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Threshold-Based Moving Object Extraction in Video Streams

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***Abstract*—**This paper focuses on the extraction of moving object in video streams using different threshold-based methods. A combination of background subtraction algorithm, filtering technique and thresholding is applied for experimental purpose. The results show that global thresholding does not generate desired results. However combination of global thresholding and adaptive filter tends to generate sharper edges than the previous technique. The model based on local thresholding generates finer and more detailed outlines of the moving object keeping the required details intact for meaningful object extraction in certain cases. Furthermore, this work proposes a general-purpose method based for segmentation of one or more than one moving object from videos with low computation load. The videos are captured using stationary camera to avoid the interference of the motion of a camera.

***Keywords*—**Background subtraction algorithm; global thresholding; local thresholding; moving object extraction; segmentation.

I. INTRODUCTION

The need of automated video surveillance system is becoming prevalent in many real time applications such as identification of anomalous behavior near an ATM or in parking area, traffic monitoring, security sensitive areas, remote monitoring, medical imaging, pedestrians monitoring etc. A video stream will be seen as a sequence of image frames over the time. Each application requires different parameters and techniques but they all have moving objects as a common thing. Various features like color, speed, shape and motion are utilized to extract the object from videos. Thus extraction of moving objects such as vehicles, people and any moving infrastructure in video processing is the relevant step of every computer vision system.

Moving object extraction involves identifying the target objects independent of their relative background. It has two major phases: Firstly the motion of the moving object is detected and then the result is passed to the segmentation phase to extract the moving object using the pixel's intensity analysis. Various motion detection algorithms proposed in the literature are based on three techniques: Optical flow, Temporal differencing and Background subtraction [1]-[4]. The optical flow methods make use of flow vectors of moving objects over time to detect moving regions. This method gives complete motion information but most of them are computationally complex, sensitive to noise and require specialized hardware for real time applications. In temporal differencing method, difference of two or three consecutive frames is taken to determine the presence of moving objects. But this method results into an inaccurate detection of moving object. The background subtraction method uses difference between the current image and background image by first initializing the reference background model. From this, most complete motion information of the object is obtained and is suitable for real time applications. But this method is susceptible to environmental changes and hence requires background model updating over time to adapt to dynamic changes in scene. A number of improvements to the basic scheme of background subtraction method exist. The difficultly level in extracting the moving object from videos depends upon some typical challenges which include sudden illumination changes in the scene, full or partial occlusion of object, motion of the camera, dynamic background (waving trees, fountains, movement of clouds etc.), video noise and presence of shadows. In the proposed algorithm, background subtraction technique is combined with different threshold modes in order to extract an accurate moving object from video streams.

The selection of accurate threshold is crucial for successful segmentation. The threshold-based methods use intensity value of the pixels to classify them into two classes, foreground pixels class and background pixels class. These methods are computationally simple and efficient to apply. Many edge detectors use thresholding for accurate edge detection in image segmentation [5] and [6]. An appropriate and automatic threshold value is difficult to determine for moving object extraction in video streams. The thresholding is broadly classified into two types: Global thresholding and Local thresholding [7] and [8]. In global thresholding, a single global threshold is applied to the entire image and handles images with uniform illumination. Thresholding using a single threshold for the whole image succeeds only under very unusual circumstances. Global thresholding results into poor segmentation of the images with strong illumination gradient. Local thresholding uses a threshold in a particular image part and also known as adaptive thresholding. A local threshold is position dependent and handles images with non-uniform illumination.

The experimental analysis is done by applying three threshold-based methods. Firstly Otsu's method [9] and [10] based on global thresholding is applied to each and every frame of the video. The second method follows a combination of adaptive filter and global thresholding. Finally the local

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adaptive thresholding on a fixed window size is applied and it provides accurate results in comparison to previous two techniques.

II. Literature Review

Extracting an object of interest from a video scene is the first relevant step in every object tracking applications. In literature, number of methodologies has been published on moving object extraction and tracking.

Many researchers have tried different techniques for moving object extraction from videos. Janne Heikkila and Olli Silven [11] have designed a new camera based automatic system for monitoring of cyclists and pedestrians. They used background subtraction method based on first order recursive filter for motion detection and Learning Vector Quantization (LVQ) for classifying the pedestrians and cyclists. Wei Zhan and Xiaolong Ji [12] have explained the moving vehicles detection algorithm based on optical flow method and threshold segmentation on optical flow image. They computed average threshold of all pixels with optical flow value. After segmentation, morphological transformation and rectangular splitting algorithm is applied on images.

Yang, Cai, and Zhao [13] have proposed the moving object detection and recognition algorithm by combining frame differencing and background subtraction. For segmentation, the value of threshold is practically set in advance. A.Sai Sunnel [14] has discussed an algorithm to estimate velocity of moving object in a scene by using Image difference algorithm from the camera calibration parameters. In [15], the authors have designed a system for segmentation of moving objects by using temporal (three consecutive frames) differencing method for motion detection. They integrated the region based segmentation to handle the issue of slow movements and also solve the problem of moving camera.

P.Vijayakumar and A.V.Senthil Kumar [16] have proposed a new approach namely ELT (Enhanced Laplacian Thresholding) for real-time segmentation in videos. They used background subtraction method along with laplacian operator to find the discontinuity of the video frames and automatic threshold is computed using Otsu's method for segmentation. In [17], the authors have designed an algorithm by integrating background registration based segmentation method, shadow cancellation method, global motion compensation method and automatic threshold method into one system for segmentation of moving objects. They designed an automatic threshold decision algorithm which consists of gaussianity test, histogram analysis and threshold decision module. The decision of automatic threshold is based on threshold decision curve by considering the standard deviation of background region. This system is limited by manual turn on and off of each module by user according to shoot environment. A window thresholding algorithm has been reported for uneven lighting image [18] where the image is divided into certain small blocks and then segmentation based on global thresholding is applied to each small block. The technique used is based on Chow and Kaneko approach [19] which divides an image into number of overlapping sub images. It is expensive to compute and requires lot of calculations.

Besides all these algorithms, researchers are still trying to either develop new techniques or modifying the existing ones. Moving object detection and extraction is an active research area. The combination of background subtraction technique with threshold-based method is adopted in the proposed work because the object extracted using thresholding has the advantages of faster processing speed, ease in manipulation and accuracy.

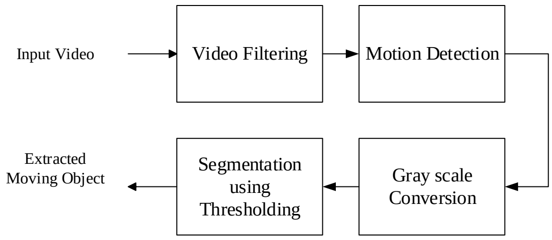

Fig. 1. Block diagram of proposed model.

III. Proposed Model

The local adaptive thresholding technique [20-22] is integrated with background subtraction method for video segmentation in the proposed model. The proposed moving object extraction model consists of filtering of video frames, motion detection using background subtraction algorithm, conversion of video frames into gray scale frames and segmentation of moving objects by thresholding. In segmentation phase, three techniques are implemented individually for comparative analysis. The final output is segmented moving object which is represented in white color. The static digital camera is used as a capturing video device. The block diagram of the proposed model is shown in figure 1. The components of the block diagram of the proposed model are discussed below.

A. Video Filtering

The filtering of video is required to improve the quality of video frames. The captured video may contain some noise regions due to climatic factors or due to camera issues. In the proposed model, the median filter is used as a video noise removal. Median filtering is effective when the goal is to simultaneously reduce noise and edges preservation.

B. Background Subtraction Method

Background subtraction method proceeds by initializing the reference background frame and then pixel-by-pixel subtraction of current frame (I_t) and background frame (B_t) is done to detect the moving object. The updation of background frame is done to acclimatize new changes into the current background frame by using the following equation

$$B_{t+1} = \alpha I_t + (1-\alpha)B_t \quad (1)$$

α is the adaptation coefficient. The value of α used in (1) is practically set to 0.5 in the proposed model in order to avoid artificial tails behind the moving objects. The pixels of resultant frame are further examined for object extraction.

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C. *Conversion into Gray Scale Frames*

The color frames are converted into the gray scale frames after the background subtraction method in the proposed model. Gray scale digital images contain only intensity values. This conversion makes an easy way for pixel's intensity analysis in the segmentation phase.

D. *Segmentation Using Thresholding*

The process of partitioning an image into regions which correspond to either foreground or background is known as segmentation. In threshold-based segmentation, each pixel of the image is compared with the threshold value for extracting the moving object from the video scene. If the intensity value of the pixel is greater than the threshold, then it is set to white color representing moving object otherwise it is set to black color representing background. In the proposed model, three threshold-based techniques are implemented which are discussed below.

1) Otsu's thresholding method computes an automatic threshold and results into the binarization of image based on pixel's intensity value. It proceeds by computing intensity histograms and probabilities of each intensity level. Iterating through each possible threshold, the desired threshold is selected which corresponds to maximum inter-class variance.

2) The second method is the combination of adaptive filter and Otsu's thresholding. The adaptive mean filter is applied over the video frame to accentuate the image features and then segmentation is done by using the Otsu's thresholding method on a constant window size. The window size is set practically by considering the size of the object in the video scene.

3) In the third approach, local adaptive thresholding based on statistical operator - mean is applied over the fixed window size to overcome the limitations of global thresholding. This method examines the weighted mean of the local neighborhood. In the proposed model, the local threshold for each pixel is employed by subtracting the constant 'C' from the mean of the local area. The size of the neighborhood is set practically so that it cover the sufficient foreground and background pixels.

Out of these three threshold-based methods, the third one results into the successful extraction of moving object from video streams in certain cases.

IV. IMPLEMENTATION

Figure 2 shows the workflow of proposed model. The sequences of steps followed in the implementation of the proposed model are discussed below.

1) Read the video file which is to be processed as an input.
2) The input video file is converted into the series of video frames.
3) After the video frames are retrieved, every frame is subjected to median filtering in order to remove noise. The filtered video frames improve the extraction of moving objects.
4) Initialize the first frame of the video as the reference background frame.
5) Update the background slightly at each frame by using equation (1).
6) Subtract the modified background frame from the incoming current frame.
7) The output frame of the background subtraction method is converted into the gray scale frame.
8) The local threshold for each pixel is computed by examining the mean of the local neighborhood of 10×10 size.
9) Threshold the resultant gray scale video frame with the mean – C, where C is a constant.
10) The intensity value of each pixel 'P' is compared with the threshold value 'T'. If the pixel's intensity value is greater than threshold, it is set to white color representing foreground moving object otherwise it is set to black color representing background.
11) Repeat each step from the first frame to the last frame of the video.
12) The final output is the extracted moving object in the video scene.

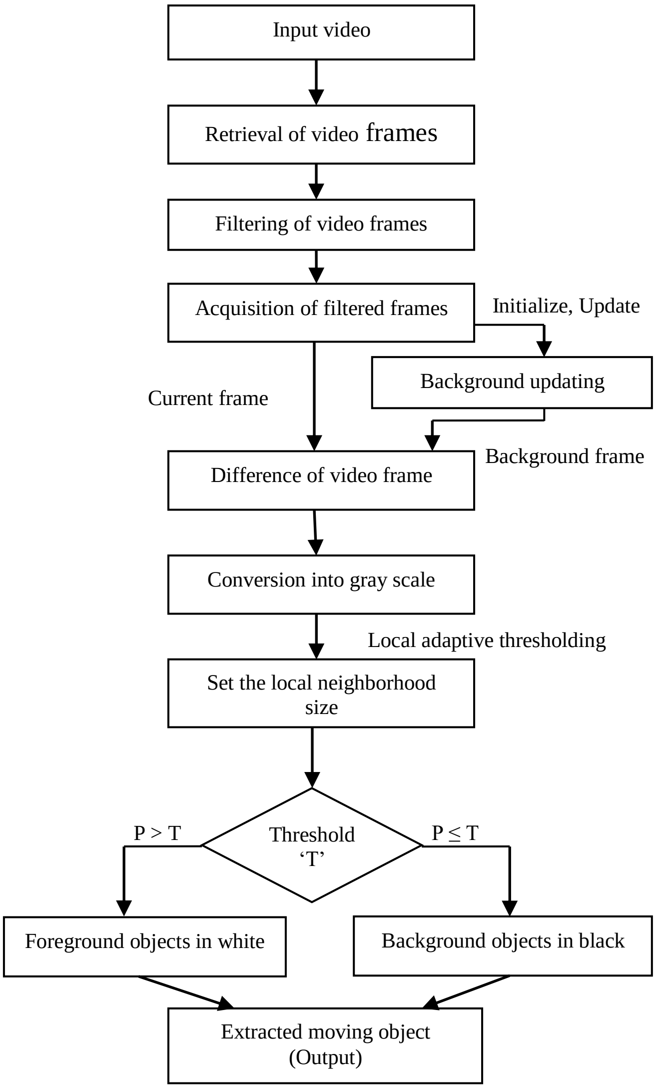

Fig. 2. Workflow of proposed model.

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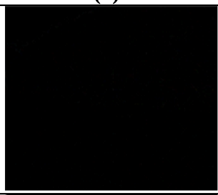
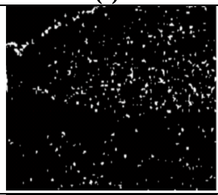
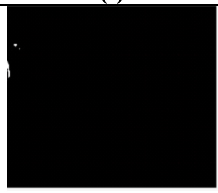
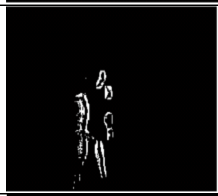
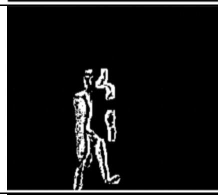
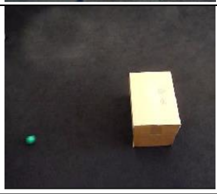
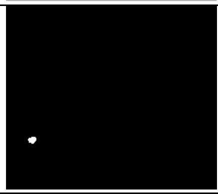
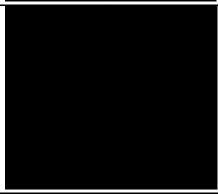
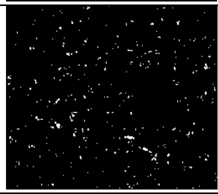
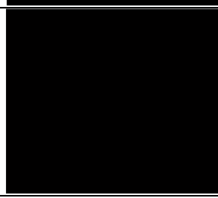
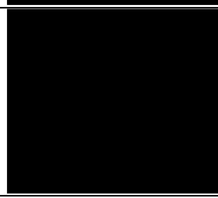
TABLE I. Experimental results of proposed work.

Video/ Frame	(a)	(b)	(c)	(d)	(e)
V_I F_{42}					
V_I F_{239}					
V_I F_{550}					
V_{II} F_{123}					
V_{II} F_{144}					
V_{II} F_{550}					
V_{III} F_{15}					
V_{III} F_{28}					

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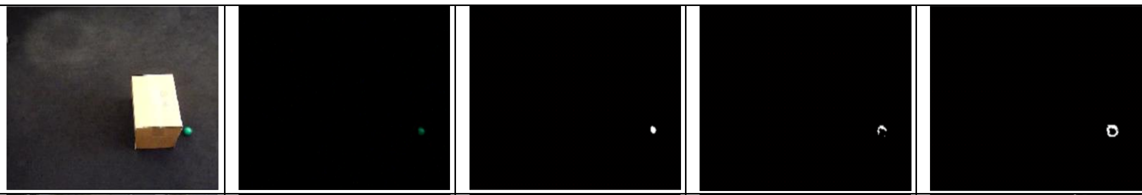
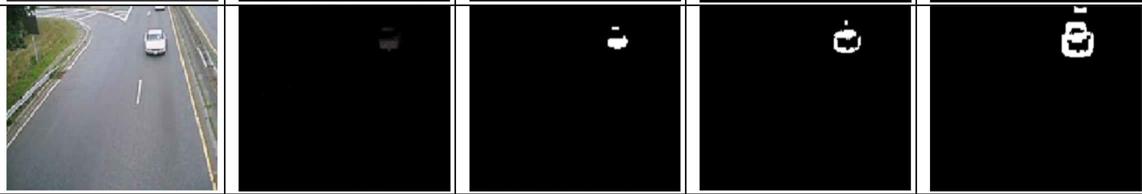
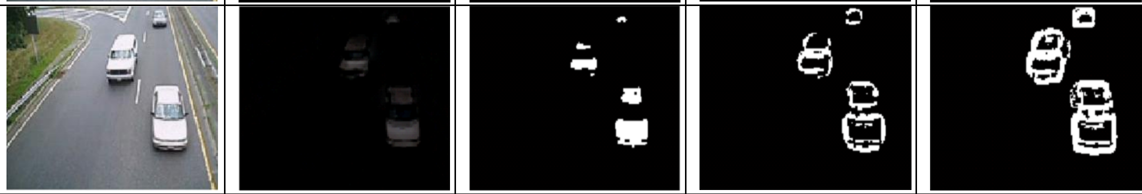
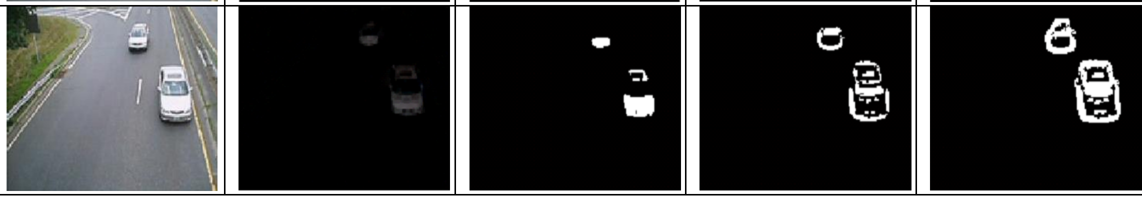
V_{III} F_{35}	
V_{IV} F_{14}	
V_{IV} F_{36}	
V_{IV} F_{91}	

V. Results and Discussion

A total of 20 videos are used for comparative analysis of three threshold-based techniques. Experimental results of the proposed work are shown in the table I. V_i represents the video number and F_t represents the frame number of video in the table. The results of 4 videos are presented in this paper. Videos V_I and V_{II} are captured by using stationary digital camera. The inbuilt videos of MATLAB V_{III} and V_{IV} are also used for evaluation of the proposed work. Column (a) shows original video frame. The background subtraction method detects the motion of the moving object. The output generated after background subtraction method is shown in column (b). Then the moving object is extracted by applying thresholding. Column (c) shows the output generated after Otsu's method based on global thresholding. It shows that the global thresholding does not generate the desired results. It also adds some noisy regions in the absence of moving object and during occlusion of moving object. The combination of adaptive filter and Otsu's method generates sharper edges than the previous technique but does not provide complete information of the moving object. The output generated by combination of adaptive filter and Otsu's method is shown in column (d). Column (e) shows the output generated after local adaptive thresholding. It shows that the local adaptive thresholding generates finer and more detailed outlines of the moving object than other two techniques. It adds thick outlines around the moving object in certain cases which is not required in the real-time applications.

For instance, F_{42} of V_I depicts that the Otsu's method based on global thresholding result into noisy regions and extract them as the foreground object in the absence of moving object. F_{28} of V_{III} shows that global thresholding degrades the video frame and extracts some noisy regions as the foreground object during occlusion of the moving object. F_{36} and F_{91} of V_{IV} depict the multiple moving object extraction in a single video frame. It is evident from all the three frames of V_{IV} that local adaptive thresholding add thick outlines around the moving object in certain cases. The experiments are performed over video frames consisting of moving objects having different shape, size, speed and color.

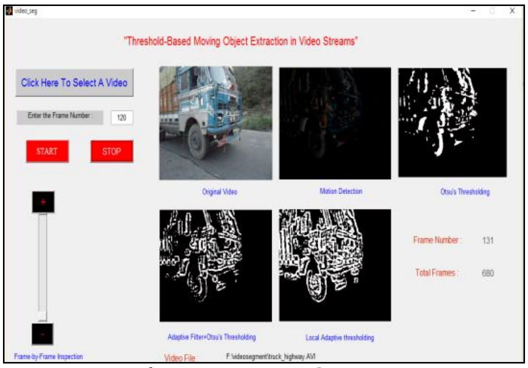


Fig. 3. Interface generating results in MATLAB.

The interface has been developed in MATLAB R2013a for implementation of the proposed model as shown in figure 3.

VI. Conclusion

A general-purpose method for extracting moving objects from video with low computation load is proposed in this paper. The video frames are preprocessed in order to remove noise by using median filter. Then the motion of the moving object

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is detected by applying background subtraction method to the processed video frames. After detecting the object, the next step is to extract that object from each incoming frame of the video by using thresholding. Different scenes of moving vehicles, moving ball and moving persons were captured in the outdoor environment by using digital camera. Three threshold-based techniques are implemented for comparative analysis. The results show that global thresholding does not generate accurate results while extracting moving object from videos. It also detects noisy regions as the foreground objects during the occlusion and in the absence of moving object. The combination of adaptive filter and global thresholding does not provide complete information of the moving object. It has been observed that local adaptive thresholding generates finer and more detailed outlines of the moving object keeping the required details intact for meaningful object extraction than the previous two techniques. In certain cases, local adaptive thresholding adds thick outlines around the moving object.

The proposed model can be extended to get more fine results by applying different methodologies. Furthermore, the algorithm for automatic selection of adaptive window size can also be integrated with proposed moving object extraction model so that it will work efficiently with real-time applications.

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