Morphology Based Moving Vehicle Detection

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Abstract :

Detection of vehicles is the most imperative domain in recent years. It performs vital role in civilian and military application, vehicle tracking is one of the major application in defense sector. Traffic planning, city planning, traffic surveillance and control are the fundamental application in civilian sector. This research paper introduces morphological techniques for video vehicle detection which are based on Morphological approach. Literature survey presents recent work on vehicle detection techniques on vision based vehicle detection using sensors. Tracking the vehicle motion and recognize their features has been rising research area in the field of computer vision and image processing. Analysis of traffic images perform following steps:

- **Fragmentation of frames**
- **Morphological operation on frames**
- **Vehicle counting.**

Keywords: Vehicle detection, Median Filter, Traffic surveillance, Thresholding, Edge Detection.

1. Introduction

Road safety is an issue of national concern, considering its magnitude ,gravity and the consequent negative impacts on the economy, public health and the general welfare of the people. Today, Road Traffic Injuries are one of the leading causes of deaths, disabilities and hospitalizations, with severe socioeconomic costs, across the world. The Indian Government has rightly proclaimed 2011-20 as the decade of action on road safety so that the present rising trend of road accident stabilizes and is reversed by the year 2020[13].So it clearly indicates the need of video based traffic surveillance system which can help to reduce the number of highway accidents.

Basically vehicle detection system works on two basic steps: 1) Generation of Hypothesis in which, location of possible vehicles is hypothesized from image and 2) Verification of Hypothesis in which hypothesis is verifies [1-2]. Motion based hypothesis is highlighted with the working model based on the vehicle activity. This method calculates the variation between scene captured and sensor by utilizing relative motion [3]. It is an attempt to propose and implement algorithm and system which is real-time oriented and vastly adaptive to traffic videos and road depend on domain specific knowledge on vehicle, road and control [4].

In concern to automatic driving, accident avoidance and pursuit some important aspects are need to evaluate like vehicles present on road and situations of traffic while driving. It is really defying task to create a system that automatically identify the vehicles moving in opposite / same direction and tracking them constantly from traffic video. The most elementary difficulty in this kind of system is the environment that continuously changes and contrasts of light [6].

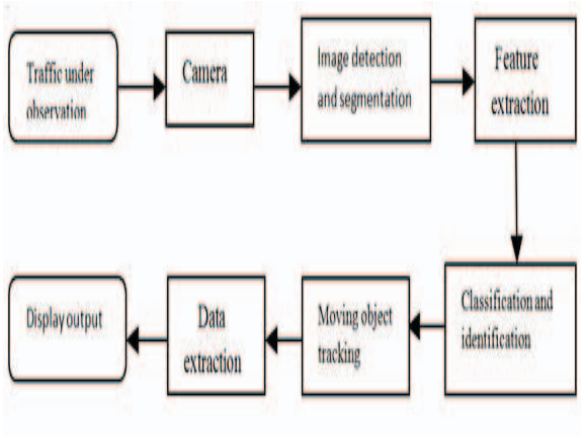

Fig 1. A Vehicle Analysis System in Typical Video [39]

In this paper, we have introduced methods which detect vehicle objects using structure (size) phenomena. Proposed algorithm is based on number of steps including video fragmentation, morphological processing and masking. Experiment is carried out on video frames of traffic videos. Which

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are taken through traffic camera, different types of traffic videos are experimented to check the variation of detection.

The remaining of the paper is arranged as follows, in section 2. Detail description of pervious work related to morphological approaches for vehicle detection is included. In section 3. Proposed algorithm is explained with help of flow diagram. In section 4.result of experiment with statistical data are given. In section 5. Conclusion and future work is mentioned.

2. Literature Survey:

C. Cheung , C. Kamath and A. Gyaourova has represent a technique that depend on block matching for tracking of object in traffic videos , for traffic video detaining a motionless airborne camera was used. This paper mainly argued the techniques of block matching for diverse complexes and resolutions [7].

Michael Werman and Yoav Rosenberg discuss a algorithm which designed for object tracking. This algorithm is depending on motion modeling and domain knowledge. Distribution matrix shows the dislocation of every point which is allocated a discreet probability. Registration of image is depending upon the motion model. At the last step background is compared with the registered [8].

C. S. Regazzoni, L. Marchesotti and A. Turolla forms a camera model which having numerous cameras. These cameras send images and images are collected from diverse locations to form an object features. Location estimation is done by using these object features [9].

Robert Van Dyck , Yiwei Wang and John Doherty discuss a simple feature based tracking method , in which image is segmented and interested objects are gathered. Changes in movement are calculated for different possible directions [10].

Gwang Yul Song et al. [44], stated an approach that detect the vehicles by edge based candidate generation and appearance based classification. They develop a monocular vision system that able to identifying vehicles behind of in front of user vehicle. Approach mainly focuses on following steps:

- By analyzing textures, Generate a candidates with respect to a vehicle.
- An appearance-based method verifies the candidates by using the AdaBoost learning algorithm.

Constantime Papageorgou and Tomaso Poggio Presents trainable system for object detection in unconstrained, cluttered scenes. The system derives much of its power from are presentation that describes an object class in terms of an over complete dictionary of local, oriented, multi scale intensity differences between adjacent regions, efficiently computable as a Haar wavelet transform.

Joshua Gleason et al. [39], introduce an approach in "Vehicle Detection From Aerial Imagery ", it focuses on detection of vehicles in rural environments and oil and gas pipeline hazard detection, is one of its application. Automatic detection of vehicle using unmanned aerial vehicles (UAV) will reinstate present pipeline patrol services that depend upon pilot optical inspection of the pipeline from low altitude high risk flights that are often restricted by weather conditions. This research compares a set of attribute extraction methods applied for this septic task and four classification techniques.

3. Methodology

This approach of moving vehicle detection involves following steps of processing. Each step having unique applicability for each bunch of frames taken from traffic videos,

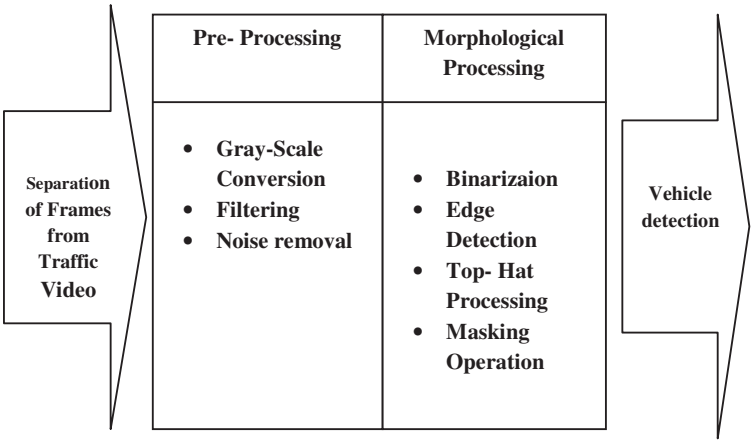


Fig. 2 Block Diagram of the Proposed System

At the initial step, traffic video are divided into frames (still images) at fixed time intervals .Obtained frames are processed from following phases ,

1. Pre-Processing Phase
2. Operational Phase (Morphological processing)

In pre-processing phase, resultant frame goes from various processes for obtaining a ready frame for vehicle detection. In this phase, frame is converting into grayscale image for further operation, which adjusts the contrast of frame. Filter operation is carried out for removing unwanted noise from frame. This operation is done with the help of median filter, purpose of involving median Filter in preprocessing is its quality of noise removing without disturbing actual set of pixels.

In operation phase, actual proposed algorithm is apply on frames, in initial step binirization operation is carried out , in which gray scale image is converted into black and white image. This operation is followed by, morphological operation which is the sequence of opening and closing operation (Top-Hat operation) is performed to visualize shape of vehicle (object). Mask is created using structuring element, this mask is superimposed on original frame and vehicle is tagged for counting. Flow diagram of proposed algorithm is shown in fig 3 .

RGB to gray conversion performed at the start of the algorithm. Gray image provides efficient range of black to white color shade present in the image. Basically RGB to gray conversion is done because of following reason

- Simplicity
- Data reduction
- To summarize

Median filtering is a nonlinear method used to remove noise from images. It is widely used as for removing noise while preserving edges. It is particularly effective at removing 'salt and pepper' type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighbouring pixels.As median filter is non liner , for two images *A(x)* and *B(x)*:

$$median\left[A(x)+B(x)\right] \neq median\left[A(x)\right]+median\left[B(x)\right] \quad \ldots\ldots$$

(01)

In this approach median filter are actively participate in removing noise and produces a significant result for detection of objects. False detection rate is controlled by using the median filter.

Binarizaion process involves conversion of gray scale image into binary image. Binary images are also called bi-level or two-level. This means that each pixel is accumulated as a bit i.e. 0 and 1.pixel value is decided by using thresholding value as shown below,

In more specific manner the thresholding methods restore every pixel in an image with a black pixel if the image intensity $\mathbf{I_{i,\,j}}$ is less than some fixed constant **T**, shown in equation

$$\mathbf{I_{ij}<T} \qquad \textit{....(02)}$$

A white pixel if the image intensity is greater than that constant. Shown in equation

$$\mathbf{I_{ij}>T} \qquad \textit{....(03)}$$

For edge detection canny edge detection technique is applied on resultant frames. Smoothened image is then filtered with a Sobel kernel in both horizontal and vertical direction to get first derivative in horizontal direction (Gx) and vertical direction (Gy). From these two images, we can find edge gradient and direction for each pixel as follows:

$$\mathbf{Edge\_Gradient(G)=G2x+G2y} \qquad \ldots (04)$$

$$\mathbf{\sqrt{}Angle(\theta)=tan{-}1(GyGx)} \qquad \ldots(05)$$

In mathematical morphology and digital image processing, top-hat transform is an operation that extracts small elements and details from given images. Basically Top-Hat transform is made with two significant morphological operations opening and closing. There exist two types of top-hat transform

- White Top-Hat Transform

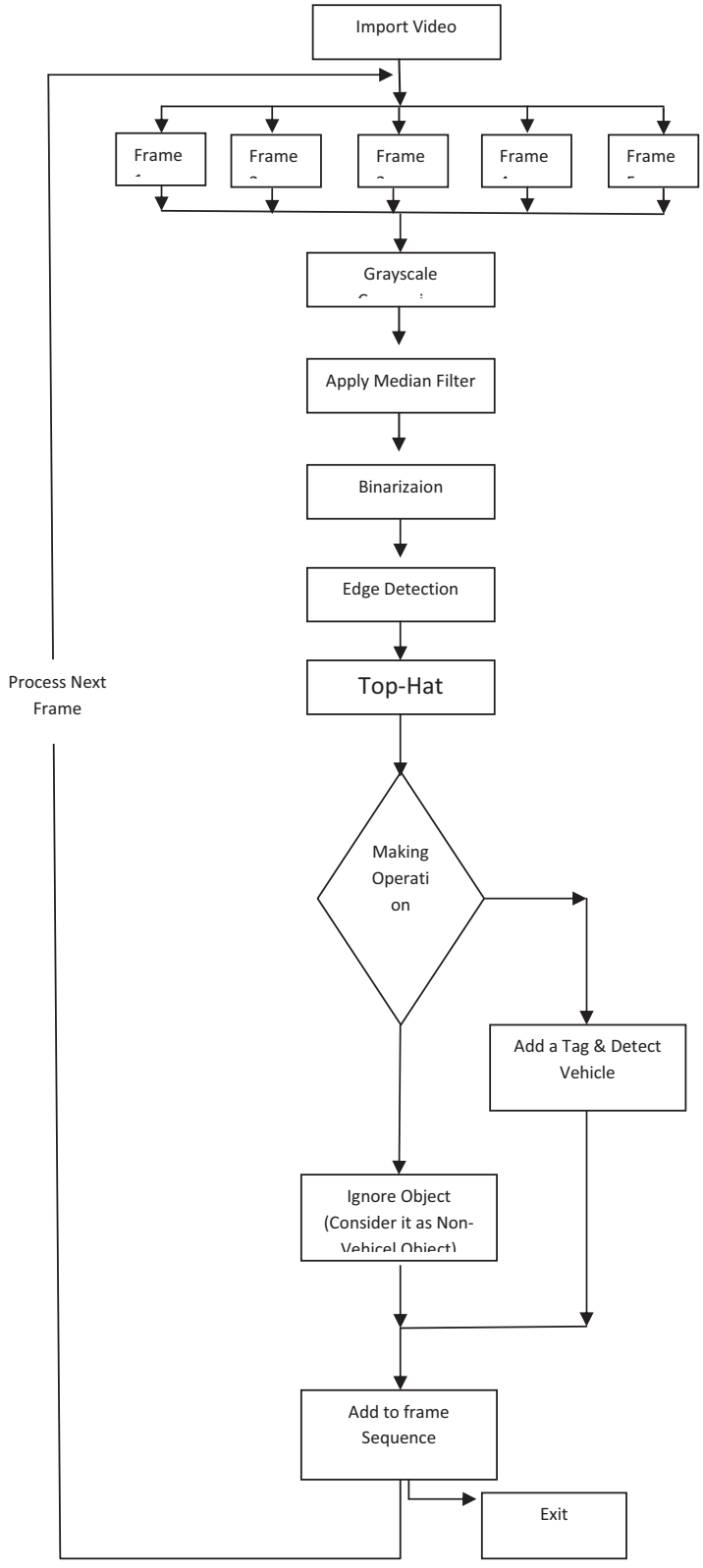


Fig.3 Flow Diagram of Algoritham

The white top-hat transform is defined as the difference between the input image and its opening by some element. Mathematical equation for Top-Hat Operation is ,

$$F: E \rightarrow R \quad \text{..... (06)}$$

Let be a grayscale image, mapping points from an Euclidean space or discrete grid E (such as R^2 or Z^2) into the real line. Let b(x) is a grayscale structuring element. Then, the white top-hat transform of f is given by:

$$T_w(f) = f - (f \circ b) \quad \text{.. (07)}$$

Where T_w denotes white Top-Hat, f denotes the image, ° denotes opening operation.

- Black Top-Hat Transform

The black top-hat transform is defined dually as the difference between the closing and the input image. Black Top-Hat Transform is also called as Bottom Hat Transform.

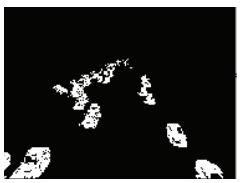
$$T_w(f) = (f \bullet b) - f \quad \text{.... (08)}$$

Where T_w denotes white Top-Hat, f denotes the image, • denotes closing operation.

Masking operation is iterative process of putting the mask on the visualized objects of binary image. Binary image shows its content as 0 and 1 (0 is for black and 1 is for white). White partition of the image is the objects present on the image (highways). In this step superimposing of mask on the white partition of image is carried out , if mask fits to the white partition its simply detect and count the vehicle and draw box around the detected vehicle else ignore object (By considering it as Non-Vehicle object). Finally the masking image is superimposed on the original image. As shown in the bellow figure 4, detected vehicles are shown in fig 7 .

Fig 4. Original Image

Fig 5. Gray Scale Image



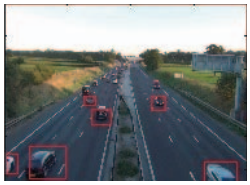


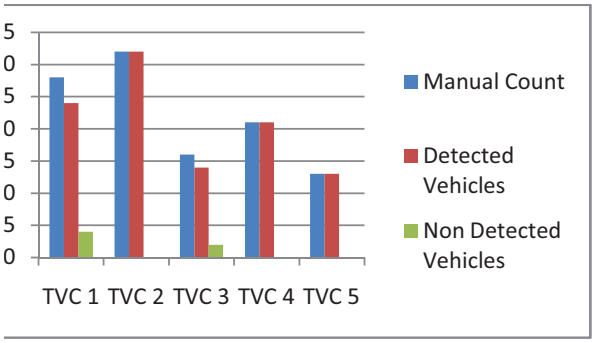
Fig 6. Black & White Image Fig 7. Detection of Vehicles

4. Experiment and result :

Sr. NO	TVC	MC	D V	NDV	POD
1	TVC 1	28	25	03	89.2
2	TVC 2	32	32	00	100
3	TVC 3	16	14	02	87.5
4	TVC 4	21	21	00	100
5	TVC 5	13	13	00	92.3

Table 1 . Result Of MVDS

Fig 8. Graph Wise Result of MVDS



Conclusion:

The setup has been tested for 15 traffic clips containing different background from different countries out of which 128 were recognized correctly. Thus, we get an overall accuracy of 91.02 % for this system. Accuracy has been calculated on the basis of vehicle detection and counting. The output has been considered as wrong even if a no vehicle detected or extra vehicle detected, no matter if the vehicle is correctly extracted. The advantages of the system include very high localization accuracy automatic intensity adjustment without much computation and syntax independent detection. The proposed method faced problems in detection stalls and cloudy environment. Finally, it can be concluded that morphological method provides better result among other morphological method (Bottom Hat approach) .

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