

# A hybrid KPM Approach for Object Tracking using particle filter

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**Abstract:** Visual object tracking is the active area of research in the computer vision. Various techniques have been developed for the object tracking. Particle filter deals with the tracking of the objects having non linear motion. Particle filter has been used in for various fields and application efficiently. Proposed Technique is based on combination of kalman filter, mean shift and particle filter. mean shift is basically for linear motion of the object and usually point based, kalman filter is also for linear object tracking but particle filter deals with the non linear motion of object.

**Keywords:** Particle filter, importance density, tracking, sequential importance sampling.

## I. INTRODUCTION

Particle filter deals with the non linear, non Gaussian and dynamic motion of the object. The basic idea behind the working of the particle filter is posterior probability density of the variables by using weighted random particles. Particle filter is based on the monte carlo method .and it is mainly applied to approximate estimate Bayes probability .particle filter deals with only updated weights of particles instead of updating the state variables directly. It was originally given by the ' Gordon'. as an improvement to the extended kalman filter for solving the non linear and non Gaussian problems. Particle filter is based on the importance sampling and finding the set of random sample spreading in state of approximate the PDE and using the sample mean to replace integration to obtain minimum variance estimation[10][8]. Particle filter is the technique that allows the fusion of different sensor data, deals with various uncertainties, and deals with data association for tracking the multiple objects .Particle filter deals with the generation of model for one variable before moving to the next variable particle filter works efficiently when the particles are generated efficiently. Particle filter allows the resampling of the particles .It uses the contours ,color feature or texture mapping . Particle filter mainly consists of two phases prediction and update. During prediction phase each particle is modified according to the region of interest in the frame (ROI).In update stage each particle weight is reevaluated based on new data obtained after the prediction state .[8] Particle filter is also known as condensation algorithm as it is being used for computer vision and tracking the object, as it keep the track of state of particle as it is based on the probability density over the time. It deals with finding the pixels that forms the contours .It was introduced by Isard and Blake [15].

Various fields in which particle filter is being used are: for forecasting models in case of object tracking and robot localization, in wave modelling, in weather forecasting, for forecasting the model of natural systems and in case of Image and video processing.

Various applications of particle filter are

- Tracking of aircraft position from the radar
- Estimate communication signal from noisy environment
- Predicting the economic data.
- Track the people and cars on roads for surveillance.
- Track the car from radio frequency measurement technique.
- Tracking of aircraft from estimated location.
- For avoiding Collision.
- For replacing the global positioning system.
- For recovery of signal from the noisy measurement

Problems faced by particle filter :

- Particle degeneration.
- Need of high number of the particles.
- Computation of particle filter is expensive.
- Suffers from non Gaussian noise and posterior
- Multimodal distribution[8]

## II. VARIOUS TYPES OF PARTICLE FILTER

Sequential importance resampling(SIR):sequential importance resampling is the technique for tracking the state of the system in high /low dimensions. It is for non linear motion tracking and posterior value calculation. It is montecarlo method that performs the inference in the state space models. Resampling eliminate the particle that have small weight and its replication with the larger weight particles. Quality of SIR filter depends on quality of importance distribution [7]

Sequential importance sampling(SIS) :SIS is the technique that is based on the sequential importance sampling. Importance sampling is basically used when target distribution is difficult to sample but it is easier to distribute from the proposal distribution .It is basically constructed by recursive propagation of weights and support points at each measurement.SIS approach is also

called by various names bootstrap filter, condensation algorithm, interacting particle approximation, survival of the fittest.[7]

Generic re-sampling particle filter(GRPF):was proposed by J.Holland in 1975and is the combination of monte-carlo method with generic algorithm for random search optimization and the technique is based on the principle of natural selection and heredity .The combination of both the algorithm improves the estimation accuracy of the particle This filter has better performance as it has internal parallelism and better search ability. It is based on the method of randomization that adapts according to the search direction. As generic algorithm has good optimization and combination it with the resampling process of particle filter gives the better results.[27]

Mixture particle filter(MPF):mixture particle filter is based on the probability hypothesis density .MPF uses the multi modal for multi target probability density. probability hypothesis density calculates the number of objects and state of the recursive procedure avoiding the uncertainty of estimation of the target.[22]

Auxiliary sampling importance resampling filter (ASIR):ASIR filter was introduced by Pitt and Shephard in 1999 to deal with deficiencies of SIR filter.It is basically derived from the SIR filter. It is better than the basic SIR filter as it naturally generate points from the sample at k-1,measurement is based on close true state.[15]

Regularized particle filter (RPF):RPF is similar to the SIR filter except at the resampling stage .It is the potential solution to the particle collapse due to sample drawn from the discrete distribution rather than the continuous one at resampling stage .[15]

Local linear particle filter: This particle filter uses the kalman filter for its variants to propose the importance density calculation for the better tracking of the objects using particle filter[7]

Rejection particle filter: Rejection particle filter is basically used when we know the upper bound of underlying densities .It is improved version of the SIR filter, but it suffers from the fluctuating problem of computational time[7]

MCMC particle filter: MCMC particle filter is the marco chain monte carlo particle filter .It is based on the the monte carlo method .this filter deals with the invariant distribution of the particles .this filter shows better convergence than the particle filter. Basic idea behind its functioning is that it replaces the general resampling to provide better results.[7]

Unscented particle filter (UPF):Unscented particle filter is generally developed to overcome the problem of the basic particle filter .The UPF deals with the better importance distribution of the particles. as the particle filter suffers from the problem of particles that belong to low likelihood area are ignored so to overcome this problem unscented particle filter is being proposed[67].

Boosted particle filter: Boosted particle filter is generally developed by the combining particle filter with the boost detection algorithm .As basic particle filter suffers from the two basic problems that is initialization of particle

filter and proper designing of the importance proposal densities.[7]

Coordinate particle filter: coordinate particle filter is basically developed to handle the higher dimensional state of the particles. coordinate particle filter is based on the recursive computation of the particles in dimensions of the state space ,this will allow resampling step after the each dimension.CPF works recursively in both time and degree of freedom of the state [ 14]

### III. LITERATURE SURVEY OF PARTICLE FILTER

Liu Lu et.al discussed in their work about the importance of the particle filter in the tracking of the object and the idea of tracking behind the particle filter tracking. particle filter is basically based on the concept of importance density of the particle . They have also discussed the particle degeneration problem that is being faced by particle filter .By this problem we loss the low weighted particles ,particles are being reduced tremendously due to the large number of the iteration that occurs while the processing of the particle filter, they have worked on the importance density for better tracking. They have also discussed about the EKPF and UPF filters to handle the particle degeneration problem.[8 ]

Aanchal Pathak et al discussed about the comparison of various techniques that are being used in digital image processing. They have discussed about the advantages and disadvantages of the particle filter and kalman filter .They also discussed the applications that are based on the particle filter. They have proposed the the technique in their future work about the combination of the particle filter and kalman filter for better results.[3]

Manuel Wuthrich et.al discussed in their work about the coordinate particle filter .coordinate particle filter is basically developed to handle the problem of high dimensionality. coordinate particle filter is based on the recursive computation of the particles in dimensions of the state space ,this will allow resampling step after the each dimension .they have also discussed recursively working of CPF in both time and degree of freedom of the state[13]

Kendra Schmal et .al discussed in their work about the numerical study of the particle filter .particle filter is the method that deals with the probability density of particles .Particle filter was initially developed by 'Gordon' .They have also discussed about the use of various fields in which particle filter is being used.PSO (particle swarm optimization ) technique is being discussed and is being used to develop the hybrid particle filter by combining PSO with the particle filter. Hybrid particle filter has better accuracy than the original particle filter.[9]

ZHAO Bin et.al discussed in their work about the particle filter that is based on the generic resampling .generic particle was proposed in 1975.They have discussed the approach of combining generic algorithm with the particle filter .Combination of this approach improves the efficiency of the particle and the state estimation of the particle.[25]

R.Sumathy et.al discussed about the use of particle filter for the face recognition .face recognition is the process of identifying the face of individual from the video sequence. sequential Importance resampling technique has been used for handling the Dynamic state of the particle. Both SIS and SIR filters are being discussed and their use in tracking the face of individual in the video. They have discussed about the various multiple pose variation of objects in multi camera network. They have developed the 3- dimensional model for tracking the faces in multi-camera network.SH (spherical harmonics)features are being efficiently discussed for the tracking of object. They have proposed a technique in which processing starts with the frame generation, SIR filter is being used for tracking and texture mapping.

Himani S. Parekh et.al discussed about the various object detection and tracking methods .various detection techniques have been discussed i.e. frame differencing ,optical flow and background subtraction. Object classification can be done on the basis of shape, motion, color and texture basis .Object tracking can be classified into various categories i.e. point based ,kernel based and Silhouette- based tracking, they have efficiently compared all the classifications and detection techniques for the better survey.[8]

Paul Brasnett et.al discussed in their work about the Particle filter with multiple cue. The sequential monte carlo method is efficiently explained with both its stages prediction and update. During prediction stage particles of video frame are modified according to the region of interest. In the updation stage particles are reevaluated according to the new values. they have worked on Gaussian Sum Particle Filter for the object tracking .Efficient comparison of both the filters have been done. Combination of colour and texture cues as compared to texture only and colour only is that the combination of both provides better results in terms of : i) accuracy and ii) robustness.[16]

Prerna Gupta et.al discussed about their survey on tracking .they have worked on the gesture recognition .they have done the efficient survey of various hand gesture tracking. various techniques are Mean shift, particle filter, kalman filter, Eigen value based technique. Gesture recognition is the important area in the field of research .gesture recognition deals with the tracking of the gestures of the individuals and tracking those gesture. particle filter track the object on basis of edges and the contours. [15]

Qing Lin et.al discussed in his work about improved technique of tracking multiple objects .in the video frame. They proposed the efficient tracking filter i.e. Mixture particle filter .This filter is based on the probability hypothesis density .this filter is based on the recursive procedure for the estimation of the object tracking. Recursion process of PHD filter is based on the two processes forecast and update, this algorithm gives the better results in the case of variable number of the objects .[19]

Sri Lakshmi Gogulamudi et.al discussed in their work about the multiple object tracking using the particle filter.

As the previous methods such as mean shift and kalman filter do not consider the environmental problems while tracking the multiple objects ,the particle filter is being used to handle such issues while tracking the multiple objects. Thresholding and frame differencing are the techniques that are being discussed for the detection of object in the video sequence.[22]

M. Sanjeev Arulampalam et.al discussed in his work about the particle filter on online tracking of the objects having non –linear motions and are non Gaussian in nature. Various algorithms for tracking the objects have being discussed they are as follows Sequential Importance Sampling Algorithm(SIS), Sampling Importance Resampling Filter(SIR),Auxiliary Sampling Importance Resampling Filter(ASIR), Regularized Particle Filter are being efficiently used for tracking of the objects in video sequence particle filter is basically the monte carlo method that is based on the point mass of the object or particles of the video frame. [14].

M. Jaward et.al discussed in their work about the multiple object tracking using particle filter. In their work they have proposed about the data association technique that is based on the joint probabilistic data association (JPDA) to handles the uncertainties of the object. They have also worked on the occlusion handling while tracking the objects. Occlusion is basically hiding of the object by the other object. Tracking of object deals with certain object deformations while it is being tracked, these are efficiently handled by the using the particle filter for tracking the object J.Joshan Athanesious et.al discussed about their survey they have done for object tracking methods in the videos .various features that are being used for the tracking are colour, edges and the texture. Tracking of the object can be done by various methods such as point based tracking approach ,kalman filter , particle filter, Multiple hypothesis tracking, kernel based tracking, mean shift based tracking, support vector machine, simple template matching , Layering based tracking, Silhouette Based Tracking Approach are being discussed.[15]

#### IV. METHODOLOGY

Particle filter has been used for the tracking the object that shows the maximum movement in the video. particle filter is generally used for the non linear motion of the objects .particles are detected on the basis of frame differencing techniques .The results shows that particle filter does efficient tracking of the object having the maximum motion

Result 1:

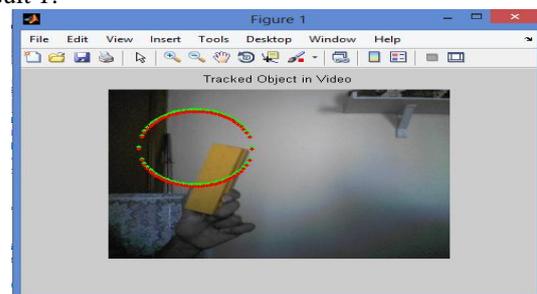


Figure 1: showing object being tracked.

Result 2:

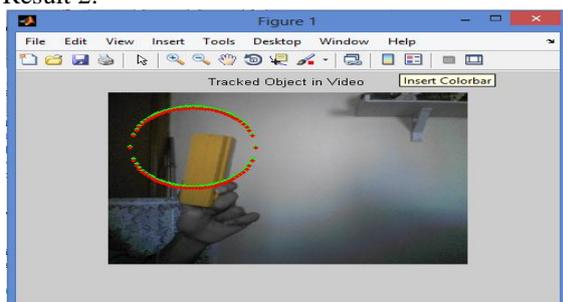


Figure 2:object being tracked

Result 3:

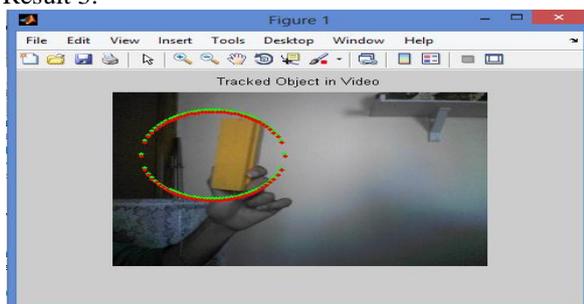


Figure 3:object being tracked

Result 4:

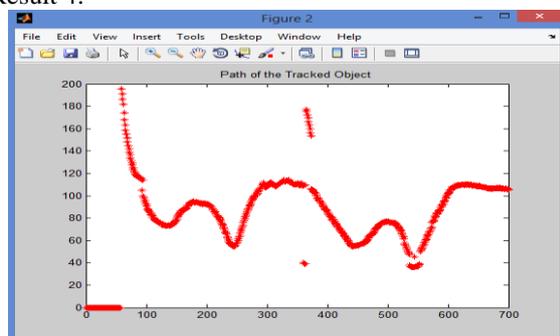


Figure 4: shows the tracked path of the object using particle filter

## V. CONCLUSION AND FUTURE WORK

Particle filter is widely used for the object tracking of the tracking of the object having the non linear motion of the object .In the proposed technique the object is being tracked by using the frame differencing technique for the object tracking. The part of video frame showing the maximum acceleration is automatically tracked by using the blind technique .In blind technique computer by itself track the max accerlating object in the video by itself i.e. without interacting with the human beings. Particle filter can be widely used for tracking the objects the multiple objects in the videos in conjunction with other filters such as mean shift and kalman filter to get the better results and improve the efficiency of the tracking .

As it is known that particle filter suffers from the major problem of particle degeneration due to n number of iteration that occurs for the tracking of object using the particle filter.

It has been proposed that it uses the new frame model for detecting features of object based on user selective regions and this is done to reduce the total selected area in given area and extracting there mean energy and hence, constructing a new reduced dataset of the original image or video dataset and then using this dataset for analysing the probability of occurrence of values using Kalman based prediction. By using particle filter mean variance of particles ,would be used to estimate the occurrence of particles by using mean values of the particle of the probability calculated by Kalman. and then it would reduce the probability area of first tracked frame and send it to the next calculated probability occurrence of the object and then it is related to the post occurrence of the object in given area.

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