Research Summary

South Carolina Department of Transportation — Office of Materials and Research

Project Information

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Research Administration

Principal Investigator

Nathan Huynh, Ph.D.
Professor, Director of Undergraduate Studies, Civil and Environmental Engineering
University of South Carolina
College of Engineering and Computing
300 Main St., Room C211
Columbia, SC 29208
huynhn@cec.sc.edu | 803-777-8947

Steering Committee Members:

Wise Stacy, Chair
Anderson Todd, (*Formerly with SCDOT*)
Morris Yolanda
Heaps Meredith
Swygert Terry

Please contact us for additional Information:

Research Unit
803-737-1969 | HeapsMW@scdot.org

SCDOT Research Website:
http://www.scdot.scltap.org/

This final report is available online at:

http://www.scdot.scltap.org/projects/completed/

Automatic Extraction of Vehicle, Bicycle and Pedestrian Traffic

Problem

Currently, the primary method being used by the SCDOT to collect 48-hour traffic data at short-duration count stations is the MetroCount Counter with pneumatic tubes as shown in Figure 1a. This method is considered 'intrusive' because its use requires placing the rubber tubes across the roadway. This intrusive method is problematic on high-volume roads. Specifically, it is not safe for the data collection crew to be in the roadways, it is difficult to secure tubes on roads with multiple lanes, and high-volume roads tend to have a higher percentage of classification errors due to multiple vehicles passing the tubes at the same time.

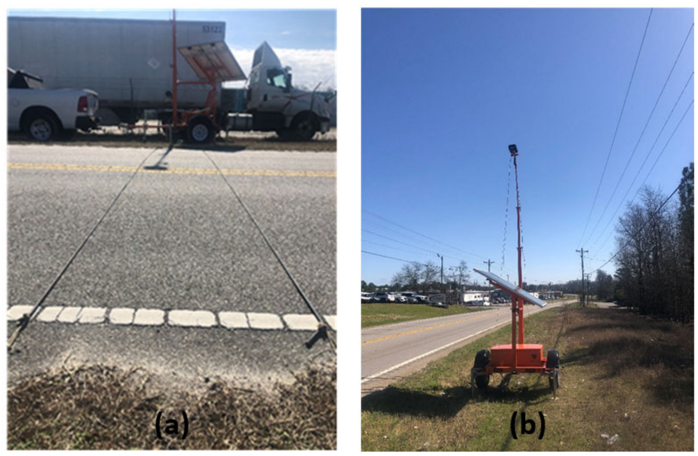

Figure 1. Methods to collect traffic data: (a) intrusive - using pneumatic tubes, (b) non-intrusive – using thermal camera and trailer

Objectives

This project investigated the use of traffic cameras to count and classify vehicles. The intent is to provide an alternative approach to pneumatic tubes for collecting traffic data at high volume locations and to eliminate safety risks to SCDOT personnel and contractors. The objectives of this research were to: 1) develop image processing algorithms to automatically extract vehicle counts and classifications as well as counts of motorcycles, bicycles, and pedestrians from videos, and 2) incorporate the developed algorithms into a stand-alone application with an easy-to-use interface to enable the SCDOT staff to process traffic videos in house.

Research

Background subtraction and foreground detection algorithms were implemented to detect moving vehicles, and a Convolutional Neural Network (CNN) model was developed to classify vehicles. To overcome the issue of poor image quality at night with the traditional visible traffic camera, the FLIR TrafiSense2 Dual (visible and thermal) camera was purchased and custom-built to allow for recording of thermal images to an external drive. To power the thermal camera, the SCDOT solicited bids for a portable solar trailer with specific power requirements, height of crank up mast, and storage capacity. Figure 1b shows the deployment setup of the trailer and thermal camera.

To overcome false detection of vehicles due to either camera motion or erratic light reflection from the pavement surface, an algorithm was developed to keep track of each vehicle's trajectory and the vehicle trajectories were used to determine the presence of an actual vehicle. Figure 2a shows a sample set of vehicle trajectories. A Windows-based application, named DECAF (detection and classification by functional class) shown in Figure 2b was developed to enable users to easily specify the folder containing the video files to be processed, specify the region for which traffic should be analyzed, specify the time interval for which the data should be aggregated, and view the detection and classification results in either PDF or CSV formats. DECAF uses the thermal CNN model to classify each vehicle at every frame of a running video while the vehicles are within the user-specified region of interest.

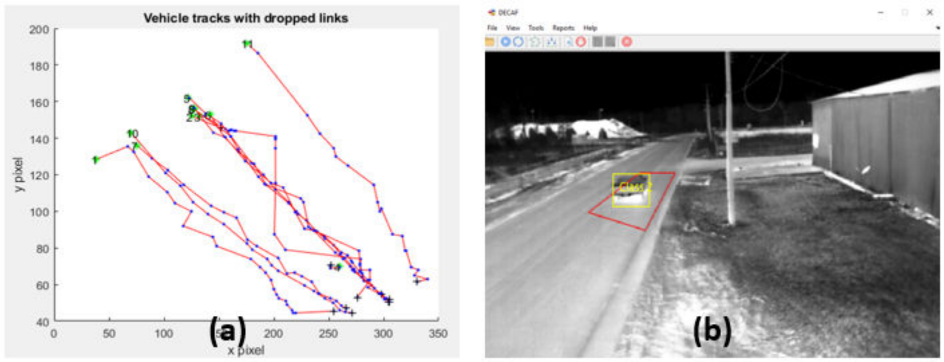

Figure 2. DECAF functionalities: (a) vehicle tracks, (b) vehicle detection and classification

Results

The thermal CNN model, when used within DECAF, yielded a counting and classification accuracy of at least 95%, which was the aim of this project. Compared to MetroCount, DECAF produced higher classification accuracy and comparable count accuracy, when deployed in recommended conditions. Table 1 shows the validation results of DECAF/thermal CNN model using an independent test dataset, not previously used to train the model. The results on the test data were comparable to the training data which indicate that the CNN model was not overfitted to the training data. The one instance with high classification error (11%) was due to breezy and gusty wind conditions during that deployment. Compared to MetroCount, DECAF produced higher classification accuracy and comparable count accuracy, when deployed in recommended conditions.

Table 1. Model validation results using independent test datasets

Location	Counting Error	Classification Error
Old Dunbar Road	1%	6%
Pineview Road	5%	5%
Rosewood Drive	4%	4%
Boston Avenue	2%	11%

Recommendations

Based on this project's findings, it is recommended that the SCDOT consider using the purchased solar-powered trailer and thermal camera to collect traffic data on high-volume roads and using the developed Windows application, DECAF, to obtain vehicle counts by categories. There are two situations where the use of the thermal camera and DECAF are not recommended: 1) breezy conditions (over 15 MPH) with gusts over 30 MPH for portions of the 48-hour period, and 2) extreme heat with temperatures above 90 ˚F for portions of the 48-hour period. Cloudy days do not pose any power problem for the thermal camera.

Value and Benefit

Deploying the trailer and thermal camera on the side of the road will be safer for the SCDOT personnel than deploying MetroCount's pneumatic tubes across multiple lanes. The level of effort required for deploying the trailer and thermal camera is similar to that of deploying the Miovision Scout which the SCDOT has done in the past. The advantage of using the in-house equipment and software is that it will save the SCDOT the video processing cost, approximately $500.00 per 48-hour count.

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