2020 IEEE International Conference for Innovation in Technology (INOCON)
Bengaluru, India. Nov 6-8, 2020

Vehicle Detection Using Image Processing

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***Abstract*- Nowadays, detection of the vehicles and their classification is very essential and also it has a lot of importance because of its use in many applications. One of the main applications is controlling and managing traffic. Vehicle detection and tracking plays a major role in the project of preventing road accidents using image processing. Tracking of moving objects is important in monitoring surveillance videos and capturing human motion. Taking its importance into consideration, an efficient algorithm is proposed to detect vehicles in an image using image processing. The image is captured from the front view of the vehicles. So, this algorithm detects vehicles using the front view. Each vehicle is detected based on its size. The two major techniques used in this algorithm are edge detection and morphological processing. Edge detection as well as morphological processing are important applications in image processing because of their wide range of uses. Edge detection is used to enhance the objects in image. Morphological operations are used to remove noise and as well as to adjust image in such a way to detect objects in an image. The simulation work of this algorithm is done in MATLAB which is a very strong scientific tool.**

Keywords— Vehicle detection; vehicles; Image Processing; image; edge detection; morphological processing.

I. INTRODUCTION

Today road fatalities and traffic management are the two major issues faced by many citizens all over the country especially in urban areas. According to the survey, in past few years around 4 lakh accidents happened each year. And 40-50 percent of the unnatural deaths are contributed by these road accidents. Among these accidents, metropolitan cities has major contribution. The important fact is that 90 percent of the accidents are done due to lack of traffic monitoring [1]. Over speeding vehicles by youth, rash driving, drunk and drive, red light jumping, using phone while driving are some of the important reasons which causes accidents due to driver's carelessness. These accidents had ruined many lives and sometimes government property is also damaged. So, this is the major challenge for the people in India especially the people who are leading urban life. To overcome these challenges, many methodologies have been proposed using emerging technologies [2]. For most of the methods, the first and foremost important step is to detect vehicles and their tracking. So, vehicle detection has a lot of importance in today's life. With the help of vehicle detection, vehicles can be tracked time to time which avoids all the problem mentioned above [3]. Vehicle detection helps in video surveillance application [4]. In past few years, many algorithms have been developed for vehicle detection and tracking. Most of the algorithms proposed are not effective and useful in all the situations. And also, most of the methods failed to work during night time because these methods couldn't recognize the difference between ambient light and head light of the vehicles [5]. So, there is still a scope of improvement in this domain. To overcome all these drawbacks, an efficient algorithm is designed to detect vehicles in an image using image processing. As Image processing is a vast domain which helps us to process the image as per our convenience and requirement by using various applications of this domain.

In this paper, an algorithm is developed for vehicle detection by mainly using two applications. The two applications which are used are edge detection and morphological processing which are two main applications of image processing. After enhancing the objects in the image, blob analysis is used to detect vehicles. Finally, rectangular box is assigned to each detected vehicle.

This paper is focussed as: In section 2, We will be briefly discussing about all the researches, existing methods and also the limitations of those methods. In section 3, the block diagram of algorithm developed is shown and the proposed methodology is explained in detail. Section 4 is concluded as summary of the method explained in section 3.

II. RELATED WORK

A unique algorithm for vehicle detection and vehicle tracking in video frames has been designed in [6]. This system is developed using gaussian mixture models(GMM) and method of blob detection. By learning the background, first they differentiated foreground from background so that the detection of vehicles becomes simple. This differentiation is done by GMM. And then to find the moving objects correctly, the noise is removed with the help of morphological operations. In each frame, the movement of objects is known by applying blob detection methods. To define rectangular boxes around each object, binary computation is done. Finally tracking and counting of vehicles is done based on the rectangular boxes drawn. But in this model GMM is used which does not consider spatial information and this is the major disadvantage for this system.

The main motto of the model designed in [7] is detection of moving vehicles and segmentation using background subtraction concept. The first step in this system is, we need to assume a stationary background and we need to take the difference between background image and the image in which vehicles should be detected i.e the input image. To know the features of the moving object, segmentation is done which is one of the most important application in video image processing. Segmentation is two-step process. First thresholding is applied and then edge detection methods are applied over the image. Then various morphological operations are performed to remove the noise in the image. The major drawback in this project is that this model cannot be considered when the background is dynamic.

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An algorithm for vehicle detection is proposed in [8] by using thresholding, image differencing, binary morphological process and edge detection. First, the frames are extracted from video. In this algorithm there are two phases- pre-processing phase and vehicle detection phase. First the background image is captured for reference image. Then thresholding is applied to both reference image and input image to convert them to binary images. Then subtraction between both the images is performed and edge detection methods are applied to identify the boundaries of the vehicles. The image is again processed with morphological operations. Finally, based on the number of pixels, all the vehicles are classified. This model cannot be used when the background is dynamic and when there are shadows in the image which is the drawback of this system.

In this paper [9], a model has been designed for vehicle detection in traffic monitoring using image processing. In this model two methodologies are defined for day time processing and night time processing. Background subtraction is performed to identify the objects. During the night time, to identify the difference between headlight and ambient light, the image intensity is analysed. And object counting methods are applied to count vehicles. As told earlier this model is also not useful in all the situations because the background cannot be static always

In this paper [10], different methodologies which are useful for object classification and identification are explained. The methodologies explained in this paper are optical flow, background subtraction, temporal differencing, frame differencing. These are the classical approaches used for vehicle detection. However, all these methods have some limitations. Frame differencing method cannot obtain complete contour of the object. Temporal differencing is not helpful when the target moves slowly because it results to inappropriate output. And for optical flow method, large number of calculations has to be performed.

In paper [11], an algorithm for vehicle detection is proposed which is done using two phases i.e the pre-processing phase and operational phase which is also termed as morphological processing phase. In phase 1, the image is firstly converted into grey scale and then noise in the image is removed with the help of median filtering. In phase 2, the image is binarized and morphological operations are applied on the image. A structuring element is first defined and then with the help of that structuring element, all the operations are performed. And then Sobel operator is used for edge detection. Finally, the vehicles are detected and counted.

In this paper [12] , an algorithm is designed to detect vehicles in the traffic scenes which are dynamic. The picture is captured by the camera which is fixed at a position to monitor and control traffic on roads. First, to detect any object in the image, we need to enhance the edges of the objects. To find the edge features of the objects, this algorithm has used Sobel operator, Scharr operator and also blob analysis. First the input is video which is converted into image frames. For each image frame, the region of interest is calculated. And then to enhance the edges, edge detection is performed. The operator used for edge detection is Sobel operator. Next step is to find all the connected components and their labelling based on connected components achieved from the image. Final step applied is blob analysis which is used to detect objects in every image. After all the objects getting detected, rectangular box is assigned to each vehicle.

In this paper [13] they explained about how the speed of the vehicle is tracked by its motion with sequence of images as input. For this model background subtraction is used. This model consists mainly 5 stages for tracking the vehicle speed.1) Pre-processing: In this stage the video is first converted into frames and then frame rate is extracted from that. In the next step noise is removed by using median filtering. 2)Moving vehicle detection: In this step, first we do background subtraction i.e., foreground detection. In this step each and every pixel's intensity values are modified using Gaussian mixture model (GMM). After differentiating the foreground, those pixels are grouped using 8 connectivity connected components. 3)Feature Extraction: In this step they are finding the edges of the image by using the j.shi and c. Tomasi method.4) vehicle tracking: It traces the moving objects with respect to successive video frames. It is done by the extracting features of objects in a frame and finds the objects in sequence. 5) speed estimation: Here, distance is calculated by comparing the centroids of the objects in previous and the next frame. Time is noted when vehicle enters the ROI (Region of interest). Then based on the formula we will calculate speed.

(Speed =distance travelled /time taken).

All the discussed models except morphological processing cannot be used for the case of static background. In the next section, we proposed an algorithm to detect vehicles with morphological processing combined with edge detection which gives better output and better accuracy compared to the existing.

III. EFFECTIVE VEHICLE DETECTION ALGORITHM

An efficient algorithm for vehicle detection has been designed in this section. Fig 1 shows us the basic design of the method developed. This method is divided into four phases as – Basic processing phase, Edge detection phase, Morphological operation phase and vehicle detection phase.

As each phase of the algorithm has its own importance, all the four phases of this method play an important role in detecting the vehicle in an image given as input. The four phases are explained as follows:

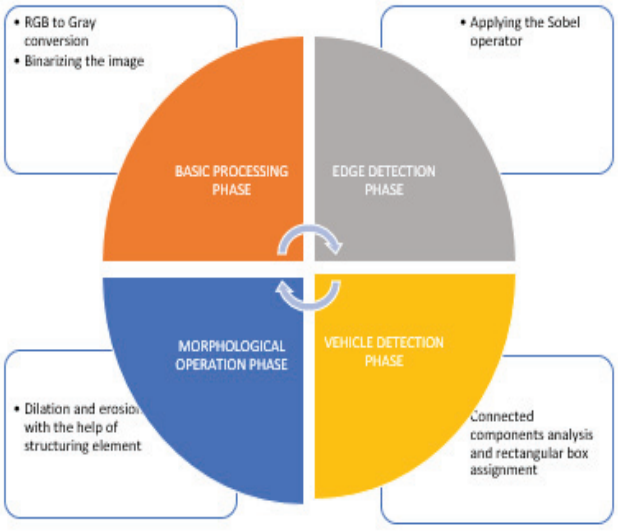

Fig. 1. Basic design of the algorithm

A. *Basic processing phase:*

In this phase, the image frame which is captured from the camera fixed at a position is taken as input to the algorithm. As the image taken is a colour image, the image is firstly converted from RGB to Gray as it is the first and foremost step followed in image processing. Then the frame which is obtained after converting to grey scale should be binarized. Binarizing the image helps us in processing the image efficiently in later stages.

B. *Edge detection phase:*

This is the important phase in this methodology because for detecting any type of objects present in an image, first we need to highlight them. So, we should now highlight the boundaries of the object for which edge detection is applied. Edge detection is one of the most important applications in image processing. In this algorithm we have used "Sobel" operator for edge detection.

C. *Morphological operation Phase:*

In this phase a series of morphological operations are applied on the image to make it suitable for the vehicle detection in the next phase. Erosion and dilation comes under morphological operations. The operations are performed with the help of structuring element. Structuring element of suitable size and suitable shape are chosen based on the size and shape of the object to be detected.

D. *Vehicle detection phase:*

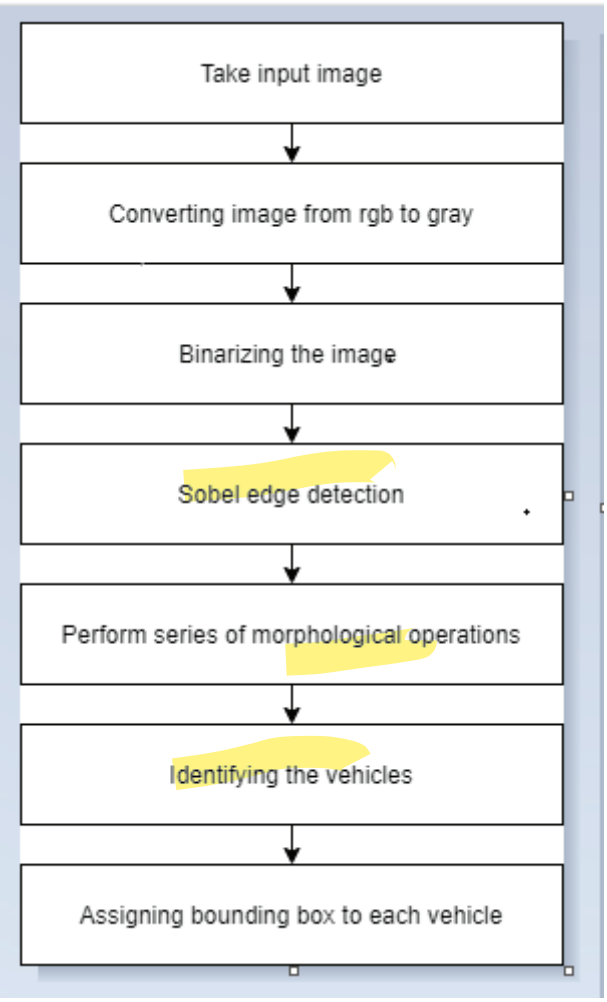

Fig. 2. Flow chart for the vehicle detection

In this phase, connected components analysis is done to remove the connected components which are fewer in number comparing with the size mentioned in the command. The size is initialized based on the size of the object to be detected. And finally, using the regionprops, rectangular box is allocated to each vehicle detected in an image.

The flowchart of the proposed method is as shown in fig 2. First, the image is taken as input to the algorithm. Then this image is converted from RGB to grey scale for better and easy processing. In the next step, the image is binarized with the suitable threshold taken. After binarizing the image, the edge detection operator is applied. The operator used here is "Sobel" operator. This operator is used to emphasize and brighten the edges of the objects in the image. With the help of edge detection, the tracking of vehicle would become easy. Then dilation and erosion operations are performed based on the shape and size of structuring element taken. Dilation connects all the necessary objects in the image. Erosion removes unwanted pixels from the image. Then based on the connected components set of pixels vehicles are detected and bounding boxes are drawn around each vehicle.

IV. RESULTS

The entire vehicle detection algorithm is implemented in MATLAB simulation software which is developed by MathWorks. The output at each step of the algorithm is shown in this section.

Fig. 3. Image Captured by the camera

Fig. 4. Phase1 Output

Fig. 5. Phase 2 Output

Fig. 6. Phase 3 Output

Fig. 7. Phase 4 Output

As seen in fig 7, the bike is also getting detected for this proposed algorithm. Whereas, in the existing algorithm only cars are getting detected. And also, as shown in fig 8, the person is also getting detected for proposed method whereas person is not getting detected for existing algorithm as shown in fig 9.

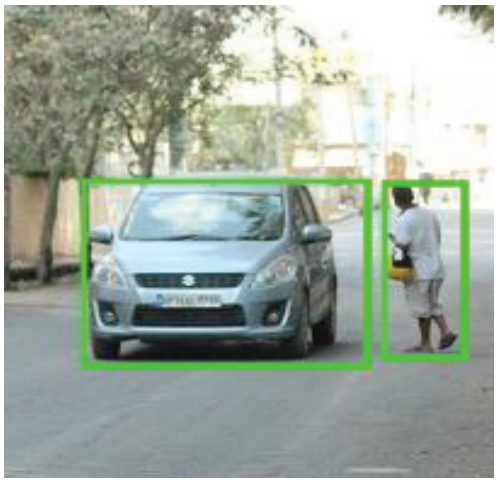

Fig. 8. Output of proposed method

Fig. 9. Output of existing method

This vehicle detection algorithm gives better output than many of the existing algorithms even during the night time. The result of the output is shown below in fig 10.

Fig. 10. Output during night time

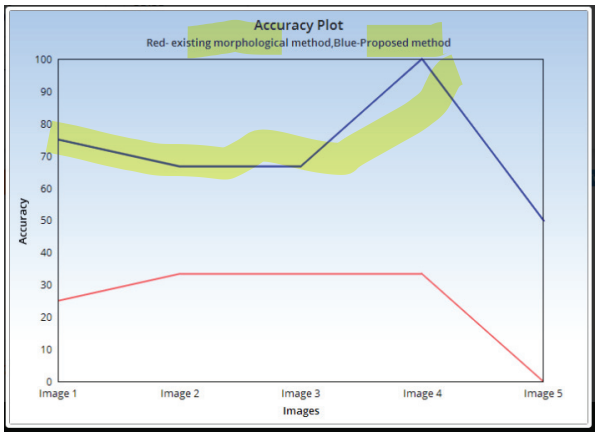

Fig. 11. Accuracy Plot

The perfect output can be obtained in the night time by placing the ambient light sensor in the system which has ability to differentiate between ambient light and headlight of the vehicles during the night time. This helps us in detecting all the required vehicles in the image. Now to show that proposed algorithm is more accurate than the existing algorithm, the results and accuracies of the previous existing algorithm and the proposed algorithm are compared using the accuracy plot shown in fig 11. This accuracy plot is drawn by considering random five real time images and by comparing the results of both algorithms.

V. CONCLUSION AND FUTURE SCOPE

Nowadays, Vehicle detection has a lot of use and importance in many of the real time day to day applications. Many researches have been done in this domain and many methodologies have been developed. But there are some limitations for the existing models which are discussed in section 2. So, an efficient algorithm has been proposed in section 3 which gives better output in all the situations based on the results shown in section 4. This proposed algorithm is simulated with real time data set of around 100 images taken at morning time, afternoon time, evening time and also night time. This algorithm works better in all the situations which can be proved by looking at the results and the accuracy plot which is shown and discussed in the previous section. Though this algorithm does not work perfectly, these results are better than existing algorithm. In this model, as we can see in the output image, the car in the shadow is not detected. To overcome this, we can use deep learning methods in which first the training is done by using vehicle dataset. And also to detect the vehicles at different times of the day, we can change threshold values which are suitable for the image intensities by using fuzzy logics.

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