Adaboost Technique for Vehicle Detection in Aerial Surveillance

R.Sindoori[#1], K.S.Ravichandran[*2], B. Santhi[*3]
School of Computing, SASTRA University, Thanjavur-613402, TamilNadu, India
[1]sindooriram3@gmail.com

ABSTRACT - An approach for vehicle detection system from satellite images, which are used in many applications. Vehicle detection is done by pixelwise classification method instead sliding window and region based methods, which are used in existing system. The vital part of the paper is feature extraction and vehicle colour classification. Feature extraction includes edge and corner detection. For edge detection, the Canny edge detector technique is applied. For, corner detection, the Harris corner detector process is applied. Adaboost is employed for vehicle colour extraction to separate vehicle and non-vehicle colours. Utterly, morphological operations are applied to enhance the vehicle detection.

Keywords - Edge detection, Adaboost, Morphological operation.

I. INTRODUCTION

Aerial surveillance is a cogent way of collecting information, which is used in a variety of applications like military operations, traffic management, and monitor troop and border movement [2]. Ground plane surveillance and fixed camera surveillance systems can occupy only smaller region but aerial surveillance system covers a larger area and suitable for fast moving targets [1], [3]. The challenging approach in aerial surveillance is vehicle detection because of motion of the camera like rotating, panning and tilting. Required objects are in different size due to different height [1]. Aerial surveillance has three main uses such as aerial monitoring of specific targets, mutual confidence building and collateral information gathering.

Aerial monitoring and mutual confidence building are explicit function and the collateral information gathering is implicit function. From the satellite video, the required numbers of frames are extracted. The foremost key technique for vehicle detection is background elimination or subtraction [4]. The background subtraction is done by several methods like approximate median, frame difference and Gaussian distribution. Then the feature extraction includes edge detection, corner detection and colour transform. Edge detection by Canny edge detector and corner detection by Harris corner detector. The adaboost is used to separate vehicle and non-vehicle colours. Finally, to boost the vehicle detection morphological operations are conducted.

II. RELATED WORK

The background subtraction has fallen into two categories, namely frame oriented or pixel oriented method. Kuno et al [5] utilised frame oriented method, the threshold is predefined to detect whether an image is motion or not. This method has low CPU voltage and easy to implement. But it is not practicable for traffic scenes due to changes in illumination are regarded as motion. Ivanov [6] proposed pixel oriented method, in which average of each pixel for a period is computed and this approach may fail when lighting conditions occur. Hinz and Baumgartner [7] proposed a flexible method, where specific vehicle models are not assumed for describing the vehicle features. When the contrast is weak, the system would miss vehicles. Cheng and Butler [3] performed colour segmentation through the mean shift algorithm. To detect vehicles, they used multiple clues. But this motion analysis algorithm cannot deal with the changes in the background and the camera motions. Their proposed method highly depends on colour segmentation results in the information fusion step.

In [8], the authors considered a method for subtracting the background colour in each frame and obtained vehicles by considering the size of the vehicles. They pretended many things like the size of the vehicles as either largest or smallest, angle and height of the camera. These parameters are known prior is impossible in real time applications. Lin et al [9] proposed cascade classifiers for vehicle detection in moving condition. At detection stage, multiscale sliding windows are generated. For training purpose, plenty of positive and negative samples are required. Major disadvantage is miss detection on rotated vehicles. Choi and Yang [10] performed vehicle detection using symmetric property about shape of the cars. There is error detection between building and road marking. For this, they utilised a log histogram shape descriptor to check the objects. But it is obtained from a fixed vehicle model. Hence it is inflexible. Colour segmentation depends on mean shift clustering algorithm. The main disadvantage is neighbour vehicle is shown as a single vehicle due to the same colour. Similarly, a vehicle is separated as a different object due to car roofs and windshields are in different colours. This paper identifies the procedure to improve vehicle detection accuracy using adaboost. In [11], authors proposed a two-level method for vehicle detection but it is not suitable for insufficient illumination. Several methods are developed in [12], [13] for edge detection in an image. However, canny edge detector is

suitable than the other methods is demonstrated in [13].

III. PROPOSED METHOD

Fig.1 demonstrates the proposed method. First, background should be eliminated from the image. The main purpose of background subtraction is to identify the foreground and targeted objects. The feature extraction process includes local feature analysis and colour classification. Local feature analysis includes edge and corner features. Adaboost is used as the classifier to separate the vehicle and non-vehicle region. Finally, the vehicle detection is enhanced by morphological operations. The main purpose is to remove noise and to reduce holes in the image.

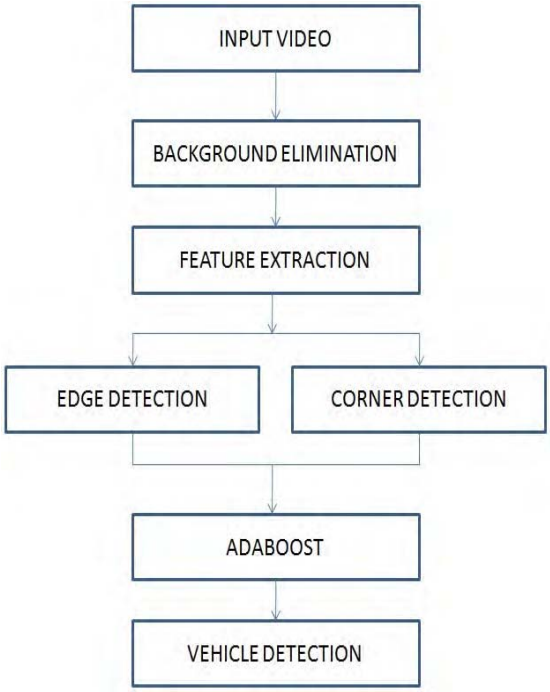


Fig. 1.Proposed method

IV. METHODS

A. Background Elimination

The key technique for detecting moving objects from video based on aerial surveillance system. This eliminating method falls in two categories such as frame oriented process and pixel oriented process [11]. In frame oriented process, the movement of targeted objects is judged by predefined threshold. If there is a change in the current frame, and its previous frames are lesser than predefined threshold, the current frame is mentioned as background and then it is eliminated. Even though this type of process is ease to implement, CPU usage is also less, and it is suitable for detecting intruders in indoor environments but it is not suitable for detecting moving vehicles in a traffic situation due to changes in illumination of outdoor environment is unstable. Hence changes in illumination are regarded as movement of objects. In pixel oriented process, the background is eliminated by averaging each value of pixels for a period [11]. Compared with vehicle region, non vehicle region occupies most of the part in the scene. Thus, colour histogram is used for each frame and removes the portion as a background where they are frequently occurring. Among the bins of histogram, the highest bins are considered as a background and it should be removed. These eliminated bins are not considered for further processing. Hence it reduces the process time and false alarms [1].

B. Feature Extraction

Feature extraction involves both local feature extraction process and colour extraction process. Local feature includes edge and corner detection. The edge and corner features are extracted by Canny edge detector and Harris corner detector respectively. Edge is a significant local modification of an image. Edge determines the boundaries of the object in a region and thereby it helps to determine segmentation and object recognition [12].The four steps for edge detection are smoothing, enhancement, detection and localization. The main pros of edge detection are to extract the essential features from the edge and thereby it reduces the amount of data to be processed [13]. The moment preserving threshold method is employed to get thresholds [14] according to the scene changes. Adaptive threshold is required due to changes in the illumination of every aerial image. Two

thresholds are needed such as the lower threshold and the upper threshold. For this process, Tsai's moment preserving method is suitable [15]. The Harris corner detector is used to get corners of an image [16]. This is used to determine intersect points in the image. It is depending on the auto correlation function, which calculates the local changes in the signal [17].

C. Adaboost

Adaboost is an ensemble method, which is the combination of weak classifiers. An ensemble learning where multiple learners are used to solve the problem. Like [18], in each iteration step the weaker classifier is trained again and hence misclassified samples are given with high weights. The number of samples required for training is limited [20], [21]. Figure 2 shows the adaboost algorithm steps. The required number of samples is taken and it is labelled. Initialize the weight of the samples. Consider the number of iterations to be used for normalize the weights. For each feature vector, train the classifier. Then the classifier has lowest computed error value is considered. Finally update the weights and the strong classifier is obtained. These are steps included in adaboost algorithm.

1. Given sample of images as $(x_1,y_1),\ldots,(x_t,y_t)$ and the iteration is N.
2. Initialize the weight of the training samples $w_{n,i}=1/t$ where $i=1,\ldots t$.
3. For $n=1,\ldots,N$
   (a) Normalize the weights, $w_{n,i}= w_{n,i}/\sum_{j=0}^{t} w_{n,j}$ where $w_{n,i}$ is probability function.
   (b) For each feature, train a classifier h_j *and* error value is calculated for h_t as
   $$e_j=\sum_{i=0}^{t} w_{n,i} y_i h_j(x_i)$$
   (c) Choose the classifier h_j with lowest e_j.
   (d) Update the weights
   $$w_{n+1,i}=w_{n,i}\,\beta_t^{1-e_i}$$
   Where $e_i=0$ if x_i is classified correctly otherwise $e_i=1$ and $\beta_t=e_t/1-e_t$.
4. Final strong classifier is
   $$h(x)=\begin{cases}1 & Z\\ 0 & otherwise\end{cases}$$

Where $Z=\sum_{t=1}^{T}\alpha_t\, h_t(x) \geq \frac{1}{2}\sum_{t=1}^{T}\alpha_t$ and $\alpha_t=\log(1/\beta_t)$.

Fig. 2.Adaboost algorithm

D. Post Processing

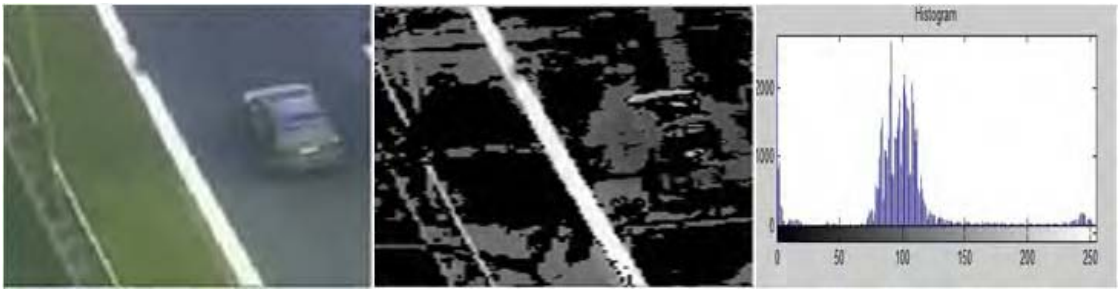
Morphological operations are used to enhance the detection process [1]. Morphological operation is a technique in which pixel value of an output image depends on the corresponding pixel in the input image and neighbour pixel. Noise and holes in the targeted objects are reduced by using the morphological operations. The methods available are dilation, erosion, opening, and closing. Morphological operations use two sets of image; one is the original image to be analysed and another one is structuring elements which have set of pixels in a particular shape [19].

V. RESULTS AND DISCUSSION

Prior information about camera angle and height is challenging one. The video which is used for this experimental analysis has 15 frames per second.

Fig. 4.Snapshots for experimental videos.

The frame width and height are 320 x 240. The data rate for video is 2800kbps. Fig. 4 shows the snapshots of experimental images.



(a) (b) (c)

Fig. 5.(a)Original image, (b)background removal, (c)histogram

Fig. 5(a) represents original image and 5(b) shows background removal. The histogram representation of the image is shown in the fig. 5(c). After the removal of the background colour and histogram representation, edge of the image is detected. Edge of the image is obtained by canny edge detector in the fig. 6(b). And the corner is detected by the harris corner detector. Fig. 6(c) represents vehicle detection output by using adaboost.

(a) (b) (c)

Fig. 6.(a)Original image, (b)Edge detection result, (c) Vehicle detection result

VI. CONCLUSION AND FUTURE ENHANCEMENT

Thus, the vehicle detection in aerial surveillance cannot mention about the camera position. Small changes in the movement of vehicles can be determined by an edge detector. For vehicle and non-vehicle colour classification adaboost is used. The experimental results show better performance and flexibility. The future enhancement of the vehicle detection system should further stabilize the results.

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