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Caltrans Division of Research, Innovation and System Information

Research Results

Repairing Inductive Loop Problems in Roadway Traffic Detector Stations

New detector diagnostics resolve faulty data issues

Transportation Safety and Mobility

MARCH 2013

Project Title:
Deliver a Set of Tools for Resolving Inductive Loops and Correcting Data

Task Number: 1116
Completion Date: September 30, 2012

This project developed tools and techniques to troubleshoot and diagnose problems with Caltrans' inductive loop detector stations.

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WHAT WAS THE NEED?

At any given time, approximately 30 percent of Caltrans' roadside traffic detection stations generate data that is questionable in accuracy and therefore unusable, according to PeMS (Performance Measurement System), the Caltrans-wide traffic database repository. Because of challenges related to determining the causes for the inaccuracies, this situation has remained mostly unchanged over the last decade, during which time considerable effort was spent with little improvement to the malfunctioning stations.

WHAT WAS THE GOAL?

The project's goal was to develop effective tools and techniques to diagnose and troubleshoot detection station malfunctions, thus allowing Caltrans to repair as many of the unreliable units as possible.

The algorithms and approaches developed in this project synergize with the C1 Reader, a tool for finding and correcting loop data errors.

Caltrans improves mobility across California by performing applied research, developing innovations, and implementing solutions.

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WHAT DID WE DO?

At the project's outset, the raw data generated from the inductive loop detector cards was assessed and fed into Type 170 and 2070 signal controllers. It became clear that a sizable amount of usable information generated by detection stations was currently being bypassed or discarded. The research team learned that single loop detector stations—most commonly installed in Southern California—were generating more accurate speed and vehicle classification information than was generated elsewhere. Comparing the single loop results with those generated by dual loop installations, which are more typically installed in Northern California, validated this improved level of accuracy.

Researchers also realized that useful information could be derived from the raw loop detector card data that was not currently being used. On the micro-scale, many types of individual detector card errors can be ascertained and even fixed before they aggregate to the point where a station's entire output is reduced. On the macro-scale, it was conclusively shown that the precise time of the onset of traffic congestion can be determined more quickly and accurately by examining the relationships in the raw loop data between multiple stations along the same corridor.

WHAT WAS THE OUTCOME?

Early in the project, Partners for Advanced Transportation Technology (PATH) researchers realized that significant amounts of data generated from the traffic detector stations' low-level raw loop detector cards were not being used. PATH researchers began developing prototype tools to capture this low-level data and assess its validity, comparing the data with video of the passing traffic. However, the project was delayed due to the cost and complexity of this hardware prototyping effort, and the team turned instead to field data collection hardware and tools already in development by Caltrans.

About the same time, the team had access to a working version of VideoSync, a software application to validate detectors, as well as prototype hardware technology, called a C1 Reader, which could capture the low level loop data without interfering with the operation of the controller. The plan was for one team to develop most of the hardware used to generate the data, while another team developed much of the supplemental software that would use that data to diagnose and troubleshoot existing problems.

The VideoSync and C1 Reader, essential for capturing the low level data, project Phase 2, is currently in progress.

PATH researchers were able to develop algorithms to generate accurate speed and classification data from single loop stations, algorithms to assess each detector's viability from statistical tests, and algorithms to determine the level of congestion across multiple detection stations. The team concluded that data communication across a cellular link is much less reliable than hardwire communication. Indeed, a significant portion of the effort expended in developing the C1 Reader was correcting communication errors induced by the cellular system.

WHAT IS THE BENEFIT?

Unforeseen project delays made it difficult to efficiently coordinate with the C1 Reader Project. Once the C1 Reader hardware becomes available, which is imminent, the benefit of synergistically combining these two efforts will be realized. The researchers did achieve the following objectives during this project:

- Used VideoSync to validate detectors using methods that are in compliance with international standards.
- Developed algorithms to determine the onset of traffic congestion with high accuracy.
- Developed algorithms to determine fleet travel time between detector stations.
- Developed algorithms for generating accurate speed and vehicle classification from single loop stations.
- Resurrected detection stations currently misreporting to PeMS by using a separate communication channel, as well as a separate data processing channel, when necessary.

LEARN MORE

See the final report:
http://gateway.path.berkeley.edu/~xylu/files/TO6327.html