DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Traffic Operations

MAY 2021

Project Title:
Evaluation of Vehicle Detection Systems Compared to Inductive Loops and Video Ground Truth Using the C1 Reader

Task Number: 3898

Start Date: May 1, 2020

Completion Date: May 1, 2021

Task Manager:
John Slonaker,
Sr. Transportation Electrical Engineer (Specialist)
john.slonaker@dot.ca.gov

Sensys Detection System Evaluation for Signals and Ramp Meters

Comparing the accuracy of Sensys Networks wireless magnetometers to inductive loop detectors for traffic signal and ramp meter actuation

WHAT WAS THE NEED?

The California Department of Transportation (Caltrans) has installed wireless magnetometers for detection in vehicle count stations on freeways in recent years and wanted to have the option of using them as detectors for actuated traffic signals and ramp meters. There was a need to test the accuracy of wireless magnetometers before approving their use in actuating traffic signals and ramp meters.

WHAT WAS OUR GOAL?

Caltrans planned work with Sensys Networks to install their magnetometers on a conventional highway intersection approach and a ramp meter freeway onramp. Once installed, Caltrans planned to compare the output data from the magnetometers with those of existing inductive loop detectors by visually verifying each detection event using video feeds from existing closed-circuit television (CCTV) cameras.

WHAT DID WE DO?

Sensys wireless magnetometers and associated communications electronics were installed at a ramp meter controlling the Westbound on-ramp of I-80 just North of Powell Street in Emeryville. Video was recorded from a CCTV surveillance camera mounted on a dedicated pole just North of the onramp. Another Sensys vehicle detection system was installed on the Northbound approach of the signalized intersection of State Route 123, i.e. San Pablo Avenue, and Cutting Boulevard in El Cerrito. Video was recorded from a CCTV camera mounted on a signal standard at the Northeast corner of the intersection.

Caltrans installed the “C1/C11 Reader” device (see image 1), developed by DRISI to sample actuation logic signals from vehicle detectors, between the input files and the controllers in the equipment cabinets at both locations. Approximately one week of C1/C11 data and video were concurrently recorded at each location.

After all the C1/C11 data and video had been captured, Caltrans processed it for analysis using the DRISI-developed VideoSync software. A few half hour segments were chosen from the entire data set to include various time periods, e.g. AM peak, midday, PM peak and nighttime, corresponding to traffic conditions of interest, e.g. congestion, max out, gap out and single vehicle actuations.

For this test, the degree of accuracy of a vehicle detector was defined as its “Sensitivity,” where

$$\text{Sensitivity} = \frac{\text{True Positive}}{\text{False Positive} + \text{False Negative} + \text{True Positive}} \times 100.0$$

According to this definition, the detector is penalized equally and cumulatively for each false positive and false negative. The more of either, the lower the Sensitivity. If there are none of either, the Sensitivity equals 100%. Another quantified result was dropped calls, which are cases when the detector correctly identifies a vehicle but reports that it has left the detection zone when it is still actually present.

The same data and video for the ramp meter and intersection were analyzed by both Caltrans and Sensys staff. Caltrans provided Sensys with the VideoSync software and the processed detection data files. The initial results from Caltrans and Sensys were quite similar, but a few detection events were initially characterized differently. These events were then reviewed, compared and resolved by Caltrans, sometimes choosing the Sensys characterization and other times using the initial Caltrans characterization.

WHAT WAS THE OUTCOME?

The Sensys wireless magnetometers were very close in accuracy to the inductive loops. However, the loops were still a little more accurate in general.

This test (see image 2) showed that consideration should be given to installing two magnetometers abreast in lanes that are wider than the standard 12 feet or where the roadway geometry is unconventional. This could be seen at the ramp meter, where most of the 3.88% difference in Sensitivity was due to the single magnetometers in the queue detection zones missing significantly more vehicles than the dual abreast magnetometers in the demand and passage detection zones. This test also indicated that extra care should be taken when configuring the call deactivation threshold of the magnetometers in any new Sensys installation, because this should minimize the risk of dropped calls.

WHAT IS THE BENEFIT?

This study can give Caltrans districts a detailed account of the typical accuracy of Sensys vehicle detection systems relative to inductive loops so they can make informed decisions when specifying detection systems for traffic signal, ramp meter and count station designs. Ultimately, it will be up to the district traffic engineers to decide whether the benefit of the relative ease of installation of the Sensys detection system is worth the slightly increased probability, as shown in this particular test, of delayed phase service.

IMAGES

Image 1: Caltrans and Sensys installing a magnetometer and connecting it to a wireless access point

Measurement	Loops	Sensys	Difference
Sensitivity at ramp meter	98.05%	94.17%	3.88%
Sensitivity at traffic signal	99.69%	99.55%	0.14%
Dropped calls at ramp meter	0.00%	0.30%	0.30%
Dropped calls at traffic signal	0.14%	0.54%	0.40%

Image 2: Cumulative accuracy measurements for Sensys wireless magnetometers and inductive loops