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Vehicle Tracking and Counting Using Image Contour

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Abstract: **- A Novel Image Contour technique to track and count the moving vehicles from the video streams of traffic scenes recorded by stationary cameras is proposed in this research work. The moving vehicles are first extracted from the traffic scene by applying the Adaptive Background Subtraction technique. After the background subtraction, using threshold and median filters, isolated image blobs are identified as individual vehicles. Once the blobs are identified, counting and classification of vehicles in a selected region are carried out. The preliminary results show that the developed system can efficiently and reliably track vehicles when the unobstructed view of the traffic scene can be obtained. For optimal camera calibration, accuracy is better than 80% in counting vehicles was observed. The present system performs better with video data in which the vehicles are moving away from the camera compared to the video data in which the vehicles are moving towards the camera. The results obtained through the developed system show that with further improvements the proposed technique can be used in real-time to count and classify the vehicles on busy traffic routes.**

Keywords**: Vehicle Tracking, Vehicle Counting, ROI.**

I. INTRODUCTION

Object tracking is a technique to determine the position of the object in the images continuously and reliably against dynamic scenes. Vehicle tracking is an important area of Intelligent Transportation Systems (ITS), which could be applied in a wide range of transportation applications to track the location of the vehicles. The general purpose of vehicle tracking is to accurately track the moving vehicles which may be found in many applications, such as vehicle detection, intersection monitoring, vehicle counting etc. This paper concentrates on tracking and following the moving vehicles in a sequence of frames from a video sequence. To identify and tracking the real time vehicle is an important concept in computer vision which is not same as vehicle detection. Vehicle detection is the process of locating an object of interest in a single frame but vehicle tracking will associate with the detection of the vehicle across multiple frames. The problem of motion-based vehicle tracking can be divided into two parts:

• Detecting moving objects in each frame.

• Associating the detections corresponding to the same object over time.

A vehicle tracking system is the complete solution for vehicle management and monitoring of vehicle location in the moving video. The video-based vehicle tracking approach has quite many advantages, such as convenience of installation, low cost operation, possible large coverage of the area of interests, and non-intrusiveness. A novel Image Contour technique to track and count the moving vehicles from the video streams of traffic scenes recorded by stationary cameras is proposed in this research work. The paper is organized as follows: Section II describes various vehicle tracking methods and its types in brief. Section III explains the proposed work. In Section IV, Experimental Results are analyzed, and finally conclusions are made.

II. VEHICLE TRACKING METHODS

Detecting the regions of moving object in the image sequence captured at different intervals is one of the interested fields in computer vision. Vehicle tracking has large number of applications in diverse disciplines such as video surveillance, medical diagnosis and treatment, remote sensing, underwater sensing and civil infrastructure. Several vehicle tracking methods have been illustrated and proposed by several researchers for different issues and are listed below:

- Region Based
- Model Based
- Active Contour Based
- Feature Based.

Region based algorithms track objects according to the variations of the regions corresponding to the moving objects [1][2]. These algorithms usually detect the motion region by subtracting the background from the current image. These algorithms cannot work well when there are multiple moving objects. The idea in region- or blob-based tracking is to identify the connected regions of the image,

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blobs, associated with each vehicle. Regions are often obtained through background subtraction and then tracked over time using the information provided by the entire region [5][6]. Model based algorithms track objects by the matching object model [8]. There are several models of vehicles. They are most robust than the feature based algorithms but slower. Active contour tracking algorithms track objects by their contours. The contours are updated in consecutive frames [3]. These algorithms provide more efficient description of objects than done in region-based algorithms, and computational complexity is much reduced. However, the inability to segment vehicles that are partially occluded remains. If a separate contour could be initialized for each vehicle, the tracking could be done even in the presence of partial occlusion. For all methods, initialization is one of the major problems. Feature based algorithms track objects by extracting their features and matching these features between frames [3][7][8]. There are some features that define a vehicle (symmetry, edges, shadow, color, size), and they are looked sequentially in the image.

III. PROPOSED WORK

The main objective of this research work is to propose an algorithm to automatically track the moving road vehicle from the input traffic video image using Contour extraction method. The following steps are applied to track the vehicle:

- Video Acquisition
- Vehicle Tracking
- Vehicle Counting

The flow diagram of the proposed work is shown in figure1.

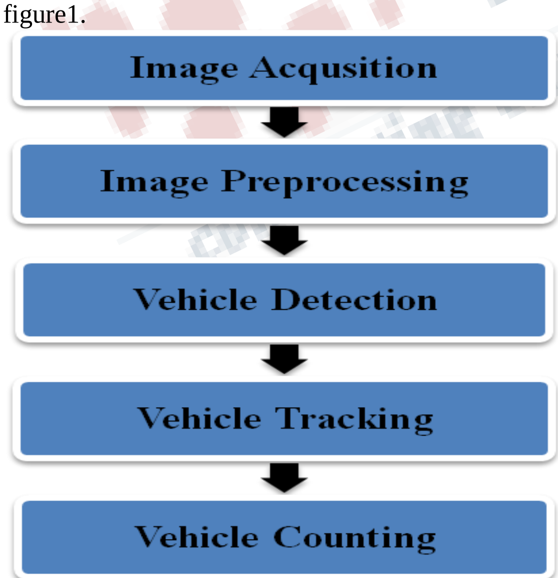


Figure 1: Flow diagram of the Proposed Method

A. Image Acquisition

Videos are made up of subsequent images (frames) which move fast enough in frequency so that human eyes can percept the continuity of its content. It is obvious that all image processing techniques can be applied to individual frames. Besides, the contents of two consecutive frames are usually closely related. Frames with vehicles in the captured moving video are taken as input for processing. A frame from moving video is taken and shown in Fig 2.

B. Image Preprocessing

The input video frame image is converted into a grayscale image. Thresholding is a method used to convert a grey scale image into binary image. The resultant image contains two classes of pixels i.e., foreground and background. To identify the class i.e., whether the pixel belongs to foreground or background, the value of weighted within - class variance will be calculated and it will be minimum for each class.

The weighted within-class variance is:

$$\sigma_w^2(t) = q_1(t)\sigma_1^2(t) + q_2(t)\sigma_2^2(t) \qquad \text{--------- (1)}$$

Where the class probabilities are estimated as:

$$q_1(t) = \sum_{i=1}^{t} P(i) \qquad q_2(t) = \sum_{i=t+1}^{I} P(i) \qquad \text{--------- (2)}$$

The individual class variances are:

$$\sigma_1^2(t) = \sum_{i=1}^{t} [i - \mu_1(t)]^2 \frac{P(i)}{q_1(t)}$$

$$\sigma_2^2(t) = \sum_{i=t+1}^{I} [i - \mu_2(t)]^2 \frac{P(i)}{q_2(t)} \qquad \text{---------(3)}$$

Where the class means are given by:

$$\mu_1(t) = \sum_{i=1}^{t} \frac{iP(i)}{q_1(t)} \qquad \mu_2(t) = \sum_{i=t+1}^{I} \frac{iP(i)}{q_2(t)} \qquad \text{-------- (4)}$$

Where P(i) is the class probabilities.

A simple fixed-level thresholding technique is proposed and the output binary image is shown in Fig 3.

Figure 2: Traffic video Frame

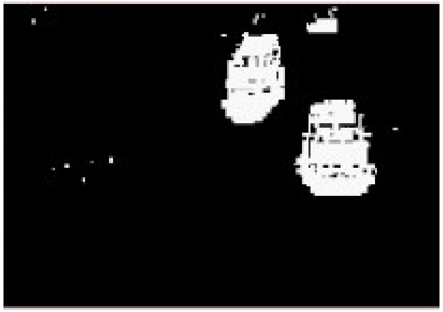


Figure 3: Preprocessed video Frame Image

C. Vehicle Detection

For vehicle detection, background subtraction approach is proposed to identify the vehicle in a video sequence. In the preprocessed video frame image, the object(vehicle) pixels are subtracted from a reference background, which is upgraded during a period of time. Background frame is initialized by the initial frame of image sequence as given in (5).

B0(x, y) = I0(x, y) ----------------------- (5)

Where B0 is the background frame and I0 is the initial frame.

To determine the changes, a mask Mn(x, y) is defined as a thresholding difference between three consecutive frames and given in (6).

$$M_{n+1}(x,y)=\begin{cases}0 & f\ |I_{n+1}(x,y)-I_n(x,y)|<1 \text{ or } \\ & |I_{n+1}(x,y)-I_{n-1}(x,y)|<1, \\ 1 & \text{otherwise}\end{cases}$$

-------- (6)

Now the background will be created by Mn (x, y). Next, the background is to be updated for (n+1) number of frames which is defined as follows:

$$B_{n+1}(x,y)=\begin{cases}\alpha B_n(x,y)+(1-\alpha)I_n(x,y) & \text{if } M_n(x,y)=0 \\ B_n(x,y) & \text{otherwise}\end{cases}$$

------- (7)

where α ∈ 0 or 1 is a time constant that controls the rate of the background. The percentage of changed pixels in the current frame is defined with respect to the preceding two frames. The best value for α can be derived from the equation (8).

$$\alpha=\frac{\sum M_n(x,y)}{areaof\ \ I_n}$$

-------- (8)

The output of background subtracted traffic vehicle image is shown in Fig 4.

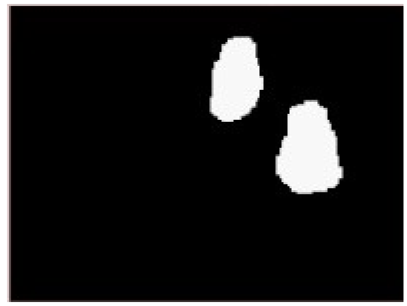


Figure 4: Background subtracted (foreground) Image

D. Vehicle Tracking

A novel bounding box method is proposed to recognize the outline of the vehicle i.e., the contour of the object. It is the smallest rectangle that completely contains the region of interest (ROI). The bounding box technique is used to detect the centroid of a particular vehicle in the image and the changes in the centroid co-ordinates. The difference or change in centroid of the object between two consecutive frames is noted. It will measure the properties of image regions on contiguous and discontinuous regions. Then, the properties of each component of the detected image regions are calculated by the function regionprops(). It returns measurements for the set of properties specified for each 8-connected component (object) in the binary image which is a structure array containing a structure for each object in the image. The vehicle object tracked from the frame using bounding box rectangle is shown in Fig 5. The centriod point which depends upon ROI (Region of Interest) is calculated. When the vehicles are coming into the ROI, the vehicle center point is calculated. After that bounding boxes are drawn.

Figure 5: Bounding Box Rectangle

After drawing the bounding box, each bounding box is counted and that will be shown in Fig 5 and Fig 6.

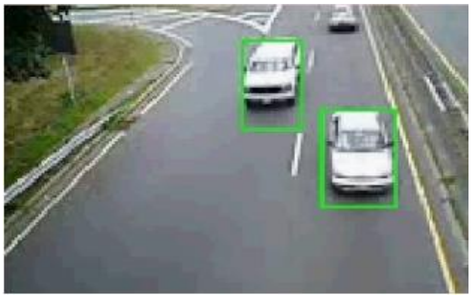


Figure 6: Proposed Method

E. Vehicle Counting

Counting of vehicles is an important task in the traffic control system. While the tracked image forms the input vehicle image for counting, the presence of moving vehicle is detected with the help of binary detection. Each bounding box rectangle is counted per frame. From fig 7, it will be calculated that the actual number of vehicles in the given frame is 2.

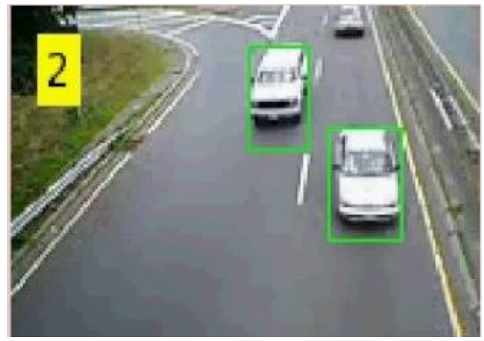


Figure 7: Vehicle Counting

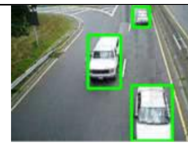
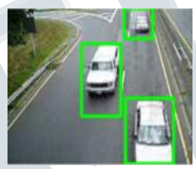
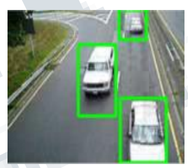
IV. EXPERIMENTAL RESULTS

The proposed method is implemented in MATLAB framework. The results of tracked vehicles are derived from different frames and are shown in table I. The tracking method is evaluated on the on the basis of number of vehicles counted by the proposed method. Given a ground truth, the performance is evaluated by computing the accuracy measure which is defined as in (9).

$$\text{Accuracy}(\%) = \frac{\text{No.of vehicles counted the by method}}{\text{Actual No.of vehicle in a video}} * 100 ------(9)$$

TABLE I: RESULT AND PERFORMANCE ANALYSIS OF TRACKED VEHICLE

S.No	Input Image	Frame No	Tracked Image	Actual No. of Vehicle present	No. of Vehicle Counted by the Proposed Method
1		4		3	3
2		14		1	1
3		34		2	2
4					

		44		3	3
5		77		2	2
6		78		2	2
7		81		3	2
8		87		3	3

V. CONCLUSION

In this paper, a real-time video with 120 frames of moving vehicles is taken as input. Each frame is separated and the vehicles are tracked by bounding box and Contour Extraction techniques. The contours are extracted for each vehicle and from the number of contours extracted the moving vehicles are counted. From experimental analysis it has been shown that, Out of 120 frames taken, the vehicles are correctly tracked and counted for 99 image frames by giving the accuracy of 82.5%. This method is most effective in real time, and it performs well for moving object detection.

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