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LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

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LRRB PROJECT COST:
$29,365

An IVS system displays roadside sign information on a smartphone or similar device in a vehicle.

MINNESOTA DEPARTMENT OF TRANSPORTATION

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In-Vehicle Sign Systems May Improve Safety When Supplementing Road Signs

What Was the Need?

The Minnesota Road Fee Test, completed in 2012, tested the feasibility of using a smartphone or similar consumer device for implementing connected vehicle and mileage-based user fee programs. That project produced additional research questions about other services that could be provided to drivers through a smartphone app.

One of these questions was whether road signage could be eliminated from the roadside and displayed in the vehicle instead. Doing so could save tax dollars related to sign installation and maintenance, improve landscapes by removing signs, and make it easy to update signs as needed by making changes in a database rather than in the field.

This project tested the impact of an in-vehicle sign (IVS) system on driver performance. The simulation suggested that replacing external signs with an IVS system would reduce safety, but that as a supplement to external signs the system might reduce traffic speed variability and improve safety.

What Was Our Goal?

The goals of this project were to test how displaying signage on an in-vehicle smartphone, either to replace or augment roadside signs, would affect driver behavior and safety, and to evaluate the usability of the in-vehicle signing (IVS) technology.

What Did We Do?

Researchers simulated a 24-mile route southwest of the Twin Cities using the Human-FIRST driving simulator. This route included freeways, rural two-lane roads and town driving. The IVS system provided visual alerts for three speed zones, three curves that required reduced speeds, two school zones and two construction zones.

The study included 40 participants, balanced across age groups and gender. Of these, 21 drove the simulated route with both external roadside signs and the IVS system. The other 19 drove the route with only the IVS system and no external signs. All participants also drove the simulated route with external signs only to collect baseline data.

Researchers collected data about the drivers' performance, including their ability to adhere to speed limits, the variability of their speed and the variability of their horizontal lane position. To assess how IVS implementation would impact roadway safety, researchers combined this information with models created in previous research that show how vehicle speed affects the likelihood of fatalities in a vehicle collision.

After driving the simulated route, participants completed questionnaires about the usability of the IVS system.

What Did We Learn?

In a baseline test where study participants drove the route with just external signs, their median speeds were 106 percent of the posted speeds. Speeds were nearly identical when the simulation included both external signs and the IVS system, and variability in speed was slightly reduced.

Drivers who only received speed limit information from the IVS system, however, drove at a median speed of 124 percent of the posted speeds. The IVS alone also increased

continued

"Sometimes smartphones are the cause of driver distraction. An IVS system might be a tool to break that distraction by showing the driver there's something important ahead and to change speed."

—Nichole Morris,
Research Associate,
University of Minnesota
HumanFIRST Laboratory

"As traffic engineers, we're very concerned about the safety impacts of people driving at different speeds. An IVS system might help reduce speed differentials, and we get really excited when we see something constructive toward that end."

—Victor Lund,
Traffic Engineer, St. Louis County

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The HumanFIRST driving simulator provides a realistic driving experience while collecting detailed data about the user's driving behavior and performance. In this test the IVS was mounted on the center console to provide or supplement speed limit information.

speed variability and horizontal lane position deviation, although the impact on lane position was relatively small and not statistically significant.

The risk analysis found that the IVS plus external signs would result in a slight improvement in fatality rates during front-impact crashes, and minimal impacts on safety in side-impact crashes and crashes involving pedestrians. The IVS alone significantly decreased safety for all three crash types relative to external signs alone.

In the usability surveys, test participants reported that the mental workload required to drive when IVS was used in place of external signs was greater than under baseline conditions. Driver satisfaction was also lower when the IVS was used without external signs.

What's Next?

This research demonstrated that an IVS system cannot currently replace external signs. However, as a supplement to external signs, the IVS system has some potential to improve safety by reducing speed variability and may be worth considering.

Potential avenues for further research are more detailed investigations of how the IVS system affects driver behavior in work zones and how an IVS system could work in conjunction with connected vehicles to show information about upcoming road conditions, speed advisories or emergency vehicles approaching from behind. Also of interest is whether an IVS system that provides auditory cues in addition to the visual cues provided in this simulation would be beneficial. Drivers would likely hear these auditory cues faster than they would see the visual displays if they use them, but they also might disable the auditory system to listen to the radio or have a conversation, or because they find the auditory system annoying.

An IVS network could be relatively simple and inexpensive to implement and maintain. Data about many of the signs currently on roadsides are available in commercial data services. In a real-world implementation, this information could be loaded into a phone or transmitted via a data network. However, not all roadway signs are available in commercial data sets, particularly in rural or less traveled areas, so creating a comprehensive statewide database would require significant collaboration among cities and counties.

This Technical Summary pertains to the LRRB-produced Report 2016-18, "Risk Evaluation for In-Vehicle Sign Information," published May 2016. The full report can be accessed at mndot.gov/research/TS/2016/201618.pdf.