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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Results

Advanced Research

Evaluating the Performance of Traffic Detection Devices

Development of VideoSync, a software tool enabling easy verification of data gathered from Traffic Detection Devices through comparison with video ground truth.

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Project Title: Roadway Detector System Evaluation

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WHAT WAS THE NEED?

Efficiently managing and operating California's highway system required round-the-clock reliable and accurate information on traffic speed and flow. This information was derived from data collected throughout the state by vehicle detection devices, which Caltrans obtained from various vendors. However, the devices did not always perform exactly as advertised. Testing often revealed that vendors' accuracy claims were overstated or based on ideal conditions measured during the middle of the day when the devices were easiest to check manually. Under less ideal conditions, such as twilight, fog, poor weather, and traffic congestion, they might have had problems with accuracy.

However, many of the traffic sensors did not operate properly, making the data unreliable. To maximize the return on the investment made in these traffic detectors, tools were needed that could diagnose and fix the problems.

On-call detection pilot support was also needed by the districts. The support included validating data collected from various detection systems and troubleshooting cabinet, traffic controller, loops, and other issues.

WHAT WAS OUR GOAL?

The objective of this project was to develop tools and techniques to test the round-the-clock performance and accuracy of vehicle detection devices while they were operating in the field.

WHAT DID WE DO?

We developed a software tool called VideoSync which could utilize video footage captured simultaneously with vehicle

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detection state data. This vehicle detection state data was gathered in real-time using the C1 Reader, a hardware device that was connected between the detector and a traffic controller. While this data collection was occurring, video footage of the traffic was also captured. By comparing the collected data and the video footage, the accuracy of the vehicle detection device could easily be assessed.

The software read both the captured data and video footage files. It then generated line graphs for the captured data. When a detector's state was high, the line on the graph was high. When the state was low, the line on the graph was low.

These graphs scrolled in the window from right to left as the video played, with the center of the graph lining up with the current video frame. By scrolling the graphs, users could see a particular detector channel go high or low when a vehicle passed the detector in the video footage. In addition, a square overlay could be placed over the video footage, filling with a translucent color when the corresponding detector was high. This made for easy visual verification of the data.

The video footage could be played back at different speeds to ensure proper analysis or stepped through on a frame-by-frame basis. Users could also step through every instance of a detector going high or low in the vehicle state data, with the video footage jumping to the corresponding time. The displayed graphs could be set to different time scales, allowing broader or narrower views of the state data in relation to the current frame.

The captured video footage and vehicle data often did not line up perfectly. To compensate for this, VideoSync could apply a time offset. VideoSync could attempt to find this offset automatically by analyzing the video footage or it could be entered manually.

WHAT WAS THE OUTCOME?

The VideoSync capability was further enhanced to differentiate among cars by applying a sharpness filter to the collected videos, which provided better vehicle detection. Two locations in District 4 were identified for evaluating the Infra-Red Traffic Logger (TIRTL). Traffic data and videos were collected, and VideoSync was utilized for the evaluation. The team awaited the completion of the Hare harness, which connected the Hare to the Type 334 cabinet terminal block, with evaluation dates scheduled for January, March, and July 2022 in Walnut Creek.

A data labeling system was developed in VideoSync to generate training data for automating the analysis process. This data was intended for experimentation and training of machine learning models to simplify manual dataset analysis. Additionally, a semantic versioning system was implemented, along with quality-of-life improvements to the Event Logger, such as hotkey saving and change tracking, to enhance user experience.

The first half of the major milestone goal of partially automating analysis for VideoSync was completed, including a system to compare C1 data channels and tag false positives and negatives. The second half of the auto-analysis implementation involved training a Random Forest model with data from C1 Viewer to match events across separate channels. Development continued with the creation of a VideoSync tool for video file conversion and significant progress was made on an average speed calculator. Evaluations for the new hybrid detection system were conducted, and analysis results were shared with relevant stakeholders.

WHAT IS THE BENEFIT?

Caltrans now has a method to improve the reliability of the vehicle detection information received at its Traffic Management Centers (TMCs). Additionally, this method can be used to evaluate new vehicle detection technology for market by comparing available products to traditional inductive loops and video ground truth. For example, a prototype has been developed and used to assess the ability of a new detector to recognize bicycles and distinguish them from cars and trucks.

For existing vehicle detection systems, this method can be used to diagnose issues. For example, if a detector has a high false positive rate, this tool can be used to assess possible causes. If vehicles from nearby lanes are triggering the faulty detector, it will be clearly visible in the video footage when jumping to each false positive in the graph.

Furthermore, this system can compare traffic detection systems to each other if they are both watching the same intersection. This allows comparing inductive loops, video detection, infrared, and new methods developed by prospective vendors.

IMAGES

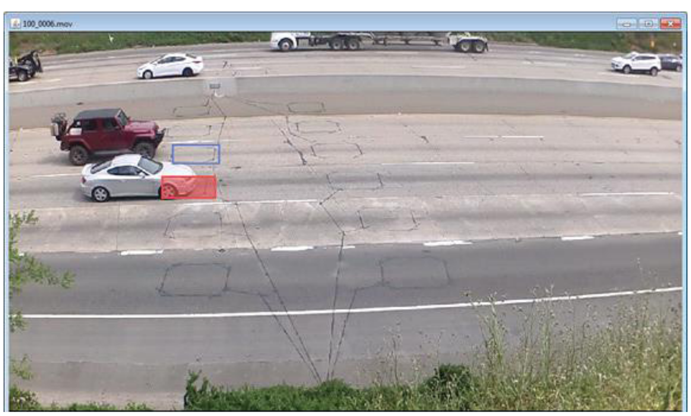

Image 1: VideoSync Prototype Video Screenshot

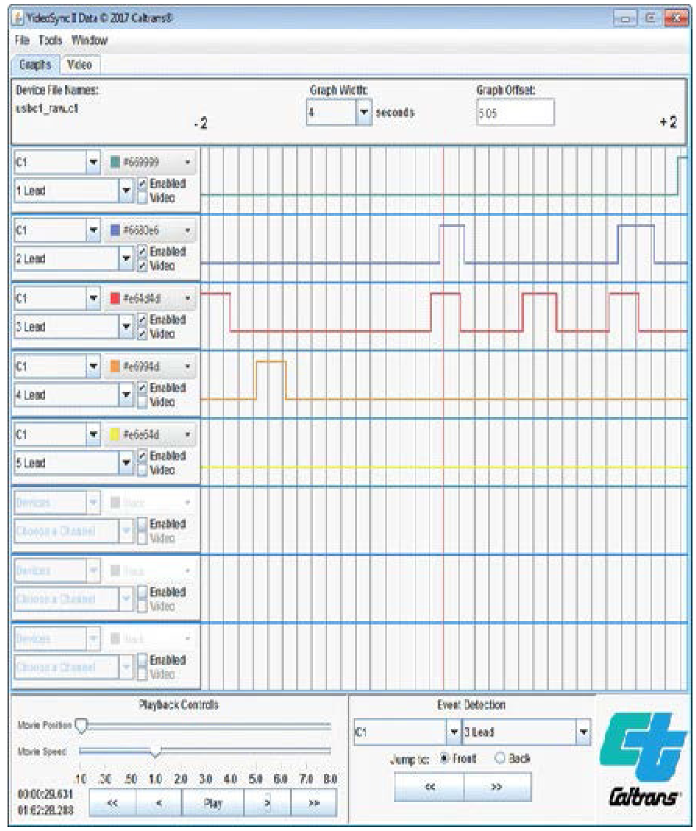

Image 2: VideoSync Prototype Main Window