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LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

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LRRB PROJECT COST:
$125,476

At the test site, solar panels powered the radar detectors mounted at the top of STOP signs located on the secondary road.

RESEARCH SERVICES
OFFICE OF POLICY ANALYSIS, RESEARCH & INNOVATION

Advanced LED Warning Signs for Rural Intersections Powered by Renewable Energy

Researchers developed the Advanced Light-Emitting Diode Warning System as a low-cost, non-intrusive, mobile warning system to improve safety at rural through/stop intersections. The system, which uses solar energy to power wireless technology for vehicle detection, shows promise in changing driver behavior by increasing wait times and reducing speeds.

What Was the Need?

Like other Midwestern states, Minnesota has many unsignalized rural intersections where high-speed major highways are crossed by lower-speed secondary roads. Recent crash data indicates that a majority of Minnesota's intersection-related fatal crashes occur at these rural through/stop intersections.

Vertical and horizontal curves can make it difficult for drivers crossing or turning into the high-speed lane to identify a safe gap in the oncoming traffic, and communicating intersection conditions to drivers approaching this type of intersection can be challenging. Static advance warning signs do not appear to be effective. Realigning intersection approaches can improve safety, but this countermeasure is expensive and difficult to justify at low-volume rural intersections, particularly given the limited budgets of local agencies managing rural roadways.

What Was Our Goal?

The objective of this research is to improve the safety of rural blind intersections by developing a low-cost, easy-to-install advance warning sign system that can be implemented as modifications of existing static signs.

What Did We Do?

Researchers developed the Advanced Light-Emitting Diode Warning System, or ALWS, using three Intelligent Transportation Systems technologies: a low-power light-emitting diode signaling scheme; wireless technology for vehicle detection; and solar panels to power the system. In October 2009, after building and testing components in the lab, researchers installed the ALWS at a rural Duluth, Minnesota, intersection with a severe vertical curve on the approach of the main highway.

The field installation included three signs with LEDs on the perimeter of the sign panels:

- One CROSS TRAFFIC WHEN FLASHING sign, installed 525 feet from the intersection in the westbound lane of traffic on the main highway.
- Two signs with the message VEHICLE APPROACHING WHEN FLASHING, installed on the secondary road opposite the STOP signs.

Researchers modified wiring on commercial signs that continuously blink so that the signs only blink when a vehicle is detected on the opposing approach. Blinking time for the sign on the main highway varies based on the time a vehicle is detected at the STOP signs on the secondary road. The signs on the secondary road blink for 10 seconds when a vehicle is detected on the main highway. If the wireless signal to the signs ceases for more than 10 minutes (that is, if the system is offline), then the LEDs blink continuously.

Four non-intrusive vehicle detectors mounted on STOP signs and posts transmit wireless signals to the signs to initiate blinking. Communication between the vehicle detectors

continued

"Overall, the ALWS was effective at reducing vehicle speeds on the main highway, increasing the wait time and altogether stopping roll-throughs for vehicles on the secondary road when a conflict exists at the intersection."

—Taek Kwon,
Professor, University of Minnesota Duluth Department of Electrical and Computer Engineering

"I believe low-cost Intelligent Transportation Systems like those used in the ALWS will play a larger role in the future as a strategy to reduce unsignalized intersection crashes and to contribute to Minnesota's Toward Zero Deaths effort."

—Victor Lund,
Traffic Engineer, St. Louis County Public Works Department

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This blinker sign on the main highway is the largest of the three signs installed at the test site. When radar detectors mounted at the top of STOP signs on the secondary road detected vehicles stopped at the STOP signs, a wireless signal transmitted to this sign initiated blinking.

and blinker signs is transmitted wirelessly, which eliminates the need to bury wires in the pavement and makes it possible to use the system on gravel roads.

A solar-integrated power pole at the intersection powers the blinker signs' LEDs and the vehicle detectors. Researchers estimated solar radiation at the test location and the expected daily power consumption of each component to select the solar panels.

What Did We Learn?

Researchers gathered video data during the three months before and nine months after installation of the ALWS. Video cameras recorded vehicles traveling toward the intersection through the vertical curve and vehicle movements through the intersection.

Video data analysis indicates the ALWS was effective at reducing vehicle speeds on the main highway an average of 4.5 mph when a vehicle was present on the secondary road. Results also indicate an increase in the wait time on the secondary road (the time it takes for a vehicle to enter the intersection after coming to a complete stop) of an average of 5.4 seconds.

The ALWS also stopped drivers from rolling through the intersection when vehicles were present on the main highway, but researchers noted an increase in roll-throughs on the secondary road when no vehicle conflict was present. This may mean that drivers treated the warning signs like a traffic signal, pausing only briefly before proceeding when the warning signs were not flashing. This driver response is a concern if electronics in the warning system fail.

Mail-in and on-site surveys augmented the video data analysis, with respondents indicating that the warning system was easy to understand and had improved the safety of the intersection.

What's Next?

The ALWS shows promise in changing driver behavior to improve safety at rural through/stop intersections. The Local Road Research Board has identified this effort as a priority for further research: It provides an effective solution for a safety concern at a low cost. Continued research might include additional field tests at intersections with differing traffic volumes and alignments, and an evaluation of alternatives for sign placement and potential solutions to discourage roll-throughs when no conflict exists at the intersection. While these projects are considered, signage at the rural Duluth, Minnesota, test site remains in place with the blinking system deactivated.

This Technical Summary pertains to LRRB-produced Report 2011-04, "Advanced LED Warning Signs for Rural Intersections Powered by Renewable Energy," published December 2010. The full report can be accessed at http://www.lrrb.org/PDF/201104.pdf.