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Detection of Pedestrian and Different Types of Vehicles Using Image Processing

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A B S T R A C T

Nowadays, the control of the traffic in the urban roads and in the highway has been a big challenge as the number of increase in the auto mobiles. So to overcome this problem we use the detection and tracking the vehicles using the traffic surveillance system. We can manage and control the traffic more easily. It is very complicated and a challenging task to identify the vehicle or a moving object in a complex environment with various background. The ratio detected of such algorithms depends on the quality of the foreground mask generated. Therefore this project is to present the detection and tracking the vehicles and the pedestrians in an efficient method which focus on trajectory motion of the vehicles and the pedestrians. In this proposed method, the pixels in the background are preserved which can be cars, bikes, buses, pedestrian, etc., the rest is discarded as the noise. Hence, our proposed method detects the vehicles and the pedestrians as mentioned and discards the rest noise as well in the same time. Here the quality of the generated foreground mask is more to increase the detection ratio. The performance is compared with other standard methods qualitatively and quantitatively.

Keywords: Vehicles, Pedestrians detection, Haar Cascade classifier, OpenCV, NumPy, Python, Machine learning.

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1. Introduction

Advanced technology has become a very important part of our life [1]. To satisfy the need of society, almost in each and every work, we use the technologies [2, 3]. In the current era, computer science is a major subject [4]. It has many real-life applications such as cloud computing [5], artificial intelligence [6], remote monitoring [7], wireless sensor network [8-10], internet of things [11- 13], neural network [14, 15], Fuzzy Shortest Path Problems (FSPP) [16-18], Neutrosophic Shortest Path Problem (NSPP) [19- 23], TP [24- 26], internet security [27],

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uncertainty [28- 32] and so on. Technology is the mode by which users can store, fetch, communicate, and utilize the information [33]. So, all the organizations, industries, and also every individual are using computer systems to preserve and share the information. The image processing plays a major role in all computers related applications. The image processing appears in many real-life applications, e.g. home security, banking system, education sector, defense system, railway, and so on. In this manuscript, we propose a model to solve the detection of various objects such as buses, cars, pedestrians, and so on by using the Haar Cascade classifier.

In traffic monitoring and management, vehicle detection plays a crucial role. The application of vehicle detection is a very big and vastly expanded application. This method is used to detect vehicles as well as the pedestrians on the highways, on the roads parking or some other place to have a track of the number of cars or any other objects present in that area or the spot. This will help us to keep track or the surveillance to have the count on traffic vehicles and what category it belongs to. This method is used to find pedestrians, faces, vehicle buildings, and instances of world objects in an image or in the video. It will use the features that are extracted and then the learning the algorithms for getting the instances of an object class. There are many applications based on this like image security, recovery, surveillance, automatic vehicle parking systems that use object detection method. Object detection uses various models such as features that are mainly based on object detection, SVM classification, and image segmentation. There are so many categorization algorithms that are being used basically for the main aim of the car detection. Basically, we are using the quantity, non-quantity, or square distance-based object detection method.

Vehicle density is calculated in the urban areas for getting information about traffic. It also helps us to decide which type of vehicle should be allowed for parking systems which are automatic. We need to have information on the automatic counting and aggregation for all vehicles which are entering or exiting out of the parking, even the people entering the mall or cinemas.

In this project, the work is based along with other image processing techniques and OpenCV and the Haar Cascade with non-negative matrix factorization. We have been using it for vehicle detection and classification.

2. Discussion on Current Existing Methods

2.1. About the Methods

There are few existing methods such as knowledge-based technique, feature-based technique, template matching technique, and appearance-based technique. The knowledge-based method has some rules to follow, and it is supported by the knowledge of the human to detect the vehicles and pedestrians. A car must have certain qualities like wheels, body; staring must be in a particular position and space between each other. The biggest issue facing in these methods is to give some set of rules. There may be many numbers of doubts and failed answers if the rules are

too simple or too much in detail. This method alone is not sufficient and may not able to figure out many cars in given many images or in a video. Feature-based technique extracts some of the structural features of the vehicles and the pedestrians and other objects. It will first be used for classifiers and then used to figure out between the physical and non-physical regions. This is to avoid the idea of the limits of our knowledge about the vehicles and the pedestrians. This method is classified into many steps and even images with many cars they can identify and has been reported a success rate of 94. The template matching method uses predefined templates of vehicles and the pedestrians or objects templates to detect or locate the vehicles and the pedestrians and other objects by the statistics between the templates and images given. In an appearance-based method, it finds out models depending on a set of delegated vehicles and the pedestrians or other images. This method approach is better than others considering the performance. To find the relevant characteristics of images this appearance-based method depends on techniques like statistical analysis and machine learning. For the feature extraction of vehicles and pedestrians and other object recognition, this appearance-based method is used mostly.

2.2. Existing Haar Cascade Model

Detection of objects using Haar feature-based cascade classifiers is an efficient and useful object detection method proposed by Paul and Jones [53]. It is based on a machine learning approach where a cascade function is collected and verified from a lot of positive and negative images. Then it is mainly used for detecting the objects in another picture. In this method we will work with vehicles and the pedestrians, and another few more objects can be detected. Firstly, the algorithm needs many more positive images (for example images of a car) and negative images (for example images without a car) to make understand the classifier and train it; then the features are extracting from it. By subtracting some of the pixels each feature obtained under the white rectangle from the sum total of the pixels under the black rectangle is a single value.

Every possible size and location of each and every kernel are used to have the number of the features (example: even over 160000 features is found in 24x24 window). For each single feature calculation, the sum of all the pixels under white and black rectangles are needed to be found. To overcome this, the integral images were used. It makes it easy for calculation of the sum of pixels, like how big can be the number of pixels and just four pixels used for an operation. Things are made super-fast using it, but most of them are irrelevant among all these features we calculated. For example, consider the image given below. Two good features are shown in the top row. The region of the car is a little dark, the first feature selected seems center on the property. The second feature selected relies on the property that the cars are darker than the road. But the same windows applying on cars or any other place is irrelevant. So how can we select the best features out of 160000+ features it is achieved by Ad boost?

After executing ***Figure 1*** using Haar Cascade we obtain the following result (***Figure 2***).

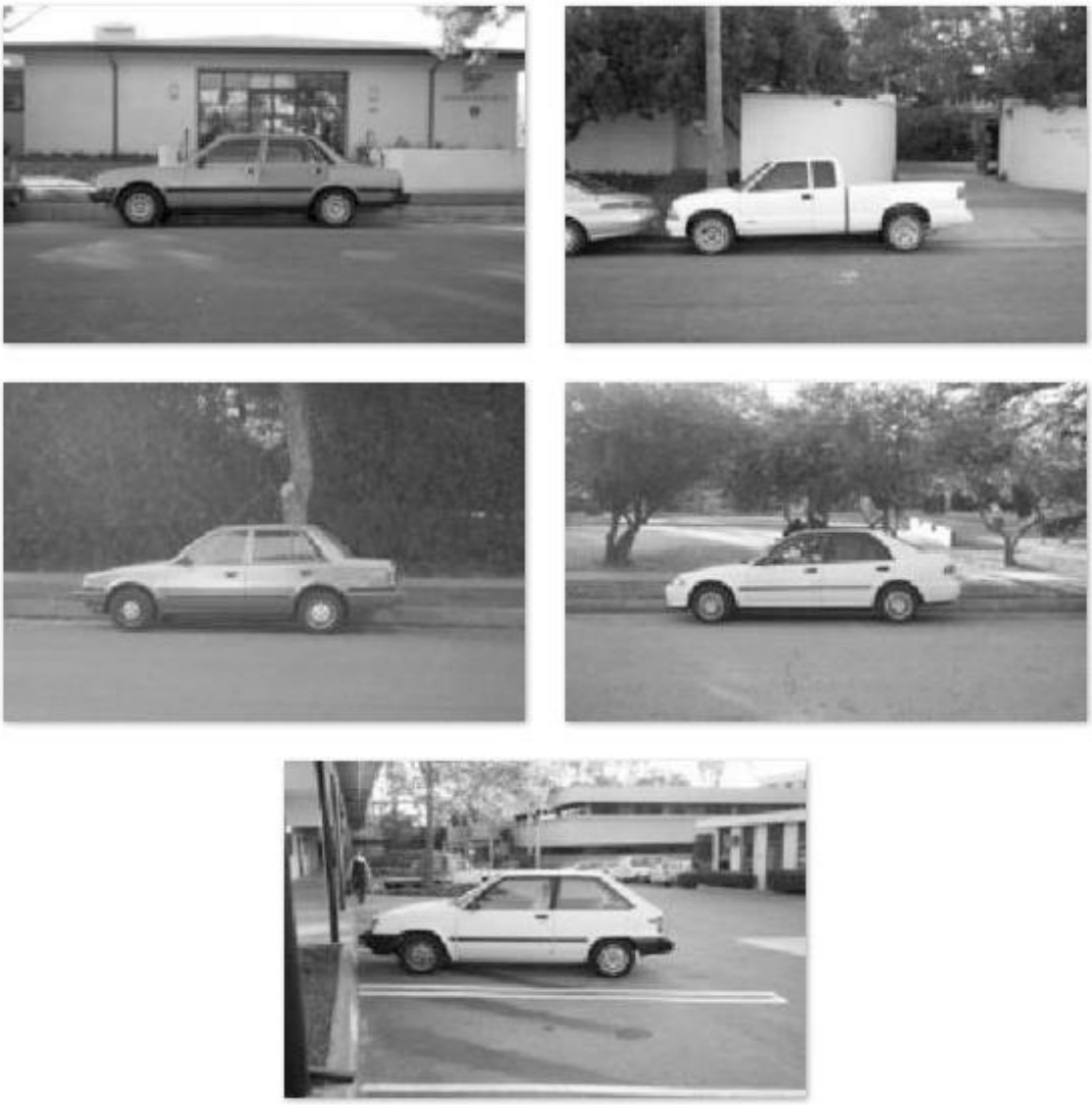

Figure 1. Gray image of cars [52].

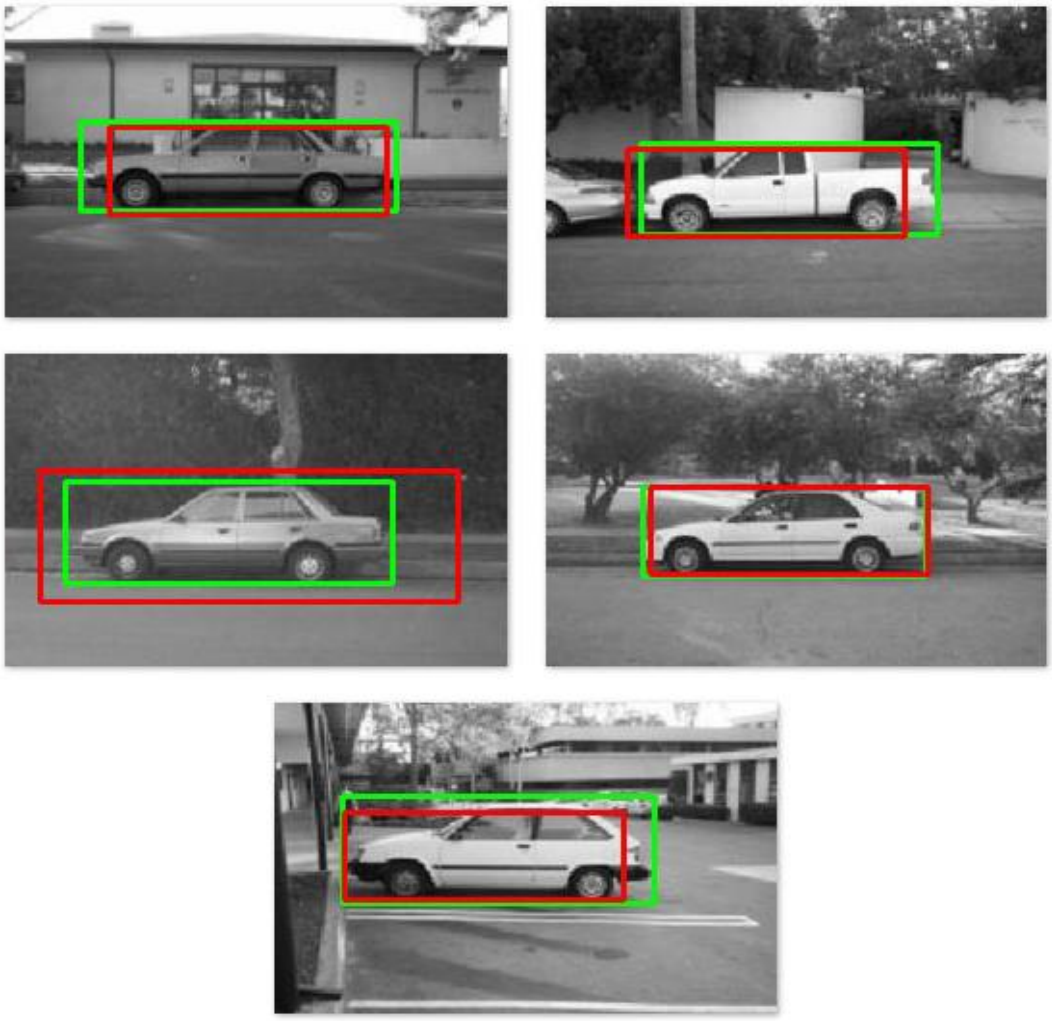

Figure 2. Obtained figure using Haar Cascade classifier.

3. Literature Review

There are many numbers of papers regarding the literature survey of vehicles and pedestrian detection. Most of them work on the car, but recent work is mainly focused on 3 or more types of vehicles. Instead of an image, they are considering video stream images.

In this paper, the author said that identifying the vehicles and the pedestrians or objects from an image using the Haar Cascade classifier. OpenCV 4.1.1 is used to implement the Haar Cascade classifier to detect vehicles and pedestrians from the images. To identify the Haar Cascade performance they use the large number of data sets containing simple and complex images.

In this paper, the author discusses the various steps of vehicles and pedestrians or object detection techniques. And, some popular detection techniques are described very briefly. Recently, vehicle density is calculated in the urban areas for getting information about traffic; it also helps us to decide which type of vehicle should be allowed for the parking system which is automatic; we need to have information on the automatic counting and aggregation for all vehicles which are entering or exiting out of the parking lots, even the people entering the mall or cinemas; tracking the vehicle and people around the countries on the roads can be calculated.

In this project, the work is based along with other image processing techniques and OpenCV and the Haar Cascade with non-negative matrix factorization. We have been using it for vehicle detection and classification, which are also the subjects to be focused on this paper.

2.3. Different Researcher's Contributions

Some of the major contributions in image processing are discussed in below (***Table 1)***.

Table 1. A literature review of image technique.

Authors	Year	Handling different problems by using an image processing technique
Harris [34]	1966	Author has proposed image evaluation and restoration.
Billingsley [35]	1970	Author has proposed applications of digital image processing.
Roesser [36]	1975	Author has implemented as a discrete state-space model for linear image processing.
Bernstein [37]	1976	Author has published digital image processing of earth observation sensor data.
Besag [38]	1989	Author introduced digital image processing.
Sun and Neuvo [39]	1994	Authors have proposed detail-preserving median based filters in image processing.
Smith and Brady [40]	1997	Authors have implemented SUSAN—a new approach to low-level image processing.
Tang et al. [41]	2007	The authors proposed "an extensible image processing suite for electron microscopy".
Plaza et al. [42]	2009	The author proposed recent advances in techniques for hyperspectral image processing.
Elad et al. [43]	2010	Authors have published the role of sparse and redundant representations in image processing.

Table 2 discussed the contribution of the Haar Cascade method is used for a different purpose.

Table 2. A literature review of the Haar Cascade technique.

Authors	Year	Handling different problems by using Haar Cascade technique
Green [44]	1966	Here the author has implemented the Pythagorean group and ergodic flows.
ter Haar [45]	1989	The author has introduced large-scale structures in turbulent fluids.
Hanai et al. [46]	2009	Author has proposed a versatile recognition processor employing Haar-like feature and cascaded classifier.
Macomber [47]	1968	Author has introduced how does a crossed-coil NMR spectrometer works?
McCormack et al. [48]	1993	The author has published machine vision applications, architectures, and systems integration II.
Nesic et al. [49]	1996	Author has proposed "Paper machine data compression using wavelets".
Paliy [50]	2008	Authors have introduced "modern problems of radio engineering, telecommunications, and computer science (TCSET)".
Plaza [42]	2009	Author has proposed recent advances in techniques for hyperspectral image processing.
Reis et al. [51]	1976	Author has introduced it as advances in image transmission techniques.
Roesser [36]	1975	Published as a discrete state-space model for linear image processing.

One undertaking from the above discussions is to identify the different structures of vehicles and pedestrians by using image processing. Additionally, the higher literature review reveals that there is varied gaps within the study of image processing of vehicles and pedestrians. As such, the subsequent gaps are studied:

- There are still very few investigations where we can detect a car, bikes, and other few more objects.
- Within one platform we can classify many objects instead of one which can be useful.
- Can easily make an analysis of how many vehicles present in a country and what time how many vehicles pass by.

Therefore this motivates us to consider vehicles and pedestrian's detection techniques. In view of the above gaps, our aim of this manuscript is to solve the vehicles and the pedestrian's detection in the very usage using Haar-Cascade classifier from images which contains the simplest and the most complex backgrounds. It is one of the preeminent detectors in terms of speed and reliability. We introduced a new method to deal with the images by using modified Haar Cascade algorithm. By using this algorithm, we can detect the image. The main attraction of the paper is to solve different types of images having one object, two objects, and three objects which can't be solved by any of the existing methods but can be solved by our proposed method. Following area unit, the most objectives were planned and accomplished during this analysis work:

- It also helps us to decide which type of vehicle should be allowed for the parking system which is automatic.
- We need to have information on the automatic counting and aggregation for the all vehicles that are entering or exiting out of the parking lots, even the people entering the mall or cinemas.
- To track the vehicle and people around the countries on the roads can be calculated.
- To check out the pedestrian walking on the road.

Here we have the option to select which type of vehicle to detect instead of detecting all of them.

4. Description of the Research Work

4.1. Research Problem

There were many problems in computer vision already existing before few years. However, using the deep learning techniques, there is an improved increment in the accuracy of these problems slowly. One of the main problems was the classification of the image, which is used by judging the class of the image which is used. A least difficult problem is the image localization, the image contains only one object and the system should judge the location of the object in the image given (a rectangular box must be showed around the object). The most difficult problem of object detection is the both localization and classification. In this method used, the input given to the system will be an image/video and the output will be a rectangular box corresponding to all the objects present in the image, along with the class of each object in each box.

4.2. Proposed Modified Haar Cascade Method

The algorithm for the proposed system is shown in below ***Table 3***.

Table 3. Algorithm for proposed system.

Steps	Overview
Step I	Considering our method, we will need an image, later we need to create a cascade classifier that will automatically give us the features of the vehicles and the pedestrians.
Step II	Here we will make use of OpenCV which will check all the image/video and the features file, so here we have NumPy arrays at the primary data points. Where we need to search for the row values and column values of the vehicles and the pedestrian's NumPy and array. This is the array with the vehicles and the pedestrians in the rectangle coordinates.
Step III	This last step includes displaying the image/video within the rectangular box. And also we need to create a cascade classifier object to extract the features of the vehicles and the pedestrians.
Step IV	Then read the image/video with vehicles and the pedestrians on it and convert it into a black and white image using COLOR BGR2GREY. Following this later we will search for the coordinate of the image. This can be obtained by using DETECTMULTISCALE. Finally, the car is detected on the window.

4.2.1. Pseudo code of proposed system

Algorithm 1 contains the detection code used in our proposed method.

Algorithm 1. Pseudocode of the proposed model.

Steps: Elaboration.
Step 1: Import CV.
Step 2: Print its version (EX: CV2-version).
Step 3: Copy-paste the cascade link.
Step 4: Copy-paste the image link.
Step 5: Create the cap obj.
Step 6: Using the while loop.
Step 7: Image is equal to cap.read () then.
Step 8: Using if loop if an image is equal to none.
Step 9: Break.
Step 10: Convert to grayscale.
Step 11: Detectmultiscale (Gray, 1.1, 1).
Step 12: Assign rectangle coordinates as cv2.rectangle (img, (x, y), (x + w, y + h), (0, 0, 255), 2).
Step 13: Then show output.
Step 14: Waitkey is equal to the time given.
Step 15: Break.
Step 16: Destroy all windows (close).

4.2.2. Graphical representation of the proposed model

In this section, the above-proposed model ***Algorithm 1*** is shown in the below flowchart ***Figure 3***.

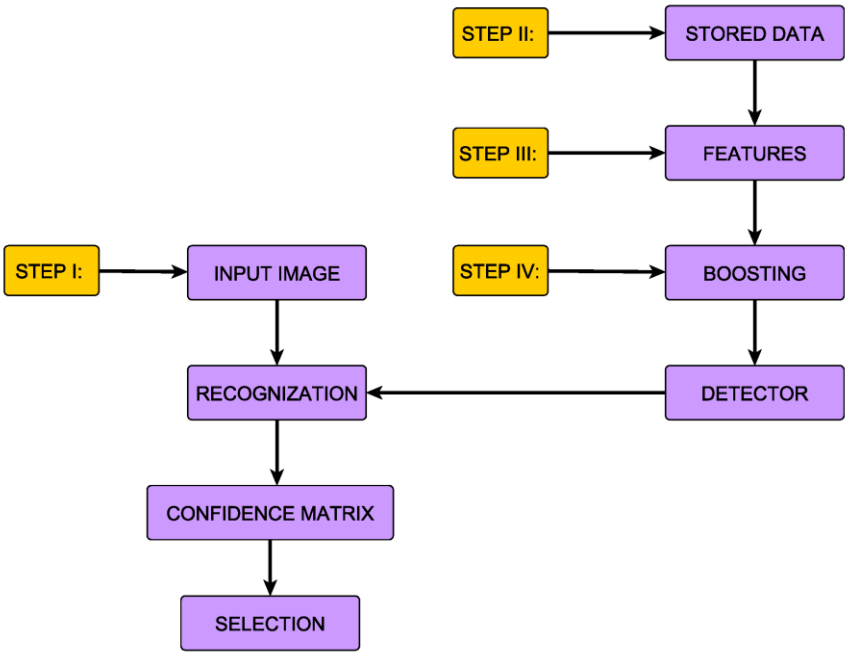

Figure 3. Flow chart for the proposed system.

5. Result and Discussion

Here we are able to see the results obtained by using our method in ***Figure 4*** and we are able to detect by selecting the options provided just like in ***Figure 4***, for example, if we select the first option car detection then we will get the result as in ***Figure 5*** like how the detection of car is shown in our result. If we want to detect the bike then we need to select the option as shown in ***Figure 4*** then we will get the result as shown in ***Figure 6*** where only the bikes are being detected. Later if we want to detect the pedestrian then we need to select the pedestrian option as shown in ***Figure 4*** there we need to select the pedestrian option hence we get the result as shown in ***Figure 7***. Similarly, if we want to detect only the bus means we need to select the bus detection option as per ***Figure 4*** then we will obtain the desired result just as in ***Figure 8*** where only the bus is being detected. By using only one application instead of using the four different applications at one time we can use this to get the desired result by selecting the option for detecting the vehicles and the pedestrian.

After executing the code using Haar Cascade and Python we get the following result (***Figure 4***)

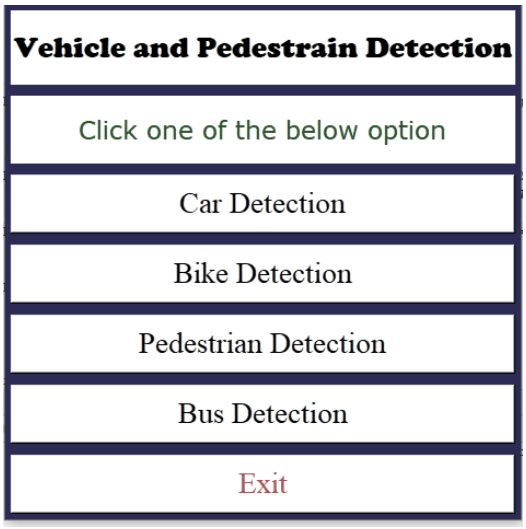

Figure 4. User selection list.

After executing the above image using Haar Cascade we obtain the following result (***Figure 5***).

Figure 5. When user selects car detection (ref. Figure 4).

Figure 6. When user selects bike detection (ref. Figure 4).

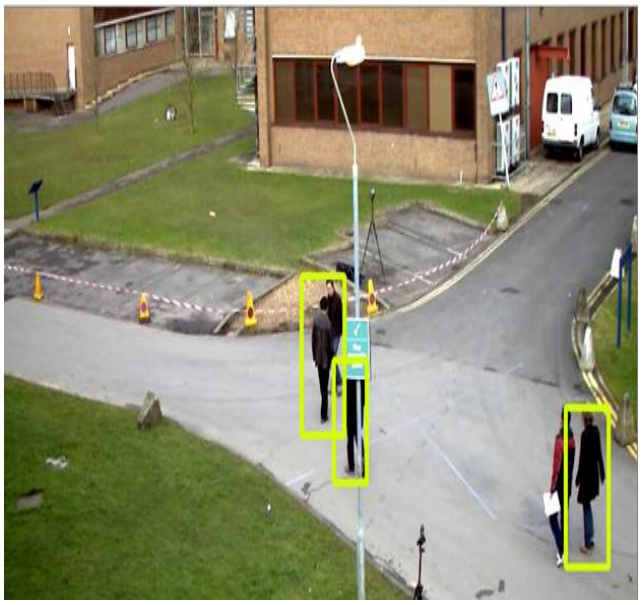

Figure 7. When user selects pedestrian's detection (ref. Figure 4).

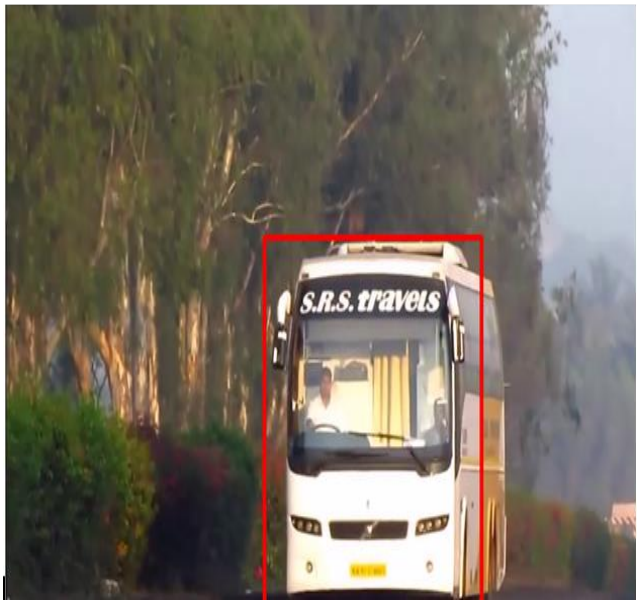

Figure 8. When the user selects bus detection (ref. Figure 4).

6. Conclusions

In the view of the present study on the image processing problem of uncertain atmosphere, the conclusions are drawn and it is recommended for the future use also. The major objective of this article was to develop and modify efficient algorithm for solving image processing, the vehicle, and pedestrian detection. In this article, we have extended one method that is Haar Cascade method. All the problems here were solved by using the Pycharm tool. The aim of the manuscript is to solve the detection in the first usage using the Haar Cascade classifiers from images/video which has the most complexity to the simplest backgrounds. It is one of the preeminent detectors in terms of reliability and the speed. The main attraction of the paper is to solve the different types of images having one object, two objects, and three objects which cannot be solved by any of the existing methods but it can be solved by using our proposed methods.

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