



Improving TxDOT's Incident Detection Algorithm

According to the Texas Transportation Institute's (TTI) recent *Urban Mobility Report*, incidents like the one shown in Figure 1 are responsible for nearly 60 percent of the total delay experienced by motorists in all urban areas. In Texas, freeway management systems are utilized in many major urban areas including Houston, San Antonio, Ft. Worth, Dallas, Austin, El Paso, and soon Laredo. Freeway management systems are planned for other major metropolitan areas in Texas such as Amarillo and Corpus Christi. An important goal of these systems is the rapid detection of incidents and the management of traffic during incident conditions. The faster an incident is detected, the more rapid the response, which decreases congestion on the roadways.



Figure 1. Incident on Urban Freeway.

Many of the freeway management systems in use in Texas utilize the Advanced Traffic Management System (ATMS) built by the Texas Department of Transportation (TxDOT). The detection capability of this system is centered on an existing algorithm that utilizes loop occupancy from roadway loop detectors. The key to optimizing incident detection performance is adjusting the algorithm parameters to achieve an acceptable

balance between detection and false alarms. However, a procedure to accomplish this adjustment for the TxDOT incident detection algorithm has never been developed.

What We Did...

The critical thrust of the project was providing TxDOT with a sound procedure to set the thresholds used in the ATMS incident detection algorithm. The research process incorporated several tasks



and, ultimately, produced four deliverables for TxDOT:

1. a documented assessment of incident detection capability,
2. recommendations for modifications to the incident detection algorithm,
3. a threshold calibration procedure, and
4. a logic flow for the automated threshold calibration tool.

The results for this project were based on extensive data analysis using Austin District data from 2002, 2003, and 2004. In addition, a statewide assessment was conducted of

operator desires for incident detection performance.

What We Found...

Capabilities Assessment

A thorough analysis examined and documented the capability of the existing TxDOT algorithm in terms of false alarms, incident detection rate, and incident detection time. These parameters are inversely proportional and cannot be optimized independently. In addition, a statewide assessment of desired performance showed that desire for incident detection algorithm performance outpaced the capabilities of actually providing that performance.

Algorithm Enhancement

During the course of the research, an enhancement was developed to the existing algorithm. Named the cross-lane comparison (CLC), the revised algorithm looks at the variability of occupancy across all travel lanes of the roadway—as opposed to the specific value in a specific lane. Figure 2 illustrates the revised algorithm.

The revision improves the incident detection performance. For 2002 data, the following results were obtained:

- Average daily false alarms were decreased nearly 30 percent.

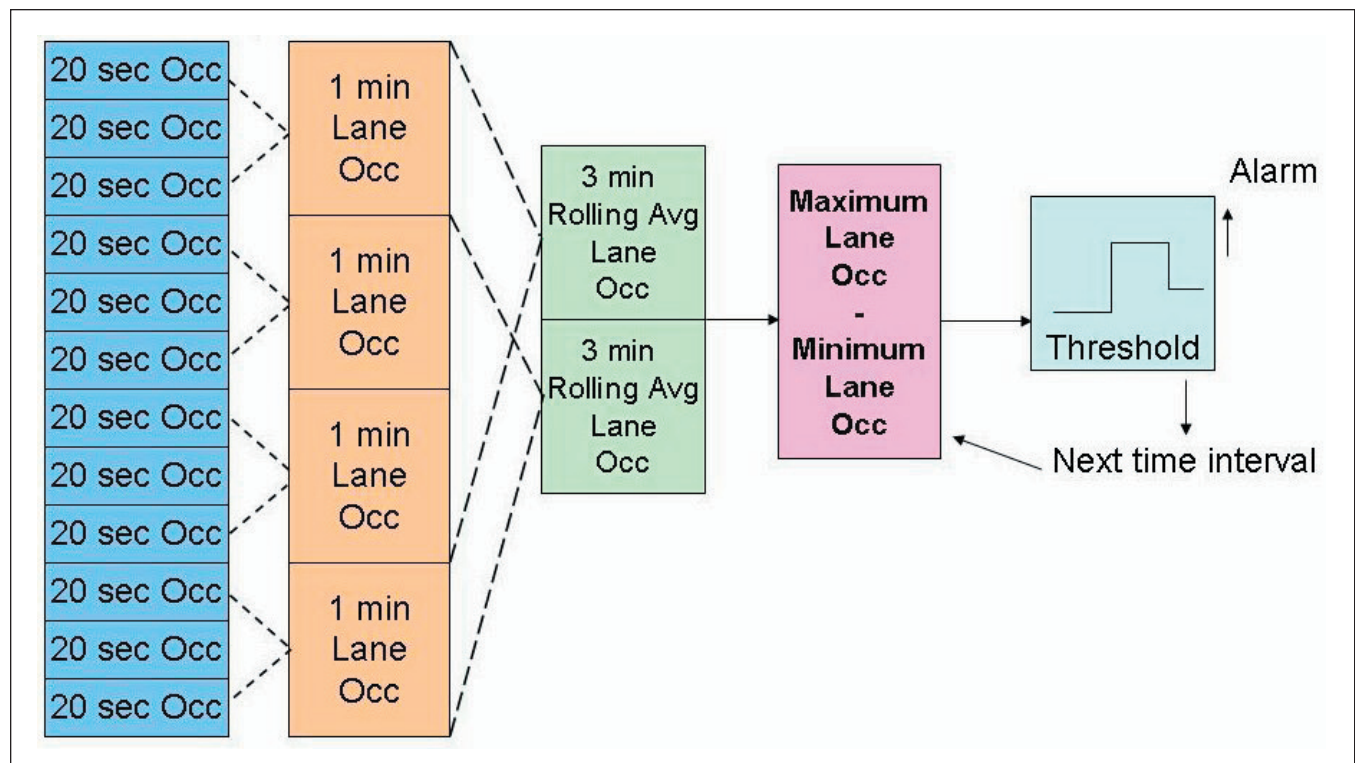


Figure 2. CLC Algorithm.



- The incident detection rate increased to an average of 56 percent, from the existing algorithm’s average of 26 percent.
- Incident detection time decreased approximately 50 percent.

Similar results were obtained for 2003 and 2004. In addition, a multi-year assessment determined how often the thresholds would have to be refreshed. The results showed that the best performance of the algorithm was obtained when thresholds were refreshed on a yearly basis.

Threshold Calibration Procedure

The project results included a systematic process for identifying the time periods and CLC thresholds necessary for optimizing the algorithm. Figure 3 shows how the CLC varies across a 24-hour period as well as an example of the time periods and thresholds that are constructed for the new algorithm.

Automated Logic Flow

One of the primary mechanisms for providing a

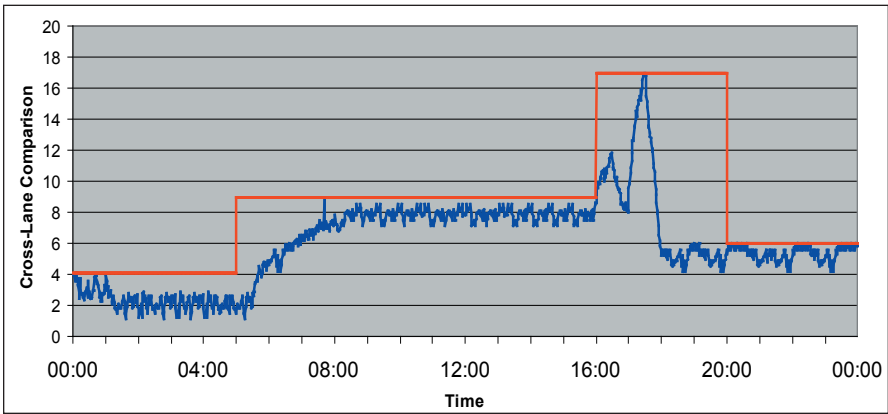


Figure 3. Example Time Periods and Thresholds for CLC Algorithm.

way for TxDOT to implement this research was to construct a detailed logic flow for an automated tool to set the time periods and thresholds necessary to use the CLC algorithm. While Figure 4 provides only an overview of the process, the project documentation contains a highly defined and detailed procedure for future implementation.

For convenient implementation, Modules 3 and 4 of the procedure use a standard desktop software spreadsheet as a proof-of-concept application. The current limitation for creating a stand-alone desktop tool is the massive quantities of data that must be analyzed in Modules 1 and 2.

The Researchers Recommend...

The products from this research provide a roadmap for TxDOT to improve its incident detection capabilities. Researchers have documented several recommendations for improving the data-logging capabilities, file structures, and data-cleaning capabilities of the field equipment used to collect and aggregate lane occupancy data. An additional recommendation is made for the TxDOT ATMS to migrate to a database format for roadway data, which would provide significant enhancements to the existing systems as well as create future opportunities for advanced operations.

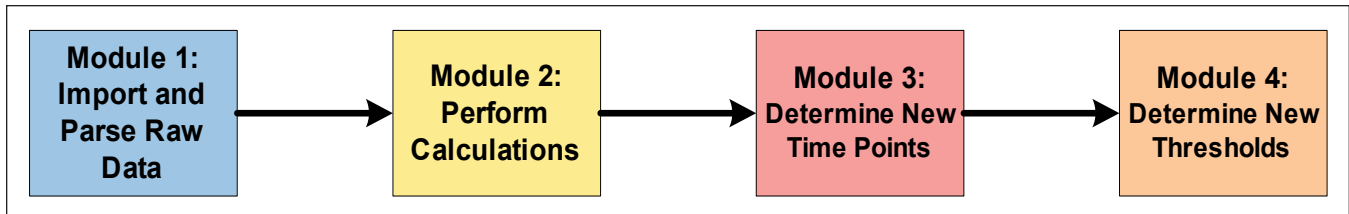


Figure 4. Overview of Automated Logic Flow.



For More Details...

The research is documented in:

Report 0-4770-1, *An Investigation into the Evaluation and Optimization of the Automatic Incident Detection Algorithm Used in TxDOT Traffic Management Systems*

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Disclaimer

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation. The researcher in charge was Robert E. Brydia.