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Vehicle Counting and Classification for Traffic Surveillance

K Vaishnavi[1], V Vaishnavi[2], D Sai Deekshitha[3], B V Ramana Murthy[4]

Department of Computer Science and Engineering, Stanley College of Engineering and Technology for Women, Telangana, India

Abstract.

This work was carried out to determine the performance of image processing algorithms in classifying and counting moving vehicles in video streams of traffic scenes recorded by stationary cameras. The method for detection and tracking approach is as follows. The moving vehicles are first extracted from the traffic scene by applying the adaptive background substraction in order detect and count the vehicles using Gaussian Mixture Model. Isolated picture blobs are identified as individual vehicles after background subtraction using threshold and median filters. After the blobs have been identified, the vehicles in a given location are counted and classified. The preliminary results demonstrate that the developed system can track vehicles efficiently and reliably when a clear view of the traffic scene is available. For optimal camera calibration, an accuracy better than 80% in counting vehicles was recorded. The results of the developed system demonstrate that with additional enhancements, it may be utilized in real-time to count and classify vehicles on busy traffic routes.

Keywords: Background Subtraction, Gaussian Mixture Model, Blobs

1. Introduction

1.1 About Project

Traffic surveillance system is a very important a part of Intelligent Transport System. An Intelligent Transport System (ITS) is the application that includes Electronic, Computer and Communication technologies into vehicles and roadways for analysis of traffic conditions, reducing congestion and enhancing flexibility . The result of the increase in vehicle traffic, many problems have appeared. For example, traffic accidents, traffic congestion, traffic induced air pollution and so on. Traffic congestion has been a significantly challenging problem. It has widely been realized that increases of preliminary transportation infrastructure, more pavements, and widened road, have not been able to relieve city congestion. As a result, many investigators have paid their attentions on intelligent transportation system (ITS), such as predict the traffic flow on the basis of monitoring the activities at traffic intersections for detecting congestions. To processes the information and monitors the results as better understand traffic flow, an increasing reliance on traffic surveillance is in a need for better vehicle detection at a wide-area.

Automatic detecting vehicles in video surveillance data is a very challenging problem in computer vision with important practical applications, such as traffic analysis and security. For many traffic monitoring systems, three major stages are to estimate the specified traffic parameters. They are Vehicle detection, count and Classification. Videos or images prepared by traffic cameras installed over the roads or on the roadside.

Vehicle detection and counting is important in computing traffic congestion on highways. The main goal Vehicle detection and counting in traffic video project is to develop methodology for automatic vehicle detection and its counting on highways. A system has been developed to detect and count dynamic vehicles efficiently. Intelligent visual surveillance for road vehicles is a key component for developing autonomous intelligent transportation systems. The entropy mask method does not require any prior knowledge of road feature extraction on static images.

Detecting and Tracking vehicles in surveillance video which uses segmentation with initial background subtraction using morphological operator to determine salient regions in a sequence of video frames. Edges are be counting which shows how many areas are of particular size then particular to car areas is locate the points and counting the vehicles in the domain of traffic monitoring over highways.

Different traffic parameters such as vehicle type, the number of vehicles, traffic density and even traffic accident information can be extracted only using traffic videos or images in a short time. Vehicle Detection is often one of the first tasks in computer vision application with stationary camera. After a vehicle is detected, other applications can be applied more easily . In this system, the object is detected by pixel wise subtraction between the current frame and the background frame. Using some threshold limit, all pixels belonging to object (that are not present in the background image) are detected. After detection of vehicle, we can count the vehicles by made an imagination line on video. Whenever the vehicle crosses the line, automatically the count will be increase.

A good alternative to these techniques can be video based surveillance systems. Video surveillance systems have become cheaper and better because of the increase in the storage capabilities, computational power and video encryption algorithms. The videos stored by these surveillance systems are generally analyzed by humans, which is a time consuming Job. To overcome this constraint, the need of more robust, automatic video based surveillance systems has increased interest in field of computer vision. The objectives of a traffic surveillance system is to detect, track and classify the vehicles but they can be used to do complex tasks such as driver activity recognition, lane recognition etc.

The traffic surveillance systems can have applications in a range of fields such as, public security, detection of anomalous behavior, accident detection, vehicle theft detection, parking areas, and person identification. A Traffic surveillance system usually contains two parts, hardware and software.

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Hardware is a static camera installed on the roadside that captures the video feed and the software part of the system is concerned with processing and analyses. These systems could be portable with a microcontroller attached to the camera for the real-time processing and analyses or just the cameras that transmit the video feed to a centralized computer for further processing.

Automatic detecting and tracking vehicles in video surveillance data is a very challenging problem in computer vision with important practical applications, such as traffic analysis and security. Video cameras are a relatively inexpensive surveillance tool. Manually reviewing the large amount of data they generate is often impractical.

Thus, algorithms for analyzing video which require little or no human input is a good solution. Video surveillance systems are focused on background modeling, moving vehicle classification and tracking. The increasing availability of video sensors and high performance video processing hardware opens up exciting possibilities for tackling many video understanding problems, among which vehicle tracking and target classification are very important. A vehicle tracking and classification system is described as one that can categorize moving vehicles and further classifies the vehicles into various classes.

1.2 Objectives of the Project

The main goal of vehicle classification is to categorize the detected vehicles into their respective classes and to count the number of vehicles crossing. Identifying moving objects from a video sequence is a basic and important task in many computer-vision applications.

1.3 Scope of the Project

- The main purpose of vehicle detection and counting from video sequence method is to counting and classifying from high quality videos.
- Detection of multiple moving vehicles in a video sequence.
- Counting the total number of vehicles in videos.
- Classification of vehicles.

2. Literature Survey

2.1 Existing System

Vehicle detection and counting is a challenging task due to many reasons such as: small size of the vehicles, different types and orientations, similarity in visual appearance of vehicles and some other objects (e.g., air conditioning units on the buildings, trash bins, and road marks), and detection time in very high resolution images is another challenge that researchers need to take in consideration.

The number of the cars detected has been determined by the estimation of the detected regions. Hyper feature map that combines hierarchical feature maps have been used in an accurate vehicle proposal network (AVPN).

Vehicle location and attributes have been extracted by the proposed coupled regional convolution network method which merges an AVPN and a vehicle attribute learning network. Fast and Faster R-CNN have been explored . In order to overcome the limitations in Fast and Faster R-CNN, a new architecture has been proposed. They have improved the detection accuracy of the smallsized objects by using the resolution of the output of the last convolution layer and adapting anchor boxes of RPN as feature map.

2.2 Proposed System

- Hyper feature map that combines hierarchical feature maps have been used in an accurate vehicle proposal network (AVPN).
- Vehicle location and attributes have been extracted by the proposed coupled regional convolution network method which merges an AVPN and a vehicle attribute learning network.
- Fast and Faster R-CNN have been explored.

3. Proposed Architecture

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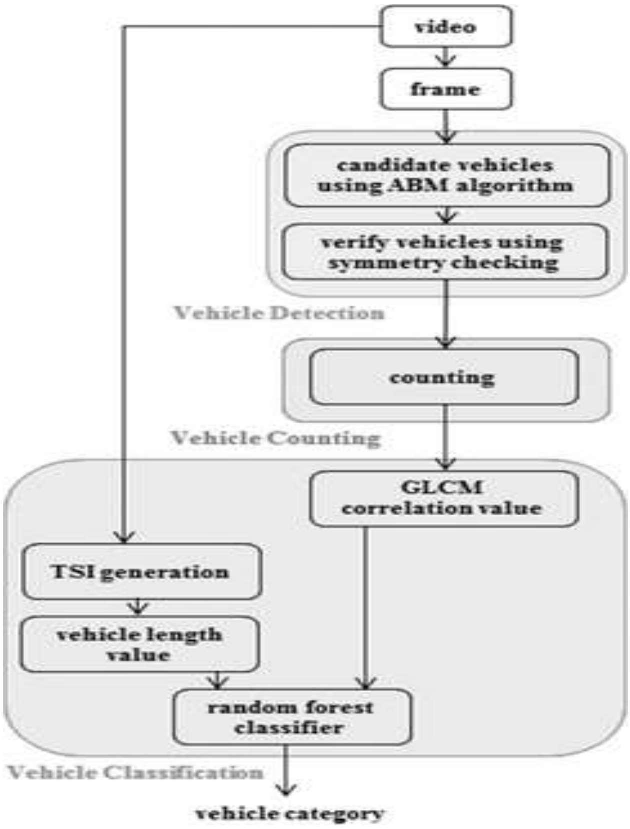

Fig 3.1: Proposed Method Flowchart

3.1 Background Substraction

Identifying moving objects from a video sequence is a basic and important task in many computer-vision applications. Background subtraction which is also known as Foreground Detection, is a technique within the field of image processing and computer vision where in an images foreground is extracted for more processing (object recognition etc.). Generally regions of interest are objects (humans, cars, text etc.) in its foreground. A common approach is to perform background subtraction, which identifies moving objects from the portion of a video frame that differs significantly from a background model.

The principle in the approach is that of detecting the moving objects from the difference between the current frame and a frame of reference, typically known as “background image”, or “background model”.

Background subtraction provides necessary clues for various applications in computer vision, for example surveillance, tracking or human poses estimation. However, background subtraction is usually based on a static background hypothesis . There are many challenges in developing a good background subtraction algorithm. First, it should be robust against changes in illumination. Second, it should avoid detection of non-stationary background objects.

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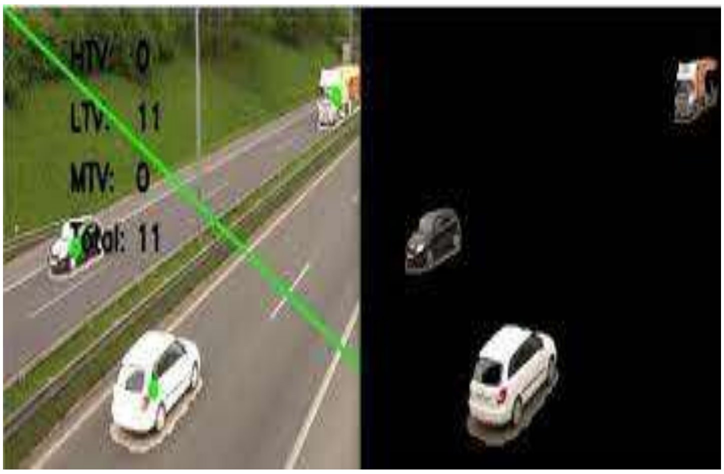

Fig 3.2: Background Substraction

3.2 Vehicle Detection

Object detection is typically accomplished by a simple background by current frame differencing and then followed by threshold. The main idea here is to make a subtraction between pixels of the background frame and that of the current frame. The pixels having value greater than certain threshold is considered to belong to the object (detected vehicle) as shown in figure 1. We use four distinct steps to detect pixels belonging to moving vehicles.

3.3 Vehicle Classification

In the classification step, we classify vehicles into three classes: small (e.g. car), medium (e.g. van) and large (e.g. bus and trunk). To reach this goal, two features are extracted to differentiate between different vehicle types. First, a length based feature is computed that is very useful for classifying vehicles according to their size. In the field of pattern recognition, a classifier is used to identify the correct class of a given object based on some classification rules and characteristics of the object, which are also called feature vectors. The main goal of this unit is to determine which category the passing vehicle belongs to. The local binary pattern (LBP) operator is a powerful feature extractor which transforms an image into an integer labels statistics.

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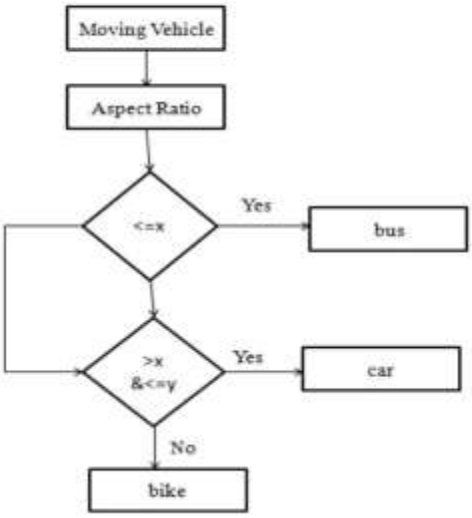

Fig 3.3: Flowchart of Vehicle classification

3.4 Vehicle Counting

For counting vehicles, we used only one counting line. We define a line in about the middle three-fifth of the frame where vehicles are expected to be detected. For each vehicle coming towards the camera, two consequent frames exist where in the first frame the vehicle centre is before the line and in the second one; it is on or after the line. It is exactly at this frame that we count the vehicle. We defined a Tracking List containing the centres of vehicles bounding boxes which are before the counting line. The Tracking list items are updated until the vehicles pass the line. Then we count and remove them from the Tracking List .

Accuracy in % = (Recognition number / actual number) X 100

Where, Recognition number = number of vehicles counted by the system,

Actual number = number of vehicles observed in the frame.

4. Implementation

4.1 Algorithm

- To Identify image pattern and its various features we use vector space and perform mathematical operations on these features using OpenCV.
- In the vehicle classification and counting solution, the vehicle is first classified, then counting is done according to the vehicle type. Typically, object detection and tracking for vehicle classification are done using two methodologies:

1. HOG-SVM based Vehicle Classification.
2. SVM based vehicle classification.

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1) HOG SVM based vehicle classification

Mobile Net SSD-based Vehicle Classification

Histogram of Oriented Gradients (HOG)

Histogram of oriented gradients is a feature descriptor used in image processing for object detection through their shapes.

How does it work?

1. Divide the image into sub-images called "Cells".

2. Compute the gradients in the cells to be described.

3. Accumulate a histogram within that each cell.

4. Group the cells into large blocks .

5. Normalize each block.

6. Train classifier to detect objects.

HOG-SVM consists of three phases:

1. Dataset collection

2 . Feature extraction and

3. Training

2) SVM based Vehicle Classification

SVM classifier has one positive class having positive sample images of the car and the second one has a negative class having all the other negative images except the car. The same is done for the HMV vehicle class model and for two wheeler vehicle class model. From the training process, it generates three SVM models as mentioned above.

Support Vector Machine is a supervised machine learning algorithm, which is used for image classification and pattern recognition. An SVM model can be considered as a point space wherein multiple classes are isolated using hyperplanes. (Support vector machine is basically a hyperplane which separates and classify multiple classes very well). The SVM algorithm is widely used for object-based classification.

4.2 Block Diagram

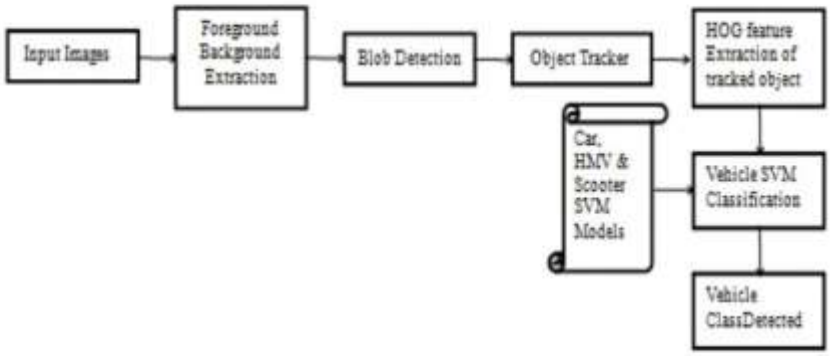

Fig 4.1: Block diagram for Vehicle Classification

4.3 Code Implementation

Open CV Open CV is an open source project an important part of the library as the implementation of those crafty data structures and algorithms you can find in Open CV. Therefore, the source codes for the tutorials are part of the library. Computer vision is a rapidly growing field, partly as a result of both cheaper and more capable cameras, partly because of affordable processing power, and partly because vision algorithms are starting to mature. Open CV itself has played a role in the growth of computer vision by enabling thousands of people to do more productive work in vision.

With its focus on real-time vision, Open CV helps students and professionals efficiently implement projects and jump-start research by providing them with a computer vision and machine learning infrastructure that was previously available only in a few mature research labs.

Python 3.7. Python is broadly utilized universally and is a high-level programming language. It was primarily introduced for prominence on code, and its language structure enables software engineers to express ideas in fewer lines of code. Python is a programming language that gives you a chance to work rapidly and coordinate frameworks more effectively.

Anaconda3 5.3.1. Anaconda is a free and open-source appropriation of the Python and R programming for logical figuring like information science, AI applications, large-scale information preparing, prescient investigation, and so forth. Anaconda accompanies in excess of 1,400 packages just as the Conda package and virtual environment director, called Anaconda Navigator, so it takes out the need to figure out how to introduce every library freely. to Anaconda appropriation that enables clients to dispatch applications and oversee conda packages, conditions and channels without utilizing command line directions.

NumPy is the fundamental package for scientific computing in Python. It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical,

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shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more

5.Result

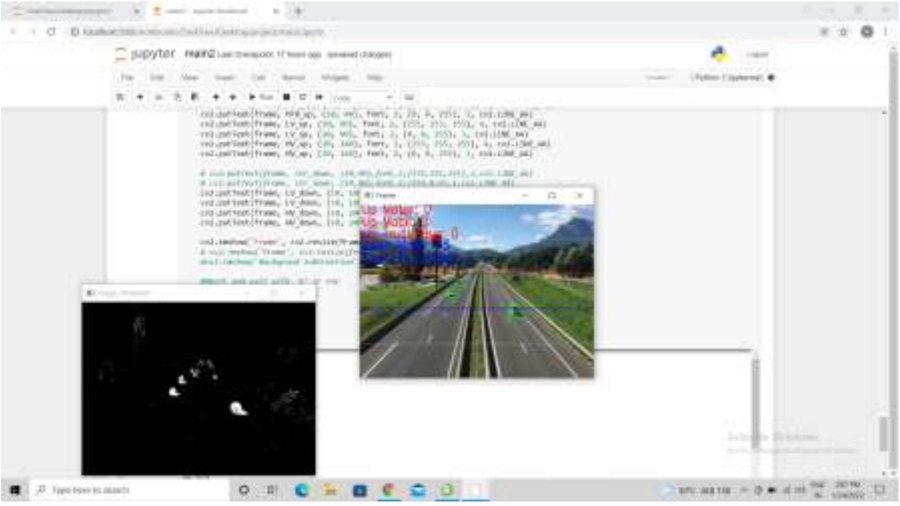

Fig 5.1: Result

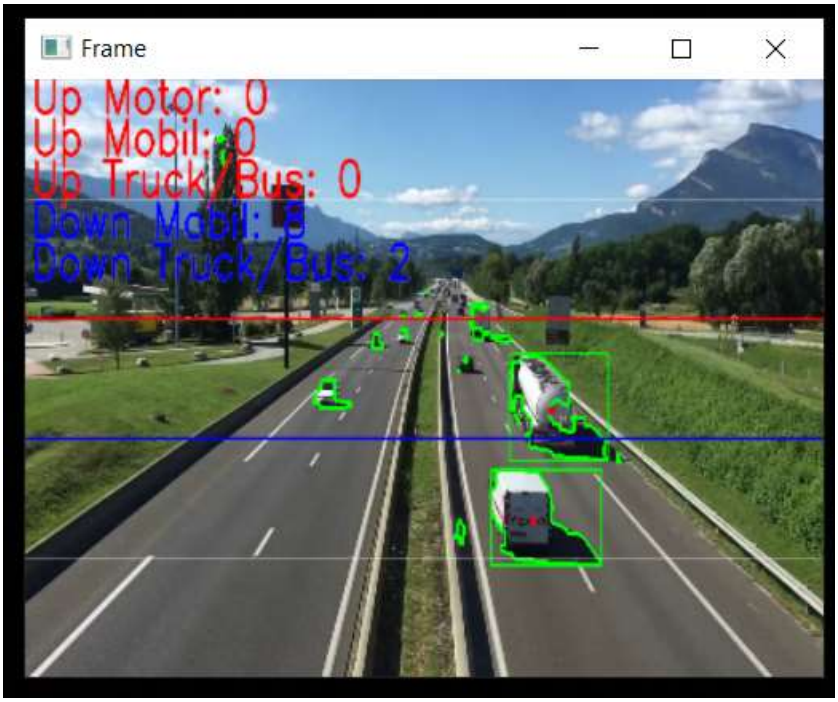

Fig 5.2: Classify and Count

Fig 5.3: Classification & Count – real time

6. Conclusion

In this paper, we proposed algorithms for vehicle detection, counting and classification for highway traffic monitoring systems. We used ABM to find vehicle candidates in the video frames and verified them by checking the reflection symmetry. Vehicles detected in sequential frames are passed to the counting procedure and vehicles counted are given to the classification step. The vehicle length in the TSI image and correlation value calculated from the GLCM matrix are used to train a RF and classify vehicles into three groups: small (e.g. car), medium (e.g. van) and large (e.g. bus and trunk) vehicles. Experimental results show the high performance of the proposed method and its good accuracy in real environments with common challenges existing in highways such as various lighting and weather conditions, shadow, camera vibration and image blurring. Some improvements such as using GPU programming or adding other texture-based features to the classification part are suggested to improve the algorithm performance and run-time. A system has been developed to detect and count dynamic vehicles on highways efficiently.

The system effectively combines simple domain knowledge about vehicle classes with time domain statistical measures to identify target vehicles in the presence of partial occlusions and ambiguous poses, and the background clutter is effectively rejected. The experimental results show that the accuracy of counting vehicles was 96%, although the vehicle detection was 100% which is attributed towards partial occlusions. The computational complexity of our algorithm is linear in the size of a video frame and the number of vehicles detected. As we have considered traffic on highways there is no question of shadow of any cast such as trees but sometimes due to occlusions two vehicles are merged together and treated as a single entity.

7. Future Scope

Several future enhancements can be made to the system. The detection and tracking and counting of moving vehicle can be extended to real-time live video feeds. Apart from the detection and extraction, process of recognition can also be done. By using recognition techniques, the vehicle in question can be classified. Recognition techniques would require an additional database to match with the given vehicle. The system is designed for the detection and tracking and counting of a multiple moving vehicle. It can be further devised to alarming system.

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