Moving Object Detection Using Incremental Statistical Mean Technique

Safvan A. Vahora[1], Narendra C. Chauhan[2], and Nilesh B. Prajapati[3]

[1] Information Technology Dept., Vishvakarma Govt. Engg. College, Chandkheda
[2] Information Technology Dept., A. D. Patel Institute of Technology, New V.V. Nagar
[3] Information Technology Dept., Birla Vishvakarma Mahavidyalaya, V.V. Nagar, India
{safvan465,narendracchauhan}@gmail.com,
nilesh.prajapati@bvmengineering.ac.in

Abstract. We propose a new approach for moving object detection. Moving object detection is low-level, important task for any visual surveillance system. The aim of this paper is to, to describe traditional approach of moving object detection techniques such as background subtraction, temporal difference, as well as pros and cons of these techniques. Finally, we propose the statistical mean technique to overcome the problem in traditional techniques. Since, simple statistical mean technique having disadvantages, to defeat those, we propose incremental statistical mean technique. Incremental statistical mean technique have need of computation to perform simultaneously, that requires parallel computation to speed up and reduce the computation complexity.

Keywords: Background subtraction, Incremental statistical mean, Moving object detection, Statistical mean technique, Temporal difference.

1 Introduction

Computer vision system have been developed to simulate most natural systems which have ability to deal with changing environments such as moving objects, objects tracking, changing illumination, changing view point. Video surveillance has received many attentions over the last year and major research topic in computer vision. In video surveillance system detection and tracking of object is lower level vision task to provide higher level event detection. Identifying moving objects is a critical task which requires video segmentation, which is used in many computer vision applications such as video surveillance, traffic monitoring, and remote sensing. [1] There are three major steps in video surveillance analysis are detection of moving objects, tracking of such interested objects from consecutive frames, and third is analysis of these tracked objects to identify the behavior, and identify the desired event.

There are numerous applications those uses video surveillance. Video traffic monitoring is gathering traffic information from various visual sources to redirect the traffic flow. Smart video surveillance system is monitoring scene continuously, to detect a desired event. Gesture recognition is to identify human gesture, fingerprint detection and eyes detection to login into a system. Video indexing can be used for automatically explanation and retrieval of videos in multimedia database.

N. Meghanathan et al. (Eds.): CCSIT 2012, Part II, LNICST 85, pp. 204–210, 2012.

Moving object detection process of classifying the pixels in video frames into the two classes, foreground pixels are considered as pixels of moving object and background pixels are considered as pixels of stationary background object. In another words, moving object detection handles segmentation of from stationary background object.

Detection of moving object can be complex due to several reasons such as noise in video sequence, sudden illumination changes, shadows and waving tree branches in the wind, rain or snow-fall for outdoor video surveillance, occlusion provide loss of information by projection of 3D world in 2D image [9].

There are various approaches have been proposed by different researchers for moving object detection. Here, we proposed incremental statistical mean technique for moving object detection, that having various advantages over the traditional approaches of moving object detection.

The rest of the paper is organized as follows. In section 2, we give details of traditional background subtraction technique, temporal difference technique of moving object detection. In section 3, we describe statistical mean technique and incremental statistical mean technique that is the modified version of statistical mean technique as described earlier in section 2. Experimental result and conclusion are described in section 4 and section 5.

2 Object Detection Methods

2.1 Background Subtraction

Object detection can be achieved by creating background model and then finding deviations from the model for each and every frame in video. Background subtraction is widely used because of its time complexity less for detecting the foreground object. Background subtraction is particularly a for motion segmentation in static scenes [2].

Background subtraction is most popular choice to detect stationary foreground objects [6],[7], because they work well when the camera is static and illumination change is gradual [8].

In this method, to detect the foreground object, the background subtraction algorithm detects the difference between the current image and the background image or often called reference image or background model. Recent background subtraction algorithms focused on robust background modeling and updating to adapt to varying illumination condition between night and day, light effects, background structures, background change from whether change and repetitive motion from clutter [3]. For a pixel location (x, y) in the current image I, is identified as foreground pixel along with background image B, if it satisfies the equation 1.

$$|I(x, y) - B(x, y)| > \tau \qquad (1)$$

Where τ is a predefined threshold [4]. The background image B is updated by the adaption coefficient η as per the equation 2.

$$B_{i+1} = \eta I_i + (1 - \eta) B_i \tag{2}$$

The core part of this method is to integrate the new upcoming information of a new image into the background image, so that background image becomes more robust. The value of η should not be large, it may create faster new changes in the background image.

The pixels constituting the regions undergoing change are marked for further processing. In general, a connected component algorithm is used to obtain connected regions corresponding to the objects.

Even though the background subtraction technique is well to extract moving object, this background subtraction technique may suffer to dynamic background changes such as the entrance of new background object or sudden illumination change.

2.2 Temporal Differencing

Temporal differencing technique uses the pixel wise difference between two or three frames in frame sequences to extract a moving object. [5] Temporal differencing technique is computationally simple and fast as well as is adaptive to dynamic environment. In temporal difference technique, extraction of moving pixel is simple and fast. It takes difference of the current and previous frames as shown in equation 3

$$| I_i(x, y) - I_{i-1}(x, y) | > \tau \tag{3}$$

where τ is predefined threshold.

Temporal differencing technique is less effective in extracting all information about target object, especially when the target object has uniform texture or target object moves slowly. When a foreground object moves slowly or stops moving in between, temporal difference technique fails in detection a change between consecutive frames and loses the target object information. Temporal difference is most sensitive to the threshold value τ, to determining pixel-wise difference between consecutive frames as well as it may left holes in foreground objects. Temporal difference require special supportive algorithm to detect stopped objects.

3 Statistical Mean Technique

There are so many drawbacks of traditional moving object detection approach, as described above section. To overcome these shortcomings, we propose the next technique is statistical mean technique. Statistical mean technique is based on the computed statistics of each and every frame of video or computed statistics of every k frames by using down sampling to reduce the processing time. In statistical mean technique base, background image is calculated by computing mean of each and every pixel available in video. For n frames and (x, y) is the pixel position of I^{th} frame, the summation of all frames computed as shown equation 4

$$X(x,y)=\sum_{i=1}^{n} I(x,y) \tag{4}$$

The summation of each pixel is in X (x, y) of n frames normalized mean model frame N(x, y), is calculated as by dividing each pixel position with n, number of frames as shown in equation 5

$$N(x,y)=X(x,y)/n \tag{5}$$

Compare this mean model N(x, y) to each and every frame from 1 to n. For every pixel (x, y) of frame I, compare that pixel position with pixel position (x, y) of normalized mean model frame N as shown in equation 6

$$|N(x,y)-I(x,y)|>\tau \tag{6}$$

where τ is a predefined threshold value. If the current pixel (x, y) of frame I, fall in this category than specify it as foreground object pixel otherwise specify as background pixel.

Although statistical mean technique gives good result, it suffers by the problem of superfluous effects of foreground objects. Whenever, object or more than one objects remains in video for long period of time, for example, an object is presents in half of the number of frames out of total n number of frames. This leads to erroneous mean model, so that the precise result of moving object detection will not be achieved. This erroneous result is created because of the superfluous effect of that object. To overcome the problem of superfluous effect of the object, modified statistical mean technique is used.

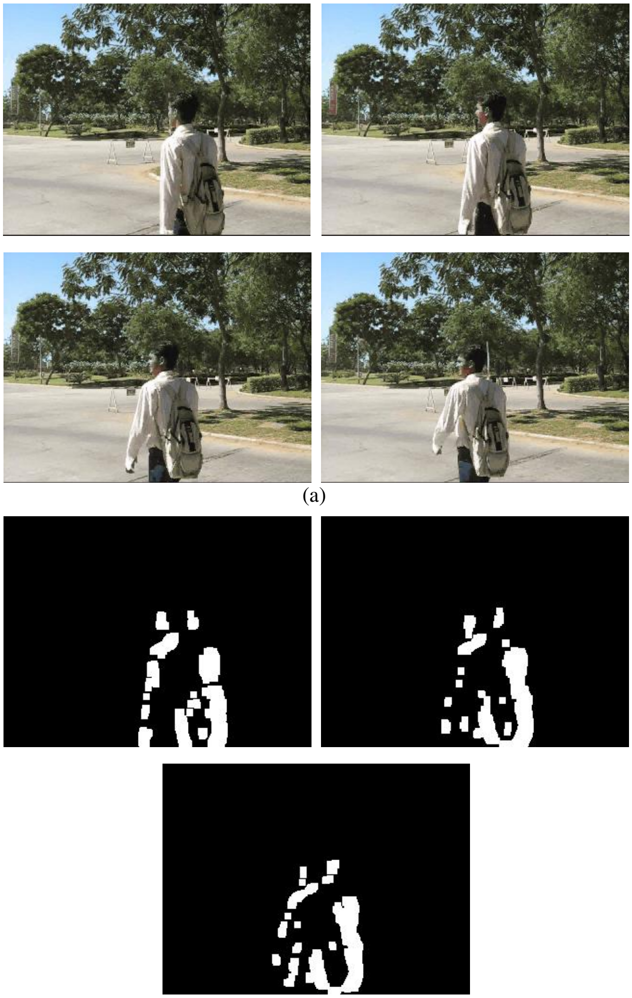
In Modified statistical mean technique, initially take k number of frames out of total n frames to calculate mean model N. This mean model N is used for detection of moving object for first frame. As the first frame is processing, simultaneously update mean model N, by taking next frame in derivation of mean model as shown in equation 7. Here, next frame is $I_{(k+1)}$ to update the mean model.

$$N_{new}(x,y)=(N_{old}(x,y)*k+I_{k+1}(x,y))/k+1 \tag{7}$$

This updated mean model N_{new} is used to for further processing to find the moving object detection. This process is repeated until it reaches to n, total number of frames.

4 Experimental Results

We tested our method on various sequences of videos acquired on outdoor environments. Figure 1 shows the output of the temporal difference method, by applying the operation as described above, under the outdoor environment. Figure 1 (a) shows the frame sequence 106 to 109 and figure 1 (b) shows frame sequence 107 to 109 of the detected object after applying temporal difference technique as described, in section 2. For example, shown in figure 1, the value of threshold τ is 30.



(a)

(b)

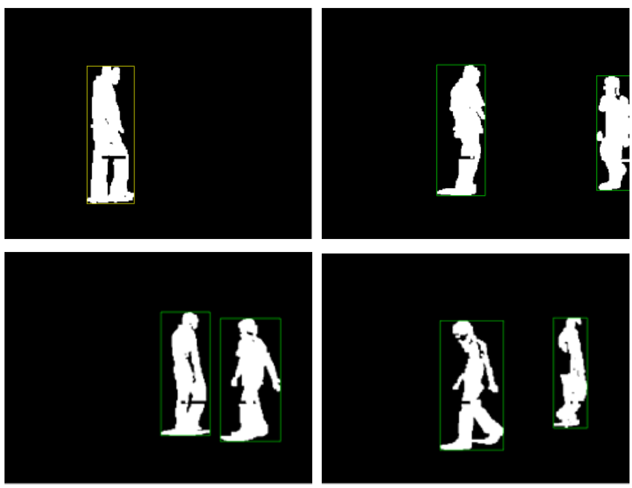
Fig. 1. Temporal Difference for moving object detection, (a) input video frame sequence 106 to 109, (b) Temporal Difference result sequence 107 to 109

As described in section 2, it may leave holes in foreground object detection as shown in result. As stated it requires the support of another algorithm to get accurate output.

Figure 2 shows, the output by applying the incremental statistical method to the video sequence acquired outdoor environment. It provide, detection of moving object accurate, it is able to detect moving object under the dynamic change in the background stationary model. For the example shown in figure 2, the value of threshold τ is 30.

Figure 2 (a) input frame sequence 101 111 121 131 of the video, and 2 (b) shows the output frame sequence 101 111 121 131 that contains moving object detected using the incremental statistical mean method, by using the equation specified in the above section.

(a)



(b)

Fig. 2. Incremental statistical mean Technique, (a) Input video frame sequence 101 111 121 131 (c) Moving object detected sequence 101 111 121 131

We have applied this technique on 12 video, indoor as well as the outdoor environment, and gives accurate result for those. Though, incremental statistical mean technique, achieves good result for moving object detection, it have some disadvantages as, it cannot deal with sudden rain or snow fall, in the video. It cannot differentiate the rain drops and moving object from the video frames. This technique requires parallel processing to reduce the time complexity. If the value of threshold is not chosen appropriate, to the environment, it may produce the inaccurate result.

5 Conclusion

Moving object detection is the first and low-level step of any visual surveillance system, after that there are so many steps remaining to perform to complete, any surveillance system. We explain the traditional moving object detection technique, with its pros and cons. As well as, we describe its drawbacks in practically in experimental result. We propose incremental statistical mean technique that is computationally fast, by allowing the parallel processing. Incremental statistical mean technique, overcome the drawbacks of traditional approach of moving object detection. It provides the good result under the illumination change due to the day and night, stationary background model change, because of this technique is incrementally changes its background model.

References

1. Elhabian, S.Y., El-Sayed, K.M.: Moving object detection in spatial domain using background removal techniques- state of the art. Recent Patents on Computer Science 1, 32–54 (2008)
2. McIvor, A.M.: Background subtraction techniques. In: Proc. of Image and Vision Computing (2000)
3. Kim, I.S., Choi, H.S., Yi, K.M., Choi, J.Y., Kong, S.G.: Intelligent Visual Surveillance - A Survey. International Journal of Control, Automation, and Systems 8(5), 926–939 (2010)
4. Heikkila, J., Silven, O.: A real-time system for monitoring of cyclists and pedestrians. In: Proc. of Second IEEE Workshop on Visual Surveillance, pp. 74–81 (June 1999)
5. Lipton, A.J., Fujiyoshi, H., Patil, R.S.: Moving target classification and tracking from real-time video. In: Proc. of the IEEE Workshop Applications of Computer Vision, pp. 8–14 (1998)
6. Mathew, R., Yu, Z., Zhang, J.: Detecting new stable objects in surveillance video. In: Proc. of MSP 2005, pp. 1–4 (2005)
7. Liao, H.H., Chang, J.Y., Chen, L.G.: A localized Approach to abandoned luggage detection with Foreground –Mask sampling. In: Proc. of AVSS 2008, pp. 132–139 (2008)
8. Alvaro, B., SanMiguel Juan, C., Martínez Jose, M.: Stationary Foreground Detection using Background Subtraction and Temporal Difference in Video Surveillance. In: Proceedings of 2010 IEEE 17th International Conference on Image Processing, September 26-29 (2010)
9. Yilmaz, A., Javed, O., Shah, M.: Object Tracking: A survey. ACM Comput. Surv. 38(4), Article 13 (December 2006)