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Announcement of Ph.D. Dissertation/M.S. Thesis Oral Defense

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Building: ___Online____________ Room: _____________________________

Day: _______Friday, March 27, 2020_________ Time: ____10:00 AM___________________

Dissertation/Thesis Title:

TRUCK TRAILER CLASSIFICATION USING SIDE-FIRE LIGHT DETECTION AND RANGING (LiDAR) DATA

Abstract:

Classification of vehicles into distinct groups is critical for many applications, including freight and commodity flow modeling, pavement management and design, tolling, air quality monitoring, and intelligent transportation systems. Federal Highway Administration (FHWA) developed a standardized 13-category vehicle classification ruleset, which meets the needs of many traffic data user applications. However, some applications need high-resolution data for modeling and analysis. For example, the type of commodity being carried must be known in the freight modeling framework. Unfortunately, this information is not available at the state or metropolitan level, or it is expensive to obtain from current resources.

Nevertheless, using current emerging technologies such as Light Detection and Ranging (LiDAR) data, it is possible to obtain commodity type from truck body types or trailer. For example, refrigerated trailers are commonly used to transport perishable produce and meat products, tank trailers are for fuel and other liquid products, and livestock is carried in specialized trailers. The main goal of this research is to develop methods using side-fired LiDAR data to distinguish between specific types of truck trailers beyond what is generally not possible by the traditional vehicle classification sensors (e.g., piezoelectric sensors and inductive loop detectors).

A multi-array LiDAR sensor enables the construction of 3D-profiles of vehicles since it measures the distance to the object reflecting its emitted light. In this research a 16-beam LiDAR sensor data are processed to estimate vehicle speed and extract useful information and features to classify semi-trailer trucks hauling ten different types of trailers: a reefer and non-reefer dry van, 20 ft and 40 ft intermodal containers, 40 ft reefer intermodal container, platforms, tanks, car transporter, open-top van/dump and aggregated other types (i.e., livestock, logging, etc.). In addition to truck-trailer classification, methods developed to detect empty and loaded platform semi-trailers. K-Nearest Neighbors (KNN), *Multilayer Perceptron (MLP)*, Adaptive Boosting (AdaBoost.M2), and Support Vector Machines (SVM) supervised machine learning algorithms are implemented on the field data collected on a freeway segment that includes over seven-thousand trucks. The results show that different trailer body types and empty and loaded platform semi-trailers can be classified with a very high level of accuracy ranging from 85% to 98% and 99%, respectively. To enhance the accuracy by which multiple LiDAR frames belonging to the same truck are merged, a new algorithm is developed to estimate the speed while the truck is within the field of view of the sensor. This algorithm is based on tracking tires and utilizes line detection concepts from image processing. The proposed algorithm improves the results and allows creating more

accurate 2D and 3D truck profiles as documented in the thesis.