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A SURVEY ON VEHICLE CLASSIFICATION AND DETECTION METHODS

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ABSTRACT

The vehicle detection and classification are two important tasks concerning in designing video-based intelligent transportation system (ITS). The ITS around the world are now facing the problem of traffic congestion. If no action is undertaken for this problem then it will continue to expand, when more and more vehicles are coming out on the road. It may convert into big problems as saturation. But, today peoples are expecting faster transport with less trouble. There are various large cities in the world, and also these large cities take too much transportation. But, it is very difficult not only to manage this transportation but also to extend the network traffic. There is only one solution to better handle the current situation by scheduling of vehicles in a proper way. For that, Vehicle detection and transportation is very important. The purpose of this paper is to give the opportunity, to the researcher, to become closely familiar with the methods used for detection and classification of vehicles. There are many methods discusses that are presented by different authors for classification and detection of vehicles. Among all of these methods, some of these methods have few limitations and some new techniques trying to reduce these drawbacks. In this paper, we are representing different methods that are useful for detecting vehicles as well as classifying them.

Keywords

Artificial Neural Network (ANN), Bayesian Classification Error (BCE), Detection and Classification of Vehicles, Estimation of Distribution Algorithm (EDA), Time-Spatial Image (TSI), and Virtual Detection Line (VDL).

I.INTRODUCTION

Video- based intelligent transportation system that brings significant improvement in a transportation system as reduced congestion and increased safety. For example, whether a traffic signal “knows” there is traffic waiting to go across; whether a vehicle traveling out of its lane; whether two vehicles are about to collide etc. What is intelligent transportation system do is, it is having authority with actionable information to make better decisions, whether choosing to take that route; when to go; how to control traffic signals as like this work make it a truly intelligent transportation system.

Traffic problem is always connected with the vehicles. This traffic congestion problem leads to environmental problems as well as cost problems that have tackled. Hence traffic monitoring and controlling techniques have been used to avoid such congestion problems.

A vehicle classification is very effectual for the intelligent transportation system (ITS).For example, management of traffic, toll collection, arrangement of vehicles (parking) etc. The focus of this paper is on the study of methods for detection and classification of vehicles.

Normally, magnetic loop detectors are often used to count vehicles passing over them. But, Vision-based video monitoring systems offer several advantages. Besides, Cameras are much less disruptive to install than loop detectors. The use of an automated system may lead to accurate design of pavements (e.g., the decision about thickness) with obvious consequences. In large metropolitan areas, the data about vehicle classes that employ a particular street is necessary [2].

Vehicles are detected from video by detecting objects that have significant motion. Motion-estimation-based techniques for detection of the vehicle are: Interframe difference method [1], Gaussian scale mixture model method [3], [4], optical flow estimation method [5] and background subtraction method [6] – [10]. Among all of these the background subtraction method is most popular for vehicle detection. A few vehicle detection methods use a deformable 3-D geometric model [11], object-based segmentation method [2] to detect the vehicle from the frames of a particular video. VDL (Virtual Detection Line) -based methods proposed for counting vehicles that are exiting the virtual line on frames of video [12] - [15]. In these methods, TSI (Time–Spatial Images) are generated from video of moving objects that pass virtual line.

Vehicles are classified after detection from video. To classify the moving objects such as humans or vehicles from video, feature-based algorithms are used [2], [4], [7].

II. REVIEW OF RECENT RESEARCH ON VEHICLE DETECTION AND CLASSIFICATION.

In [2], the authors described algorithms for vision-based detection and classification of vehicles in monocular image sequences of traffic scenes recorded by a stationary camera.

The system uses a camera that is positioned on a pole, examine the scenes of traffic. For that, the system needs the camera calibration parameters and direction of traffic. The proposed method automatically extracts the background from video with the help of this vehicle separated from the background. Then collect these connected regions. After that, vehicle parameters are retrieved. Then, identify the tracked vehicle. Finally, vehicle classification is made out. In this paper, a classification error occurs due to small separation among vehicle classes.

The steps are as follows:

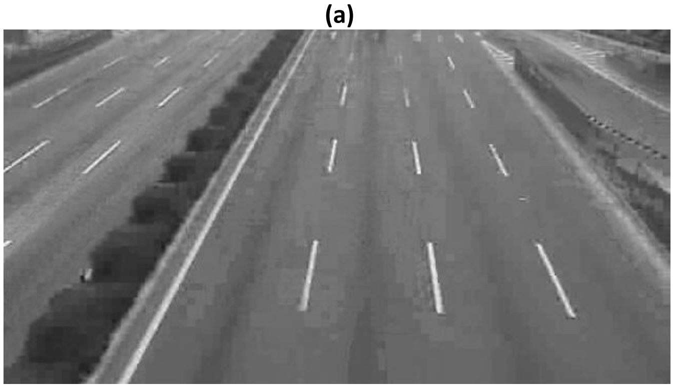
1) Segmentation: vehicles are separated from the background in the picture. The outcome of the segmentation step is a collection of connected areas
2) Region Tracking: This tracks regions over a sequence of images using a spatial matching method.
3) Recovery of Vehicle Parameters: It is information about the camera’s location.
4) Vehicle Identification: This stage groups the tracked regions from the previous stage into vehicles.
5) Vehicle Tracking: To enable tracking of vehicles, difficulties as occlusions, noise, etc., our system tracks at two levels—regional level and the vehicle layer.
6) Vehicle Classification: In previous stage vehicles have been detected and tracked, they are separated.

In [8], authors proposed method, the background is subtracted from a current frame of the video to get foreground blobs (objects) that correspond to the moving vehicles. The challenging part of the method is the estimation of the background that may undergo frequent non ideal imaging environments such as glittering of the camera, shadow, change of illumination, and noise pollution [16].

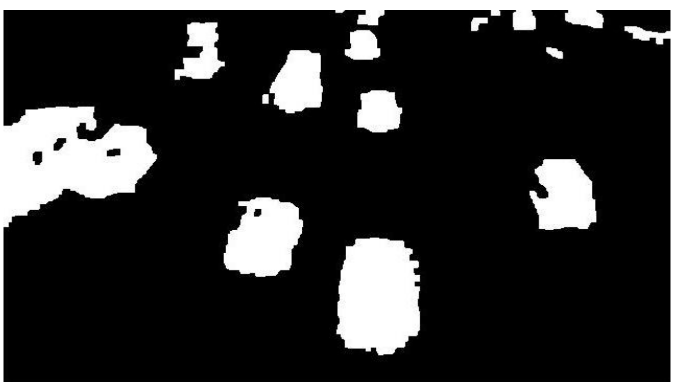
Objects in the image are determined that which objects belongs to foreground and which ones belong to the background. Then grayscale pixel values which belong to the background are used for small changes in background. Thus, backgrounds will not be distorted by moving vehicles. Figure1 (a) current frame, background with moving blobs; 1 (b) establishes the background that does not contain moving targets and 1 (c) contain illustration of moving vehicle detection using morphological operations.

The performance of background-subtraction-based vehicle classification methods are highly dependent on the initial background, which is usually approximated by a heuristically chosen thresholding of the difference frames [7]. The computational burden of such methods cannot be ignored when features of the segmented parts of all the frames of the video are considered and the classification of features is done using a nonlinear classifier.

(a)



(b)



(c)

Figure 1. Background-subtraction method (a) Current frame, (b) Initial background, (c) Vehicle detection using morphological operations

In [11], the authors have been described algorithm for model based localization and identification of vehicles from monocular images. A deformable model is set up with 12 parameters. The EDA (Estimation of Distribution Algorithm), approach generates a many models based on the deformable model and chooses the best model and position by evolution using the BCE (Bayesian Classification Error) evaluation method. This algorithm can not only carry out the localization and recognition of vehicles, but also recover the real shape of different kinds of vehicles. It can deal with different vehicles, different poses and static occlusions.
Figure 2 is about to take advantage of model based methods and avoids the disadvantages of fixed model, set up a deformable model containing 12 shape parameters so that it can be adapted to fit all kinds of vehicles.

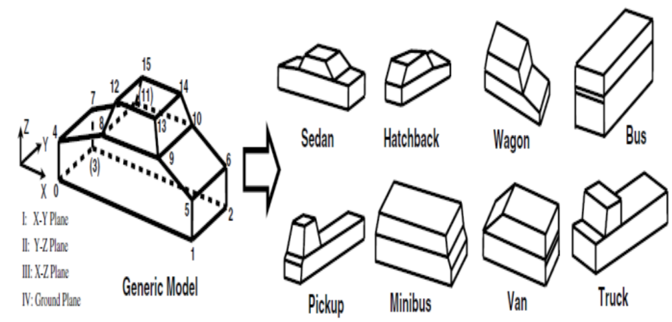


Figure 2.A generic 3D vehicle models which can be deformed to fit with different vehicles

In [12] -[15], the authors present a time-spatial imagery based algorithm to estimate the road status from video. In these methods, a time-spatial image (TSI) is generated using the luminance value of the pixels of the moving targets that go on the virtual line. Each of the moving objects that pass the VDL creates a blob in a TSI, and the total number of vehicles is counted by detecting these blobs. One of the major causes of error in counting vehicles from a single TSI through the challenges of identifying moving objects that are occluded with each other. Counting errors may happen because of not only the occlusion caused by the limitation of the camera angle but also the morphological operations used for the generation of segmented blobs corresponding to moving objects that are close to each other.

In Figure 3 the time-spatial image can be used to detect congestion by the Hough transform and edge detection as following steps:

Step1: Image preprocessing, change color frame to gray;
Step2: Setting detection line;
Step3: Generate Time-spatial image;
Step4: To detect the edges use Canny Edge Detector;
Step5: Use Hough-transform to detect line pattern. Then calculate the length *L,* direction and line number. Separate out the lines with these parameters, and get valid horizontal line number N.
Step6: Edge occupation rate calculated.
Step7: Congestion estimation;

The system first raised time-spatial image methods for traffic congestion estimation and used different methods in complex environments. The algorithm meets the requirement and demonstrates good results. The time-spatial method is robust in complex lighting and traffic environment [16].

In [17], the authors proposed a technique through which the vehicles are detected and sorted based on their sizes. The algorithm is based on a set of steps including image differencing, morphological process and thresholding. Figure 4 shows a block diagram of system for vehicle detection.

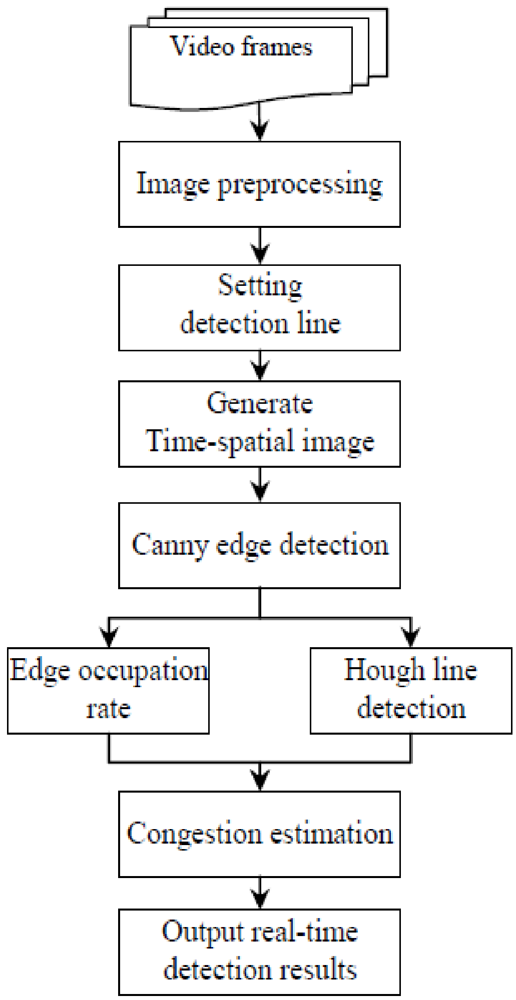


Figure 3.Flow chart for time-spatial image base method.

The frames are passed through two phases, preprocessing phase and vehicle extraction phase. In the preprocessing phase, the image goes through different processes to obtain an image ready for vehicle detection. In vehicle detection algorithm the actual processing for detection is performed. Figure 5 shows the final output for the detection classification result. The proposed algorithm has achieved a success rate of 85%. In order to tackle the problem of diffusion of multiple vehicles together as a result of dilation operation, multiple level erosion techniques can be used to separate the connected vehicles.

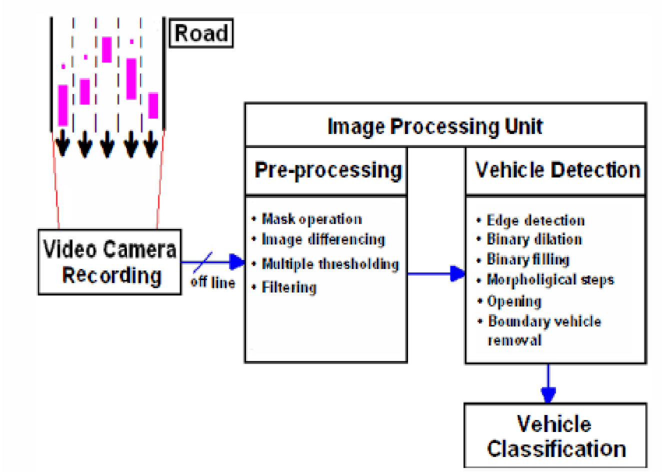


Figure 4.Block diagram of a system

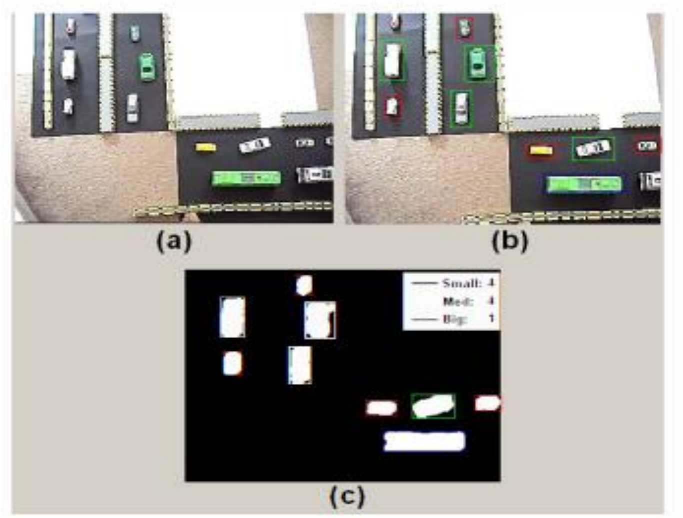


Figure 5.Detection and classification result (a) Original image (b) Detected vehicles (c) Image generated through the algorithm for vehicle detection and classification

In [18], the authors developed a new approach based on object-oriented image analysis methods for detection and classification of road vehicles from airborne color digital orthoimagery at a ground pixel resolution of 20cm.The steps are as:

Step 1: A vector-generated road mask was used to constrain detection and classification of vehicles.

Step2: Image segmentation and edge detection algorithms were done to separate vehicles from the background of the road region.

Step3: By using the feature information of image objects, a fuzzy logic classifier was constructed to classify the extracted object regions into the vehicle and the non-vehicle regions.

Final: Based on the calculated average length and width of vehicles, classified vehicles into three categories: small, medium and big. And the counts of the three vehicle classes were derived. The automatic counts match with the manual counts very well.

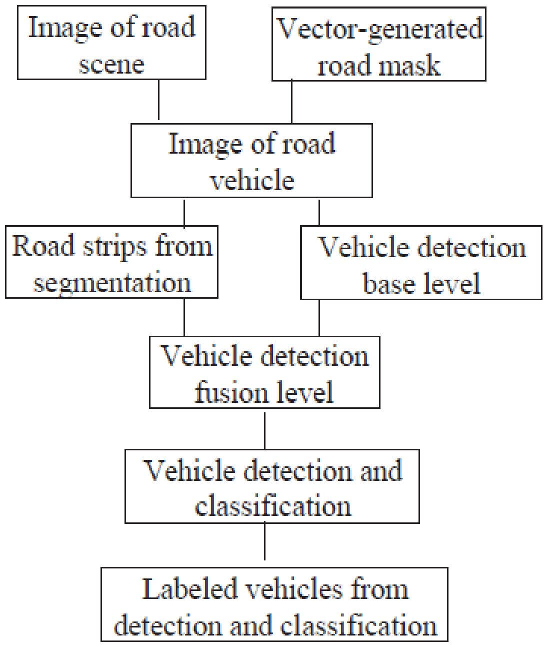


Figure 6.Flowchart based on object-oriented image analysis method.

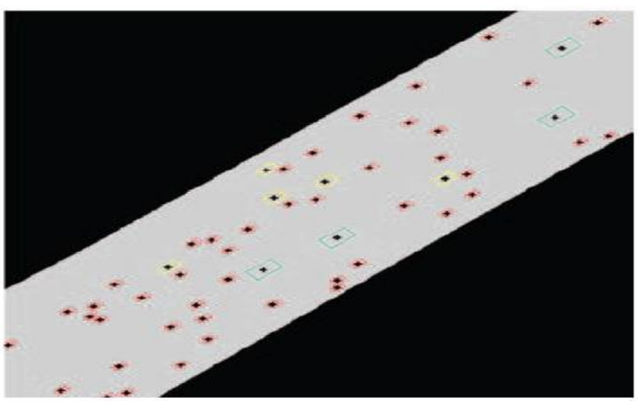


Figure 7.Vehicles after detection and classification

In [19], the authors presented efficient algorithm based on image processing using the top view of vehicles according to size. The algorithm is based on different steps including image difference, threshold, detect edges and binary morphological process**.** The experiments are carried on the frames of road through video recording using a top view of the camera. The frames have gone through two phases: 1) pre-processing Phase and 2) vehicle detection phase. In the pre-processing Phase, the image passed through different processes to obtain an image that is ready for vehicle detection as shown in Figure 8. It is a Block diagram of the system. These morphological operations are also applied in some techniques as [14], [16], and [17].

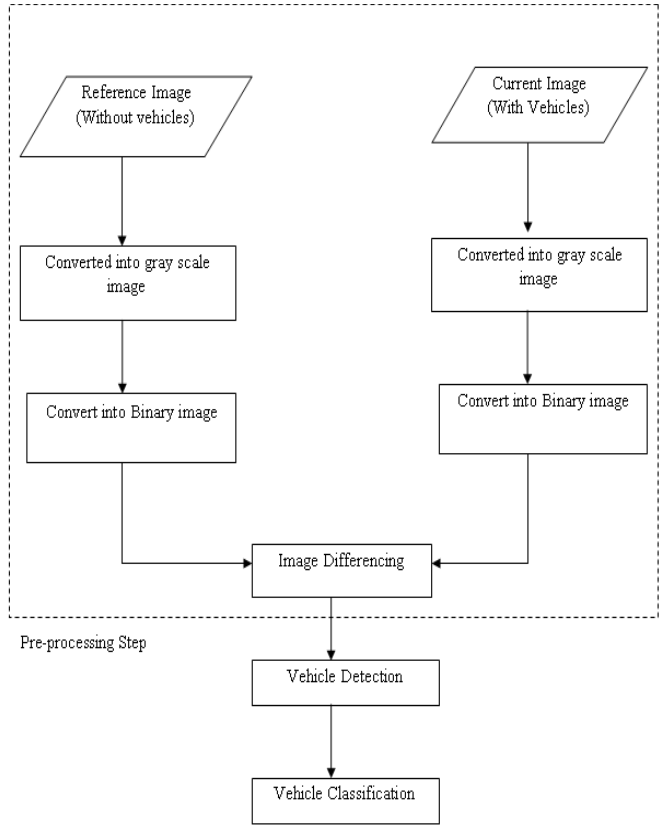


Figure 8.Flow diagram of a proposed System.

The steps are as follows:

Step1: To detect the vehicles from the road, an image is taken from the road without vehicles on it this image is Reference image. It is shown in Figure 9.

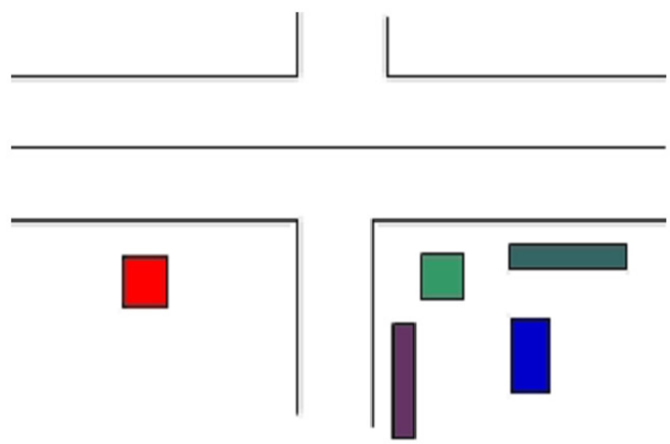


Figure 9.Reference Image

Step2: The second image is the image to detect the vehicles this is Current image. It is shown in Figure

10.

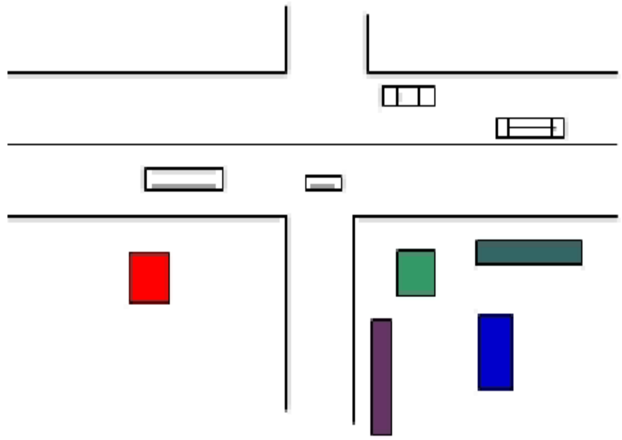


Figure 10.Current Image

Step3: Both images are converted into grayscale. These images are displayed as binary images to do binary morphological operations.

Step4: To convert both reference and current images into binary images a thresholding is applied to both the grayscale images to convert them into binary images.

Step5: Now, the image is ready for vehicle detection.

The image after differencing is shown in Figure 11.

Step6: Edge detection is done on the preprocessed image to bring it to a proper shape.

Step7: Do the first level of dilation in three directions.

Step8: To remove unwanted objects binary filing of holes is performed.

Step9: Then, again second level of dilation is performed to increase the size of unwanted objects.

Step10: Morphological opening.

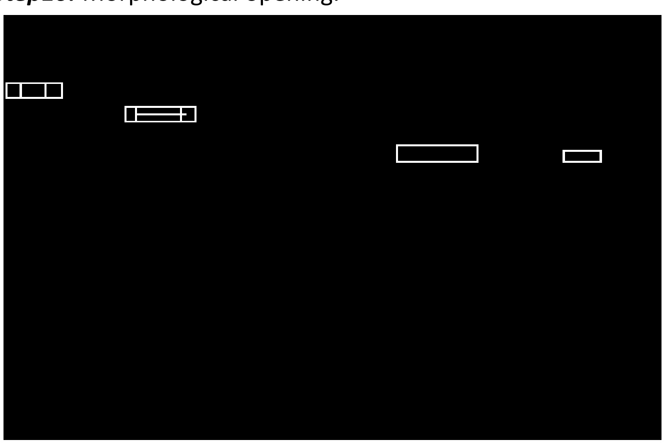
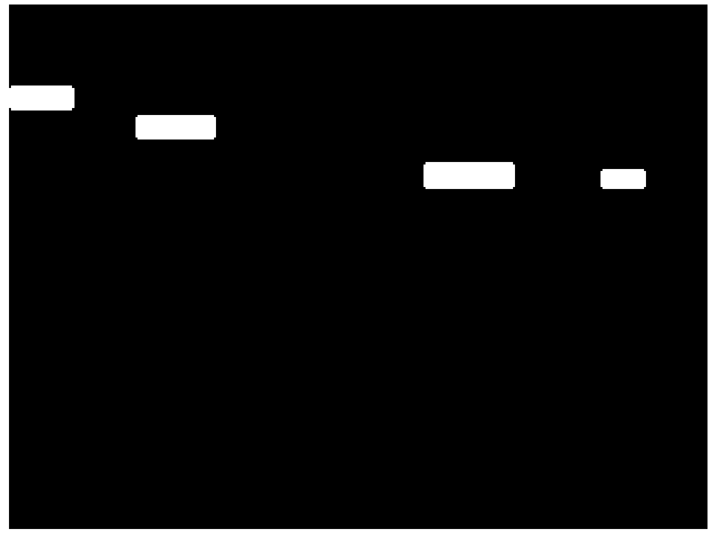


Figure 11.Difference image

The final output is as shown in Figure 11.

Total number of vehicles = .4



Vehicle in path 1 =...2. Vehicle in path 2 =...2

Figure 12.Final output

In [20], authors present application of neural network for vehicle detection and classification. Neural Network (NN) used for vehicle detection and classification. Figure 12 shows the stages of Vehicle detection and its classification as follows:

Image Preprocessing: Different video clips has been taken from the camera and converted into frames.

Motion Segmentation: For detecting the objects first step is segmenting the image to separate vehicles from the background.

Blob Tracking: *V*ehicles that are isolated from the background are tracked in this stage.

Feature Extraction: This is the result of the previous step and compute traffic parameters.

Vehicle Identification: The System assumes that vehicles may be made up of multiple blobs. This stage groups the tracked blobs into vehicles.

Vehicle Tracking: After identification of vehicles. This stage simply checks whether vehicles are merged.

Vehicle Classification uses NN: Vehicle classification is made in the dimensions of the vehicles like actual length and height. Artificial Neural Network (ANN) approach has done well in vehicle classification and gets results.

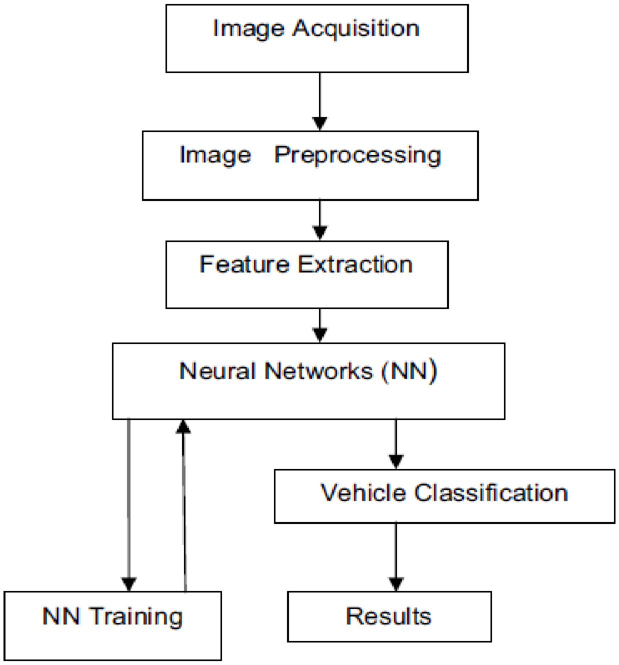


Figure 13.Vehicle detection and classification scheme

There have been cases where the system is not able doing the classification correctly. In scenes where traffic density is very high, it causes many vehicles occlude with each other. The algorithm may detect multiple vehicles as a single and affecting count. Because of the shadows also vehicles classify incorrectly.

III. CONCLUSION

In this paper we discuss about various methods for the detection and classification of vehicles. With the help of this review we come to know that a large amount of literature on detection of vehicles. At the same time, less work done for classification of vehicles. This is because vehicle classification is not that much easy as compared to detection of vehicles. We can say that vehicle detection is the preliminary step of vehicle classification.

Generally, in real-world traffic scenes, occlusions, shadows, changes in weather, different lighting conditions and camera noise etc. such type of difficulties occur for vehicle classification. During the survey, we find some points that can be further improved in vehicle detection and classification techniques that will achieve more efficient accuracy in results.

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