PORTABLE DEVICE FOR VEHICLE COUNTING, CLASSIFICATIONAND SPEED MEASUREMENT

Madhura Bhavsar, Mansi Parhadkar, Parichay Gyanchandani, Ashish Tiwari
Ajinkya Nilawar

Department of Electronics and Communication Engineering,
Shri Ramdeobaba College of Engineering and Management (Affiliated to RTMNU) Nagpur (M.S.), India – 440013

ABSTRACT

This paper focuses on the development of a portable roadside device for vehicle counting, classification and speed measurement which are necessary parameters for planning modern intelligent transport system. The system consists of Raspberry Pi and camera for capturing video. The system is implemented with Python & Machine Learning algorithm implemented using TensorFlow API libraries. While implementing the code the vehicles present in the video frame are classified and the ones crossing the region of interest (ROI) are detected and their speed is measured. Finally, it is observed that the system is capable of performing the tasks of vehicle counting, classification and speed measurement with an accuracy of 70-80%. The developed system can be helpful for traffic flow management and the results show that it can be implemented practically for monitoring the traffic.

Keywords: *Counting, Classification, Speed measurement, OpenCV, TensorFlow.*

I. INTRODUCTION

This paper describes a portable roadside device which is capable of detecting, counting and classifying vehicles along with their average speed measurement.

Traffic count, speed measurement and vehicle classification are fundamental data for a variety of transportation projects ranging from transportation planning to modern intelligent transportation systems.[1] This is also majorly done for traffic surveys. Traffic surveys are a source of traffic information (traffic flow) which aids decision making and planning with the aim of understanding and developing an optimal transport network with efficient movementof traffic andminimal trafficcongestion problems.

The maintenance of a level of service for road/street traffic requires information about problem locations for traffic, so that measures to improve safety, driving comfort and traffic throughput can be allocated in the right way. Restoration of the road network, such as structural maintenance and daily care, can be performed more purposefully and economically if information about traffic volumes at different times is properly utilized.

Traffic congestion may be alleviated by improving the efficiency of the current transportation system through the implementation of advanced technologies. Real-time traffic surveillance is one of the most important components of such an approach, and real-time travel information is useful for advanced travel advisory systems. Emergency management agencies such as police, fire stations, and ambulance dispatchers may also benefit from real-time traffic information in routing their vehicles through the transportation network to save lives. Roadway safety and efficiency will be significantly enhanced by employing remote sensing and communication technologies capable of providing low-cost, scalable, and distributed data acquisition of road conditions.

Traffic surveys are carried out nationally using diverse and modern range of counting equipment. Still "Traffic Monitoring" and "Information Systems" related to classification of vehicles rely on sensors for estimating traffic parameters.[3]The existing measurement technologies are inductive loops, anisotropic Magnetoresistive sensors, single point magnetic sensors etc. The existing data acquisition technologies in transportation systems suffer from the following drawbacks:

Energy efficiency: Most of the existing technologies need to be constantly connected to a main power source or battery. Connection to the main power source limits deployment of the instruments, and using batteries imposes regular maintenance cycles.

High cost: The majority of technologies require expensive instruments, which inhibit cost effectiveness of large-scale and distributed traffic measurements.

Installation and maintenance: Most existing technologies need significant maintenance and calibration and are costly to install. Installation costs may include wiring of the instruments to power sources or the wiring required for communication.

Scalability: The majority of existing technologies cannot be deployed on a large scale due to limitations such as installation cost, wiring, availability of energy sources, etc.

Low-speed and offline measurements: The lack of low-cost real-time communication between measurement points and the decision-making centers inhibits fast and automated decision making.[10]

II. LITERATURE SURVEY

ILDs (Inductive Loop Detectors) are used to estimate vehicle speed and length with the use of reference clock frequency. Inductive loop detectors (ILDs) are a widespread technology used by many transportation agencies for vehicle detection andmeasurement of traffic flow rates. Single inductive loops, bythemselves, do not measure individual vehicle speed. But every setup requires 2 ILDs per lane and needs to be fixed in ground.[4]

AMR (Anisotropic Magnetoresistive) Sensors are used for classification of vehicles depending upon the change in resistance noted when subjected to varying magnetic field . Magnetic sensors and anisotropic Magnetoresistive (AMR)sensors have also been evaluated for vehicle classification by some research groups. The main limitation of theseworks is their inability to distinguish between sedans versus sport utility vehicles (SUVs), pickups, and vans.Furthermore, the magnetic sensors that have been evaluated arebased on devices that were directly embedded in the roadway lane.[9]
A single-point magnetic sensor method works on the principle where the original waveform is transformed into numerical format by data fusion technology for feature extraction. However, the accuracies of classification in this method is not very highwhich is mostly between 70%-90%. Also this method lacks reasonable feature extraction andselection process, which are of crucial importance to efficiency and result of classification.[4]

In portable sensor system, vehicle classification is performed based on the magnetic length and average magnetic height ofvehicles. Vehicle length is estimated by multiplying the detection time by the estimated speed.

Vision-based video monitoring systems offer a number of advantages over earlier methods.Example applications of the OpenCV library include Human-Computer Interaction, Object Identification, Segmentation and Recognition, Face Recognition, Gesture Recognition, Camera and Motion Tracking, Ego Motion, Motion Understanding, Stereo and Multi-Camera Calibration and Depth Computation and Mobile Robotics. OpenCV library contains over 500 functions which can be used in above application areas. OpenCV has many powerful image processing functions.[8]

III. SYSTEM DESIGN

The proposed system uses a single camera mounted on a pole or other tall structure, looking down on the traffic scene. It can be used for detecting and classifying vehicles in multiple lanes and for anydirection of traffic flow.

Fig. 1*:* Proposed System

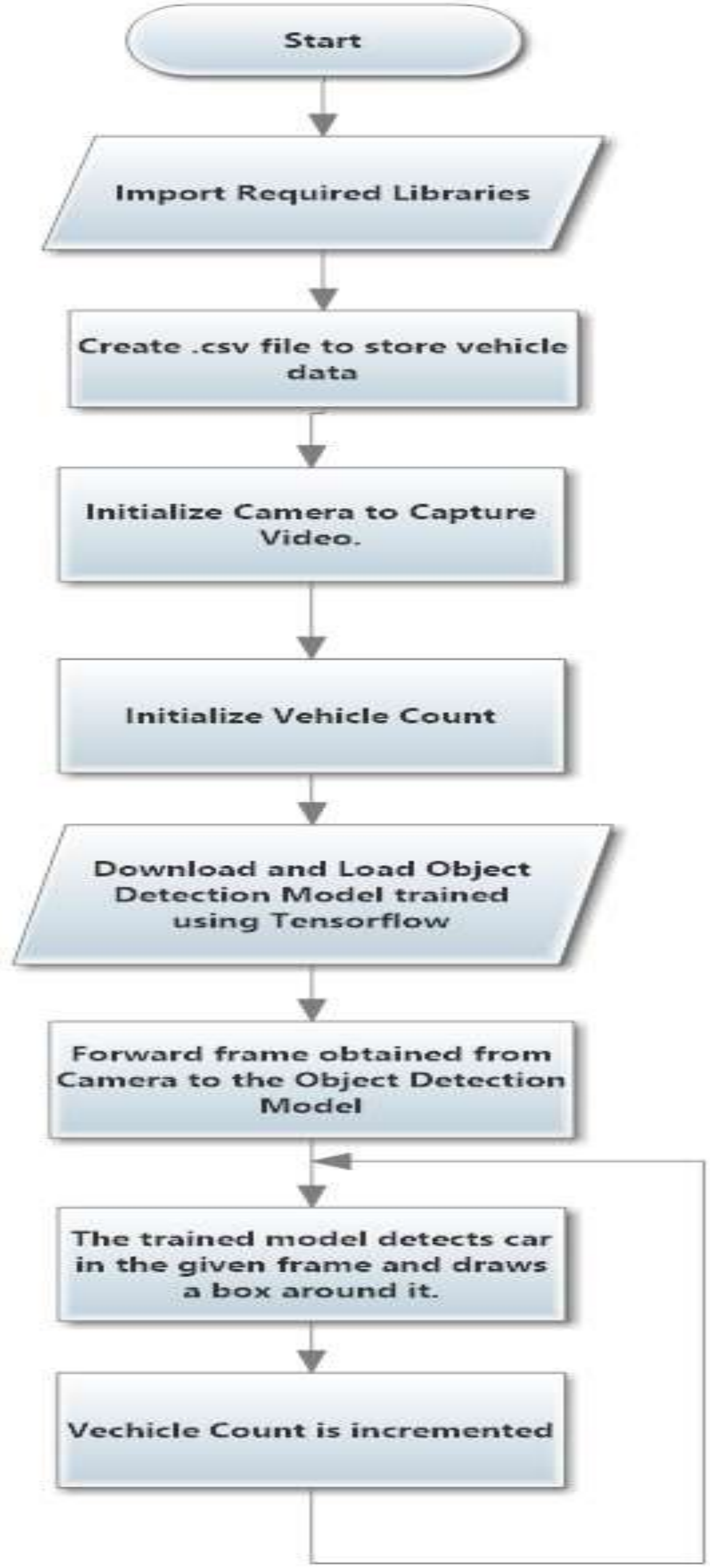

Fig. 2*:* Working of proposed system

Proposed system used Raspberry Pi 3B+ and USB webcam Logitech C270. Raspberry Pi works on 5V power supply and webcam can support a resolution up to 720p at 30fps.

The video is captured by webcam and fed to the Python script. The program detects vehicles, classifies them and measures their speed. Python libraries like TensorFlow, OpenCV etc. are imported in order to use their functions.

A .csv(comma separated values) file is used in order to store the gathered information in proper indexes for future reference. Once .csv file is created, camera is initialized to capture video frames and vehicle count is initialized to zero. Proposed system uses machine learning techniques to train a model in order to detect vehicles. This trained object detection model is imported and loaded into the Python script using TensorFlow. The objects are detected and counted when the front of the vehicle touches the ROI (Region of Interest) line.

The proposed system detects object and captures it, and a box is drawn around the detected objects and vehicle count is incremented after every new object is detected.Each box represents a part of the image where a particular object was detected. The algorithm scores every box where the score represents the level of confidence of the algorithm of rightly classifying the object and its color. The detected objects are fed to the trained model for classification by feature similarity. The difference between the time when the front of the vehicle touches the ROI line and the time when the back of the vehicle crosses the ROI line determines the rate at which the vehicle is approaching.

OpenCV is a cross-platform library using which we can develop real-time computer vision applications. It mainly focuses on image processing, video capture. The library has more than 2500 optimized algorithms, both classic and state of the art computer vision algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human action in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red-eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality etc. It has C++, Python , Java and MATLAB interfaces.[7]

TensorFlow is an open source software library for numerical computation using data-flow graph. Nodes in the graph represent mathematical operations while the graph edges represent the multi-dimensional data arrays (tensors) communicated between them. TensorFlow is cross-platform. It runs on nearly everything: GPUs and CPUs.[1]

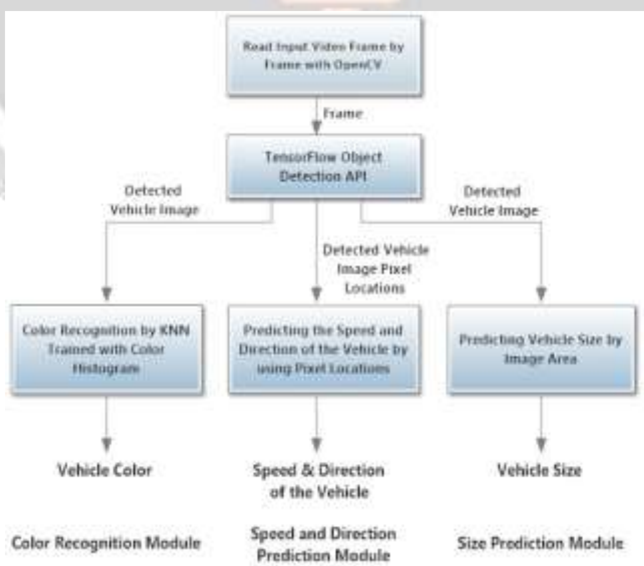

Fig. 3: *Operational Algorithm of the Proposed System*

Fig. 4*:* System output. Text accompanying each detection gives the count, type, speed, direction and color of the vehicle.

IV. CONCLUSION

It is observed that the system is capable of performing the tasks of vehicle counting, classification and speed measurement with an accuracy of 70-80%. These results demonstrate that the proposed system correctly detects a vehicle, tracks it and counts the vehicles passing through the captured video frame and displays the speed with which it is travelling. The developed system can be helpful for traffic flow management and the results show that it can be implemented practically for monitoring traffic. Although, the system can produce error if vehicles are travelling in close proximity. Some of the aspects of the proposed system can be further analyzed and improved for other purposes.

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