A Highly Adaptive Method for Moving Target Detection in Dynamic Background with a Simplified Manner

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ABSTRACT
Target detection is an approach to extract object from image, however it is difficult task when object is moving. Moving target detection is a key area in image processing such as traffic control system, activity monitoring security system, CCTV footage etc. For detecting a moving object in dynamic background, a background subtraction based method has already been suggested. These methods does not give better results when object is moving very fast, object is very tiny and presence of lighting effect. To overcome these problems, we propose a new method for Moving Target Detection in Dynamic Background. It achieves dynamic scene using certain probability of time and subsequent frame difference method and addresses the difficult scenario, where object is moving very fast and background changes frequently. In order to increase the accuracy of a proposed method, rate of change in background is calculated in fixed time of interval which will maintain dynamic behavior of object as well as background. The experimental results show that the proposed method can detect moving object more efficiently and completely in both cases online as well as offline video

Keywords
Background subtraction, Frame difference, Moving target detection, Dynamic background.

1. INTRODUCTION
Moving target detection is the process of extracting the target from background. Moving object detection is challenging task, especially where background change frequently or object move rapidly. Intelligent visual surveillance system is an important and useful in various fields like activity monitoring security, medical, communication, traffic management and other fields. Moving target detection plays a key role in such type of application. Object extraction from a video is a difficult task in image processing. Object extraction is difficult when background change frequently and object move very fast.

In current scenario commonly used method for moving target detection are background subtraction, frame difference and optical flow method. Frame difference method is very simple and it does not detect all point of object, this method is highly affected by noise [1]. Second method is background subtraction, in this method first frame set as background and remaining frames subtract from first frame. Background subtraction is commonly used for moving target detection, it detect target completely. Third method is Optical flow method but is not suitable in real time application because its calculation is complex and required more hardware and therefore it is also very costly.

Components for moving target detection methods are background, foreground, threshold and current frame. Background is the static scene that is still visible and foreground is component of interest for the application. Threshold is a fixed value T that split an image into two part background and foreground respectively. Current frame is the incoming image at any period of time. The whole process of moving target detection is completed in two steps, first is segmentation and second is object extraction. Segmentation is imperative step of moving target detection. Segmentation algorithm is divided in two types based on gray level discontinuity and gray level similarity.

Threshold is one of the most important techniques for segmentation. In segmentation, each image pixel gray level value is compare to the threshold value. This technique creates two part of image, one is above threshold (object) and other is below threshold (background). In above equation if difference of pixels is greater than Threshold value than it set as a part of background and where value is less than set as a foreground.

In the earlier research work done by the various researchers, a background-modeling algorithm has been described for segmentation of moving objects from the background, which is capable of adapting to dynamic scene conditions. But problem with these methods is that it does not deal when object is very small, moving very fast and even does not provide better result in presence of lighting effect. There are a number of factors that complicate the automatic detection process, these factors include like motion of camera, highly dynamic background, effect of shadow and Varity of object. To overcome this problem, we proposed sensitive new method for moving target detection in dynamic scene. Here we introduced the extension of moving.

Yangquan et al. developed a method for moving target detection based on alpha parameter that is changed background using certain probability of time [1]. It works

efficiently in dynamic sense, but it cannot handle difficult situation such as light effect and high effect of moving object.

$$R(x,y) = |f_k(x,y) - B_{k-1}(x,y)| \quad (1)$$

$$B_K(x,y) = B_{K-1}(x,y), f(x,y) B_K(x,y) = B_{K-1}(x,y), f(x,y) \quad (2)$$

Superposition in a certain probability

$$g(x,y) = \begin{cases} 1\ if & f(x,y) > T \\ 0\ if & f(x,y) \le T \end{cases} \quad (3)$$

Where B_k is a background for K^{th} frame and f_k is a K^{th}current frame. R_k (x, y) is an absolute difference between current frame and current background.

Huijuan and hanmei[3] have emphasis on background updating based on backgroung subtraction using five frame difference.This method is efficiently reduce the effect of shadow but it cannot handle condition where background change rapidly.

2. PROPOSED METHODOLOGY

Object extraction from a video is a difficult task in image processing. The result of target detection is input of other parts of image processing. So accuracy is a key factor of this module. Yangquan et al. have proposed an algorithm (Moving Target Detection in Dynamic Background using background subtraction) to detect moving object and handled in dynamic sense. When moving target detection technique is used in dynamic sense, it suffered from some problems such as rapid changes of light, object is very small and detection of right object when object is move very fast.

2.1. Background Subtraction

Background subtraction is frequently used method for Moving Target Detection. The basic scheme of background subtraction is to subtract the image from a background image that works as reference image. Three basic steps are involved in the background subtraction methods [4]. The first step is to constructs a reference image representing as a background image, while threshold selection is done in second step. Threshold value is decider in subtraction method to obtain a desire result. Third step is subtraction or pixel classification, if the pixels difference is greater than the certain threshold value, it consider as a part of foreground and remaining part is consider as background [5]. Equation of subtraction process is given below

$$R(x,y) = f_k(x,y) - B(x,y) \quad (4)$$

$$G(x,y) = \begin{cases} 1\ if & R(x,y) > T \\ 0\ if & R(x,y) \le T \end{cases} \quad (5)$$

In above equetion B (x, y) is a background frame, f (x, y) is a current frame and R (x, y) is a pixels difference between current frame and background frame.T is a threshold value .

Figure 1 show the flow of background subtraction method. Result of subtraction is compared with threshold value, if it is greater than threshold value than it consider as a foreground and extract the position of object as an output. Result of this process depend on threshold value, so selection of threshold should be dynamic for better result [10].This method is used where background is not changed or camera is fixed [14]. The key advantage is easy to implement simplicity and give better result on noise image.

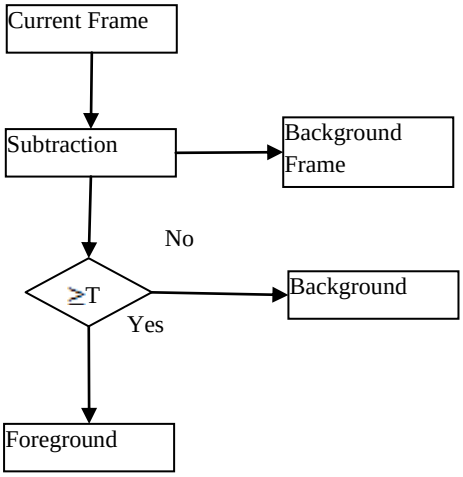

Figure 1: Flow chart of Background Subtraction

2.2 Background and Object behavior update dynamically

We proposed a new method for moving target detection which removes the weaknesses of existing method. Proposed method is efficiently work in natural light, as well as Indoor Surveillance and achieved dynamic sense using flag variable. The value of flag is decided with the help of frame difference method and max limit of flag is use for maintain dynamic behavior of background. In order to achieve high accuracy max limit of flag variable is change dynamically through rate of change in background in fixed interval of frames. Dynamic background is decided in two steps:

(a) Calculate pixel difference between every current frame and previous frame.
(b) Flag value is reached in a max limit of flag value.

These two parameters mentioned above decide the new background. When above conditions are true and flag reach a max limit, then background is changed and current frame set as a new background. Mathematical expression for Moving

objects extraction using background subtraction is given below:

$$R(x,y) = |f_k(x,y) - B_{k-1}(x,y)| \qquad (6)$$

$$G(x,y) = \begin{cases} 1\ if & R(x,y) > T \\ 0\ if & R(x,y) \leq T \end{cases} \qquad (7)$$

Where, R (x, y) is a difference of current frame and background frame. R (x, y) is compare with threshold value, if it is greater than T than set a pixel value is 1 otherwise set 0. New background $B_k(x,y)$ is depending on R (x, y) and certain probability of time. However camera is move or any changes in background than current frame set as a background frame.

In our proposed method, we use *SetFlag ()* and *GetMovingObject ()* functions are used for moving target detection. *SetFlag ()* function used three parameters current frame $F_k(x,y)$ previous frame $F_{k-1}(x,y)$ and time t. *SetFlag()* return current value of *flag* and this value is used in *GetMovingObject()* function. *GetMovingObject ()* function used three Parameters current frame $F_k(x.y)$,

background image and *flag* value. Current *Flag* value is decide new background. Figure 2 shows the abstract view of proposed method.

The steps perform by proposed algorithm are as follows:

(i) Read Video either online or offline.
(ii) Video is converted into number of frames
(iii) First frame is set as a background image
(iv) Apply noise removal filter for reduction of noise.
(v) Every frame is subtract from background image and compared from threshold (T) value.
(vi) If the value is greater than threshold, it is consider as a foreground.
(vii) Value of flag is increased when subsequent frame difference is zero and mean error value is less then threshold value.
(viii) When flag value is reached a max limit of flag then background is changed and current frame set as a background image
(ix) Above all step execute for all frames of video.

In order to determine rate of change of background efficiently in a fixed frames interval for dynamically maintain flag max limit, there is need to improve accuracy of algorithm which will provide or express dynamic behavior of any object. Flag value is set dynamically set by *setflaglimit()* function. This function calls every fixed frames interval and return new flag limit value.

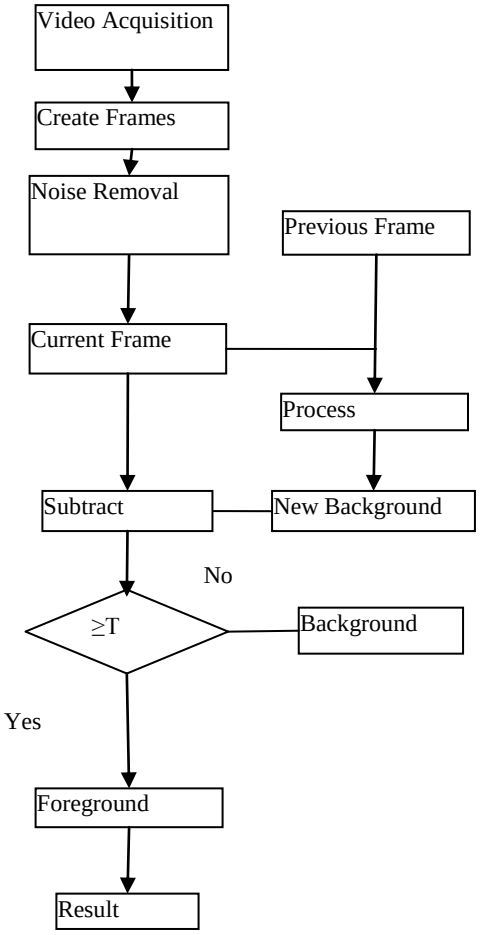

Figure 2: Flow chart of proposed method

This function work on rate of change of background. When rate of change in background is high or greater than 50 percent of previous changes in background than new flag limit is set for high accuracy otherwise same as old value.

$\Delta B(x,y)$ is change in background

$\frac{d\Delta B(x,y)}{df}$ is rate of change in background with respect of frame interval,

Flag Limit=

$$\begin{cases} New\ limit & if\ \frac{d\Delta B(x,y)}{df}\ more\ than\ 50\% \\ Old\ limit & if\ \frac{d\Delta B(x,y)}{df}\ less\ than\ 50\% \end{cases} \qquad (8)$$

3. RESULT ANALYSIS

The proposed method has been applied to large number of videos and results are compared with existing method. This section has shown some results for both cases i. e. for live as well as offline video. In this approach, background subtraction method is used for target detection with the help of frame difference method. This method resolves the problem of detection of target, where object is moving very fast and

background change frequently. The result of our proposed methods shows that the algorithm can detect moving object more efficiently as compare to the existing method.

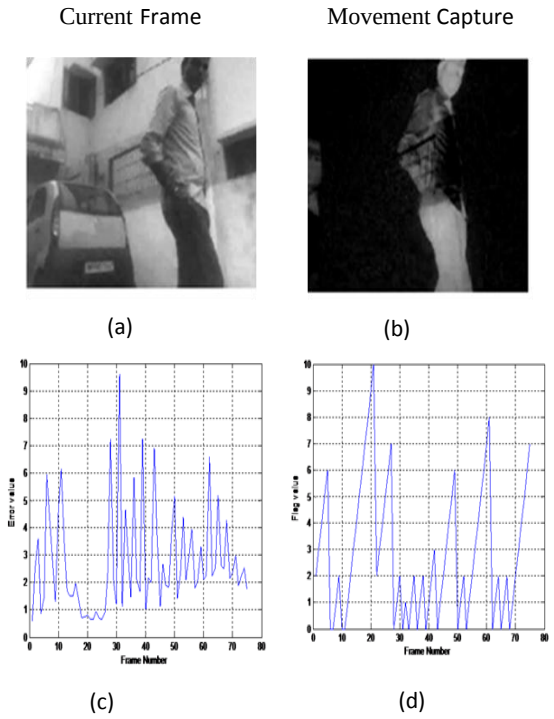

Figure 3: Result of proposed method

Figure 3 shows the results target detection using our proposed method. Current frame is shown in figure 3 (a), in this frame car is stay and person is moving. Figure 3(b) shows the target in current frame after applying proposed method. In this example, car is considered as a part of background. Figure 3 (c) and 3 (d) shows the graphs between error value and frame number and then second graph between flag value and frame number; figure 3 (c) shows the absolute difference of pixel value of current frame and background frames. In this example, threshold value is set at 4 and total frames in video are 80. When error value is less then threshold level, than flag value is increased by one. Figure 3(d) shows the flag value corresponding to frame number. In above example, error value is less then threshold value i. e. between10 to 30 frames number. When flag value is reached a fix value (here 10) then background changed. In this example flag value reached a fixed level (here 10) in between of 10 to 30 fames and at this point background is change. The result of our proposed method shows that method give better result in terms of detecting the target efficiently as compare to existing method

Experiments on Live Video

Now we give results using our proposed method on the live videos, here video is recorded by CCTV camera and then apply proposed method for moving target detection. In some cases, background is change and in some cases effect of light is change, obtained results shows that our proposed method detect moving object completely and sharply.

Case1 - Experiments in light effect

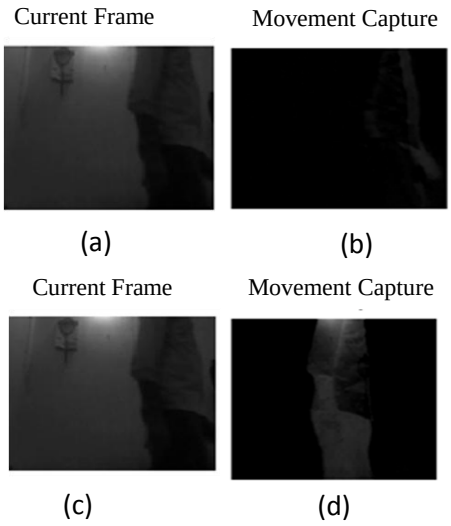

Figure4 : (a) & (c) Current Frame (b) Moving Object detected by existing method (d) Moving Object detected by proposed method.

Case2 - Experiments in Indoor Surveillance (only hand is moving)

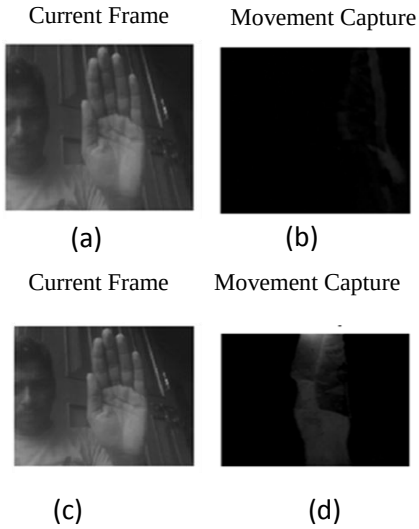

Figure5: (a) & (c) Current Frame (b) Moving Object detected by existing method (d) Moving Object detected by proposed method

Figure 5 (a) to 5 (d) show the result for indoor surveillance and compare with existing method. Figure 5 (a) and 5 (c) show the current frames, in these frames only hand is moving and rest of the body is stationary. Proposed method give better result than existing method and work in dynamic fasion. In this frame only hand is treated as moving target and rest of the body set as a background. In this case when hand is moving very fast, existing method can not detect moving object and shap of object is scattered. While proposed method is capable to handle this type of situation and provide better result in comparision to existing method.

Case3 - Experiments in outdoor Surveillance (in presence of natural light)

Case3 shows results of outdoor Surveillance with effect of natural light. In above example person is moving and car is stationary, proposed method capture person as a moving object and car as a background.

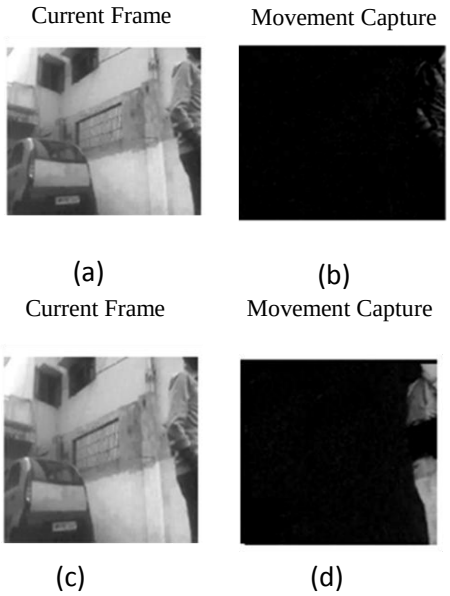

Figure6 : (a) & (c) Current Frame (b) Moving Object detected by existing method (d) Moving Object detected by proposed method

Experiments on offline video

In this case, we apply proposed method on some recorded videos and capture moving object in different time slots and results are compared using existing method. We take **recording of Japan high speed train accident** as an input for proposed method and capture moving object in different time slots. Proposed method capture moving object sensitively and maintain shape of object when object is moving very fast.

Case1 - Experiment in time t1

In this example, size of object is very small because CCTV camera is too far from train. The proposed method is very sensitive for this case; it can detect movement of object efficiently. Movement captured by proposed method has some small white point that is indicated by moving object. While existing method cannot detect any movement and whole frame consider as a background. Therefore, proposed method is very sensitive and captures the movement of tiny object efficiently.

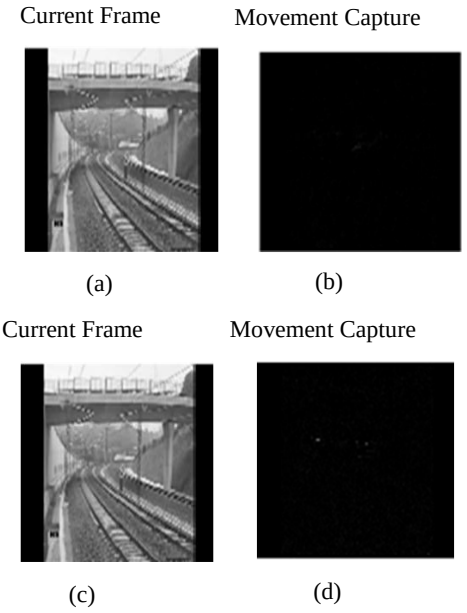

Figure7 :Result at time t1 (a) & (c) Current Frame (b) Moving Object detected by existing method (d) Moving Object detected by proposed method

Case2 - Experiment in time t2

The second experiement is performed when the train is coming near to CCTV camera, here train is visible but still very small. Figure 8 (a) shows the current frame in time t2 and figure 7 (b) shows moving object using existing method. Moving object detectd by proposed method is shown in figure 8 (d).

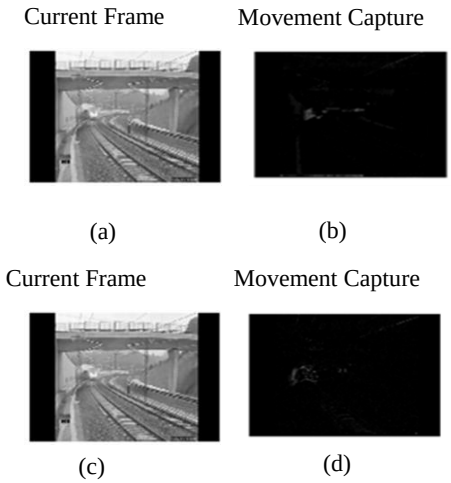

Figure8 :Result at time t2 (a) & (c) Current Frame (b) Moving Object detected by existing method (d) Moving Object detected by proposed method

When experiment is performed with the existing method, shape of object is scattered and dust and air also treated as a foreground. While proposed method is able to identify moving object and capture all points of moving objects as shown in the figure 8 (d). Hence, the results clearly shows that the proposed method is better then existing method.

Case3 - Experiment in time t3

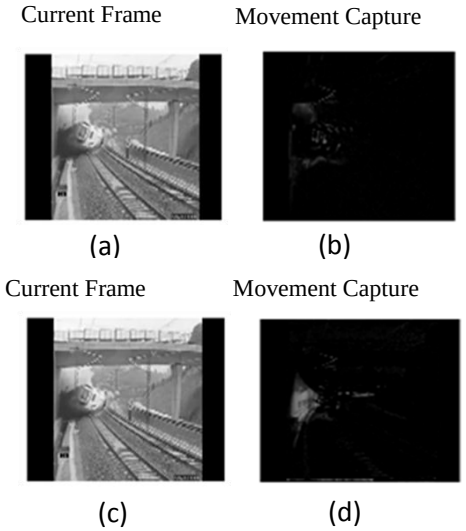

Figure9 :Result at time t3 (a) & (c) Current Frame (b) Moving Object detected by existing method (d) Moving Object detected by proposed method

Case4 - Experiment in time t4

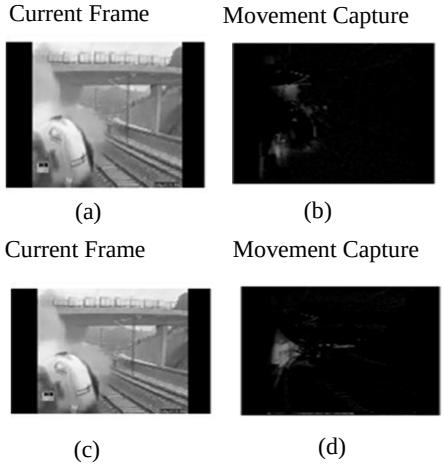

Figure10:Result at time t4 (a) & (c) Current Frame (b) Moving Object detected by existing method (d) Moving Object detected by proposed method

In above example train was running very fast and it has been misbalance. In this scenario, existing method is not giving proper output. Figure 9 (a) show the current frame and figure 9 (b) show the output after application of existing method; here shape of object is not clear. Figure9 (d) shows results with proposed method; it gives sharp and better result than existing method.

As shown in figure 10, train is very close to camera and movement is very fast. Figure 10 (b) show the moving object detected by existing method, here object is not identify properly and air, dust are also treated as a object. Proposed method resolved this type of problem and gives clear result than existing method. Figure 10 (d) show the output of proposed method, shape of moving object is better than figure 10 (b).

4. CONCLUSION

The earlier method has detected moving object and handle object in dynamic sense. But it cannot handle difficult situation (such as object is moving fast, object is very tiny etc.) and cannot provide perfect intelligent visual surveillance system. All these weaknesses are recovered in our proposed method, which is based on bckground subtraction. The improved method is very sensitive and self adaptive method. This method addressed the difficult scenario i. e. fast movement of object, small object, and able to handle low light effect and background change frequently. The experimental results shown that proposed algorithm is able to detect moving object more efficiently and completely in both cases online as well as offline video.

Thus, it is conclude that the proposed technique is able to maintain the shape of object completely and efficiently and shown better performance as compared to the existing techniques. In future research, we can further improve the system robustness and can reduce the effect of shadow in moving targets.

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