2009-23TS
Published February 2010

RESEARCH
SERVICES SECTION

TECHNICAL SUMMARY

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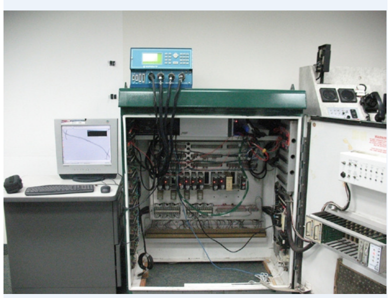
PROJECT COST:
$70,000



Investigators conducted lab simulations using a personal computer, controller cabinet and signal controller.

Integrating Platoon-Priority Signal Control with Advance Warning Flashers

What Was the Need?

When intersections are located fairly close to one another, vehicles tend to arrive in batches and can be effectively managed with coordinated signal control to keep vehicles moving along the major approach. In contrast, isolated high-speed rural or suburban signal-controlled intersections often operate poorly during peak times. For these intersections, advance detectors fail to recognize an approaching batch—or platoon—of vehicles, and vehicles on the major approach can experience increased delays while waiting for relatively few vehicles on the minor approach.

Two strategies have been used to provide for smooth progression of platoons along transportation corridors, but there was little literature on how these methods might be integrated:

- Platoon-priority signal control systems identify the arrival of a platoon of vehicles and coordinate signal timing between a series of intersections.
- Advance warning flashers warn motorists on high-speed approaches that the signal phase will be turning yellow.

Conventional AWF configurations add a fixed interval (7 to 8 seconds) at the end of a green phase, during which the flashers activate. This tends to increase delays on the minor approach, and these installations also leave out the "dilemma-zone protection" of a typical high-speed intersection, which involves detectors that extend the green light phase if a vehicle is at the point where it could not safely stop were the light to change. As these detectors are already present in platoon-priority signal control systems, integrating them with AWF seemed a promising method of increasing the efficiency of high-speed isolated intersections while retaining dilemma-zone protection.

What Was Our Goal?

Investigators aimed to develop an integrated signal control system that would:

- Detect in real time long platoons approaching the intersection and extend the green light to allow these vehicles to pass without causing excessive delays to the small number of vehicles on the minor approach.
- Use both platoon identification and AWF to provide a better starting time for warning flashers based on traffic conditions that leaves in place dilemma-zone protection.

What Did We Do?

Investigators developed two algorithms to test in a lab simulation:

- Platoon-priority algorithm: This two-stage algorithm keeps track of vehicle arrivals at the intersection to detect a platoon. Each additional vehicle following the platoon is evaluated to determine where to provide platoon priority to the vehicle.
- AWF algorithm: This algorithm uses advance detector data and signal controller status in real time to predict when the green phase will terminate due to an excessive interval in between vehicles arriving on the green. The arrival time of each vehicle at the dilemma-zone detector is used to place a hold on the phase to safely clear the vehicle from the dilemma zone.

Investigators used the intersection of Minnesota Highway 55 and Argenta Trail in Inver Grove Heights, Minnesota—a high-speed, signalized isolated intersection with major and

continued

“The next step is to field-test the platoon-priority strategy. Rural high-speed intersections are good candidates for testing if they have high volumes of through traffic on the major approach and limited traffic on the side street.”

–Susan Zarling,
Mn/DOT Traffic Electrical Systems Engineer

“We made the cabinet-in-the-loop simulation as realistic as possible by integrating the algorithms in the testing architecture. Vehicle arrivals to the testing intersection were simulated by a computer program, and the traffic light was operated using the controller cabinet.”

–Henry Liu,
Assistant Professor, University of Minnesota Department of Civil Engineering

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Traffic data gathered using detectors at this high-speed, signalized isolated intersection was used in simulations of different signal control systems in the lab.

minor approaches—to gather vehicle speed distribution data for the simulation. Current detection equipment, located approximately 300 to 400 feet from the intersection, was used with a new advance loop detector installed 1,000 to 1,250 feet upstream of the intersection. Together, the two detectors allowed investigators to identify platoons based on vehicle speed and the time difference between vehicles.

To test the integrated system, investigators applied the algorithms in a cabinet-in-the-loop system consisting of a personal computer, an actual signal controller and a controller cabinet. The integrated system software that applies the algorithms receives advance detector information such as vehicle type and speed from data gathered in the field. It also receives phase detector status and signal status from the cabinet and, when required, sends controller override input calls to the cabinet.

What Did We Learn?

Performance measures were calculated to determine reductions in cumulative delay and number of stops when comparing the platoon-priority model against operations in normal signal control mode. Investigators found a more than 50 percent reduction in delays and stops for the major approach with the platoon-priority model, and overall intersection delays and stops were reduced by 20 percent.

Advance detection at 1,250 feet provided optimal performance, and with advance detection at this distance and an approach speed of 65 mph, the system was able to provide 6 to 7 seconds advance warning of end-of-green in a majority of the cases. However, the system was not as effective at intersections with a high percentage of platoons making turns.

What’s Next?

Mn/DOT is considering locations to field-test the integrated system. Good candidates for field tests are rural high-speed intersections that experience vehicle platoons, limited turning movements on major approaches and light traffic on side streets. Cabinet-in-the-loop lab testing of the proposed intersections will precede any testing in the field.

This Technical Summary pertains to Report 2009-23, “Development of a Platoon-Priority Control Strategy with/out Smart Advance Warning Flashers for Isolated Intersections with High-Speed Approaches,” published July 2009. The full report can be accessed at http://www.lrrb.org/PDF/200923.pdf.