Joint Transportation Research Program

Principal Investigator: Professor Darcy Bullock, Purdue University, darcy@purdue.edu, 765.494.2226

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

Sponsor: Indiana Department of Transportation, 765.463.1521

SPR-3206 2011

Performance Evaluation of Traffic Sensing and Control Devices

Introduction

High quality sensing and control systems are essential for providing efficient signalized arterial operations. INDOT operates over 2600 traffic signal controllers, approximately 2000 of which use some form of vehicle detection. The private sector continues to develop innovative sensing technologies that may potentially benefit Indiana motorists and taxpayers by improving system efficiency and lowering installation and maintenance costs. However, the acceptance of new sensing technology requires careful evaluation because to ensure that they provide robust performance 24 hours a day, 365 days a year, with minimal impact on maintenance resources.

This project was initiated with the objective of assisting INDOT with evaluating new sensing and control technology. As the project progressed, there were several opportunities to partner with colleagues at other agencies, institutions, and businesses to leverage collective resources and accelerate implementation on a national scale.

Findings

This study developed a technical protocol for evaluating vehicle detector performance and applied those techniques to both video detection (in partnership with Texas) and wireless magnetometers. Based on experiences in designing the detector test bed, recommendations are given for stop bar detection zone design using wireless magnetometers. Additional results include a detailed study of the inductive loop detector sensing range for several loop geometries, and an innovative method for interrogating NTCIP-compliant traffic signal systems to allow quality control on signal timing plan implementation. Since this project spanned several years, interim results were documented in the professional literature as they became available. This technical report summarizes those results and provides references to the published papers.

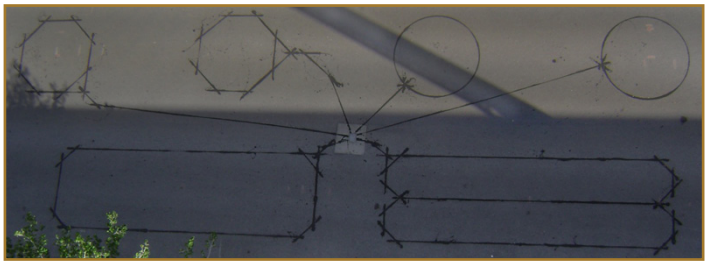
A methodology for evaluating vehicle detectors was developed in a collaborative effort with Texas Transportation Institute in an effort to broaden national support for better performing vehicle detector specifications such as those adopted by INDOT. This research effort helped define how detection technology should be evaluated (and promoted developing a national consensus).

This testing methodology was directly applied to evaluation of wireless magnetometers. The evaluation concluded found that these detectors met the standards of ITM 934, with the stipulation that detection zone designs must be carefully designed. During this project several lessons were learned regarding the detection zone configuration during an iterative design and testing process carried out between the research team and staff from Sensys. Recommendations for detector spacing were developed as a result of this process.

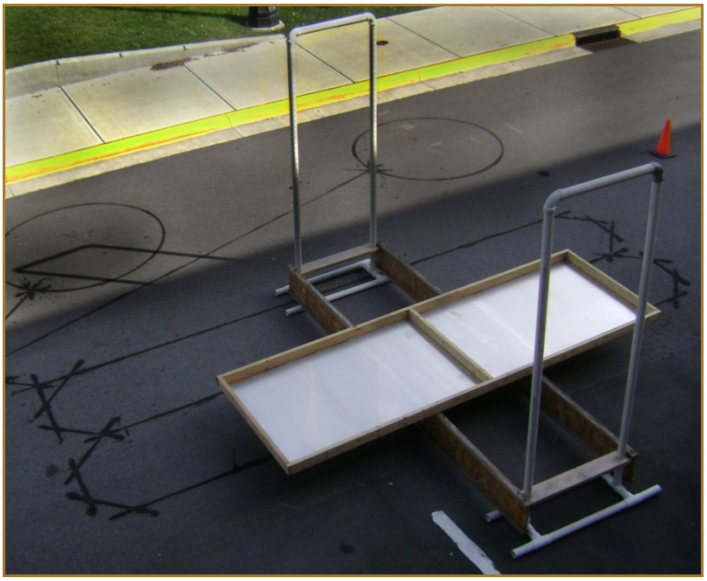
Magnetometer installation: Filling core void with epoxy.

Completed magnetometer installation.

Additional research included an investigation into the sensitivity of loop detectors of different geometries. Although loop detectors have been in use since the 1920s, there has been practically no published research documenting the comparative sensitivity of alternative loop designs with empirical data. We have carried out a study under controlled conditions for four common loop designs that measured the response of the loops to a simulated vehicle undercarriage at different vertical and horizontal locations relative to the loop. We observed no differences among the four geometries regarding the spread of the detection area into adjacent lanes. It was also found that a certain loop geometry that was expected to have enhanced sensitivity in the loop center actually exhibited less sensitivity over that region. Finally, another topic that the research team was asked to investigate was the possibility of developing a methodology for checking traffic signal controller settings for consistency across intersections. The research team worked with an industry partner to develop a tool that would populate a database table with the signal controller settings by investigating all of the nodes of the NTCIP tree by executing a walk of the tree using the standard SNMP protocol.



Loop detector test bed.



Test in progress.

Implementation Recommendations

The results of this project have had a positive impact on agency operations prior to the release of the final report. INDOT has currently adopted the vehicle detector evaluation methodology as ITM No., 934-08P. The evaluation of wireless magnetometers led to the addition of this new detector technology to the approved materials list, which will potentially reduce detector installation and maintenance costs, as well as potentially allow enhanced information to be collected from signal systems. The magnetometers have been used to actuate the traffic signal at the SPR-3206 test intersection since 2009, and may open the way for the development of an improved vehicle detection standard and lead to more effective methods of constructing new signalized intersections.

References

1. Bullock, D. M., C. M. Day, T. M. Brennan, & J. R. Sturdevant. Performance Evaluation of Traffic Sensing and Control Devices (SPR-3206). Publication FHWA/IN/JTRP-2011/17. Joint Transportation Research Program, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2011. DOI: 10.5703/1288284314641
2. Middleton, D., R. Longmire, D.M. Bullock, and J.R. Sturdevant, “A Proposed Specification Concept for Vehicle Detection.” In Transportation Research Record No. 2128, TRB, National Research Council, Washington, DC, pp.161-171, 2009.
3. Day, C.M., Premachandra, H., Brennan, T.M., Sturdevant, J.R., and Bullock, D.M. “Operational Evaluation of Wireless Magnetometer Vehicle Detectors at a Signalized Intersection.” In Transportation Research Record No. 2192, Transportation Research Board of the National Academies, Washington, DC, pp. 11-23, 2010.
4. Day, C.M., Brennan, T.M., Harding, M.L., Premachandra, H., Jacobs, A., Bullock, D.M., Krogmeier, J.V., and Sturdevant J.R. “Three Dimensional Mapping of Inductive Loop Sensitivity with Field Measurement.” In Transportation Research Record No. 2128, Transportation Research Board of the National Academies, Washington, D.C., pp. 35-47, 2009.
5. Brennan, T.M., B.D. Griggs, G. Grimmer, A.M. Hainen, C.M. Day, J.R. Sturdevant, and D.M. Bullock. “An Empirical Approach for Defining the Design Space for Traffic Signal Timing Parameters.” Submitted to Transportation Research Record, July 2011, under review.