

**ABANDONED OBJECT DETECTION AND TRACKING IN VIDEO
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Abstract- Abandoned Object detection is most critical task in visual surveillance system. Many Public or open areas are facilitated with cameras at the multiple angles to monitor the security of that area for keeping citizens safe. This is known as the surveillance system. Object detection and tracking are important and challenging tasks in many computer vision applications such as surveillance, vehicle navigation and autonomous robot navigation etc. Different methods are used to detect and track object. In this method Gaussian Mixture Model (GMM) is used for object detection and Kalman Filter (KF) for Object tracking. By using Background Subtraction to detect foreground object in an image taken from camera. Morphological operation is used to filter out noise and remove imperfections. The experimental results show that the proposed method runs quickly, accurately and fits for the real-time detection.

Keywords- video surveillance, abandoned object detection, Gaussian Mixture model (GMM), Blob Analysis, Kalman Filter (KF), object detection and tracking, Background subtraction.

I. INTRODUCTION

In last decade many terrorist attacks took place at railway stations, hotel, mall, cinema halls and many other crowded places. Many people face this type of problem. To fight this problem government appointed multiple strategies. Video surveillance is one among them. But problem with CCTV system is they are fully controlled and monitor by human. Human eyes are not effective for looking multiple displays at a time. To enhance the processing of CCTV system for video stream abandoned object detection system was introduced.

Object tracking is used to identify and track object in sequence of video frame. Using tracking owner of an abandoned object or luggage is easily known.

1.1. Object Detection

Object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class (such as human, buildings or cars) in digital image and videos.

1.2. Object Tracking

Object tracking means identifying & following same object in sequences of video frames. Camera is used as input sensors to acquire frames to form the video. To remove noise from captured frames noise reduction technique is used to improve the image quality, to detect moving object, based on color of the moving object in frame. Extraction of objects from frame using the different features is known as object detection. Every object has a specific feature based on its shape.

1.3. Object Detection and Tracking

Object detection and tracking has variety of applications in computer vision such as surveillance, vehicle navigation, robot navigation, remote control vehicle, to track people in indoor environment, people and car in outdoor environment etc. Detecting abandoned object or abandoned luggage is referred to as a problem of left luggage or abandoned object detection in the visual surveillance research for public security. It is very critical task particularly for identifying suspicious stationary items.

The main aim of object tracking and detection is to establish a correspondence between object parts in consecutive frames and to extract information about objects such as posture. Tracking detected objects frame by frame in video is a significant and difficult task. It is a crucial part of smart surveillance systems since without object tracking, the system could not extract cohesive temporal information about objects and higher level behavior analysis steps would not be possible. Moving object detection is the first step in video analysis.

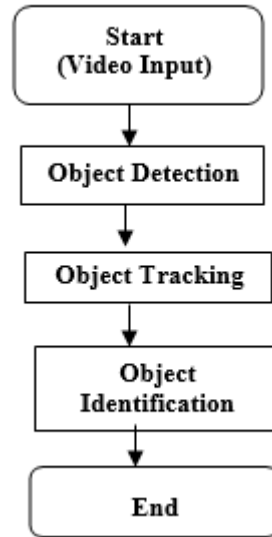


Figure 1. Flow of Object Detection and tracking

II. LITERATURE SURVEY

Kevin Lin et al. [1] proposed a temporal consistency model combining a back-tracing algorithm for abandoned object detection. The temporal consistency model is described by a very simple Finite state machine (FSM). It exploits the temporal transition pattern generated by short and long-term background models, which can accurately identify static foreground objects. Their back-tracing algorithm iteratively tracks the luggage owner by using spatial-temporal windows to efficiently verify left-luggage events.

A.Singh et al. [2] proposed an object detection system based on a dual background segmentation scheme. The background segmentation is adaptive in the nature and based on the Approximate Median Model. It consists of two types of the reference backgrounds, Current and Buffered background, each with the different time interval. Blob analysis is done on the segmented background and a dynamic tracking algorithm is devised for tracking the blobs even under the occlusion. Detection results show that the system is robust to variations in lighting conditions and the number of people are in the scene. In addition, the system is simple and computationally less intensive as it avoids the use of expensive filters while achieving better detection results.

Kahlil Muchtar et al. [3] proposed an automatic system for abandoned object detection. The main contribution of the method is to provide a comprehensive solution, which can identify the status of an object, abandoned, removed, or partially occluded. He employs the combination of background modeling based on mixture of Gaussians (GMM) and Markov Random Field (MRF). Furthermore, he employs a cast-shadow approach to enhance the shape of abandoned object. By combining these two approaches the abandoned object detection can perform well and obtain accurate results. The Gaussian Mixture Model (GMM) was proposed by Grimson and Stauffer. The pixel-based method to the model each pixel (regarded as background) into a mixture of Gaussians. In addition, each Gaussian has its own weight to represent its portion of the data accounted for from corresponding distribution.

Q. Fan et al. [4] proposed a novel approach to the abandoned object detection using the framework of relative attributes. Specifically, they design three physically interpretable attributes (staticness, foregroundness and abandonment) to characterize different kinds of alerts raised by various objects in the scene. They learn ranking functions for each of the attributes to rank order the alerts based on their strengths on the corresponding attributes. The attributes are used as input to an alert prioritization method which performs a ranking using alert importance.

YingLiTian et al. [5] proposed a new framework to robustly and efficiently detect the abandoned and removed objects in complex environments for real-time video surveillance. The mixture of Gaussians background subtraction method is employed to detect both background and static foregrounds by using the same Gaussian mixture model. Then static foregrounds were classified into abandoned or removed objects by segmenting and comparing the surrounding area of the background model and the foreground image. Method can handle occlusions in the complex environments with crowds. Furthermore, in order to reduce false alarms, authors have employed tracking information in to a small temporal window to provide an additional cue to filter out the impact of spurious and noisy trajectories for abandoned object detection.

Fatih Porikli et al. [6] proposed a robust method that uses dual foregrounds to find abandoned items, stopped objects, and illegally parked vehicles in static camera setups. At every frame this method adapts the dual background models using Bayesian update, and aggregate evidence obtained from dual foregrounds to achieve temporal consistency. This method does not depend on object initialization and tracking of every single object, hence its performance is not upper bounded to these error prone tasks that usually fail for crowded scenes. It accurately outlines the boundary of items even if they are fully occluded. Since it will execute pixel wise operations, it can be implemented on parallel processors.

IV IMPLEMENTATION

Object Detection in video surveillance in our system consist following step to detect abandoned object in video frame. Object detection in video surveillance is a critical task to detect abandoned object in video. Firstly divide video into frame then using GMM for object segmentation to detect abandoned object and plot bounding box around abandoned object using blob analyzer to easily identify the object. Kalman filter is used to track object in video surveillance by using Background Subtraction to detect foreground object in an image taken from camera. Morphological operation is use to filter out noise and remove imperfections. Figure 3. Represent Overview of system.

4.1. Gaussian Mixture Model (GMM)

Gaussian Mixture Model is model used to detect person or object in Surveillance video. GMM is used for object segmentation in video. GMM is probabilistic model for representing normally distributed subpopulation within an overall population. Gaussian mixture model based on background model to detect the moving objects. For detecting moving objects in video surveillance system the use the Gaussian mixture model, is essential this model has the color values of a particular pixel as a mixture of Gaussians. But the pixel values that don't fit the background distributions are considered as foreground.

If random variable X is Gaussian, it has the following PDF:

$$PX(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (1)$$

Where μ is the mean
 σ^2 is the variance (σ is called the standard deviation).



Figure 2: How GMM is working in our system (Detect Object and Draw bounding box)

4.2. Kalman Filter

Kalman filter is used for object or person tracking. A Kalman filter is used to estimate the state of a linear system where the state is assumed to be distributed by a Gaussian. The Kalman filter is a recursive predictive filter that is based on the use of state space techniques and recursive algorithms. It is estimated the state of a dynamic system. This dynamic system can be disturbed by some noise, mostly assumed as white noise. To improve the estimated state the Kalman filter uses measurements that are related to the state but disturbed as well. Kalman filtering is composed of two steps. Process Equation of a kalman filter:

$$X_k = AX_{k-1} + W_{k-1} \quad (2)$$

Where A represent transition matrix and X_k is the state at time k-1 to k. Vector w_{k-1} is the Gaussian process noise N.



Figure 3: How kalman filter is working in our system (Correction, prediction)

4.3. Background Subtraction

In background subtraction an absolute difference is taken between every current image $I_t(x,y)$ and the reference background image $B(x,y)$ to find out the motion detection mask $D(x,y)$. The reference background image is generally the first frame of a video, without containing foreground object.

$$D(x,y) = \begin{cases} 1 & \text{if } |I_t(x,y) - B(x,y)| \geq \tau \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

Where τ is a threshold, which decides whether the pixel is foreground or background. If the absolute difference is greater than or equal to τ , the pixel is classified as foreground, otherwise the pixel is classified as background.

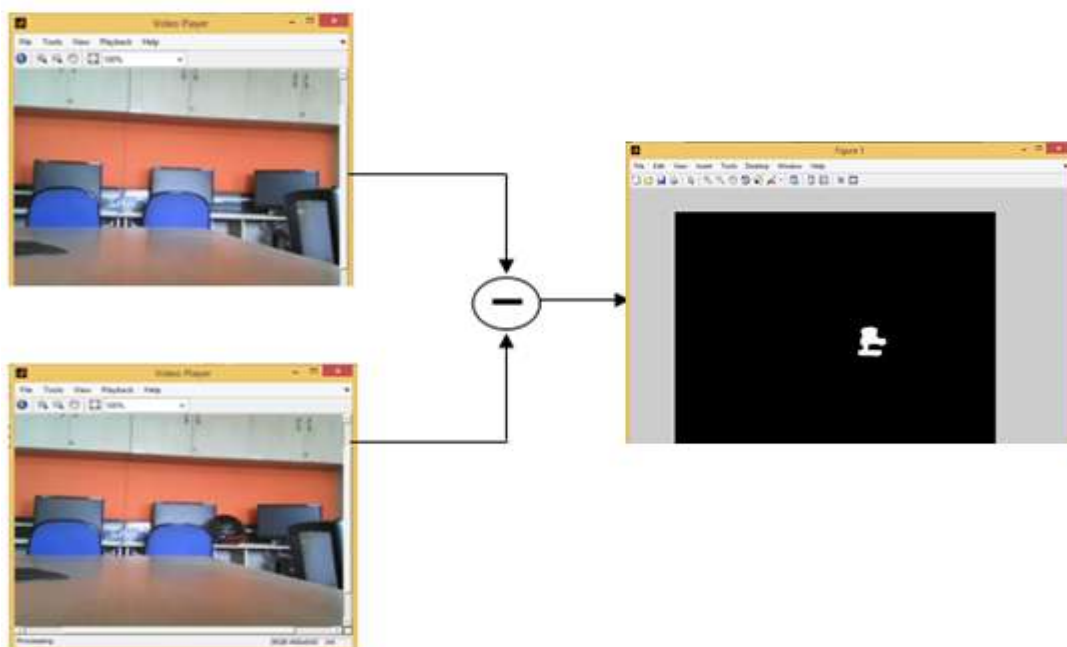


Figure 4: How Background Subtraction is working in our system

4.4. Morphological image processing

Binary images may contain numerous imperfections. In particular, the binary regions produced by simple thresholding are distorted by noise and texture. Morphological image processing pursues the goals of removing these imperfections by accounting for the form and structure of the image. These techniques can be extended to greyscale images. A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value only if the test is successful at that location in the input image.

Morphological image processing operation can be performed

4.4.1. Erosion- Erosion of a binary image f by structuring element s produce new binary image. Erosion removes small scale details from a binary image.

$$g = f \ominus s \quad (4)$$

With ones in all locations (x, y) of a structuring element's origin at which that structuring element s fits the input image f .

$$g(x,y) = \begin{cases} 1 & \text{if } s \text{ fits } f \\ 0 & \text{otherwise} \end{cases} \quad (5)$$

4.4.2. Dilation- Dilation of an image f by a structuring element s produce a new binary image. Dilation adds a layer of both inner and outer boundaries of region.

$$g = f \oplus s \quad (6)$$

With ones in all locations (x,y) of a structuring element's origin at which that structuring element hits the input image f .

$$g(x,y) = \begin{cases} 1 & \text{if } s \text{ hits } f \\ 0 & \text{otherwise} \end{cases} \quad (7)$$

4.4.3. Closing- The closing of an image f by a structuring element s (denoted by $f \bullet s$) is a dilation followed by an erosion.

$$f \bullet s = (f \oplus s_{rot}) \ominus s_{rot} \quad (8)$$

Where s_{rot} - Structuring element rotated by 180

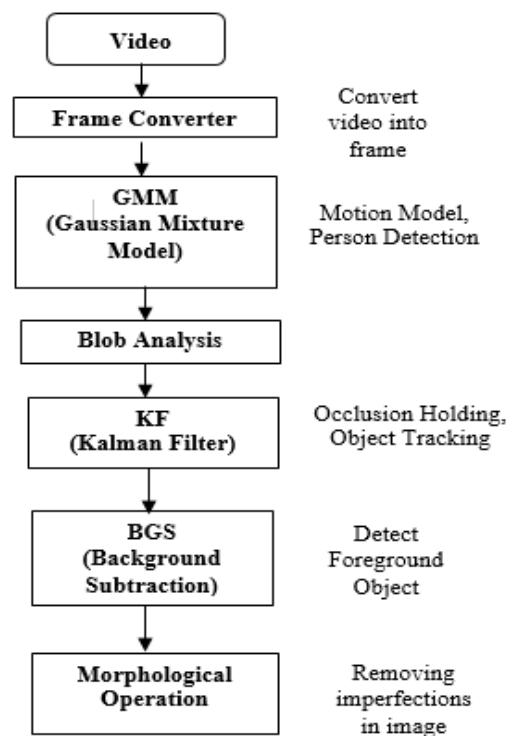


Figure 5. System Overview

V. RESULT

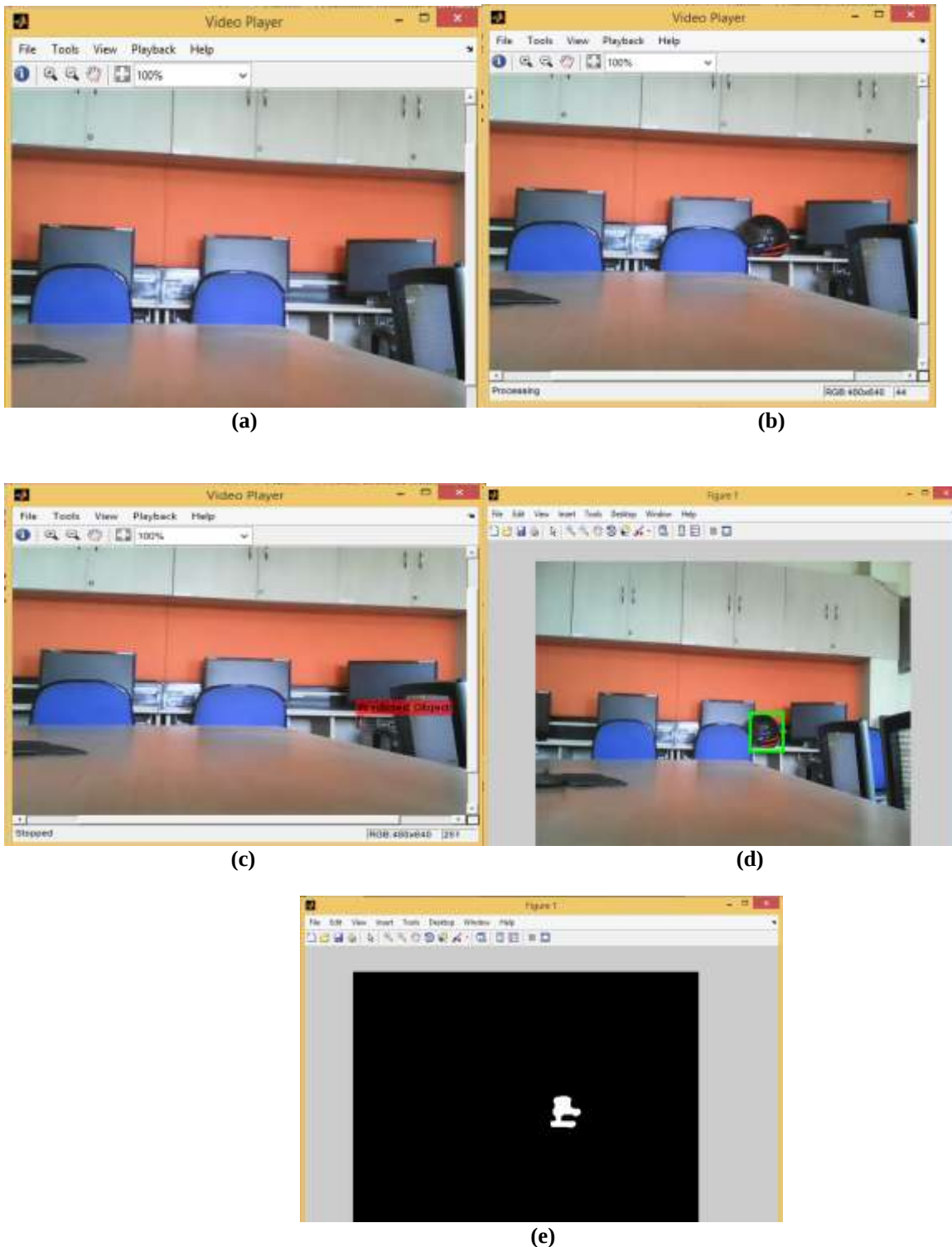


Figure 6. a) ReadingVideob) Video Framec) predict objectd) object detection and shown using green color bounding boxe) Foreground Object Detected

VI. CONCLUSION

This is successfully carried out using GMM (Gaussian mixture model), KF (Kalman Filter) and Background subtraction. Giving video input to the system then framing is carried out to convert video into image then GMM use for person detection in that frame. Blob analysis is used to draw bounding box around the detected object. Kalman Filter is used for Object tracking to easily track the object in that frame that's why the security of surveillance video is increased. By using Background Subtraction to detect foreground object in an image taken from stationary

camera. Morphological image processing is used to filter out noise and remove imperfections. The experimental results show that the proposed method runs quickly, accurately and fits for the real-time detection.

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