Introduction

The ability to accurately measure and cost-effectively collect traffic data at road intersections is needed to improve their safety and operations. This study investigates the feasibility of using laser ranging technology (LiDAR) for this purpose. The proposed technology does not experience some of the problems of the current video-based technology, but less expensive low-end sensors have limited density of points where measurements are collected that may bring new challenges. In this report a novel LiDAR-based portable traffic scanner (TScan) is introduced to detect and track various types of road users (e.g., trucks, cars, pedestrians, and bicycles). The scope of this study included the development of a signal processing algorithm and a user interface, their implementation on a TScan research unit, and evaluation of the unit performance to confirm its practicality for safety and traffic engineering applications.

Work Done and Findings

The TScan research unit was developed by integrating the Velodyne HDL-64E laser scanner within the existing Purdue University Mobile Traffic Laboratory. The motion of the LiDAR sensor located at the top of the mast was accounted for with the readings from an inertial sensor. The primary research objective was to develop an ef-
ficient signal processing method to extract the useful traffic information.

The developed TScan method identifies and extracts the background with a method applied in both the spherical and orthogonal coordinates. The moving objects are detected by clustering data points, tracking clusters, and fitting rectangles to the clusters. Detected moving objects are classified as heavy and non-heavy vehicles, bicycles, and pedestrians. The resulting trajectories of the moving objects are stored for future processing with engineering applications. The developed signal-processing algorithm is supplemented with a user interface for setting, running, and inspecting the results during and after data collection.

In addition, one engineering application was developed in this study for counting moving objects at intersections. Another existing application, the Surrogate Safety Analysis Model (SSAM), was interfaced with the TScan method to allow extracting traffic conflicts and collisions from the TScan results. A user manual was developed to explain the operation of the system and the application of the two engineering applications.

The TScan performance was evaluated by comparing to the best available method: video frame-by-frame analysis with human observers. It was concluded that the TScan performance is sufficient for measuring traffic volumes and speeds, classifying moving objects, and counting traffic conflicts. Nighttime conditions, light rain, and fog did not reduce the quality of the results. Several improvements of this new method are recommended and discussed in this report.

Implementation

Experimentation with the computational load and execution speed of the algorithm indicated that the processing during data collection can be executed in real-time. Implementation of the method to practice must be done through one or two prototypes. The report includes the technical and user’s specifications of a trailer-based TScan prototype. The report also provides user manuals for setting and operating the TScan research unit and for counting vehicles, pedestrians, and traffic conflicts.

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