulator. To minimize the task of entering initial and boundary conditions, the researchers prepared software to store data from 3,000 detectors in a relational database. This software can produce initial and boundary conditions for any modeled section by accessing the database. To give users a uniform and simplified way to view results, the researchers also developed a visualization model for plotting the relevant measures of effectiveness specific to a particular application, such as ramp control, incident management, and lane closures.

> *"This is the first program that has been able to give us any kind of indication of the difference between [ramp] metering and non-metering."*
>
> *—Rich Lau, traffic systems and research engineer at the Minnesota Department of Transportation's Traffic Management Center*

To test the system, the researchers developed an application in which a real-time ramp control strategy was compared with the no control alternative. The simulation was implemented on a segment of heavily traveled freeway that included 20 exit and 20 entrance ramps controlled during the afternoon peak hours, six weaving sections, a

lane drop section, and three bottleneck locations. The experiment consisted of two test cases, one involving normal congestion, and the other with congestion increased by 20 percent; simulations were performed for each with and without ramp control. The researchers collected and measured total travel time in vehicle-hours, total delay in vehicle-hours separately for the mainline and the ramps, and total travel in vehicle-kilometers for the whole network.

Research Results

The results revealed that total travel time in the mainline decreased by 4 percent when control was introduced under normal congestion. Total ramp delays increased substantially as expected, but overall total travel time in the system was reduced by 35 percent and delays, by 62 percent. In heavy congestion, the total system travel time decreased by 24 percent and total delay by 39 percent. Generally, in both cases with control, higher speeds were achieved and flow was smoother throughout the freeway. Thus, the control algorithm achieved its objective of maximizing flow through the bottleneck of each zone.

The researchers found that an even more important outcome of the test application was that quantification of the results was a much easier task. The new method allows access to the quantitative results of continuously changing demand patterns without manual field measurements.

Research Impacts

The system has significant potential for testing or developing new integrated solutions, parameter calibration, and algorithm optimization of specific freeways. What makes it unique is that the entire simulation, database, and control logic package can be used to estimate parameters and compare and evaluate ramp control strategies interactively, so improving current methods and experimenting with new control algorithms will be easier and more practical. In addition, the involvement of traffic managers at the Minnesota Department of Transportation means that what the research team developed will be useful to, and accepted by, professionals in the field.

What's Next

Because their results are preliminary, the researchers will confirm them with other simulators, improved modeling, better assumptions, and calibration.

Related Publications / Presentations

Hourdakis, J. and Michalopoulos, P.G., 2000, "Development and Implementation of a Virtual Traffic Management Center," Seventh World Congress on ITS, Torino.

Hourdakis, J. and Michalopoulos, P.G., 1999, *Towards the Development of the Next Generation Traffic Management Centers: TRAMLAB System*, proceedings of the Sixth World Congress on ITS, Toronto.

Koka, M., Hourdakis, J. and Michalopoulos, P.G., "Computer-Aided Testing and Evaluation of Adaptive Ramp Control Strategies," presented at the 2000 Annual TRB meeting, Washington D.C.

Michalopoulos, P.G. and Hourdakis, J., 2000, "Simplifying Simulation for ITS Applications," presented at the ITS America annual meeting, Boston.