ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 2, Issue 1, January 2013

Frame Differencing with Simulink model for Moving Object Detection

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***Abstract*— Visual sensor networks (VSNs) have been attracting more and more research attention nowadays. Identifying moving objects from a video sequence is a fundamental and critical task in many computer-vision applications. One of the simplest techniques for detection is background subtraction (BS) and frame difference, which identifies moving objects from the portion of a video frame that differs significantly from a background model. BS refers to the process of segmenting moving regions from image sequences. Background subtraction is a process of separating moving foreground objects from the non-moving background. In this paper, one of the traditional background subtraction techniques which is frame differencing (FD) algorithm is conducted using Simulink model to detect moving vehicles, pedestrians in urban traffic video sequences etc. The result of moving object detection using FD is not perfect that enable this research to experimental post-processing technique which is adaptive threshold in HSV color space for outdoor environment.**

***Index Terms* — tracking, background subtraction, FD, Adaptive Threshold**

I. INTRODUCTION

Detection is an inherent part of any efficient tracking algorithm. The detection process helps identifying and localizing moving objects within any scene. The simplest way of accomplishing detection is through building a representation of the background and comparing each new frame with this representation. This procedure is known as *background subtraction* (BS) [3].

There are many researches have been done for object detection. Each technique proposed from low to high complexity and has its own strengths and weaknesses. Most of these techniques have limitations and cannot handle dynamic changes of the background, e.g., gradual or sudden (e.g., moving clouds), motion changes including camera oscillations and high frequency background objects (tree branches, sea waves, etc.) and changes in the background geometry (such as parked cars) [3].

Though the generic BS method is simple to understand and implement the disadvantages of the *frame difference* BS is that it does not provide a mechanism for choosing the parameters, such as the detection threshold, and its inability to cope with multi-modal backgrounds.

The objectives in this project are to create simple, accurate and less complexity traditional background subtraction technique with post-processing for moving object detection.

II. BACKGROUND STUDY

Background subtraction is a popular technique used to detect the moving object from a stationary camera. It is done by comparing the current frame and the background.

There are two main categories of background modeling technique which are non-recursive technique and recursive technique. Non-recursive technique uses sliding window approach to estimate the background and store the previous frame in a buffer. It is a very adaptive technique but requires large memory. In comparison to non-recursive technique, recursive technique requires less memory. It only stores one frame as the background and updates it time to time. The disadvantage of this technique is if there is any error at the background model, it needs longer time to disappear [2].

Based on the past literatures, traditional background subtraction technique alone not sufficient enough to produce good moving object detection. Therefore, many post-processing techniques have been invented and tested in order to satisfy the demand such as adaptive threshold, morphological technique, blob processing, optical flow among others [3],[7].

III. METHODOLOGY

Fig. 1 shows the flow of the FD background subtraction method with post-processing. The flow starts from processing the raw video input frame. The input frame will be converted it into a simpler format for the next step at pre-processing stage. Next, background will be modeled and updated in background modeling using FD technique. Unidentified pixel will be validated in order to attain the target moving foreground object. In post-processing, adaptive threshold method will be applied in a way to provide a better foreground detection results [4].

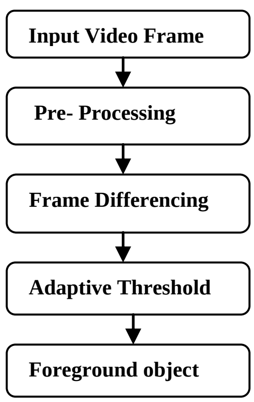

Fig. 1 Block Diagram of FD Background Subtraction Method with Post- Processing

A. Background Modeling

Most of the existing BS techniques such as operate at pixel level. FD is the simplest form among of background subtraction method. It is done by comparing the pixel from the current frame and the previous image as the background .

The time T is crucial since its update determines the model ability to adapt to illumination changes and to handle appearances and disappearances of objects in a scene. If the frame rate is known, the time period T can be adapted: $T = N/ fps$, e.g., as a ratio between the number N of frames obtained through the online process and the frame rate, *fps*, frames per second.

Background Modeling is a process of estimates the background of the input video, model the background and finally updates it continuously.

$$\left| \text{frame}_t - \text{frame}_{t-1} \right| > T \qquad (1)$$

The current frame will be subtracted from the previous frame and the pixel difference will be compared with a threshold as given in (1). The absolute difference between the two frames is greater than the threshold, the pixel will be assumed as part of the foreground. Otherwise, it is considered as background pixel. The main consideration for this technique is on how to determine the suitable threshold value.

The advantage of this method is its highly adaptive background model and less computational load. In fact that the background is based on the previous frame, it can adapt to changes in the background at 1/fps (one frame period) . In the other hand, if the objects motionless for more than one frame period, it will be considered as part of the background. Another fatal consequence using frame differencing is that uniform moving object will be detected as background.

B. Adaptive Threshold

Adaptive threshold (AT) takes grayscale or color image as input and outputs a binary image. This technique examines the intensity of a certain size of the neighborhood pixel. It takes the average of the neighborhood pixel intensity as the threshold.

The proportionality between the pixels belonging to the foreground to the pixels from the background is assumed constant in most adaptive models [24]. This assumption does not hold true when videos of objects are captured from a close proximity. In such circumstances, the proportion of pixels belonging to the objects of interest, i.e., the foreground pixels are much higher than the background pixels.

The theory behind this technique is that smaller area of an image will have approximately uniform illumination. The size of the neighborhood pixel should be sufficient enough to cover the foreground and background pixels.

This technique works well for stationary image segmentation. The result from this technique will then be merged with the FD result.

C. Algorithm used in the Experiment

The Simulink[6] provides an interactive graphical environment and a customizable set of block libraries that let you design, simulate, implement and test a variety of time varying systems, including communications, controls, signal processing, video processing and image processing [5]. One specific algorithm that SSC Charleston inspected was the Sum of Absolute Differences (SAD), as detailed by E.A. Hakkennes of the Delft University of Technology in the Netherlands [7]. SAD is one of the

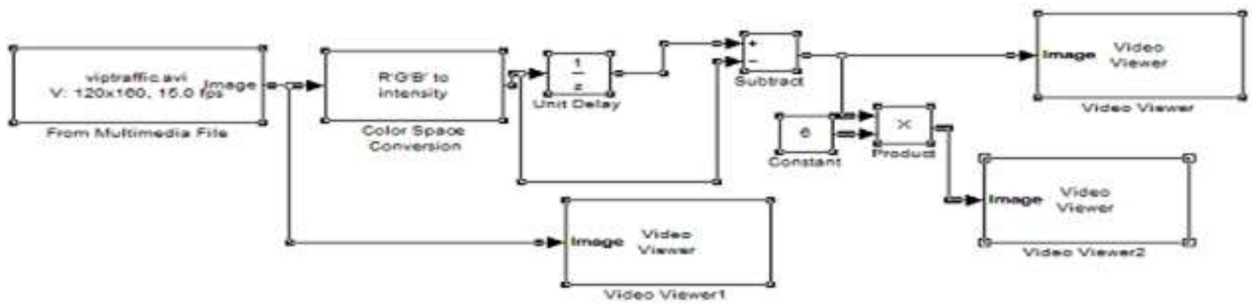

Fig.2 Simulinks model for frame differencing technique

most effective algorithms in current automated video surveillance systems. SAD is a summation of the absolute differences between pixels in an image. In this algorithm, each pixel is compared with every pixel from the next image (one frame delay). The sum of these calculations corresponds to a value which can be used to form an output matrix (video) with only the changed (moving) pixels. The formula is shown in equation (2).

$$SAD=\Sigma_i\Sigma_j|\ I_k(i,j)-I_{k-1}(i,j)| \quad (2)$$

Where $I_k(i,j)$- current frame and $I_{k-1}(i,j)$- Previous frame

III. RESULT & DISCUSSION

The performance of the proposed frame differencing with post-processing technique will be illustrated over real video sequences using simulink model as shown in fig.2

We drawn three types of output here in this diagram as shown in fig. 2,from whose outputs are at video viewer, video viewer1, video viewer2 are represented in fig. 4,fig. 3 and fig.5 respectively.

Experiment is conducted using an outdoor video with resolution of 640 x 480. Two of this video sequence frames are shown in fig.3.Part a, represents the frame when only one car is present whereas Part b represents the frame when more than one car is present.

(a) (b)

Fig.3 moving car of video sequence with(a) one car (b) more than 1 car.

As mentioned in part III. A, it is necessary to determine a suitable threshold (T) value where the foreground and background pixel will be separated completely. In this paper, experimental begins by applying predetermined threshold. The output will be evaluated based on the accuracy, true positive rate (TPR) and false positive rate (FPR). Fig.4 shows the output of block namely video viewer as shown in fig. 2.As the o/p is, only the subtraction of two consecutive frames.

Fig.4 Moving Object Detection with Output of FD with (a) one car (b) more than 1 car.

A range of threshold value from 8 to 14 is acceptable. This range of threshold value gives lower FPR, medium TPR but high accuracy within 95%.For

ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
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adaptive threshold, the threshold value depends on the neighborhood pixel intensity and size of the neighborhood pixel needs to be considered.Fig.5 shows the output of block namely video viewer 2 as shown in fig. 2.As the o/p is, the product of a constant and the subtraction of two consecutive frames

Fig.5 Moving Object Detection with (c) Output of FD with adaptive threshold with(a) one car (b) more than 1 car.

Through all the experiments, the accuracy is increasing stage by stage when different value of threshold been selected as shown in Fig. 6. FD is the accuracy line for traditional background subtraction frame differencing alone. FD+AT is the accuracy line after adaptive threshold technique is performed

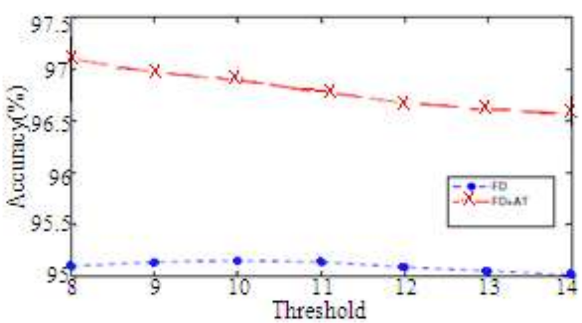

Fig. 6 Threshold vs. Accuracy for Moving Object Detection for FD and Post-processing Technique

V. CONCLUSION

As a conclusion, simple traditional FD can be enhanced to detect good moving object detection by introduced post processing technique. In this paper, the results show that by adding techniques which is adaptive threshold (AT) in HSV color space. In future, it is good for other researcher to test these similar techniques for indoor environment and other traditional background subtraction method such as Mixture of Gaussian (MOG).

ACKNOWLEDGMENT

I acknowledge the support of the Assistant professor Ms Manisha M Chahande and AITTM (Amity Institute of Telecom Technology & Management) under the adaptive threshold project for supporting this research.

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