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Heavy-Vehicle Detection Using SVM and HOG Features

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Abstract-Traffic monitoring is important in every country to cope up with the increasing population. Tracking and vehicle monitoring is always a challenging task as they are used for surveillance control and traffic planning. In earlier method, the detection of vehicles is classified using Artificial Neural Network with Histograms of Oriented Gradients. The major challenge due to advent of computer is to choose appropriate algorithms for real time dataset. Therefore, the entire work in this study is carried out by using Python with OpenCV method. A vehicle detection and classification algorithm that works in real time is proposed in this work. Further, the heavy vehicles detection is classified using the Support Vector Machine with a new set of features, Histograms of Oriented Gradients. The results show that the proposed method with Support Vector Machine training parameters is better than earlier method.

Keywords: Vehicle detection, Classification, Python, OpenCV, Support Vector Machine, Histograms of Oriented Gradients, Traffic Surveillance.

I. INTRODUCTION

In the current scenario, the population of city and number of vehicles on the road is increasing day by day. However, traditional vehicle systems may be declined and not recognized well due to the vehicles being occluded by other vehicles or by background obstacles such as road signals, trees, weather conditions, and etc., and the performance of these systems depend on a good traffic image analysis approaches to detect, track and classify the vehicles. Therefore, the traffic video surveillance includes detection, classification, tracking of vehicles, monitoring traffic rule violations, detection of accidents, counting the number of vehicles, automatic number plate recognition etc [1], [2]. A vehicle detection and classification algorithm that works in real time is proposed in this work. In recent years, researchers are focused on these difficulties and proposed some resolutions which are simple but operative. Python [8] has become the common language for many data science and machine learning applications. In addition, OpenCV has become an extensive set of classic and state-of - the-art computer vision and machine learning algorithms [7].

Vehicle classification is an important part of the intelligent transport system. The objective of classification is to identify the type of vehicles.. Undoubtedly, if vehicles are classified precisely in real time, the overall system efficiency can be significantly improved. The commonly used features for image classification are its colour, geometry, gradients, edges and Eigen vectors[4]. In this work we are concentrating on the development of a fast algorithm for detection and classification of vehicles for the traffic surveillance.

The HOG algorithm is first suggested for recognition of pedestrians by Shashua et al [11]. Dalal[6] used the algorithm in complex environment to recognize the human being and started to use in many applications such as real time license plate recognition, face recognition. The simplest classifier available is the k-nearest neighbour (k-NN) [7] which doesn't require any separate training stage. It search for the closest neighbour to the input feature from the dataset and assign the class label according to it. Chen et al.,[13] used the Support Vector Machine (SVM) for the vehicle classification[18]. SVM [14] is basically a binary classifier, where positive and negative samples are used for training and it will find a hyper plane to separate the two classes. Several algorithms are available in the literature to accomplish these tasks. Therefore, the entire work in this study is carried out by using Python with OpenCV method [7].

The main focus is on the real time applicability of vehicle detection and classification algorithms on variable traffic densities such as highways and cities. The detection is only focused on the vehicles which are in motion. In most of the places, heavy vehicles are restricted from travelling through cities and other heavy traffic areas which should be monitored with the help of computer vision techniques.

The rest of this paper is organized as follows. In Section II Data Description and Pre-Processing is explained. Section III explains the classification method. Experimental results are given in section IV and section V concludes the paper.

II. DATA DESCRIPTION AND PRE-PROCESSING

An experimental study on real life situations of the highway traffic was done using the video sequences to detect and track the moving vehicle on road. 100 traffic videos are taken from digital camera on various traffic densities such as highways and cities. The video includes all vehicles such as car, motorcycles, buses, trucks etc. All videos with a minimum of one minute of time chosen for vehicle tracking are of the same light intensity and were taken during the day. The detection is possible if there is continuous motion.

Therefore, the video obtained from the camera is converted into images. After convert it to gray scale, then auto and canny function is applied to reduce noise. The contours are used in the edge map, keeping only the largest one which is presumed to be the bus and non-bus images and resize it to a canonical width and height (200x100).

- KNeighborsClassifier is used to recognize and distinguish the difference between bus and non-bus.
- A Histogram of Oriented Gradients (HOG) feature extraction on a labeled test set of Images is performed.
- Finally, train a SVM classifier with the set of bus and non-bus images.

(a) (b)

(c) (d)

Figure 1. (a) & (c) Test image of bus and non-bus (b) & (d)Visualization of HOG image of bus and non-bus image.

III. CLASSIFICATION METHOD

The detailed block diagram for vehicle detection and classification of the proposed system is shown in the Figure.2:

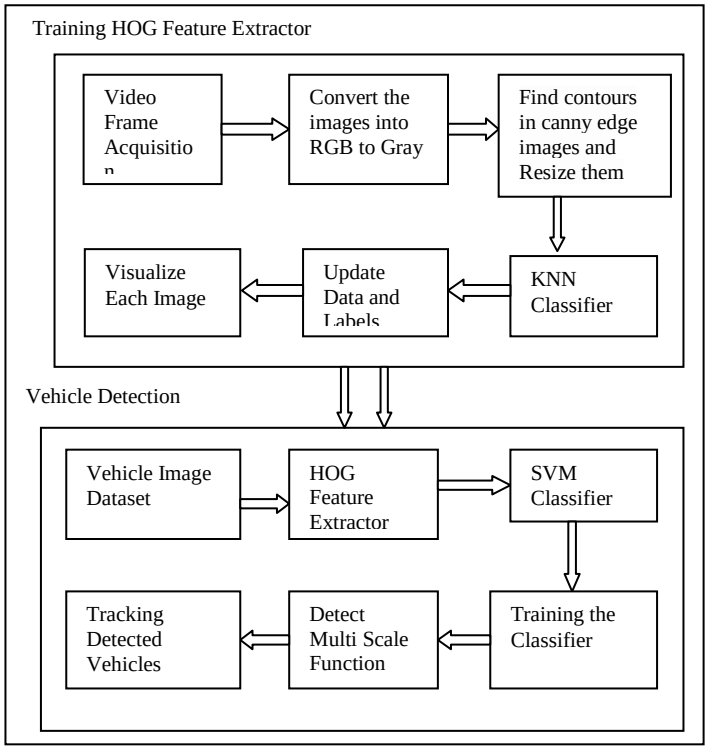


Figure 2. Block diagram of vehicle detection and classification system

Classification of vehicles is an important task in the traffic monitoring, since it can be used to get the type of vehicles or any other information regarding a particular vehicle that is passed through the region of interest. The classification is done using Support Vector Machine (SVM) with Histograms of Oriented Gradients (HOG) [19]

A. Histograms of Oriented Gradients

Image descriptor is mainly used for the Pedestrian detection. A HOG relies on the property of objects within an image to possess the distribution of intensity gradients or edge directions. Gradients are calculated within an image per block. A block is considered as a pixel grid in which gradients are constituted from the magnitude and direction of change in the intensities of the pixel within the block.

In the current example, all the sample images of a buses are fed to the feature descriptor extraction algorithm; i.e., a HOG. The descriptors are gradient vectors generated per pixel of the image. The gradient for each pixel consists of

magnitude and direction, calculated using the following formulae:

$$g = \sqrt{gx^2 + gy^2} \quad (1)$$

$$\theta = \arctan\left(\frac{gy}{gx}\right) \quad (2)$$

In the current example, gx and gy are respectively the horizontal and vertical components of the change in the pixel intensity. A window size of 200 x 100 is used for bus images since it matches the general aspect ratio of vehicle images. The descriptors are calculated over blocks of pixels with 8 x 8 dimensions. These descriptor values for each pixel over 8 x 8 block are quantized into 9 bins, where each bin represents a directional angle of gradient and value in that bin, which is the summation of the magnitudes of all pixels with the same angle. Further, the histogram is then normalized over a 16 x 16 block size, which means four blocks of 8 x 8 are normalized together to minimize light conditions. This mechanism mitigates the accuracy drop due to a change in light.

The SVM model is trained using a number of HOG vectors for multiple buses. The HOG of the detected vehicle is fed to the trained SVM and the output determines the class of that vehicle. This is generated using Python. From Figure1 Visualization, it can be observed that the maximum peaks of the histograms are at the edges of the object and it describes the shape of that object.

B. Training the Classifier

After selecting the appropriate feature and classifier according to the application, next step is the training of the classifier. Here supervised learning is employed. The SVM model is trained using a number of HOG vectors for multiple buses. The SVM returns the label with the maximum score, which represents the confidence to the closest match within the trained vehicle data. The task of calculating matching scores is exceptionally heavy to compute. Hence, once detected and identified, the labelled vehicle in an image needs to be tracked to reduce the computation in future frames until the particular vehicle eventually disappears from the video.

IV. ALGORITHM AND EXPERIMENTAL RESULTS

We attempt to detect the heavy vehicles especially bus using OpenCV and SVM classifiers. The tools which we have used in this algorithm are Python and Git. The image dataset used in this project was developed from the images which clicked from camera. Also some photos were taken from the internet (not containing copyright issues) to test varying conditions.

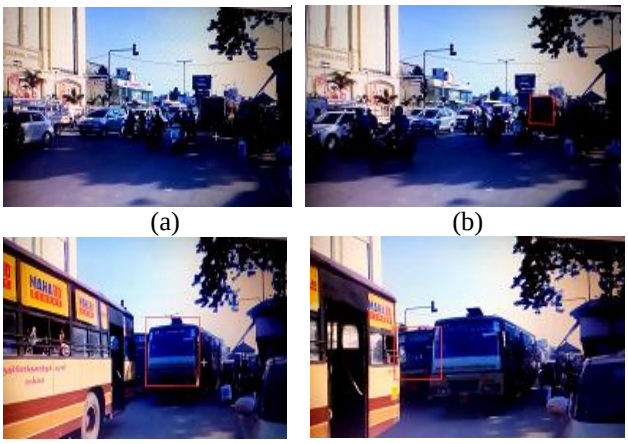
The data is shuffled and split into a training (80%) and testing (20%) data set.HOG features are extracted from training set - to characterize and quantify on bus and non-bus images. There are plethoras of classifiers however we are considered SVM classifier.

It has been observed SVM is more appropriate for its balance between training speed and prediction accuracy. A linear SVM classifier is fit to the data, and a prediction is output. The algorithm given below was used for heavy vehicle detection and classification:

Algorithm for Bus Recognition system

- Input the Image
- Import OpenCV to resize all images(both bus and non-bus) to a fixed size and to flatten them.
- Performed a Histogram of Oriented Gradients(HOG) feature extraction on a labeled training set of Images.
  - Lets declare the list variables, data matrix= HOG Features and labels=images (both bus and non-bus) in training set,.
  - Lets loop over the image paths in the training set
  - For each image i=1 to n
  - Load the image, convert it to gray scale, and detect edges
  - Find contours in the edge map, keeping only the largest one which is presumed to be the bus and non-bus images
  - Extract all images and resize it to a canonical width and height (200x100)
  - Extract Histogram of Oriented Gradients for bus and non-bus
  - Update Data and Labels for each image
- Train" the nearest K Neighbours classifier
- Extract Histogram of Oriented Gradients from the test image
- visualize the HOG image
- Train a SVM classifier with the set of bus and non-bus images.
- Pass all the SVM parameters to the HOG object.
- Finally, call the Detection function and track the particular vehicle.

We have tested the algorithm on image sequences on different scenarios like traffic junction intersection, cities as shown in Figure 3. The classification accuracy of Support Vector Machine (SVM) with Histograms of oriented gradients (HOG) is of 87.33 %, which is the highest among earlier method and the HOG with ANN achieved 82.5%[4].



(a) (b)

(c) (d)

Figure 3: Real-time bus detection using SVM and HOG Features (a) Original Frame (Saravana store Junction in Chrompet) (b) bus detection (c) & (d) various bus detection

This proposed method was also applied on Gaussian Mixture-based Background/Foreground Segmentation Algorithm MOG2Subtractor as shown in Figure 4, produces same accuracy which will mask the foreground scene and extracts vehicle alone.

(a) (b)

Figure 4: Real-time bus Detection using MOG2 Subtractor (a) Original Frame (b) bus detection

V. CONCLUSION

Vehicle detection plays an important role in modern surveillance and security applications. Many earlier methods have used Artificial Neural Network (ANN) with Histograms of Oriented Gradients for detecting the vehicles. However this study has been successful by implementing Python with OpenCV method. Further this study considered heavy vehicle detection (bus) using Support Vector Machine (SVM) with Histograms of Oriented Gradients (HOG) has been successful with good classification accuracy when compared to the earlier method achieved through ANN. In general, it can be observed that high accuracy level can be attained using HOG based SVM. Further study can be considered for the classification of truck and other heavy vehicle with more complex features.

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