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A Novel Method of Detecting and Tracking of Moving Objects for Video Surveillance System

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ABSTRACT: Computer vision system like video surveillance system provides security, surveillance and best solutions to avoid security related problems. Such type of computer based vision system mainly includes basic steps like object detection and Tracking. The normal surveillance like CCTV includes a person to monitor the system and it records the situation continuously. Our paper focuses mainly on detecting of an object only when there is a motion. By this the wastage of memory can be limited and thus avoids human intervention in identifying the security threats. Morphological Filtering is used to remove the noise and to enhance the image. Background Subtraction method like Gaussian Mixture Model (GMM) is applied to detect the foreground objects and tracking is done by Kalman filters.

KEYWORDS: Background subtraction, Gaussian Mixture Model (GMM), Morphological Filtering, Kalman Filter.

I. INTRODUCTION

Video Surveillance [1] system is a process of analyzing the video sequences in order to check the behavior, activities or other information from the video sequence[2]. Computer vision was viewed as the perception component of determining the agenda to mimic human intelligence and to endow robots with intelligent behavior. Monitoring the electronic equipment like CCTV cameras, are put in several places like airports, parking heaps, train stations and banks. Formerly, the video imaging has been importantly used as a forensic tool during an event. The video surveillance system requires continuous manual monitoring which is infeasible because of factors like human fatigue and cost of manual labor and also continuous recording in video surveillance may lead to use of large storage space. Moreover, one person will solely observe more or less four cameras at a time with sensible accuracy. Consequently, this needs standard human resources for time period video monitoring using recent technology. In order to overcome these problems we proposed a system which adapt background subtraction and object tracking in real-time video surveillance system.

A video surveillance system is primarily designed to track key objects or people exhibiting suspicious behavior as they move from one position to another and record it for possible future use. In computer vision application detecting the moving object is an important step. Human can easily detect and distinguish object easily, but it is hard for computer to detect and recognize object like humans, that is why developing an object detection system which is not complicated and adaptable is important. The activities of targets such as (humans, vehicles, etc) are monitored using a video camera in a scene for visual surveillance.

II. RELATED WORK

The important step in computer vision application is detection of moving objects. In this paper we use morphological filtering to remove the noise and unwanted pixels and to enhance the image, Gaussian mixture model is the method used for background subtraction.

1.1. MORPHOLOGICAL FILTERING

Morphological filtering process is a collection of non linear operations related to the shape or morphology of features in an image. There are two fundamental operations of morphological filtering they are Erosion and dilation [3]. Morphological filtering is used for reducing the noise and enhancing the detected images. A morphological operation

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gives the better edges to the moving objects and produces the better output. Morphological techniques examines an image with a small shape or a template called the structuring element.

The structuring element is a small binary image, that is a small matrix of pixels, each with a value of zero or one. The matrix dimensions represents the size of the structuring element. The pattern of ones and zeros represents the shape of the structuring element- diamond, square and cross shape.

The structuring element is usually chosen as odd dimension matrix and the origin defined as the centre of the matrix. When a structuring element is placed in a binary image, each of its pixels is associated with the corresponding pixel of the input image under the structuring element. If the origin of the structuring element and the corresponding pixel of the input image is 1, then it is said to fit the image. Similarly, any of the pixel of the structuring element and the corresponding pixel of the input image is 1, then it is said to hit the image.

Erosion of a binary image f by a structuring element s (denoted $f \theta s$).The structuring element is imposed on top of the input image so that the origin of the structuring element coincides with the input pixel coordinates. If the structuring element matches with the input, the origin of the structuring element is considered in the output. This procedure is repeated for every pixel in the input image.

Dilation of an image f by a structuring element s (denoted $f \oplus s$) . The structuring element is imposed on top of the input image, so that the origin of the structuring element coincides with the input pixel coordinates. If atleast one element of the structuring element matches the input pixels, then the origin of the structuring element is considered in the output. This procedure is repeated for every pixel in the input image.

1.2. BACKGROUND SUBTRACTION

MIXTURE OF GUASSIANS

At times the change in background object is not permanent and takes place at a faster rate than that of the background update. Few examples like raining, snowing and watching sea waves. In such condition single valued background is not a suitable model.

Stauffer and Grimson came up with adaptive background mixture model that can cope with multiple background objects. The adaptive background mixture model proposed can be more clearly defined as it gives the description of background and foreground values.

Stauffer and Grimson [4] in background adaptive mixture model provide the probability of observing certain pixel value, x, at time t by means of mixture of Gaussians:

$$P(x_t) = \sum_{i=1}^{k} \omega_{i,t}\, \eta\, (x_t - \mu_{i,t}, \Sigma_{i,t}) \qquad (1),$$

Where k is the Gaussian distributions considered to report only one of the observable Background or foreground objects. Gaussians involve two or more variable quantities such Red, green and blue values. In additional cases k set is to be between 3 and 5. If these variables are considered to be independent then the co-Variance matrix (Σ_i), simplifies to diagonal.

For the (1) to become a model of background alone a basis is needed to provide distinction between foreground and background distributions. All the distribution that are ranked based on the ratio between peak amplitude and standard deviation. The presumption is the higher and more Close-packed the distribution is the more likely to belong to the background. The first Starting B distributions in ranking is satisfying.

$$\sum_{i=1}^{B} \omega i > T \qquad (2),$$

Where T is a assignment threshold accepted as background. For each frame time t, there are two problems that must be simultaneously solved a) assigning the new observed value, x_t, to the best matching distribution and b) estimating the updated model parameters. These two algorithms can be solved by an algorithm called expectation maximization (EM) working on the buffer of last n frames. Since this algorithm is extremely costly, the matching is approximated in these terms:

$$(x_t - \mu_{i,t})/\sigma_{i,t} > 2.5 \qquad (3)$$

The first in ranking order is accepted as a match for x_t. Furthermore other parameters are updated only for this matching distribution and by using simple on-line cumulative averages. If no match is found, then the last ranked distribution is replaced by a new one centered in x_t with low weight and high variance [5].

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1.3. TRACKING

KALMAN FILTER

Object tracking is accomplished by estimating the object's position from the previous data and creating the existence of object at the estimated position, this is done by using Kalman filter. Tracking of an object is often done by providing the frame number from where the tracking has to be started [6]. From the chosen frame any object are often selected for tracking by setting the position of the mask and then the object can be tracked in successive frames. The equations for Kalman filters are under two categories they are the time update equations and measurement update equations. The time update equations are responsible to forecast forward the current state and error covariance estimates to get a priori estimate for following time step. The measurement update equations are accountable for feedback. This is used for including a new measurement into the a priori estimate to get an upgraded a posteriori estimate. The time equations are thought as predictor equations and measuring update equations are thought as corrector equations [7].

In the time update comes the present state estimate ahead in time.

State Prediction: $X_{predk} = A^* X_{k-1} + B^* U_k$ (1)

Where X_{predk} is the vector means predicted process state at time k.

X_{k-1} is vector means process state

U_k is a control vector.

Error Covariance Prediction: $P_{predk} = A^* P_{k-1} {}^*A^T +Q$ (2)

P_{predk} is the error covariance at time k.

P_{k-1} is a matrix means error covariance in the state prediction at time k-1

Kalman Gain: $K_k = P_{predk} * H^T *(H * P_{predk} * H^T + R)^{-1}$ (3)

H is matrix converting state space into measurement space.

R is measurement noise covariance.

State Update: $X_k = X_{predk} + K_k * (Z_k - H * X_{predk})$ (4)

Error Covariance Update: $P_k = (I - K_k * H) * P_{predk}$ (5)

Following steps are enforced for tracking one object.

- Background frame has been calculated by taking average of all the pixels.
- Frame range has been chosen from tracking of any object that has to be started.
- From chosen frame object to be tracked has been chosen by locating the mask.
- For chosen object its center of mass position has been identified and from center of mass all the equations of time and measurement update are calculated. For chosen frame the particular position X and error P has been calculated.
- For all the remaining frames following steps are reiterated.
  1. Background subtraction has been done to search out all the moving regions within the frame.
  2. From the found regions, region with the low distance from the region chosen in previous frame has been chosen.
  3. Chosen region's center of mass and other parameters are used to calculate time and measurement update equations.
  4. Obtained state position values X has been kept in array for each frame.
  5. Line joining each stored point has been drawn in each frame that shows the trajectory of the chosen moving object.

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III. RESULT

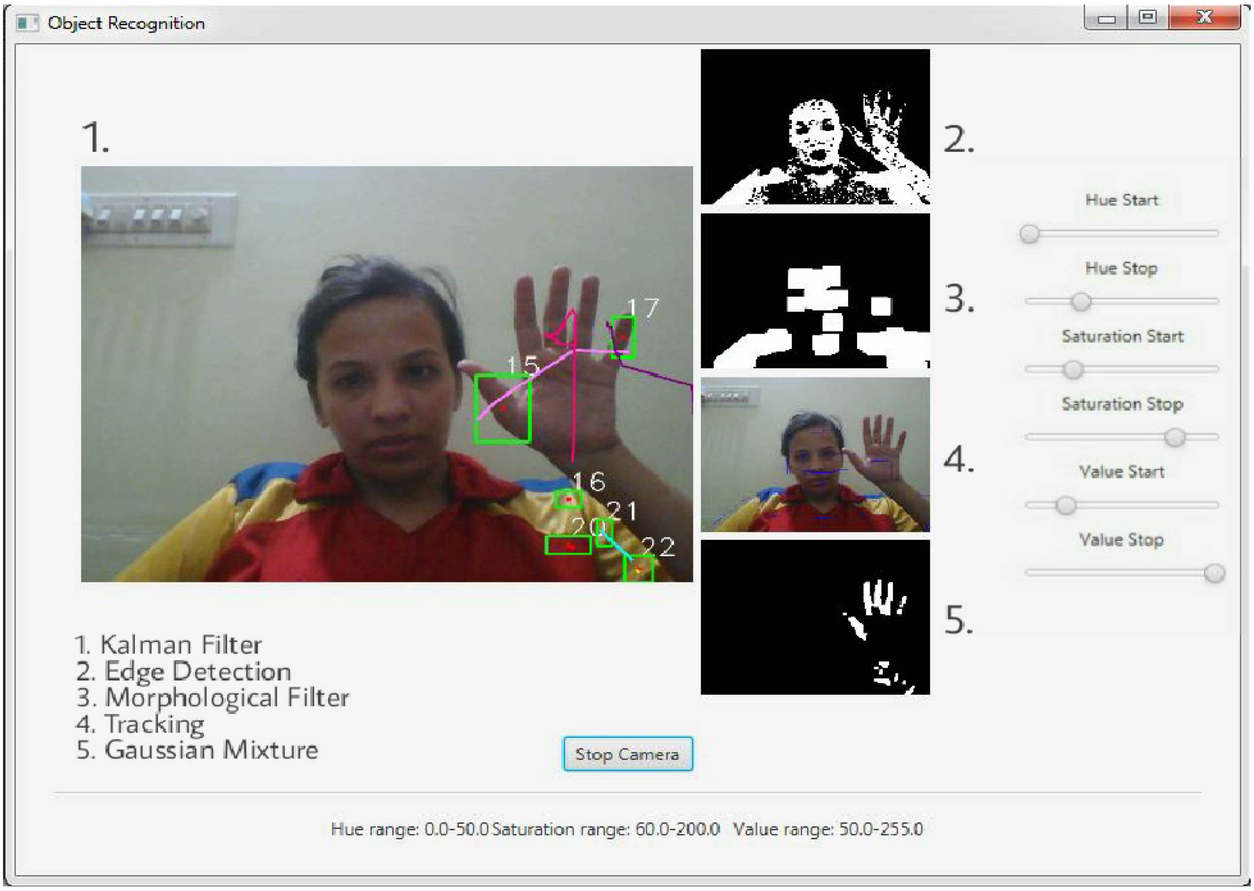

Fig : Result of the proposed system

IV. CONCLUSION

This work focuses on image processing technology for intelligent video surveillance system to detect the multiple moving objects. The main objective of this paper is to reduce storage space by detecting and capturing only the moving objects. To remove the noise and enhancing the image morphological filtering is used. Background subtraction is the method of subtracting the foreground image from the background image. Gaussian mixture is one the technique used for background subtraction. Kalman filter is the technique used for tracking of moving objects.

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