2017-08TS
Published June 2017

DEPARTMENT OF TRANSPORTATION

RESEARCH SERVICES & LIBRARY

TECHNICAL SUMMARY

Technical Liaison:
Steve Misgen
Steve.Misgen@state.mn.us

Project Coordinator:
Deb Fick, MnDOT
Deb.Fick@state.mn.us

Principal Investigator:
Henry Liu, University of Michigan

PROJECT COST:
$150,000

Identifying intersections where drivers are likely to run red lights can help engineers prioritize traffic investments.

Using SMART-Signal Data to Predict Red Light Running at Intersections

This project developed a methodology using traffic data collected by the SMART-Signal system to identify intersections prone to red light running and, therefore, serious crashes. This methodology could help MnDOT prioritize intersections for safety improvements.

What Was the Need?

Engineers traditionally measure an intersection's safety using the number of crashes that actually occur there. However, collisions are rare and somewhat random events, and it can take a long time to collect enough data to accurately assess a single location's safety.

Traffic conflicts—"close calls" in which one or both drivers must brake, swerve or take some other evasive action to avoid a crash—happen much more often than collisions do. As a result, many research projects use traffic conflicts as an alternative measure of safety.

Red light running (RLR) is one of the most common and dangerous causes of traffic conflicts at signalized intersections. While not every RLR event leads to a collision, it is often the first step in a process that ends in one.

Additionally, crashes caused when drivers run red lights are typically right-angle crashes, which are frequently severe. About 45 percent of right-angle collisions result in injury compared to about 25 percent of other crash types. Reducing right-angle-crash frequency can therefore significantly improve overall road safety and reduce costs related to traffic collisions.

MnDOT's Safety Group wanted to determine whether it was possible to objectively and automatically identify intersections where RLR events are most likely to occur. Developing a methodology to identify the most dangerous intersections would help MnDOT prioritize locations for safety improvements.

What Was Our Goal?

Several previous MnDOT research projects had developed the SMART-Signal system, an automatic system that collects data from traffic signal controllers at signalized intersections. MnDOT has installed the system at more than 100 intersections in the Twin Cities. This project sought to develop tools that use SMART-Signal data to evaluate safety performance at intersections.

What Did We Do?

Researchers analyzed SMART-Signal data collected at the intersection of Boone Avenue and Trunk Highway 55 (TH 55) in Golden Valley between December 2008 and September 2009. This intersection is equipped with both stop-bar detectors and advance detectors located about 400 feet upstream of the intersection. Researchers used stop-bar-actuation data and details about traffic signal phases to identify RLR events at the intersection.

However, since most intersections are equipped only with advance detectors, this method cannot be used to measure RLR events at all intersections. As an alternative, researchers used vehicle-speed and traffic-volume data from the advance detectors, along with recorded traffic-signal-phase information from SMART-Signal, to identify potential RLR events. They compared these potential events to actual RLR events identified using stop-bar data and developed a formula to predict whether an RLR event would occur. This formula can be applied at intersections of major and minor roads that are not equipped with stop-bar detectors.

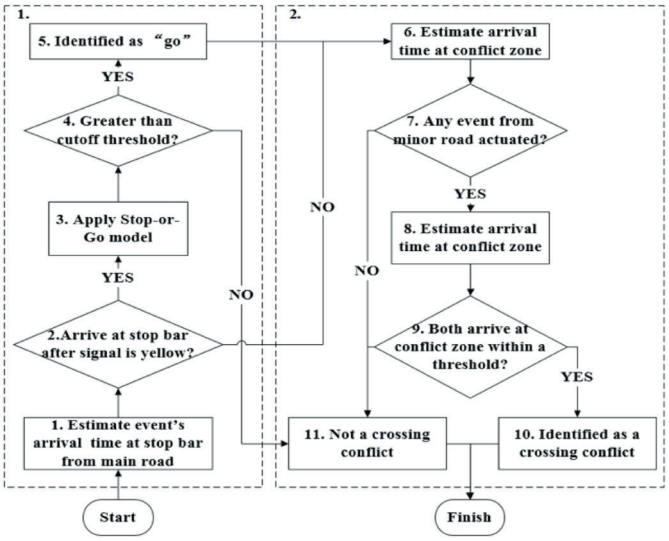
continued

"The essence of this project was to develop a toolbox that traffic engineers can use to determine an intersection's safety performance."

—Henry Liu,
Research Professor,
University of Michigan
Transportation Research
Institute

"This research provides a way to classify intersections that have a higher potential for red light running."

—Mick Rakauskas,
Former Research Fellow,
HumanFIRST Program,
University of Minnesota



This flowchart shows the methodology for determining whether an RLR event will result in a crossing conflict.

Researchers then used data from a minor road to develop a method that identified whether an RLR event would lead to a traffic conflict. In this method, an intersection is first divided into four conflict zones (two in each direction). When a vehicle from the main road enters the intersection, the method enables researchers to calculate when the vehicle enters and leaves each of the conflict zones it passes through. Then they determine whether a vehicle from the minor road is in the same conflict zone. Using this methodology, researchers estimated the number of daily traffic conflicts at other intersections on TH 55. These estimates were based on data collected in 2009 and between 2012 and 2015.

Finally, researchers developed a regression model to evaluate whether adding the number of predicted traffic conflicts to a more standard model that used average annual daily traffic (AADT) would correlate with the number of actual collisions at that site. They evaluated the model using data from seven four-legged intersections and two T-intersections on TH 13 and TH 55.

What Did We Learn?

The formula for predicting RLR events matched observations 83.12% of the time, based on more than 2,000 data points.

The number of daily crossing conflicts at TH 55 intersections ranged from 7.9 (at Glenwood Avenue in 2009) to 51.2 (at Winnetka Avenue in 2013).

While limited data were available for the regression model (as no site had more than four years of SMART-Signal data available, and there were only 11 crashes in total), the model suggests that estimated average traffic conflicts and minor-road AADT both contribute to accurate prediction of right-angle-crash frequency, while major-road AADT does not. Due to the limited data available, however, these conclusions should be considered preliminary.

What's Next?

While there are currently no plans for follow-up studies, additional research efforts could include continuing to evaluate and improve the prediction model as more data are collected, and installing video cameras at intersections to validate the proposed methodologies.

Produced by CTC & Associates for:
Minnesota Department
of Transportation
Research Services & Library
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research

This Technical Summary pertains to Report 2017-08, "Estimation of Crossing Conflict at Signalized Intersection Using High-Resolution Traffic Data," published March 2017. The full report can be accessed at mndot.gov/research/reports/2017/201708.pdf.