iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: V Month of publication: May 2021

DOI: https://doi.org/10.22214/ijraset.2021.34487

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue V May 2021- Available at www.ijraset.com

Vehicle Detection using Haar and HOG Feature Extraction Algorithms and SVM with Speed Estimation

Mallika Gaikwad[1], Mrudula Joshi[2], Rucha Desai[3], Bhushan Patil[4]
[1, 2, 3, 4]Department of Computer Engineering, Rajiv Gandhi Institute of Technology, Mumbai, India

Abstract: As a result of many accidents and over speeding, improving safety and traffic management are the most important goals of the Advanced Driverless Assistance Systems (ADAS). Therefore it is important to find a solution to these issues which is cost effective and accurate. So, in order to achieve better performance of detection and speed tracking of multiple vehicles at the same time in an extremely busy and fast moving urban environment, we propose a vision-based two-step detection vehicle tracking system by combining the Histogram of Oriented Gradients and Haar Features algorithms. These algorithms work together as HOG firstly carries out feature extraction of the target vehicle and then the Haar features uses the edge features to extract the prospect of the Region of Interest (ROI). Later the extracted HOG features which are obtained from the ROI are then classified by using Support vector machines (SVM). The proposed method uses an SVM classifier to classify the extracted images into vehicle and non-vehicle images. This approach makes it clear that the vehicle in real time is indeed an actual vehicle and makes the model accurate. Experimental results illustrate the precise and accurate multiple vehicle detection in different scenarios.

Keywords: HOG, Haar features, Vehicle detection, Feature Extraction, SVM, Speed Estimation.

I. INTRODUCTION

With the rapid urbanization and increase in automobile sector, the number of vehicles are increasing 1rapidly in India and internationally and because of increase in usage of vehicles, the number of road accidents due to careless driving and over speeding actions are also increasing. According to a report by World Bank, with only 1 % of the world's vehicles, India accounts for 11% of the global deaths in road accidents, the highest in the world. The transportation industry is expanding very expeditiously and so the vehicle environment plays a vital role. This vehicle environment has become so high-speed that to own a vehicle is become a comfort. In today's modern era, where the automation is at its peak, and with the idea of development of smart cities, the need for vehicles to be fast and smart has also increased. But with being fast and smart they also need to be accurate and effective. So for the vehicles to be of this level, there is a need for Advanced Driver Assistance System (ADAS). Automatic Driving System should be capable of minimizing road accidents and help in better traffic management and reduce over speeding cases which leads to tragic accidents. Vehicle detection is useful in many applications such as self-driving cars, speed tracking systems, automatic parking systems, vehicle counting systems, traffic management systems etc. Vehicle traffic management is very important as traffic safety is also a major concern with the rise of vehicles. Vehicle detection is widely investigated due to its applications in vehicle safety and auxiliary driving. With the need vehicle detection and tracking, speed estimation is also important. Over speeding is also major issue when it comes to careless driving. While manufacturing cars, the manufacturer makes the best quality car with new features and advancement which enhances the engine and makes the car fast which results in over speeding and leads to accidents.

Because of such demand of self-driving vehicles and rise in technology, there is a need for proposing a vehicle detection system which is not only accurate but also gives absolute efficacy in terms of multi-vehicle tracking and speed estimation. We propose a system where multiple vehicles are detected along with their speed with the help of SVM based algorithm and combining the HOG and Haar features. HOG is feature descriptor algorithm which extracts the features of the fed image whereas the Haar cascade function is an edge detection algorithm used for detecting the edges of the vehicles and then SVM is a hyper plane classifier which classifies the trained images into positive and negative images.

II. OBJECTIVES

A. To be efficient and accurate for Advanced Driver Assistance System (ADAS).
B. To be able to track multiple vehicles at once.
C. To detect speed of the multiple passing vehicles simultaneously along with tracking.
D. To be useful for traffic management.

III. METHODOLOGY

A linear SVM will be trained using feature extraction algorithm. The features are normalized using standard scalar from sklearn. After the training of the model, detection of vehicles can be tested. The model is trained with Car and Not- Car pictures. The HOG features detect the heat maps from the different pictures and trains the model to learn which of the pictures most likely contain the cars and which don't. We also estimate the speed of the vehicle is detected in the video. We will create a simulation where we already have the video recorded which will be fed to the machine. The desired flowchart of the model is shown below.

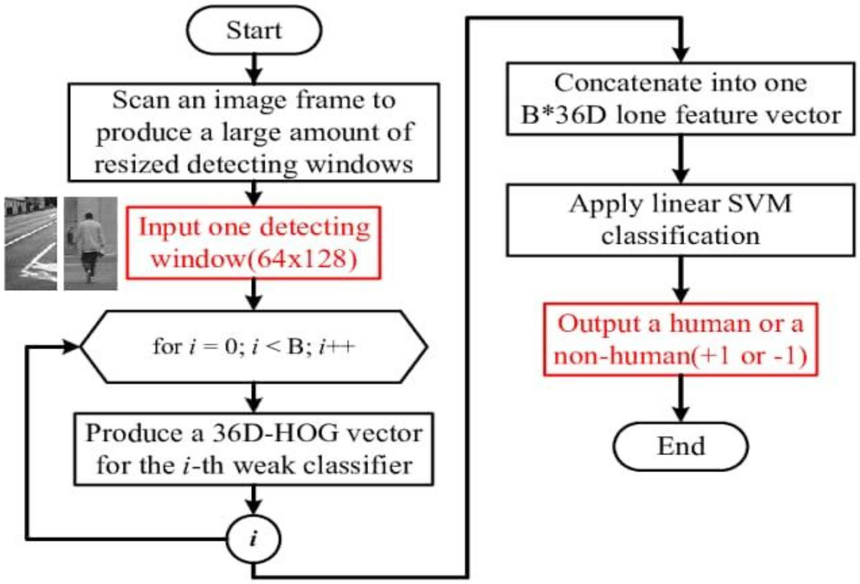

Fig 1. Flowchart of the model

The model undergoes following 6 steps while detecting the vehicle:

A. Read Image

The model will first train the given data. For that the image data of car and not car has been fed to the model. This will then fetch each image one by one and apply the selected algorithm to give results. Later we select a simulated appearance of video to demonstrate the process. So for this step, we will be selecting an image from the video sequence L(x, y).

B. Image Processing

The appearance of vehicle could be described by local oriented gradient histogram in an image. HOG features are calculated according to the following steps:

1) Compute horizontal GH and vertical GV gradients of the image
2) Calculate both norm and orientation of the gradient.

$$N_G(x,y) = \sqrt{G_H(x,y)^2 + G_V(x,y)^2}$$

$$O_G(x,y) = a\tan(\frac{G_H(x,y)}{G_V(x,y)}$$

C. Multi-scale scaling

Targets have large differences in positions and sizes in the images, so without loss of generality, the scale factor is set to 1.2.

D. Haar Features Extraction

The specific feature extraction is obtained through training the set positive and negative samples. Firstly, the integral image is obtained by processing the first image. Secondly, the integral image is intensively scanned by using eight selected Haar feature prototypes in different scales and the rectangle feature vectors of different scales and positions will be formed.

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E. SVM classifier

SVM supervised algorithm is applied to the captured and processed images. When an object is detected as a car, a bounding box is drawn.

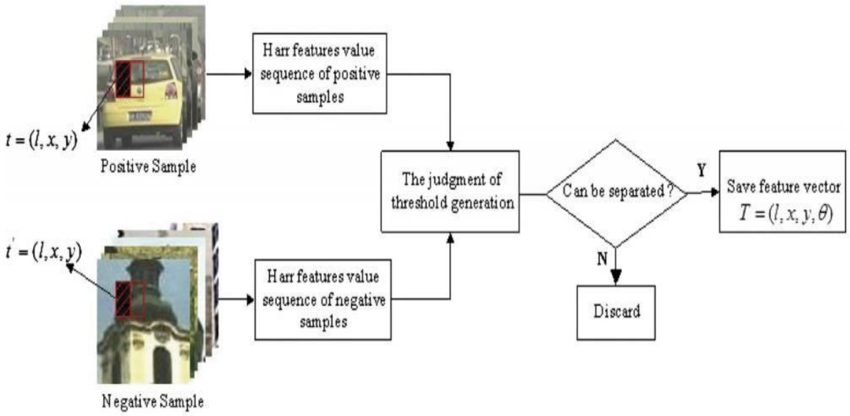

Fig 2. Trained SVM classifier

F. Speed Estimation

We can calculate the speed as

Speed = D- meters * fps * 3.6

D-meters is the distance travelled in one frame. The average fps is already calculated during video processing. So, to get the speed in m/s, just (d-meters * fps) will do. We then multiply the estimated speed with 3.6 to convert it to km/hr.

IV. RESULTS AND DISCUSSIONS

The purpose of this model is to find the precise objects by using HOG features to analyse the images with reduced ROI. The model uses HOG algorithm to extract features which are been fed to the system as trained data. Then Haar cascade function which is an edge detection algorithm where the edges of the vehicle images are detected which were extracted from the HOG algorithm to make them more accurately visible. Based on the selected features, reduced ROI can be obtained for improving the real-time calculation performance and then SVM which classifies the trained images into positive and negative images. For maintaining the detection rate and false positive rate, the model tries to ensure higher detection rate in its first detection period to maximize the possibility of including all potential objects. The SVM classifier then comes into its role of separating these images as positive and negative images for more efficiency in detecting the images are cars.

Fig 3. The Graphical User Interface for the model

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This figure above is the frontend of the model from where you can select a file as a input video which the model will test. This GUI is created using Tkinter.

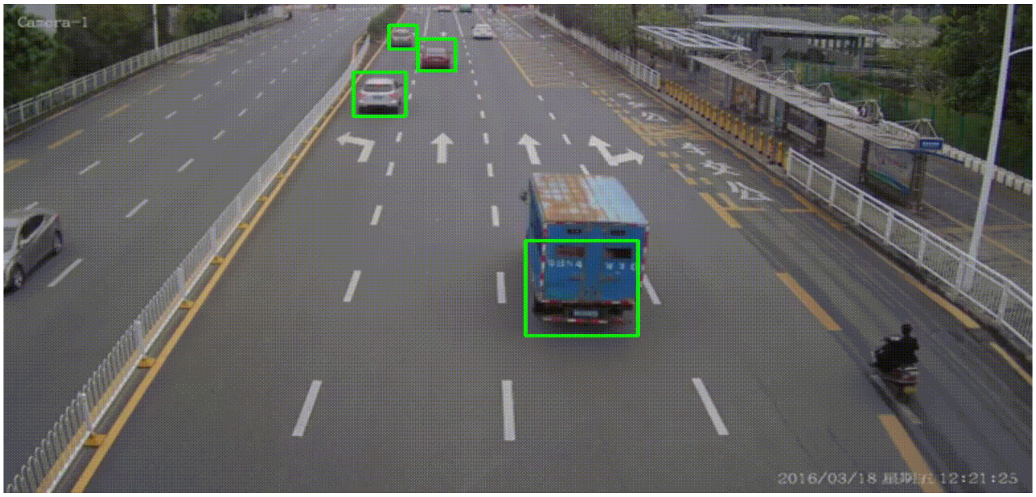

Fig 4. Multiple vehicles are detected at the same time

We have used the combination of HOG and Haar feature algorithms which enables vehicle detection in multiple lanes.

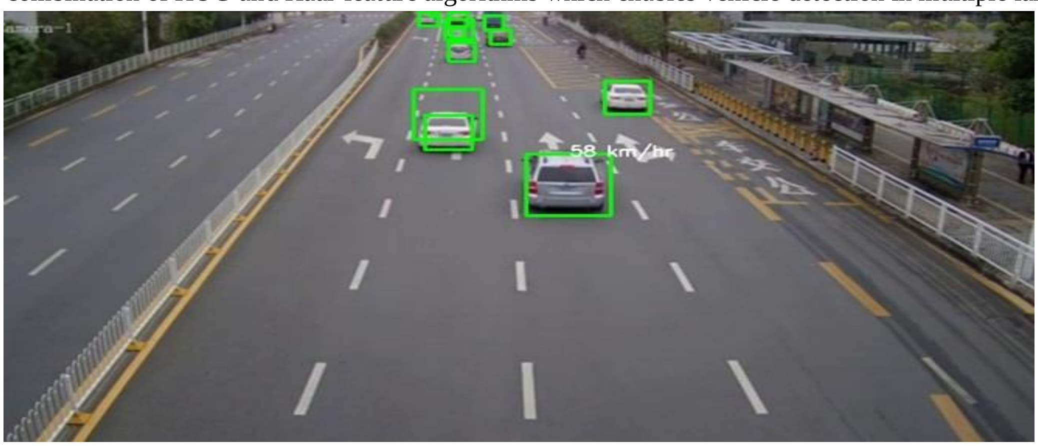

Fig 5. Vehicles which are accurately detected also estimates it speed

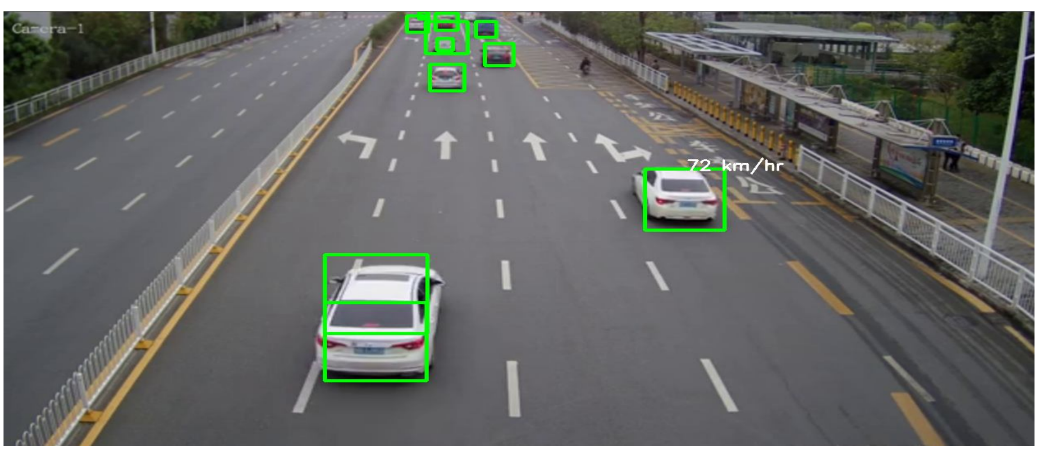

Fig 6. Another example of a car in different lane accurately detected along with its speed

Here in the above output figure the vehicles are getting detected along with their speed, the speed of the vehicles visible in the frame is also being estimated.

V. CONCLUSION

This model detects vehicles and estimates with efficacy and probable accuracy therefore minimizing road accidents and over speeding cases. This model is implemented by using the SVM based model, using HOG and Haar feature method to improve the accuracy of vehicle detection. The use of a Gradient Oriented Histograms (HOG) for the training phase and an SVM classifier gives good results for the detection of vehicles. The method is applied and the experimental results showed that the proposed approach can detect multiple vehicles in the conditions of multi-lane, partial coverage, curves, tunnel, etc., verifying the validity of the proposed approach. In addition, the proposed method shows higher detecting accuracy and time efficiency than the conventional ones due to the combined use of the Haar and HOG features in the proposed procedure. Also, using the object detection classifier, the model can show the probability of the object detected actually being a vehicle. We have also implemented the speed estimation algorithm in this project as an additional functionality to enhance and improve the accuracy of the model.

VI. ACKNOWLEDGEMENT

We would like to precise our sincere gratitude to Dr. Sanjay U. Bokade, Principal and Prof. S. P. Khachane, H.O.D of Department Computer Engineering of Rajiv Gandhi Institute of Technology for granting us this great opportunity to learn, research and prepare this paper on “Vehicle Detection using Haar and HOG Feature Extraction algorithms and SVM with Speed Estimation”. We sincerely thank our project guide Prof. Bhushan Patil for his thorough guidance throughout the process of carrying out the project work. Finally we would also like to thank my colleagues and friends who supported and helped us in completing this paper successfully.

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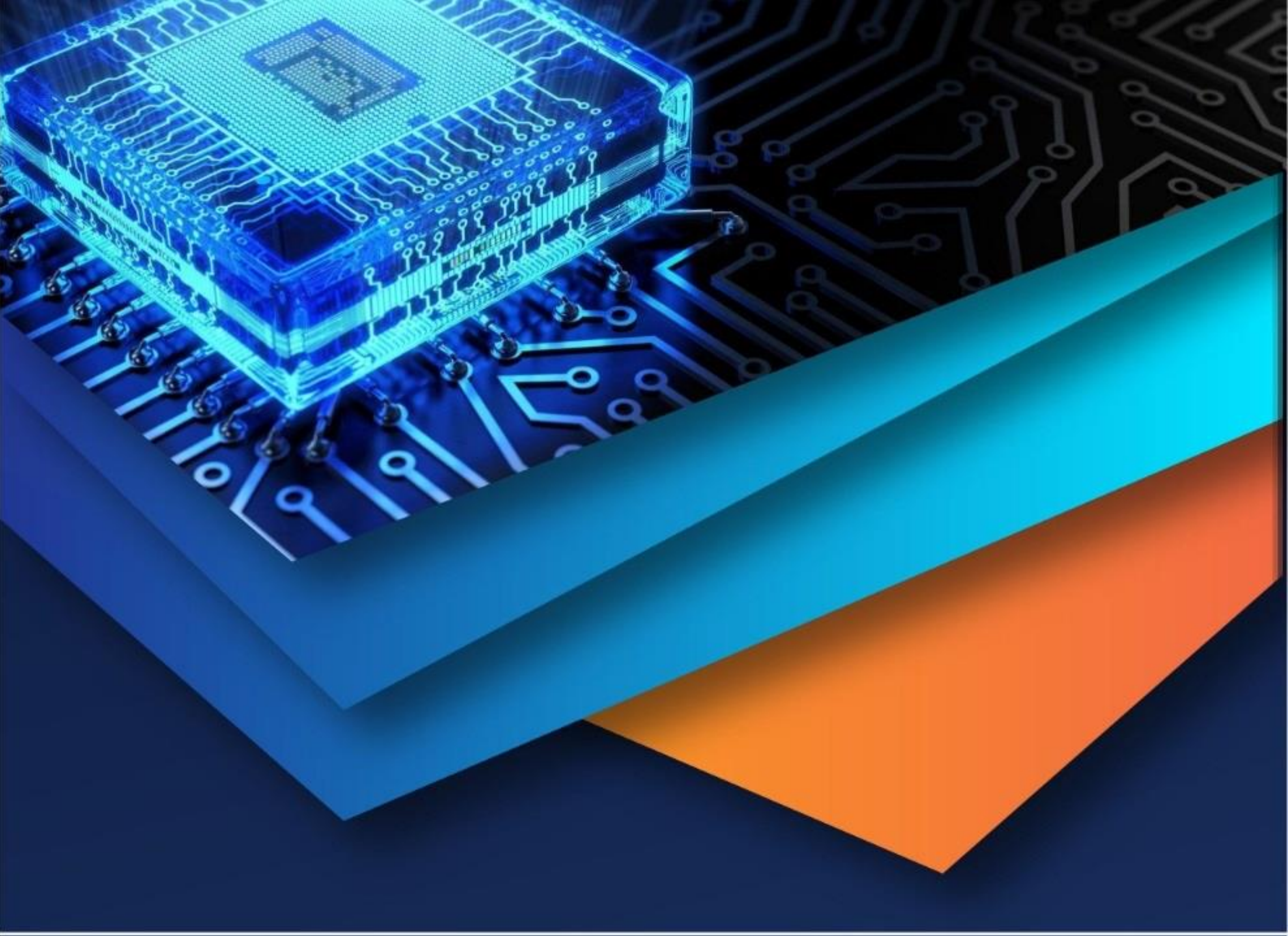

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