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RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS, RESEARCH & INNOVATION

TECHNICAL SUMMARY

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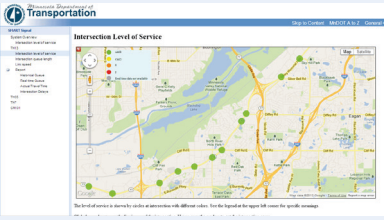
PROJECT COST:
$239,000



A Web-based interface allows users to monitor traffic congestion at intersections in real time.

Putting Research into Practice: Improving Traffic Signal Timing with the SMART-SIGNAL System

The SMART-SIGNAL system is a cost-effective solution for improving traffic signal timing that will help MnDOT ease congestion along arterial roadways. By providing improved performance tracking, the system will also help MnDOT prioritize resources and communicate travel information to the public more effectively.

What Was the Need?

To help reduce congestion on arterial roads, traffic engineers try to optimize the timing of traffic signals to produce the most efficient flow of traffic through intersections, preventing backups and reducing traffic delays. Optimizing signal timing is especially important given that congestion on arterial roads is increasingly a problem. These roads carry a large percentage of traffic, and backups at major intersections are often worse than those on surrounding freeways.

However, optimizing traffic signals and managing arterial congestion require traffic data that is often not readily available. While road sensors and surveillance cameras are commonplace on arterials and freeways, traffic data collection on arterial roads still requires costly manual traffic counts and other labor-intensive methods. Consequently, agencies are less equipped to inform drivers of expected delays on arterials as compared to highways.

To address these problems, researchers at the University of Minnesota developed the SMART-SIGNAL (Systematic Monitoring of Arterial Road Traffic and Signals) system, which leverages existing traffic signal infrastructure, such as in-pavement sensors at vehicle-activated stoplights, to automate the process of collecting arterial traffic data. The system includes electronic hardware that can be easily installed in existing traffic signal control cabinets located at intersections. These data collection units record traffic data and relay it to a server at a traffic control center, where engineers analyze the data to detect emerging congestion patterns and adjust traffic signal timing accordingly.

What Was Our Goal?

The goal of this project was to further refine the SMART-SIGNAL system hardware and graphical user interface for easier installation and management, and to implement the system at 13 intersections along Trunk Highway 13 (TH 13) in Burnsville, Minnesota.

What Did We Implement?

This project implements the research from Report 2009-01, Development of a Real-Time Arterial Performance Monitoring System Using Traffic Data Available from Existing Signal Systems, which developed the SMART-SIGNAL system and tested it on an 11-intersection arterial corridor along France Avenue in Hennepin County. Using collected data, researchers developed new algorithms to measure traffic signal performance. Results also showed that the system's estimated travel times were highly consistent with recorded travel times.

How Did We Do It?

Investigators refined the SMART-SIGNAL system by upgrading its data collection units to be more compact and compatible with new traffic controller cabinets (NEMA TS2 type) being adopted by MnDOT, and to allow real-time communications with the traffic

continued

"The SMART-SIGNAL system takes all the data we have in the traffic signal cabinet and turns it into usable information for traffic engineers to assess how their signals are operating."

—Steve Misgen,
Traffic Engineer,
MnDOT Metro District

"Data collection and performance monitoring are critical for improving traffic signal operations, and yet before the development of the SMART-SIGNAL system, these tasks were prohibitively expensive for most agencies."

—Henry Liu,
Associate Professor,
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The refined SMART-SIGNAL system's data collection unit is far more compact than its previous iteration and can easily be installed in MnDOT's latest traffic controller cabinets.

control center server. Where the previous iteration of the SMART-SIGNAL system was a far larger computer that periodically uploaded data via a cellular modem, the current system is a small box that communicates via fiber optic cables.

Investigators also refined the graphical user interface of field data collection units to allow easier setup and resetting. They also developed a Web-based interface for the traffic control center server to allow remote access to local field computers and the generation of both real-time arterial performance measures and historical statistical reports.

Investigators installed the refined SMART-SIGNAL system on 13 intersections of TH 13 between Yankee Doodle Road and TH 101 in Burnsville, and demonstrated system configurations at field intersections and the regional traffic management center.

What Was the Impact?

The refined SMART-SIGNAL system is more compact, is easier to install and access, and has a far lower manufacturing cost than the previous iteration, allowing transportation agencies to use it to monitor the performance of their signalized arterials on a large scale. Its new data collection unit approaches the ultimate goal of plug-and-play installation at intersections.

The refined Web-based user interface can be accessed either inside or outside the MnDOT network, and allows users to conveniently monitor real-time intersection level of service, vehicle queue length and travel time as well as generate historical reports on queue length, travel time and intersection delays. The final research report describes in detail the installation and configuration of the system, including both data collection units in the field and traffic control center server software.

What's Next?

Since the completion of this project, MnDOT has installed the SMART-SIGNAL system at 22 additional intersections along TH 7 and is planning installations on 40 intersections along TH 65 and TH 10. MnDOT is also sponsoring further SMART-SIGNAL applications in three ongoing projects: Improving Traffic Signal Operations for Integrated Corridor Management (ICM), which seeks to use the SMART-SIGNAL system to mitigate congestion caused by traffic incidents on adjacent freeways; Automatic Generation of Traffic Signal Timing Plan, which is developing algorithms to automate signal timing; and Arterial Congestion Report, which will track the annual degradation of arterial performance measures for better prioritization of traffic signal retiming projects.

This Technical Summary pertains to Report 2013-06, "Research Implementation of the SMART SIGNAL System on Trunk Highway (TH) 13," published February 2013. The full report can be accessed at http://www.lrrb.org/PDF/201306.pdf.

The research being implemented via this project can be found mainly in Report 2009-01, "Development of a Real-Time Arterial Performance Monitoring System Using Traffic Data Available from Existing Signal Systems," published December 2008. This report can be accessed at http://www.lrrb.org/PDF/200901.pdf.