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Intelligence Video Surveillance Added and Removed Object Detection

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Abstract- In this paper, we propose background subtraction and Kalman filter for object detection and tracking. We use Gaussian mixture for background model and Kalman filter for predict the path of the object. Here Gaussian model take more time for computation and give more noise. In this paper we use morphological operation for removing the noise from the foreground image. In this paper, we also count the number of object detect by the program.

Keyword- Video Surveillance, Background Subtraction, Kalman Filter, Gaussian Mixture Model, Object Detection, Object Tracking

I. Introduction

Video surveillance is important security tools nowadays. It can track the objects/persons but also identify their behavior. For security reason the video surveillance systems are used in the traffic monitoring, banks, ATM, automotive safety, many computer vision applications, including activity recognition, shops and public places by using detection of object and motion based object tracking. Due to real time monitoring, the users check the activities and take the action to avoid unwanted incident. The Intelligence Video Surveillance (IVS) systems improve the security and monitoring efficiency by tracking, classification and analyzing the behavior of individual or group of the objects over long distance and user interference at the end of the systems. It is used to monitor real time events, to distingue between persons and objects like bag, vehicle etc. The tracking of moving object is divided into two parts:

1. Detection of objects in each frame
2. Track the detected object over time

In IVS, video analysis, which is done by analysis frame by frame, is the first step to detect the objects in video. For detection of the object, there are many methods like frame differencing, optical flow and background subtraction. In this paper, we use background subtraction and Kalman filter to track the object.

II. Background Subtraction

It is a process to extract background and foreground object from the frame. The foreground object can be persons or any other objects. First step for background subtraction is background modeling. Background Modeling must sensitive enough to recognize moving objects. Detection of the object can be done by subtracting reference frame from the current frame. If the difference between the pixels is above threshold level then it is classified as the moving object or foreground object. The background subtraction method is also called foreground detection.

The detected foreground object's image can be degraded due to blurring, motion and noise. If the object in the frame is outside the camera then information of object's path is lost. It is called blurring. The background model can expressed as follow:

$$B_{t+1} = B_t + [a - M_t + b * M_t]D_t \quad \ldots\ldots\ldots (1)$$

Where, B_t represent the background model, M_t represent moving object mask, D_t represent difference between current frame and reference background model, a and b represent rate of changing background.

Background subtraction algorithm is simple algorithm, but very sensitive to the changes in the external environment and has poor anti- interference ability. However, it can provide the most complete object information in the case background is known. Background subtraction adapted approach is shown in figure-1. In this paper, we adopt Mixture of Gaussian method. In Gaussian Method, The background model is parametric. Each pixel location is represented by a number (or mixture) of Gaussian functions that sum together to form a probability/distribution functions. Even though the mixture of Gaussian method is complex and tedious, it provides better results by our modified parameters.

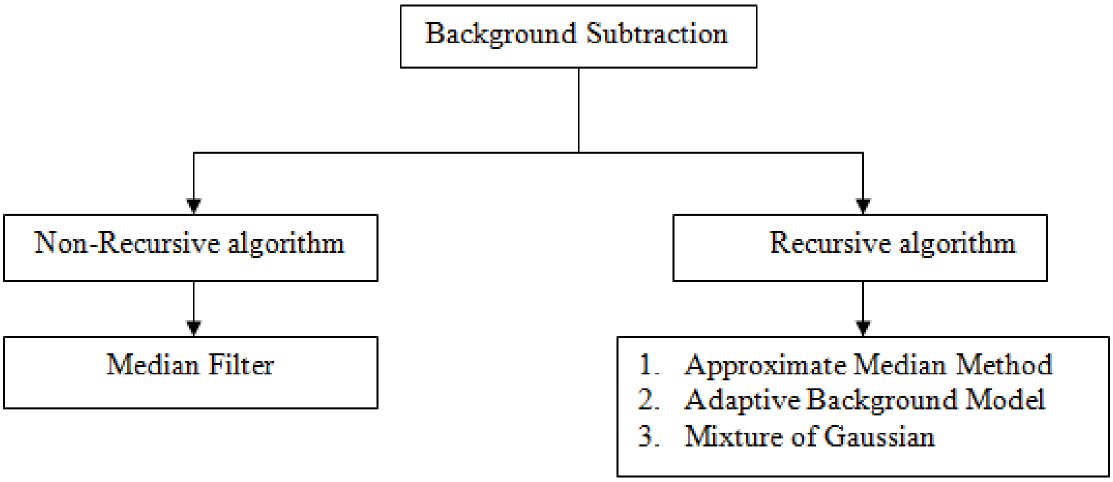

Figure 1 Background Subtraction Approach

III. Kalman Filter

Kalman filter is firstly published by R. E. Kalman in his paper of a recursive solution for the discrete data linear filtering problem in 1960. The Kalman filter provides estimate of the state of process with minimum mean squared error. It is a set of mathematical equations. It can be used to estimate of past, present and future state of process. In this paper, we use Kalman filter to track the objects and to predict the path of them.

The Kalman filter uses feedback control to estimate the process. The equation of the Kalman filter is divided into two parts:

1. Time Update Equation
2. Measurement Equation

Time Update Equations use current state and error covariance estimate in current for predict the next state of the system. Measurement Equation is used for feedback by updating error covariance. The Kalman filter deals with to give optimal solution and to track single and multiple objects. The estimation can be done by as follow.

The linear stochastic difference equation for X∈ R^n:

$$X_k = AX_{k-1} + BU_{k-1} + W_{k-1} \text{..................................} (2)$$

Measurement Z∈ R^n,

$$Z_k = HX_k + V_k \text{..} (3)$$

Where, U is the input, W_k and V_k are random process variables represent process and measurement noise respectively and H is the Kalman gain. Kalman filter works shown in figure-2.

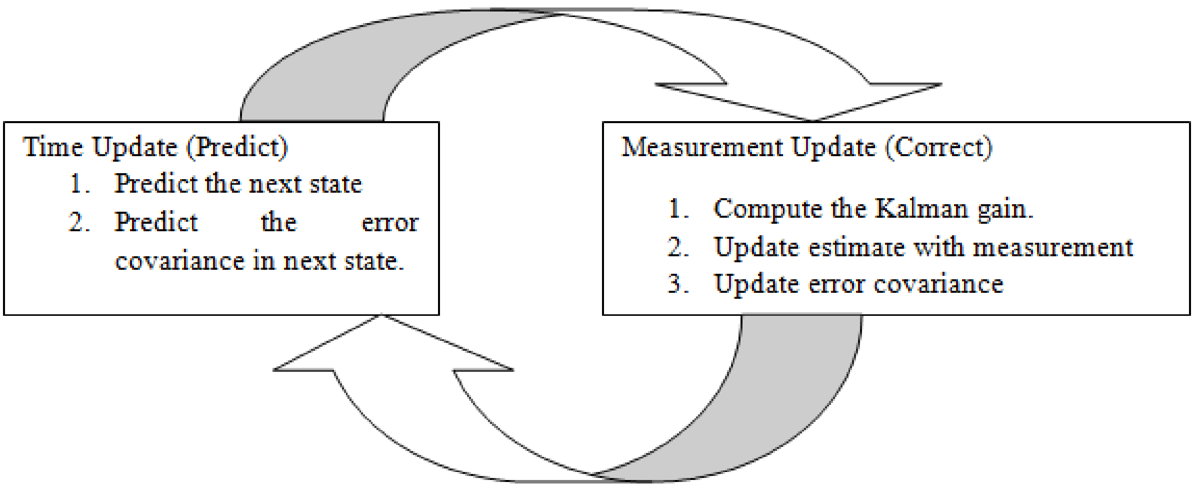

Figure 2 Working of Kalman Filter

IV. Proposed Method

Here, we firstly do background subtraction. For doing that, following things are kept in mind:

1. Background subtraction method should detect the object when it first appears.
2. For background image, we define threshold pixel level. If the pixel level satisfy this level then it consider as background image.
3. Background model have to adapt adequate change in background image.

The steps followed are listed below. Figure 3 show the flowchart of proposed method for object detection and tracking.

- Use the Gaussian Mixture Model for the background subtraction.
- After getting the foreground image, use morphological operation for removing noise from the foreground image, which is done by connecting the blobs.
- Use equation (2) and (3) to predict the path of the object.

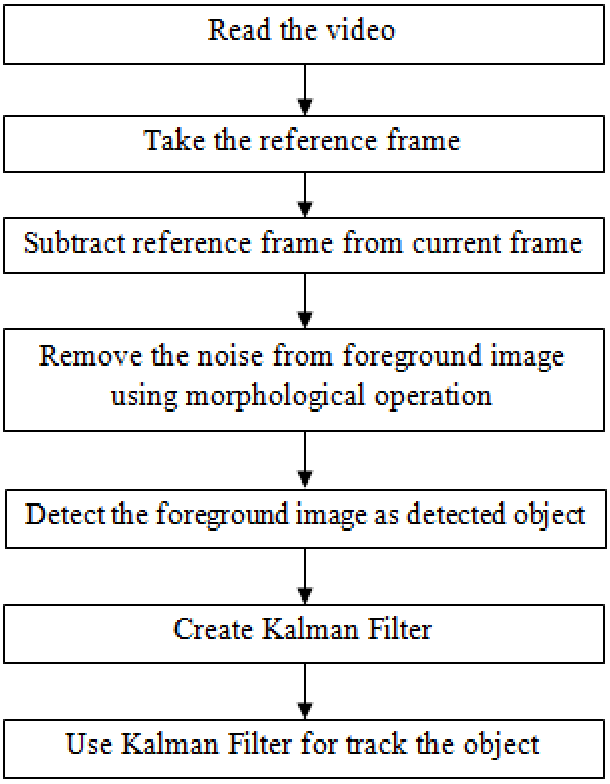

Figure 3 Flowchart of Proposed Method for Object Detection and Tracking

V. Result

The proposed method is implemented in MATLAB. The figure 4 shows the reference frame. The figure 5 shows the frame of original video. Figure 6 shows the foreground image for the frame of the figure 5 and figure 7 shows the detected object. In figure 6 and figure 7, we draw rectangular box around the detected object.

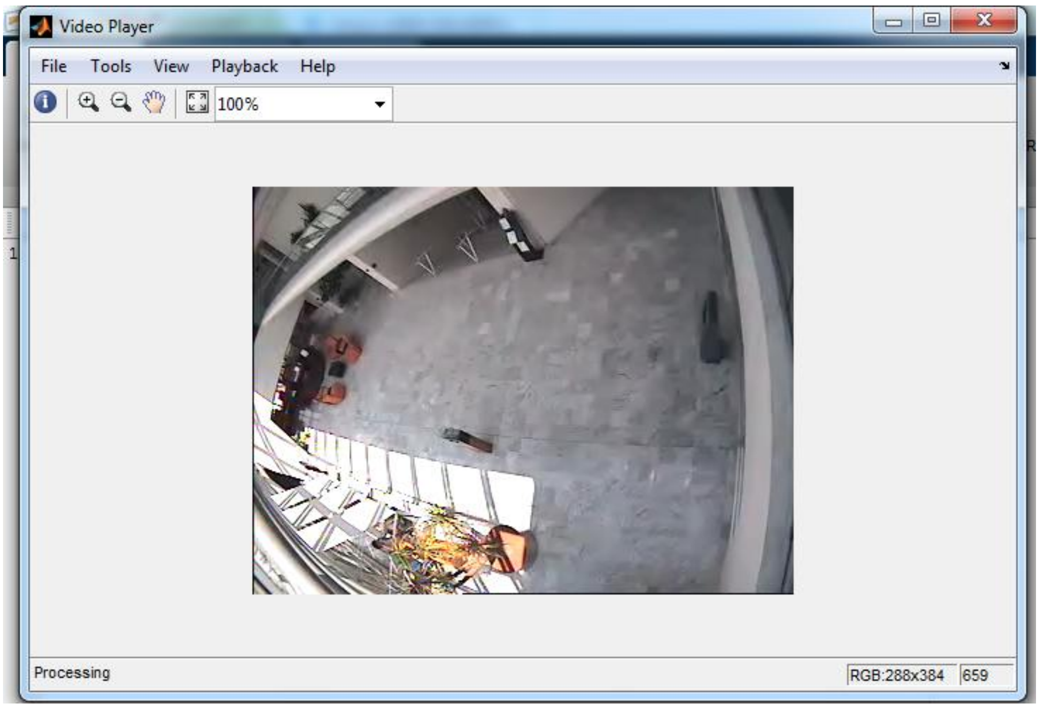

Figure 4 Reference Frame

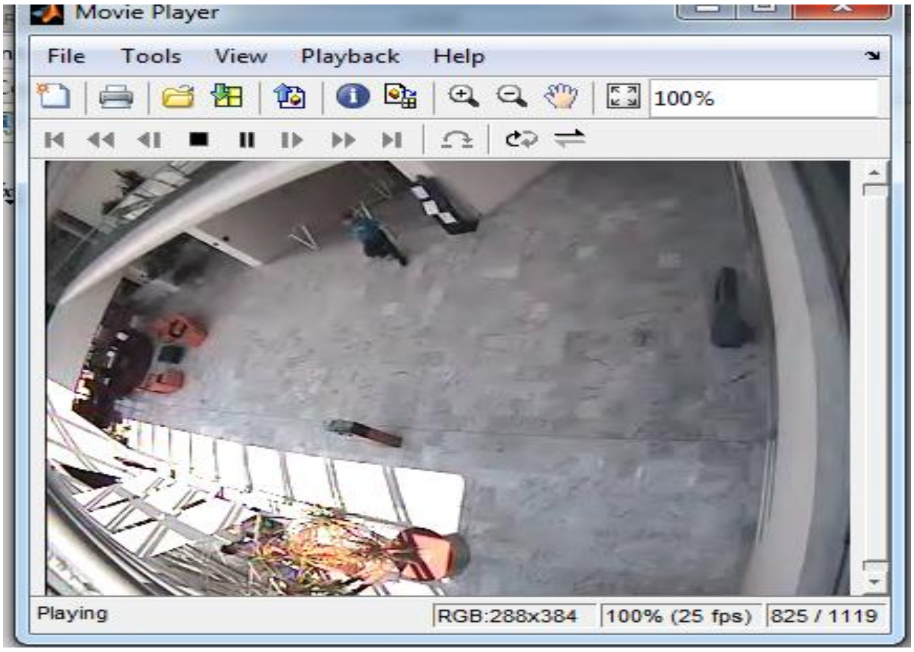

Figure 5 Original Video

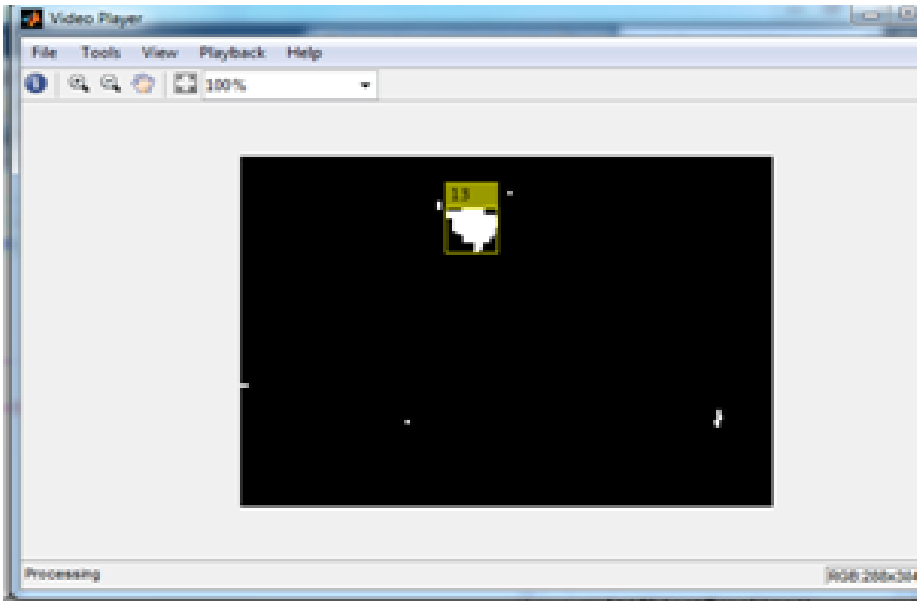

Figure 6 Foreground Image

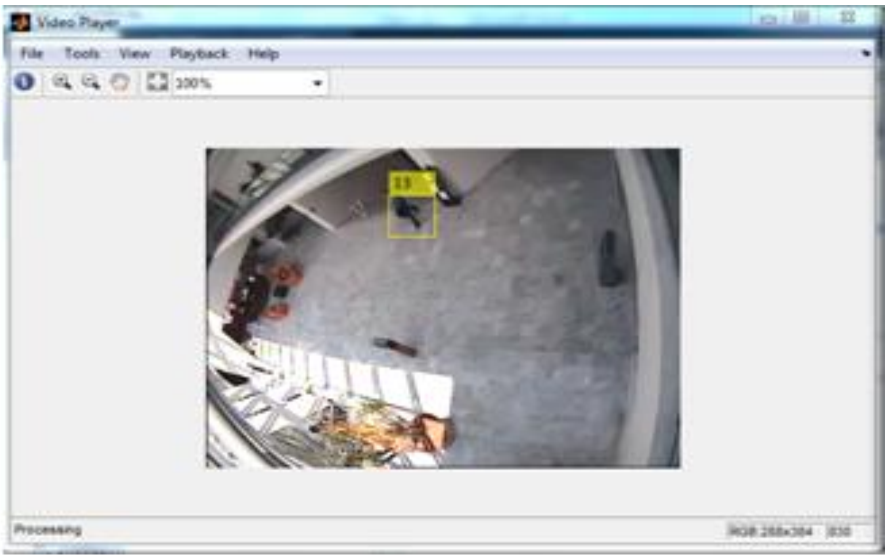

Figure 7 Detected Object and Track by Kalman Filter

VI. Conclusion

In this, we assume that all objects are moved in straight line and with constant speed. The Gaussian Mixture model is easy to implement and give complete operation but it takes long time for computation and it also gives more noise. So, we have to use morphological filtering for removing noise.

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