Communication Document

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Diagnosing Chronic Errors in Freeway Loop Detectors from Existing Field Hardware

WHY WAS THIS RESEARCH UNDERTAKEN?

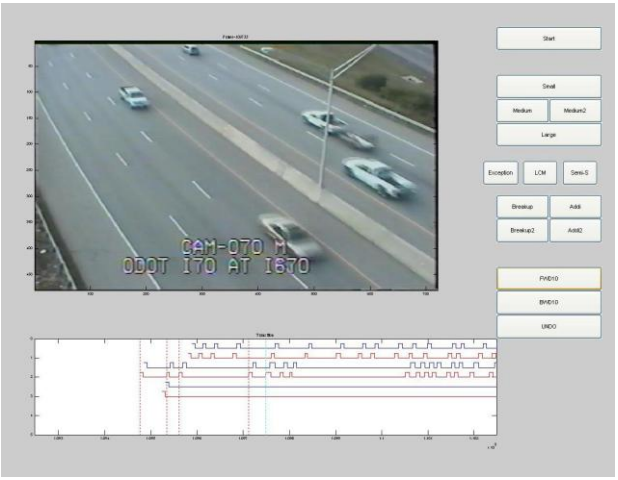
Traffic Management applications such as ramp metering, incident detection, travel time prediction, and vehicle classification greatly depend on the accuracy of data collected from inductive loop detectors, but these data are prone to various errors caused by hardware and software problems. The impact of these errors will propagate to the subsequent measurements of flow, occupancy, and speed and can end up affecting traffic control decisions and traveler information. In an effort to improve the quality of loop detector data, this research sought to identify the presence of several detector errors that would otherwise go undetected and could degrade the performance of the aforementioned applications.

WHAT WAS DONE?

This research developed algorithms to automatically identify two types of detector errors that are difficult to diagnose in the field: splashover, the false detection in one lane of a vehicle from an adjacent lane; and pulse breakup, when a single vehicle produces two or more pulses in its lane of travel.

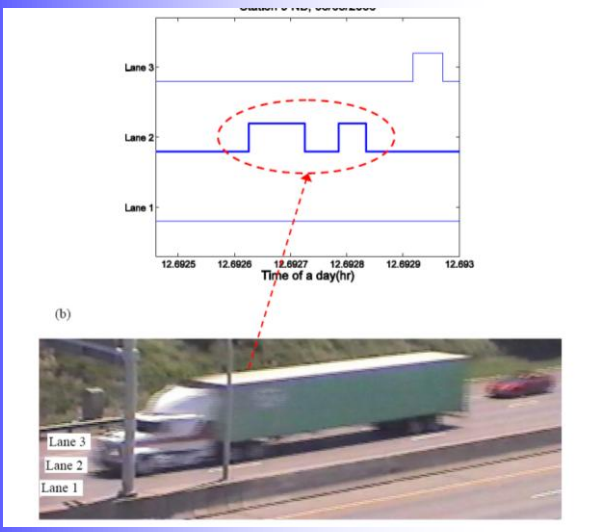
The first step was to collect data. Individual vehicle actuation events, sampled at 240 Hz, were collected from various loop detector stations. During the first phase, data was collected from 65 loop detector stations comprising 658 mainline loop detectors. The second phase collected data from 19 loop detector stations comprising 268 mainline loop detectors. Efforts to collect a third set of data from an additional 10 loop detector stations comprising 150 mainline loop detectors were unsuccessful due to technical problems with the communications software.

At 15 of the detector stations, a concurrent video ground truth record was captured to develop and validate the detector error identification algorithms. The video was first recorded on VCRs from fixed location CCTV cameras as well as on portable video camcorders mounted on overpasses or the side of the freeway. The video was then digitized, and individual frames were extracted and synchronized with the corresponding loop detector actuations. A purpose built software "ground-truthing" program with a graphical user interface was developed in MATLAB to semi-automate the process of comparing the ground truth video record to the loop detector data. Each detection event was then manually classified using the MATLAB program.



After all the data had been collected, the researchers developed and tested algorithms to identify data with splashover and pulse break up errors. Once these algorithms were coded, they were used to process the collected data. For comparison, the same data was processed using two previously developed programs from other researchers. All the results

were compared to the “ground-truth” video data to determine the programs’ effectiveness in identifying detector errors and classifying vehicles.



RESULT OF THE RESEARCH

At the 15 loop detector stations that were “ground-truthed,” this project’s program correctly identified 5 out of 7 detectors that exhibited splashover, as identified in the ground-truth video, while two out of the 61 detectors that did not have actual splashover were erroneously identified as such. When compared against the other existing error detection programs, it exhibited the best performance in differentiating between detectors with and without actual splashover problems.

In free flow traffic conditions, this project’s program correctly identified 92% of the actual pulse breakups, as identified by the ground-truth video, as opposed to the 68% and 67% correctly identified by the other existing error detection programs.

In congested traffic conditions, this project’s program correctly identified 93% of the actual pulse breakups, as identified by the ground-truth video, as opposed to the 29% and 8% correctly identified by the other existing error detection programs.

WHAT DO THE RESEARCHERS RECOMMEND?

The researchers suggest that the improved detector calibration enabled by their methods could lead to an inexpensive way to improve the quality of loop detector data from existing loop detector stations. In the short term, their algorithms could be incorporated into a field diagnostic tool to assess the performance of individual stations. In the longer term, such tests could be incorporated into standard controller software so that the controller can continually assess the health of the detectors. Ultimately the benefits of this research could be seen in applications like length based vehicle classification, travel time estimation using vehicle re-identification, and traffic flow modeling.

IMPLEMENTATION STRATEGIES

The field diagnostic toll could be implemented by tapping into the data upstream of the controller using a Case TMS-100 (formerly “InfoTek Wizard”) to sample the output of the detector cards and run the coded algorithm on board to provide diagnostic information via the serial interface to a technician with a laptop PC. Further research would be needed to determine if these algorithms could be run concurrently on a 170, or possibly a 2070, controller with standard count station software.

CONTACTS

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