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An Analysis on Moving Object and Tracking in Video

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Abstract: ***Object tracking in video sequences has been attracted by many researchers now-a-days. In domain of image processing and computer vision, detecting object and tracking object's motion to identify characteristic has been introduced as a demanding research area. Here in this paper some tracking methods are mentioned and categorized into different categories. Approaches used for tracking objects are like Mean Shift, Kalman Filter, Particle filter etc. Performance of tracking depends upon background information. Here, we have discussed the feature descriptors that are used in tracking to describe the object's appearance. Tracking methods are classified into three groups in this paper. A detailed description of respective method is provided into each group with their positive and negative points.***

Keywords: Feature Descriptor, Background Modelling, Gaussian Mixture model, Kalman filter, Particle filter, Mean filter.

I. INTRODUCTION

Now-a-days tracking an object in video sequence of surveillance camera is demanding application. It is more challenging to improve recognition and tracking performance. So many methods exists for tracking of objects but all of them have some drawbacks. Some of the methods are contour-based models, region-based models and feature point-based models.

A. Contour- based object tracking model

For finding object outline from an image [1] active contour is used. By considering outlines as boundary contours, the objects are tracked in contour based tracking algorithm. After that these contours are updated dynamically in next upcoming frames. Active contour model presents a discrete version of this approach. The advantage of the point distribution model to limit the shape is taken by discrete version of this approach. This algorithm is highly sensitive to start the tracking so makes it difficult to initialize tracking automatically.

An object tracking method was introduced by chen [7] which consist of two stages. Firstly to locate the object in complex environment kernel-based method is used. After this to improve the tracking results they again used contour based method and tracked the object contour after the target localization.

Hu et al. [8] proposed an effective framework for tracking object contours. Their proposed framework integrated different model such as tracking initialization algorithm, color-based contour evolution algorithm and adaptive shaped based contour evolution and markov model based dynamical shape model.

Using point processing a modified contour-based multiple object tracking algorithm was proposed by Rajabi and Nahvi [9]. This proposed approach presents the advantage of multiple objects tracking. This system can detect and track the peoples in indoor environments videos. For background estimation they have used Gaussian mixture model (GMM) based background modelling.

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B. Region-based object tracking method

The tracking of objects on the basis of color distribution of the tracked object is the basis for the region based object model [2,3]. Object is represented on the basis of color. So, it is computationally efficient. Its efficiency is degraded when several objects move together in image sequence. The object tracking is largely dependent on the background model used in the extraction of the object outlines when there is absence of information about the shape of object.

Andrade et al. [15] introduced a novel technique with the help of region derived descriptors for segmentation and tracking. By portioning the image into series a homogeneous regions of an image are obtained. So the problem of object extraction changes from pixel based to database analysis.

An object extraction scheme consisting of two trackers was proposed by Wei et al. [16]. By using Adaboost-based global color feature selection the pixel wise tracker extracts an object. Region tracking is achieved by using bidirectional labelling scheme.

A region based tracking method was proposed by Kim and Sim [17] for the detection of multiple moving objects which uses a differential image. In unconstrained environment, a technique of background image update is applied to ensure accurate object detection. They have used particle filter which gives a robust object tracking framework under complex conditions. This also improved estimation accuracy for complicated tracking problems.

Varas and Marques [18] presented a region based particle filter for generic object tracking and segmentation. Their proposed approach combined color based particle filter and region based particle filter. Multiple hypotheses for tracking objects were used by particle filter.

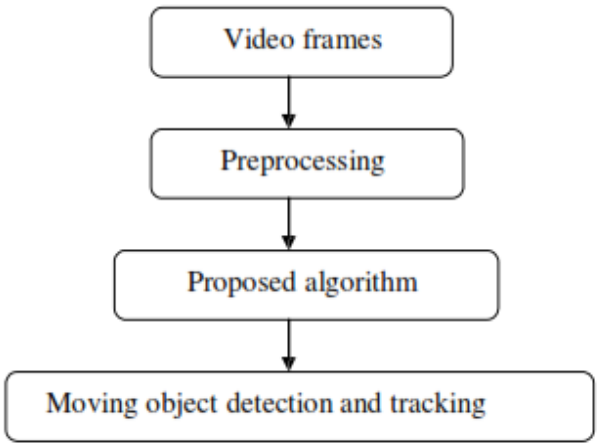

Figure 1: A typical object tracking system in video

C. Feature point based tracking model

To describe the object feature points are used in feature point based model [4,5]. There are basic three steps in feature based tracking model. By extracting elements the object is tracked and recognized in the first step. The second step is to collect them into higher level features. In the last step match these extracted frames between images in successive frames. The important step of feature based object tracking is feature extraction and feature correspondence. Feature correspondence is the challenging problem of feature point based object tracking because a feature point in one image may have many similar points in another image and hence results in feature correspondence ambiguity.

Corner feature based object tracking method using Adaptive Kalman Filter was proposed by Li et al. [10]. Moving object corner feature was used. Then, the number of corner point variation across consecutive frames to is used to automatically adjust the estimate parameters of Kalman Filter.

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An improved tracking method was presented by Rahman et al.[11] which can track both single object and multiple objects in video sequences with fast or slow moving object. Background subtraction and feature matching of SIFT features are used in their proposed method. Object is detected with the help of background subtraction. Matching of motion features and SIFT features helps in detection and tracking of an object.

Based on Mean Shift and on-line feature selection, Bai [12] presented a novel object tracking algorithm. The target object is defined in 4-D state space. In their algorithm, state estimation of the tracking objects is done with the help of Kalman filter**.**

Kim et al.[13] proposed an algorithm combining background information based motion detection, feature extraction and block matching. A set of features called shape control points (SCPs) are generated by detecting edges in the neighbouring four directions in their algorithm.

Biresaw et al.[14] developed a feature point tracker. They have used time reversed back tracking evaluation criteria together with Partial Least Square regression to improve the performance of the tracker.

II. FUTURE DESCRIPTORS

Selecting the right feature plays a very important role in video object tracking. We need to find the object visual feature uniqueness to clearly distinguish the objects in the feature space. Some features are as follows:

A. Color Feature: Color descriptors are used to increase the discriminative power of intensity based descriptors [19]. Two physical factors influencing the apparent color of an object are:

1) Spectral power distribution of the illuminant
2) Object's surface reflectance property

The color information of an object is usually described by RGB color space. But RGB color space is not a perceptually uniform color space. However the HSV (Hue, Saturation and Value) is an approximately uniform color space. There exists no efficient color space to define the features of an object.

Scale Invariant Feature Transform (SIFT) is a technique which is used for detection and extraction. The intensity channel is a combination of R, G and B channels in SIFT descriptor. So SIFT descriptor is variant to light color changes.

B. Gradient features: In human detection in video sequences gradient feature plays a very important role. To represent objects like human body, shape/contour of the human body is used in gradient based methods.

Edges features: The change of intensity of an image is strongly related to object boundaries because after boundary of object the intensity changes instantly. Edge detection techniques is used to identify the instant change. These changes are less sensitive as compared to color features. Canny Edge detector is optimal so mostly used in finding the edges of an object.

C. Texture features: In Comparison to color features and edge features, to generate the descriptors for the texture features a processing step is required. Local Binary Patterns (LBP) texture feature are known as one of the efficient features. The LBP operator is tolerance against illumination changes and this is the most important feature of it.

D. Optical flow: Optical flow is defined as the translation of each pixel in a region and can be found out by a dense field of displacement vectors. Motion-based object segmentation and tracking applications mostly uses optical flow features..

E. Spatio-temporal features: Now-a-days local spatio-temporal features are widely used. These provide a visual representation for recognition of actions and visual object detection [21]. Local spatiotemporal features captures the salient and motion pattern characteristics. These features provide relative representation of events independently.

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F. Multiple features fusion: The multi-feature fusion scheme has achieved high boosting performance or robustness, in the field of computer vision, multimedia and audio–visual speech processing, etc [21].

G. Biological features: Biological features are important in describing the biological characteristics of human. Attention Regions (ARs) and Biologically Inspired Model (EBIM) features the recent used biological features. Humans biological vision mechanism can be described by these biological and hence to achieve robust recognition.

III. OBJECT TRACKING

An object tracker is useful because it finds out the motion trajectory of an object as video frames progresses along with time by identifying the object position in every frame of the video. Object tracker can also find the complete region that is occupied by the object in the image at every time instant. The detected objects in frames are being tracked in the subsequent frames. We can do separately or jointly the task of object detection and object correspondence establishment. Object regions in every frame are obtained with the help of object detection algorithm in the first scenario and object tracker perform the objects correspondence task across frames. After this in the next scenario, information from previous frames helps in finding the object region and correct estimation of correspondence.

STATISTICAL METHODS OF TRACKING:

A. Kalman filters: It is a single object state estimation procedure. To predict and correct system state, Kalman filter is used as an estimator. To study system dynamics, estimation, analysis, control and processing Kalman filter is useful. The states of past, present, and future of an object or variable efficiently are predicted by this filter very precisely. For a linear system Kalman filter finds the correct estimation, with white Gaussian noise. For a linear system the discrete time process can be described by the following equation

1) Process equation

$$X_{k+1} = AX_k + W_K$$

Where X_k is the system state vector, W_k is Gaussian process noise vector and A is the process transition matrix.

2) Measurement equation

$$Z_{K=} HX_K + V_K$$

Where Z_K is measurement vector, V_K is the Gaussian measurement noise vector and H is the measurement matrix.

The two most important steps of Kalman filter are

i) Prediction (time update) step

ii) Correction (measurement update) step.

The nonlinear version of Kalman Filter is Extended Kalman filter (EKF). To linearize about the current mean and covariance Extended Kalman filter uses Kalman filters.. There might also be some cases where EKF finds better or more robust solutions. In recent days Extended Kalman Filtering (EKF) along with ANN is being used in training.

B. Particle Filters: The state variables are normally distributed (Gaussian) is the problem of Kalman filter. So, those state variables that do not follow Gaussian distribution Kalman filter will give poor estimations for those state variables. This problem of the Kalman filter can be solved with the help of particle filtering.

In particle filtering, the conditional state density $p(X_t \mid Z_t)$ at time t is represented by a set of samples $\{s_t^{(n)} : n = 1, \ldots, N\}$ (particles) with weigh π_t (sampling probability). The weights define the importance of a sample, that is, its observation frequency. Particle filter uses a common sampling scheme i.e. *importance sampling* to find new samples. The *importance*

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sampling scheme can be done in three steps, i.e. selection (selection of random samples), prediction (generate new sample from selected sample) and correction (Weights corresponding to the new sample are computed using the measurements Z_t).

C. Multiobject Data Association and State Estimation: Very good results are obtained by Kalman filter, extended kalman filter and particle when the objects are not close to each other. For tracking multiple objects in the video sequences by using Kalman or particle filters, the most likely measurement for a particular moving object needs to be associated with the object's state. This is called the correspondence problem. So for multiple object tracking the most important step we have solve is the correspondence problem before kalman or particle filters are applied. Nearest neighbour approach is the very simplest method to solve the correspondence problem. Data Association algorithms are used to associate the objects state like position, velocity, size with the available filters. Some of the methods to solve the data association are Linear Assignment problem (LAP), Stable Marriage problem (SMP) and Munkers algorithm etc. However the correspondence problem is hard to deal with when the moving objects are close to each other, and then the correspondence shows incorrect results. These filters fail to converge when incorrectly associated measurement occurs. There exist several statistical data association techniques to tackle this problem. Two mostly used techniques for data association in this complex scenario are Joint Probability Data Association Filtering (JPDAF) and Multiple Hypothesis Tracking (MHT).

IV. CONCLUSIONS

In this article, we present a literature survey of object tracking approaches and also give a brief review of related topics. We divide the tracking approaches into three categories, contour based, region based and feature based approach. In our survey we have seen that moving tracking is a kind of motion tracking. We expect that this survey on moving object tracking in video with rich theoretical details of the tracking methods along with bibliography contents will give valuable contribution to research works on object tracking and encourage new research.

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