Moving object detection and tracking using Multiple Webcam

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***Abstract*— Real time object detection and tracking is an important task in various surveillance applications. Nowadays surveillance systems are very common in offices, ATM centers, shopping malls etc. In this paper, an Automated Video Surveillance system is presented. The system aims at tracking an object in motion and identifies an object in multiple webcam which would increase the area of tracking. The system employs a novel combination of Gaussian Mixture Model based Adaptive Background Modeling Algorithm and a RGB color model used for identifying an object in multiple webcam.**

Keywords*— Moving object detection and tracking; Gaussian Mixture Model; Adaptive Background Modeling; color as a feature; video surveillance.

I. INTRODUCTION

Detection, tracking and identifying people in real time videos have become more and more important in the field of computer vision research. It has many applications, such as video based surveillance and human–computer interaction. Its aim is to locate targets, retrieve their trajectories, and maintain their identities through a video sequence.

A. Related Work

In order to solve the challenging problem of human tracking and detection, a huge number of studies are already done related to tracking and detection of moving object. In [1] Adaptive Gaussian mixtures have been used for modeling non stationary temporal distributions of pixels in video surveillance applications. Significant improvements are shown on both synthetic and real video data. Incorporating this algorithm into a statistical framework for background subtraction leads to an improved segmentation performance compared to a standard method. In [2] a method employs a region-based approach by processing two foregrounds resulted from gradient and color-based background subtraction methods. In [3] system employs a novel combination of an Adaptive Background Modeling Algorithm (based on the Gaussian Mixture Model) and a Human Detection for Surveillance (HDS) System. The HDS system incorporates a Histogram of Oriented Gradients based human detector which is well known for its performance in detecting humans in still images. In [4], it uses modeling each pixel as a mixture of Gaussians and using an on-line approximation to update the model. The Gaussian distributions of the adaptive mixture model are then evaluated to determine which are most likely to result from a background process. Each pixel is classified based on whether the Gaussian distribution which represents it most effective part of the background model. In [5] it uses a method for human tracking using a stereo camera system called “Subtraction Stereo” and color information. The tracking system using the subtraction stereo, which focuses its stereo matching algorithm to regions obtained by background subtraction, is realized using Kalman filter. To make the tracking system more robust, the new method also uses color information as distinctive information of person.

B. Our Contribution

In this paper we are implementing a technique which can continuously track and identify multiple people from one or many place using multiple webcam by using adaptive background subtraction with Gaussian mixture model technique, handoff the color as feature to identify the person in many webcam.

C. Outline

In sec. I we describe about introduction, related work and our contribution to the system. In sec. II we introduce overview of system, frame differencing, Gaussian Mixture Model overview and identification of moving object. Subsequently, we provide performance analysis in sec. III. Finally, in sec. IV we conclude.

II. SYSTEM MODELLING

A. Overview of system:

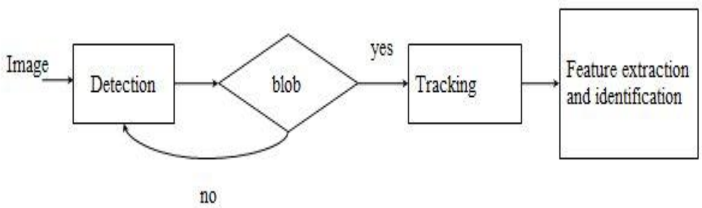

Fig. 1. Flow chart of generalised object detection and tracking.

The flow chart shows how an image taken from live webcam is processed for tracking and identification purpose. The first process is detection of moving object for that

Gaussian mixture model is used. Second process is to track a moving object for that blob analysis is used, third process is identification of moving object in multiple webcam for that color feature is used and hand off of the feature is done between the webcam.

B. Frame Differencing

A statistical background image of the video scene is obtained. This background image is subtracted from the current frame image and threshold. The foreground regions of interest are extracted from the threshold image after appropriate morphological operations. The algorithm flow for Static Background Subtraction is depicted in Fig. 2.

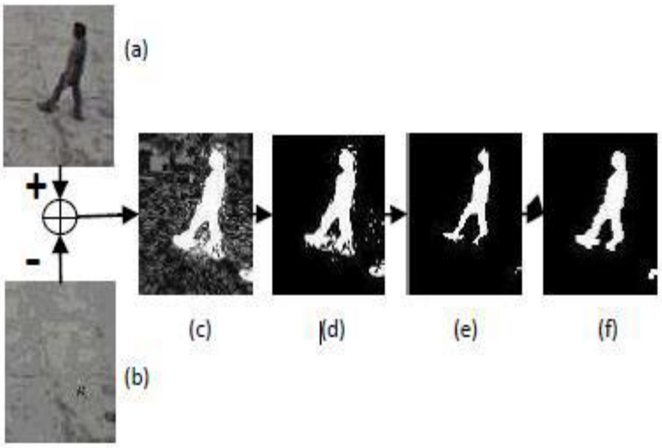

Fig. 2. Static Background Subtraction

The Static Background Subtraction system is not resilient to illumination changes or long lasting changes in the scene. Hence an Adaptive Background Modeling scheme should be adopted. In the following discussion, an implementation of the Gaussian Mixture model algorithm is presented, originally formulated by Stauffer et al [4], and subsequently modified by Harville et al [10].

C. Gaussian Mixture Model Overview:

The following algorithm models each individual pixel as a mixture of K-3D Gaussian distributions in the color space.

Pixel Value

$$X_t = \begin{bmatrix} X_{r,t} \\ X_{g,t} \\ X_{b,t} \end{bmatrix} \quad (1)$$

The probability of observing the current pixel is

$$P(X_t) = \sum_{i=1}^{K} w_{i,t} * \eta(X_t, \mu_{i,t}, \Sigma_{i,t}) \quad (2)$$

Where, K is the number of distribution, $w_{i,t}$ is estimate of the weight at i^{th} Gaussian in the mixture at time t and η is the Gaussian probability density function.

$$\eta(X_t, \mu, \Sigma) = \frac{1}{(2\pi)^{\frac{n}{2}}|\Sigma|^{\frac{1}{2}}} e^{-\frac{1}{2}(X_t-\mu_t)^T\Sigma^{-1}(X_t-\mu_t)} \quad (3)$$

Where,

$$(X_t - \mu_{k,t})^2 > \beta\sigma_k^2$$

$$\mu_t = (1-\alpha)\,\mu_{t-1} + \alpha X_t \quad (4)$$

$$\sigma_t^2 = (1-\alpha)\sigma_{t-1}^2 + \alpha(X_t - \mu_t)^T(X_t - \mu_t) \quad (5)$$

Where α is taken as a learning constant. The distributions are sorted according to the values $\frac{w_k}{\sigma_k}$. The first B distributions are chosen from the sorting to represent the background according to the following criteria:

$$B = \operatorname{argmin}\left(\sum_{K=1}^{b} W_k > T\right) \quad (6)$$

The new pixel value is classified as a foreground pixel if no match is found amongst the B distributions. The least weighted distribution is replaced with the distribution corresponding to the new pixel value.

Preprocessing of an image

Morphological operations are done by using structuring element square of matrix 5x5 for smoothing the image.

bwareaopen(binary image,P)

Removes from a binary image all connected components (objects) that have fewer than P pixels, producing another binary image this operation is known as an area opening.

D. Identification

BlobAnalysis : The BlobAnalysis object computes statistics for connected regions in a binary image

BBOX: computes the bounding box BBOX of the blobs found in input binary image.

centroid: gives the co-ordinates of the moving object the coordinates are in the form of *M*-by-4 matrix of [x y width height] bounding box coordinates, where *M* represents the number of blobs and [x y] represents the upper left corner of the bounding box.

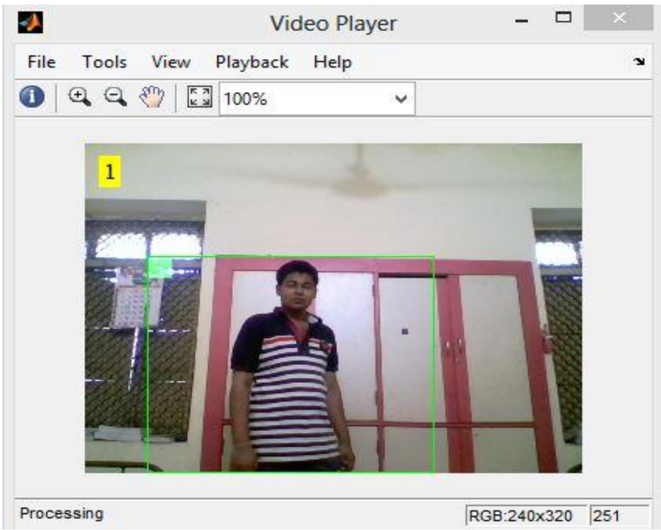

Fig. 3. Bounding box as green color, green is the color tag as an identity mark.

Extraction region of interest from moving object in this project people are being detected by using color information. So our region of interest is a small mask located at central part of moving object. In that we are extracting its color information. By using centroid information we are able to locate the central part of moving object extracting 10x10 matrix color information.

Region of interest:

Fig. 4. 10x10 color mask from the Centre of bounding box

A color tag is inserted to the left upper corner of the bounding box as an identifying mark to that moving object.

Fig. 5. Flow chart of object detection and tracking using four Webcam

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In this system four webcam are used for identifying and tracking two people. A person is entered first in webacm1, this person is identified by frame differencing and Gaussian mixture model, and bounding box is made around the foreground object which gives the co-ordinates of the moving person. For extracting the color mask we take an 10x10 matrix from the center of the bounding box an extracting the mask assume this person is tag as red color in upper left side as an mark of identity. For second person we may tag a green color as an identity mark. The mask are continuously compared with the foreground object and if the mean of difference of two mask is less than threshold then the same color tag is given as in webcam1. In multiple webcam an multiple person can be tracked using this method.

III. PERFORMANCE ANALYSIS

The figure below shows tracking of one person in webcam 2 where the green color rectangle box i.e. bounding box is used to track the moving object. Left upper corner shows the count and the green color tag is inserted at the upper left of the bounding box as an identification mark.

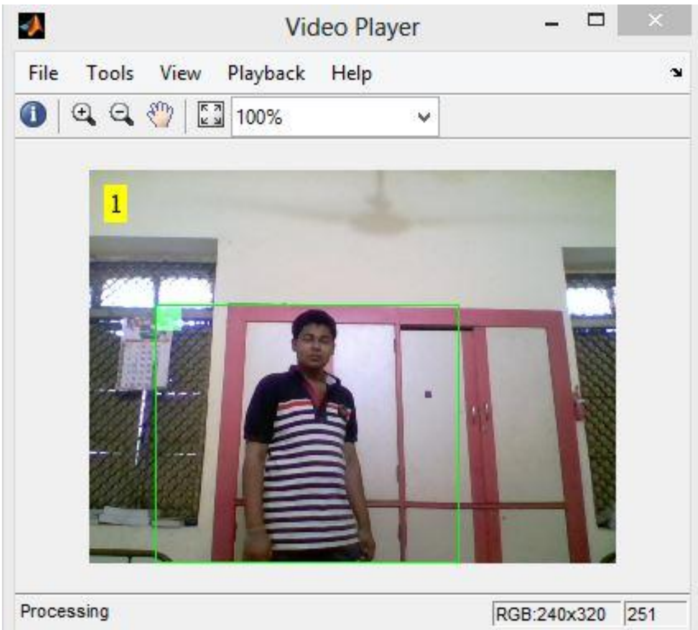


Fig. 6. one person tracking in webcam2

Same person is tracked in webcam 1 since both the webcam are placed close to each other and it can be observed that same person are having same color tag that is green color.

Fig. 7. tracking of one person in webcam1

Fig. 8. two person tracking in webcam1

Fig. 9. two person tracking in webcam2

The above figure shows two person are been tracked in two webcam continuously. In first webcam the color mask are crop and are compared with the second webcam and if mean difference between the two mask is less than threshold (we set threshold as 7) then same color tag is inserted as a mark for identification.

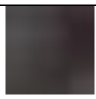
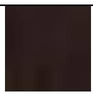
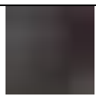
Web cam1	**Mask of figure 8(X1)**	**Mask of figure 8 (X2)**	**Mask of figure 8 (X3)**	**Mean of difference X1 & X2**	**Mean of difference X1 & X3**
				**33.0083**	**5.5372**
Web cam2	**Mask of figure 9 (y1)**	**Mask of figure 9 (y2)**	**Mask of figure 9 (y3)**	**Mean of difference Y1 & Y2**	**Mean of difference Y1 & Y3**
				**39.5041**	**2.6612**

Fig. 10. comparison of color mask of two person

The above table shows the comparison of color mask of two people. The mean difference between each mask is calculated. The mean difference between the color mask of same person in webcam 1 & 2 is less than 7, hence they got same color tag and of different person is greater than 7, and hence they got different color tag. This shows that our algorithm works perfectly for tracking of multiple objects in multiple webcam.

IV. CONCLUSION

The system presented in this paper for Moving object detection and tracking in four webcam are successfully performed in matlab2013. This system successfully tracks two people and identifies them in four webcam continuously by inserting tag's for the respective person. Tracking is done by using Gaussian mixture model and for identification purpose we are used rgb color information as a feature.

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