DRISI

Caltrans Division of Research, Innovation and System Information

Research Notes

University Transportation Center (UTC) FAST Act - PSR 049: Investigation of LIDAR sensing technology to improve traffic monitoring along multilane freeways

Investigating the accuracy of vehicle classification from analysis of point-cloud measurements form LiDAR detectors installed on state highways

Transportation Safety & Mobility

JANUARY 2022

Project Title:
Investigation of Truck Data Collection using LIDAR sensing technology along Rural Highways

Task Number: 3449

Start Date: October 1, 2021

Completion Date: September 30, 2022

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WHAT IS THE NEED?

Detecting and classifying trucks on state highways is important for planning and budgeting for road maintenance, because even though trucks represent a small percentage of total traffic, they cause most of the pavement damage. Conventional classification technology such as inductive loop signature sensors and piezo-based automatic vehicle classifiers are not widely deployed along many rural highway corridors, because electric power service is often not available, and installation is too costly. Meanwhile, temporary sensors such as pneumatic road tubes wear out quickly and expose workers to live traffic in typical deployment and retrieval procedures.

WHAT ARE WE DOING?

This study will install Light Detection and Ranging (LiDAR) sensors at several locations along existing freeway corridors in both side-fire and overhead configurations. Several LiDAR test sites along major freeways in Southern California have already been established by the research team to collect heavy duty truck data. A new data collection site for this study has been determined to be located at the Laguna Canyon overpass along the Interstate 405N freeway in Irvine. Three additional sites will be identified in partnership with Caltrans Districts 7 and 8. Significant datasets at all study sites will be collected. The LiDAR data at the Laguna Canyon overpass will be collected concurrently with video and inductive signature data for validation and sensor performance comparisons. The data will be analyzed using previously developed background subtraction and reconstruction algorithms to extract vehicle images from the LiDAR point-cloud.

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Since LiDAR vehicle data is inherently large due to the very high resolution of point-cloud data, the researchers will investigate data reduction methods that can efficiently reduce the data storage and transmission requirements associated with vehicles while preserving salient features required for advanced monitoring applications. The researchers will apply advanced machine learning models such as deep neural networks to address imbalanced datasets associated with vehicle classification problems to enhance previously developed classification models. Detailed physical measurements and positions will be extracted from each detected vehicle's LiDAR point-cloud reconstruction and trajectory. The resulting traffic stream parameters will be compared with inductive loop sensors and validated by video where applicable.

WHAT IS OUR GOAL?

The purpose of this study is to investigate the use of LiDAR technology for accurate classification of trucks, according to the established Federal Highway Administration (FHWA) scheme, along rural highway corridors as an alternative to in-pavement detection and classification infrastructure.

WHAT IS THE BENEFIT?

With their high resolution, three-dimensional representation, and panoramic field-of-view, LiDAR sensors can provide detailed point-cloud measurements and characterization of objects and thus have the potential for advanced measurements beyond the capability of conventional vehicle detection and classification systems. With more detailed knowledge of the number, percentage and types of trucks travelling state highways, Caltrans can more judiciously allocate budgets for road maintenance.

WHAT IS THE PROGRESS TO DATE?

The kick-off meeting was held on October 28, 2021, concurrent with a presentation of findings from the previous task in this project. The researchers have installed LiDAR detectors at three locations: the San Onofre weigh station on SB I-5 in District 11, the Laguna Canyon overpass on NB 405 in Irvine in District 12 and the Agricultural Inspection Station on WB I-10 in Blythe in District 8. The research team has collected several preliminary point-cloud representations of vehicles from these sensors.

Work planned for next quarter:

The researchers plan to install one more LiDAR detector at a location to be determined in conjunction with Caltrans. They plan to collect more data and begin to investigate data reduction methods that can efficiently reduce storage and transmission requirements while preserving salient features required for vehicle classification.

IMAGES

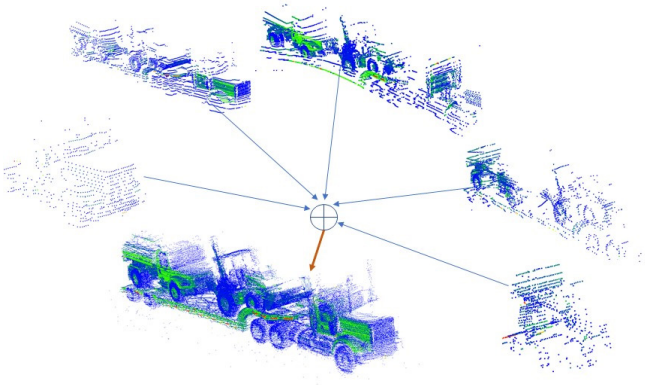

Image 1: High-resolution three-dimensional reconstruction of a truck from LiDAR point cloud data

Image 2: A Velodyne LiDAR detector records a point-cloud image of a passing truck on SB I-5 at San Onofre

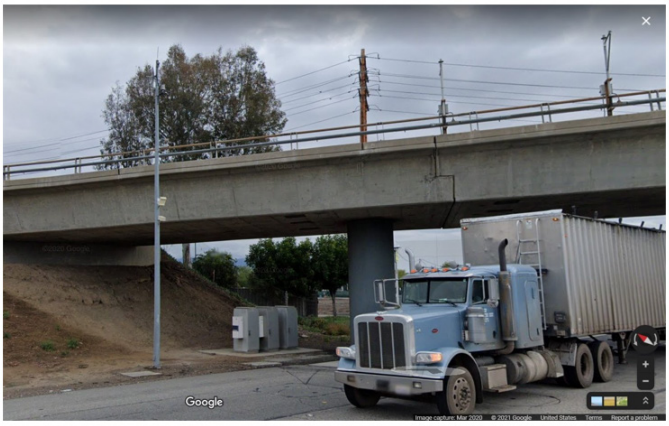

Image 3: A truck passes the Laguna Canyon site