Implementation of the Gaussian Mixture Model Algorithm for Real-Time Segmentation of High Definition video: A review

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Abstract— **The detection of moving object is important and critical task in Real -Time video signal. This becomes more critical under this circumstances such as luminance changed, weaving leaves, rainy weather, under heavy snow fall weather. In this paper we studies background subtraction algorithm for foreground detection. Foreground detection is mainly with help of these two approaches, pixel to pixel and frame to frame comparison. But in real-time video sequence pixel to pixel foreground detection is complex because it has more time for processing because in this method compares pixel value. And in frame to frame comparison method compare two consecutive frames. In this paper by using GMM Algorithm improves result in case of less illumination as well as the images having moving objet of the background. In this paper, many soft computing techniques is used such as filtering, mean square error, recall , precision etc. will used for identifying foreground.***)*

Index Terms— soft computing, filtering, recall, precision, MSE, GMM, BG, FG.
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I. INTRODUCTION

Identifying of moving objects from a video sequence is a fundamental and critical task in video surveillance. For security purpose motion detection is very essential. Basically motion detection is the process of detecting change in position of an object relative to stationary part. Normally background subtraction based on static background but this is not applicable Real-Time video signal. In previous work mostly algorithm assumes that illumination in scene remains constant [1-2]. Grievously in indoor environment reflection or animated images on screens lead to background images and in outdoor environment illumination is changed due whether problem identification of moving becomes more critical when luminance is changed. In background subtraction technique, set the background and then see what changes occur in background. In defining the background is assumed that stationary objects that can be variations in color and intensity versus time. Foreground detection process is detection of moving object. Foreground detection can be achieved by both mechanical and electronic system. When apply electronics system, for detecting a moving object a simple algorithm is used for motion detection. In this algorithm compares the current image with a reference image. Generally in video processing video signal is segmented into image frame [3]. A common method for real-time segmentation of moving regions in image sequences involves "background subtraction," [4].

The methods are available for moving object detection are Background subtraction and Feature comparison [2]. Background subtraction is very common technique for foreground detection. Background subtraction divides in two categories [5].
1. Frame To Frame Comparison
2. Pixel To Pixel Comparison.

In frame to frame comparison techniques two consecutive frames are compared. And in pixel to pixel comparison method two consecutive pixel value of video signal are compared. First method is better because in this method whole frame is compared but in second method each pixel value is compared. So pixel to pixel comparison algorithm is more complex and processing speed also reduces in pixel to pixel to comparison. So first method, is suitable and faster .

Real-Time video processing, demands simple and fast algorithm. For achieving best result in Real-Time video sequence update the background properly. Efficiency and accuracy of Real-Time video signal depends upon the background updating technique and value of threshold value in background subtraction technique [1]. For outdoor environment new illumination independent algorithm, is used for background subtraction this is background subtraction algorithm using GMM.

II. RELATED WORK AND CONTRIBUTION

In most algorithms in foreground detection is assumed that illumination is constant. This is very vast area for research many researchers works on this area. We summarized some works in below table.

S. N.	Title	Technique	Outcome
1.	A statistical approach for real-time robust background subtraction and shadow detection	Clustering detection elimination	Detection rate =0.99 Brightness distortion=0.4
2.	An Improved Adaptive Background Mixture Model for Real time Tracking with Shadow Detection	Adaptive background mixture model	Shadow detection reduces the effect of small repetitive motions in the background scene.
3.	Multi valued Background/Foreground Separation for Moving Object Detection	fuzzy approach to the background model update procedure	For WS Recall=0.8606 Precision=0.9684 For MR Recall=0.8751 Precision=0.9108
4.	Robust techniques for background subtraction in urban traffic video	Frame differencing and adaptive median filtering	This technique gives better result under fog, snow and heavy traffic
5.	GPU implementation of Extended Gaussian mixture model for Background subtraction	Extended Gaussian mixture model	Frame rate and speedup decreases.
6.	Moving object detection using Matlab	Thresholds at various Phases.	This algorithm detects background dynamically and gives effectively foreground and also removes the shadow.
7.	Real-time background generation and foreground object segmentation for high-definition color video stream in FPGA device	Methods based on optical flow and background generation followed by background subtraction.	The foreground object segmentation method gives three pieces of information: lightness, color and texture in order to obtain better results and removes the shadows.
8.	ASIC and FPGA Implementation of the Gaussian Mixture Model Algorithm for Real-Time Segmentation of High Definition video	Open CV version of the Gaussian mixture model (GMM), a background identification Algorithm.	The FPGA implementation when compared with previously proposed background identification circuits provides Improved speed and logic utilization.

III. ALGORITHM USED FOR MOVING OBJECT DETECTION

Motion detection in consequent images is nothing but the detection of the moving object in the scene. In video surveillance, motion detection refers to the capability of the surveillance system to detect motion and capture the events [6]. Motion detection is usually a software-based monitoring algorithm which will signal the surveillance camera to begin capturing the event when it detects motions. This is also called activity detection.

Let us consider that a video frame in which background is highway image as shown in fig 1. Let us assume that this is first frame. A moving object is entered on highway as shown in fig 2. Let us assume that this is second frame. When we compare this two consecutive frame then pixel of same value is subtract. As shown in fig 3(detection of moving object) same pixel which is in background is subtracted and pixel value of car is changed frame to frame is detected. GMM algorithm is used for improving result as shown in fig 4. This output is proposed output.

Fig 1: Reconstructed Background   fig 2: Moving object
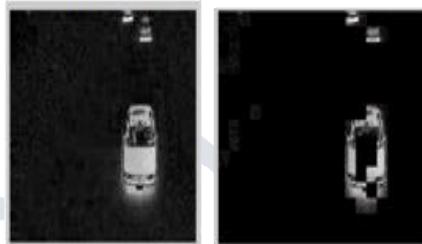
Fig 3 detection of moving Object   Fig 4: Detection of moving object using GMM algorithm

Background subtraction algorithm is completed in   four steps. These are
1. Preprocessing
2. Background detection
3. Foreground detection
4. Data validation

      1. Preprocessing: Preprocessing, consist collection of simple images processing tasks. In image processing mostly images are available in either RGB or HSV color space. In video signal one scalar value per pixel. In preprocessing reduce camera noise which produces under such circumstances like rainy, fog whether of outdoor images. In preprocessing smoothing can also used reduce the camera noise.
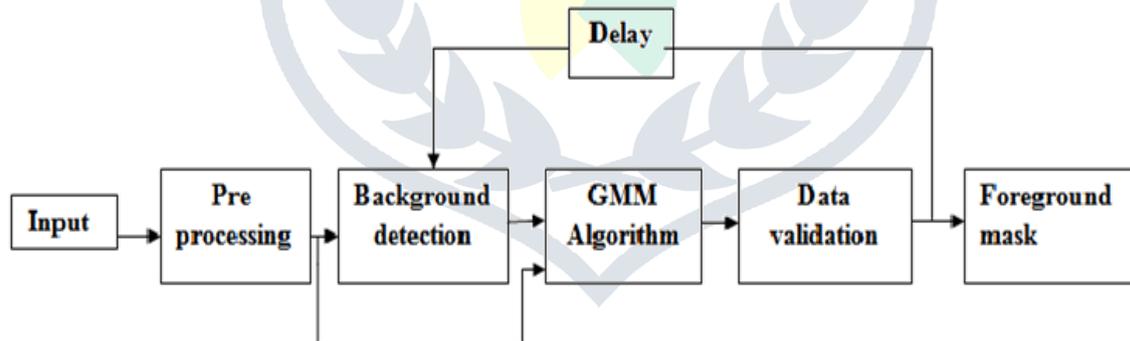

Fig 5 Proposed Methodology

2.   **Background modeling:** background modeling plays very vital role in background subtraction algorithm. Background modeling divides into two parts [2, 7] .

   A. Non Recursive

   B. Recursive

      A. Non Recursive: In non recursive method stores previous video frame of video signal. Non recursive technique is used sliding window approach for background estimation. Some common technique used in non recursive method. This method is frame differencing, median filtering, linear predictive filter and non parametric model

      B. Recursive: In recursive method do not stores previous video frame. Recursive techniques commonly use approximated median filtering, Kalman filter and mixture of Gaussian. In comparison of non recursive technique, recursive technique requires less storage of memory.

Background estimation: The absolute background subtracting estimation by the help of this equation [4].

IF D=$|C - B| > T$
O =1 (OBJECT)   (1)
ELSE
O = 0 (BACKGROUND)

Where C = pixel value of current images.
B = pixel value of background images.
D =absolute difference of current and background images.
O = binary difference images.

Threshold error is produced between current pixel and background pixel [4].

3. Foreground detection: foreground detection compares the video frame with the background model and identifies candidate foreground pixel from the input frame. The most commonly used approach for foreground detection is to check whether the input pixel is significantly different from the corresponding background estimates [2]. Generally threshold value is taken lower value (small number 3 to 5) [6] in this paper take threshold value 2.5 .

$$|It(x,y) - Bt(x,y)| > T \qquad (2)$$

Another popular foreground detection scheme to threshold based on normalized statics [4]:

$$\frac{It(x,y) - Bt(x,y) - \mu d}{\sigma d} > Ts \qquad (3)$$

Where μd = mean of $\left||It(x,y) - Bt(x,y)\right||$
σd = standard deviation of $\left||It(x,y) - Bt(x,y)|\right|$
For all spatial location of (x,y)

4. Data validation: Data validation is improving the result of foreground detection. In background detection arises the three limitation first, they ignore any correlation between neighboring pixels; second, the rate of adaption may not match the moving speed of the foreground objects; and third, non-stationary pixels from moving leaves or shadow cast by moving objects are easily mistaken as true foreground objects. After data validation evaluate result by the help of two formulae. These formulae are recall and precision. These formulae compare various backgrounds modeling technique. These formulae are mentioned below
Recall: in image processing recall is the common parameter which is used to improving result of two consecutive frames. Recall is ratio of number of retrieved images that are also relevant and total number of relevant images. In this paper number of number of retrieved images that are also relevant is number of foreground pixel which is correctly identified and total number of relevant images is number of foreground pixel in ground truth [1].

$$recall = \frac{\text{number of foreground pixel correctly identified by algorithm}}{\text{number of foreground pixel in ground truth}} \qquad (4)$$

Precision: precision is ratio of number of retrieved images that are also relevant and total number of retrieved in this number of retrieved images is number of foreground pixel detected [1].

$$precision = \frac{\text{number of foreground pixe correctly identified by algorithm}}{\text{number of foreground pixel detected by the algorithm}} \qquad (5)$$

Mean Square Error: The mean square error is used as part of the digital image processing method to check for errors. Two MSEs are calculated and then compared to determine the accuracy of an image
Now we calculate the mean square error by the formula [8]

$$MSE = \frac{1}{M.N} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} (I(m,n) - Iref(m,n)).^2 \qquad (6)$$

IV. CONCLUSION

We have studied a few of the papers in the field of detection of moving object in the background subtraction algorithm. The detection of moving object is very essential for security purpose. For correct and efficient detection of moving object to reduce the load on the human observer and traffic monitoring, an automatic method for detection of moving object is highly desirable. In this paper automated moving object detection methods through background subtraction has been surveyed. After surveying we can conclude that the automatic detection method for the moving object in the background subtraction algorithm can be broadly classified into following category. pre-processing, background modeling, foreground detection, and data validation. Various algorithms have been

proposed in the literature. For example, for feature extraction background subtraction and foreground detection are used. Background subtraction subtracts same pixel value whereas foreground detection is used to extract moving object. We analyze them based on how they differ in preprocessing, background modeling, foreground detection, and data validation. In background modeling we used recursive and non recursive method .The advantage of recursive technique is that it does not require the prior knowledge of the system under consideration and are very well suited for modeling the dynamic systems on a real-time basis. The results of methods proposed by different people in traffic video processing are used to focus on the various combinations of techniques and their performances. The results of various algorithms are discussed.

V. FUTURE SCOPE

The detection of the moving object in the traffic monitoring is a difficult task. After studying the previous research papers in the field of detection of moving object, it is found that a lot of work has been done in the field of detection of moving object. But very little research work has been done in the field of moving object detection by the help of background subtraction. Further, the development of automated analysis of background subtraction using GMM has been hindered by the subtle nature of moving object abnormalities which appear as under some critical weather like heavy rain, fog. Hence there are very large scope of research in this field exists.

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REFERENCES

[1] S.C. S. Cheung and C. Kamath, "Robust Techniques For Background Subtraction In Urban Traffic Video", IS&T/SPIE's Symposium on Electronic Imaging San Jose, CA, United States pp. 183-192 January 18-22, January 2004 San Jose, CA, United States .

[2] V. Zeljković, Željen TRPOVSKI, Vojin ŠENK "New Algorithm For Moving Object Detection" pp. 117-132, Yugoslav Journal of Operations Research 14 (2004),

[3] Z. Zeng,andWeihong, "Moving Object Detection Based Frame Difference and Graph Cuts", Journal of Computational Information Systems (2012) , pp. 21–29 Yuyong China

[4] C. Stauffer and W.E.L Grimson , "Adaptive background mixture models for realtime tracking" , in Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit., vol. 2, pp. 1–7 Jun. 1999 Fort Collins, CO, USA,.

[5] M. Rose Simon and jincy Fernande, "Survey On Various Techniques In Region Based Foreground Detection",International Journal of Advanced Computational Engineering and Networking, , Volume-2, Issue-6, June-2014

[6] G.S. Babu, "Moving Object Detection Using Matlab", International Journal of Engineering Research & Technology (IJERT), vol. 1, no.6, August – 2012 Andhra Pradesh India. Accepted: 15 October 2012 Springerlink.com pp.61-77

[7] T.Kryjak, M. Komorkiewicz and Marek Gorgon "Real-time background generation and foreground object segmentation for high-definition colour video streamin FPGA device" received: 31 March 2012./

[8] M. Genovese and E. Napoli, "ASIC and FPGA Implementation of the Gaussian Mixture Model Algorithm for Real-Time Segmentation of High Definition video" ,IEEE Transactions On Very Large Scale Integration (VLSI) Systems, Vol. 22, No. 3, March 2014 pp 537-547 Naples Italy.

[9] K. T. Pong and R. Bowden, "An Improved Background Mixture Model for Realtime Tracking with Shadow Detection", In proc 2nd European workshop on advanced video based surveillance system pp. 1-5.

[10] H. Jiang, H. Ardö, and Viktor Öwall, "A Hardware Architecture for Real-Time Video Segmentation Utilizing Memory Reduction Techniques", Vol. 19, No. 2, pp.226-236 February 2009 Member, IEEE Special Issue

11] I. Haritaoglu, D. Harwood, and L. S. Davis, "A fast background scene modeling and maintenance for outdoor surveillance" Proc. 15th Int. Conf. Pattern Recognit., vol. 4. Jan. 2000, pp. 179–183.

12] Naveen hintalacheruvu, Venkatesan Muthukumar "Video Based Vehicle Detection and Its Application in Intelligent Transportation Systems" Received July 30, 2012; revised August 28, 2012; accepted September 7, 2012