Object Detection and Tracking Using Particle Filtering
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Abstract—In many tracking application systems, object tracking is most challenging problem of computer vision field. In our proposed work we used the frame differencing and particle filter mechanism is used to track the object in a color video. We use the background subtraction based frame differencing mechanism to detect the object. Particle filter is use for effective object tracking in image sequences. Particle filter uses a color particles that is displayed on the object. To track the object using particle filter we concentrated on the color particles in the detected foreground object. Experimentation carried out a standard database i.e. viper, pets, caviar and human activity databases (such as Kth, Weizmann).

Keywords—background substraction, object tracking, particle filter, object detection.

I. INTRODUCTION
Object tracking is track the object in video scene. Object tracking is mainly used in different detection and tracking many mechanisms such as traffic surveillance, human aided interaction system. Object tracking is difficult in a visual scene such as abrupt change in motion, illumination change, and occlusion of object. Many video analysis system are divided into three steps, detecting moving object, track the object in each frame and analysis of object track to recognize their behavior.

The particle filtering technique with multiple cues such as color, texture and edges as observation features is a powerful technique for tracking deformable objects in image sequences with complex backgrounds. The proposed particle filter (PF) embeds a data association technique based on the joint probabilistic data association (JPDA) which handles the uncertainty of the measurement origin [9]. Pan Pan[11]proposed approach to particle filtering on general graphs in video tracking applications: (i) object tracking using high-order Markov chains; and (ii) distributed multiple object tracking based on multi-object graphical interaction models.

II. RELATED WORK
There are many approaches about object tracking has been previous decades.
Yilmaz et al. [1] provided a detailed theory on object detection and object tracking in this area. Object tracking is divided into three main categories such as point tracking, kernel tracking and silhouette tracking.
Md. Zahidul Islam [2] presented a Particle filter based algorithm which deals single object tracking. Pierre-Marc Jodoin[3] provided Subtraction algorithm for effective and efficient temporal anomaly detection and localization, its works equally well on human, car, animals and other objects in both uncluttered and highly cluttered scene. Weiming Hu et.al.[4] Performance of Adaptive counter based algorithm handling of abrupt change motion; particle swarm optimization is adopted to capture the global motion. Du-Ming Tsai et al.[5] In this paper, proposed that a fast background subtraction scheme using independent component analysis (ICA) for indoor surveillance. S. Saravanakumar et. al. [6]Background subtraction and show removal algorithm works effectively in the event of occlusion in the video sequences. Massimo Piccardi [8] Background d subtraction technique review based paper provides a review of main methods and an original categorization based on speed memory requirement and accuracy. Deepak Gambhir et. al. [12] In this paper automatic segmentation and color feature based video object tracking algorithm accurately segment the moving object reducing the effect of the shadowing and/or noisy pixel and successfully track moving object. Jaward, Mihaylova et.al.[9]Proposed particle filter (PF) embeds a data association technique based on the joint probabilistic data association (JPDA) which handles the uncertainty of the measurement origin. Deepak Gambhir et. al. [12],Proposed, an efficient tracking algorithm which automatically segments the moving object and uses color as the key feature to track. Jialue Fan et.al.[14] Proposed a unified approach to object tracking and recognition.

Chong Chen et. al. [15]proposed approach to the solution of Sylvester’s equation is equivalent to the classical SVD method for 3D-3D pose estimation. They introduced a method to estimate tracking and pose parameters within the framework of particle filtering. Our approach can be used to directly estimate the 3-D rotation parameters from 2-D image sequences without constructing a 3-D model or system training and learning prior to estimation. Nan Liang et. al. [16] In this paper, proposed aiming at improve the performance of the particle filter. A method based on ensemble kalman filter is introduced to construct proposal distribution for particle filter. In object tracking process , a fusion model combined color model with shape model with shape model is used to describe the target. Synh Viet Uyen Ha et al. [17] presented, the problem of tracking a moving object is considered using the probabilistic method and to combine the Kalman filter and particle filter for color-based tracking. Anup S. Sabbi et al.[18].This paper presents and compares two methods for tracking objects in a stereo camera system using particle filters which differ in the way they address the problem of stereo correspondence during the filtering process. In the first approach, two particle sets, one for each of the left and right
stereo image frames are maintained and a mapping between the two sets is established by soft-stereo constraints. In the second method, the particles are tracked in three-dimensional space and mapped back into the image frames to make the observations. Hongwei Ying [19], Object tracking based on color feature often fails in a complex background. To tackle this problem, a particle filtering object tracking approach based on local binary pattern and color feature is proposed in this paper. Local binary pattern texture textured gray image information in the neighboring region, the color histogram, a global description of targets in color image. These two features, such as particle filtering are combined under the frame, which is represented by the color and local binary pattern histogram is the target can be complementary to each other.

III. PROPOSED APPROACH

In proposed approach number of particles are track the object in a continue moving frames. The proposed method is sub divided into two ways

1. Frame differencing mechanism is used to detect the object in a video from number of frames.

2. Particle filter applied to track the object in each frame to recognize their behaviour. And particles are displayed on the object.

The actual flow of proposed work object tracking using background subtraction is show in Figure 1. Video is an electronic medium for the recording, copying and broadcasting of moving visual image. The block diagram of particle filter based object tracking is the following four steps

a. Input video: Take an input video as color video have a combination of consecutive of different frames. Input video is nothing but a number of frames i.e. images.

b. Pre-processing: In this steps input video is converted into gray scale video for removing noise in the video. It is simple image processing task as a raw input video.

c. Object Detection: it is important steps in which object detected using background subtraction techniques. Foreground is detected using frame differencing method.

d. Object Tracking: Tracking of detecting moving object from frame to frame. Particles are displayed to each and every frame to track the object and their behaviour.

A. Background Subtraction Using Frame Differencing Method

Background subtraction is used to detect a foreground object. It is difference between incoming frame and its background model. Particles are spread in whole frame whenever tracking object they deflected therefore restricts the area using background subtraction.

In background subtraction frame differencing method is used. Frame differencing is difference of two frames i.e. current and previous frame. If the difference is greater than threshold foreground is detected otherwise background.

Algorithm:

1. For each frame 1……..N
2. IF(|Current Frame - Previous Frame| > Th)
3. Foreground is detected.
4. ELSE
5. Background is detected.
6. END

B. Tracking Object Using Particle Filter

Particle Filtering is a technique for implementing a recursive Bayesian filter by Monte Carlo simulations. The idea is to represent the probability density function with a set of random samples with associated weights and to compute estimates based on these samples and weights[18].

Particle filter is needed to define the particle and its properties

\[ X_k = \{x, y, \hat{x}, \hat{y}\}, \]

- Create particle step consist of N particles creation which have random locations \((x, y)\) and random velocities \((\hat{x}, \hat{y})\).

The step of prediction contains the modification of randomly generated particles using system model, which is in case of object tracking in video sequence equals

\[ s_t = A s_{t-1} + w_{t-1}; \]

Where, A defines deterministic and \(w_{t-1}\) stochastic part. This step occurs the change of particle position and its velocity based on mentioned system model.

- The next step is to look at the color of your posts and target specific particles on the basis of equality, value is the actualization. The degree of similarity to the target using the actual color and color difference is calculated as

\[ D = C - C_{\text{target}}; \]

Where \(k = 1… N\) determines particle index, \(C\) is actual color (one dimensional vector) on position \(x_k; y_k\) and \(C_{\text{target}}\) is color of target. Scalar value of likelihood is obtained by

\[ L_k = D^* \times D; \]

Where \(D^*\) is transposed matrix D. In this step is important to assign to particles, which position is out

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**Fig.1.** Block diagram of particle filter Based object tracking using background subtraction
of video sequence frame boundaries, the lowest possible value, for example -Inf.

- In step of resampling, thanks to cumulative distribution of weights and generation of N random numbers, particles are resampled/rearranged, where particles with low weights are relocated to particle positions with higher weights.

The simple algorithm of particle filtering is shown in below.

Algorithm:

1. Prediction: Predict the present state of each particle using previous information. Present state is represented in below equation
   \[ X_t^n = f(X_{t-1}^n) + A_n \]
   Where \( A_n \) shows the random noise, \( X_{t-1}^n \) is the predicated state of particle.

2. Filtering: Reselection of particle accordingly to their likelihood method which is represented as
   \[ L = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{(c - \mu)^2}{2\sigma^2}} \]
   Where \( L \) is the likelihood and \( c \) is the color value of the pixel.

C. Combine of Frame Differencing and Particle Filtering.

Frame differencing is detecting object in each frame and particle is show on detected object. Using these two method object detect and track effectively.

Initially input video is converted into grayscale video. Video nothing but number of frames. From each frame we detect the object from each frame. If the foreground i.e. object is detected.

Particles are created at randomly on each frame and update the particles on the foreground object. Similarity of particle is calculated using likelihood function. Resample the particles resemble function and particles display and track the object. Repeating the same procedure particles is remove fist position its positions changes as per object movement. The procedure f proposed method is given below.

Algorithm:

1. Input video is converted into grayscale video
2. For each frame 1……..N
3. IF(|Current Frame - Previous Frame| > Th)
4. Foreground is detected.
5. END IF
6. ELSE
7. Background is detected.
8. END ELSE
9. Create particles at randomly
10. For each particle
11. Update particles on the foreground object.
12. Calculate likelihood of the particles
14. Displayed particles on tracking object.
15. END For
16. END For.

IV. RESULTS

Experimental results are taken on background subtraction and particle filter show on the object. Results are display in figure 2. 1st row of fig. 2 original video are show in results. 2nd row video frames are converted into grayscale. Background subtraction method is detecting the object each and every frame shows in 3rd row. These detect the object restrict the area of video frames; it is very useful for tracking object using particles. These particles are not disturb they move each and every frame shows in 4th row.

Fig.2 Results obtained using subtracted background using particle filtering method
V. CONCLUSIONS

Experimentation carried out on the standard database of image sequence caviar and human activity databases (such as Kth, Weizmann) for effective object tracking as shown in figure 2. From the experimentation we observed that the frame differencing mechanism is easy to implement and detecting the object quickly and by using a particle filter we track the object effectively. In future, object tracking can be done using block matching motion estimation algorithm to find motion vector in an image sequence.

REFERENCES

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