

## A Review on Moving Object Detection and Tracking Methods in Video

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### Abstract

In today's world, object detection and tracking is much widespread and specially used for motion detection of various objects. In object detection, the first step is to identify objects in the video sequence and cluster pixels of these objects. Classification of an object is the next important step to track the object. The object tracking can be applied in most of the fields that include computerized video surveillance, traffic monitoring, robotic vision, gesture identification, human-computer interaction, military surveillance system, vehicle navigation, medical imaging, biomedical image analysis and many more. The purpose of this work is to represent the various steps involved in tracking objects in

a video sequence, explicitly object detection, classification, and tracking. This paper describes various object detection and tracking methods and the comparison of various techniques for different phases of tracking.

**Key Words :** Object detection, tracking, classification, video processing.

## 1 Introduction

In the field of image processing applications, object tracking plays a vital role [1]. Object detection and tracking are both most dynamic research area with number of application including computerized video surveillance, robotic vision, traffic detection, vehicle navigation, object identification and much more. Video is sequence of images, each is called as frame. There are both moving and static object in sequence of images. Moving object which can be a person, bird, vehicle etc. also called as foreground object and background object can be the static things. Detecting the semantically meaningful moving object is the task of moving object detection [2]. To track object, we must first detect an object. Tracking is carried out to check the presence of object in videos. Basically, there are three steps included in object tracking. Object detection, classification and tracking of an object.

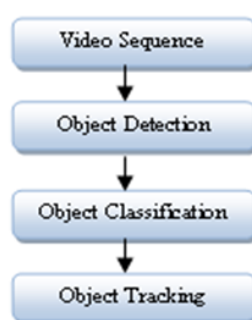


Fig.1.1. Steps for Object Tracking

### A. Object Detection

In the video sequence, to identify objects [3] and cluster pixels of these objects [4] object detection is performed. There are several methodologies for object detection which include frame differencing, background subtraction and optical flow [5].

### B. Object Classification

The classification of an object can be done after the object detection based on their shape, color, motion, and texture. There are many approaches of classification methods such as color based, shape based, texture-based and motion-based classification method.

### C. Object Tracking

Object tracking is the process of finding an object of interest in the video to get the useful information by keeping the track of its motion, orientation and occlusion etc. [6]. There are various methods to track the objects such as kernel tracking, point tracking, and silhouette based tracking. There are various algorithm to track the object and classification is done based on that algorithm, for example, algorithms for tracking the object can be categorized into discriminative and generative tracking, on appearance based model [7][8].

## 2 Object Detection Methods

In video sequence, identify the objects of interest and cluster pixels of these object is the preliminary step of object tracking process. Detection of the region of interest of user can be attained by various methods which include frame difference method, optical flow method and background subtraction method as shown in figure 1.2.

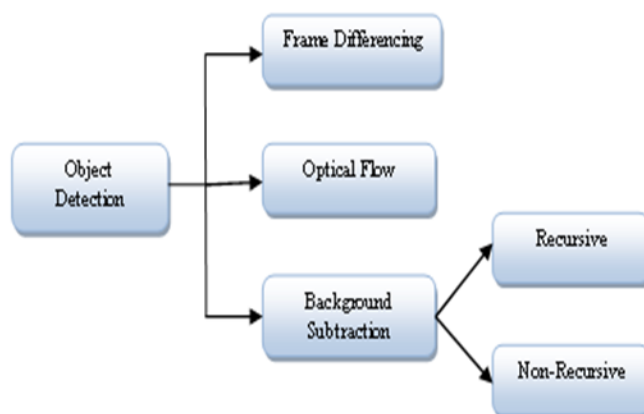


Fig.1.2. Categorization of Object tracking

## 2.1 Frame Differencing

Frame differencing is object detection technique in which the moving object is evaluated by finding the difference between two consecutive frames. It is easy to implement and its calculation is simple. For moving object, it is usually difficult [9], to obtain complete outline because of strong adaptability, for dynamic environments, as a result it is not accurate for the detection of moving object.

## 2.2 Optical Flow

For tracking the objects which are in motion optical flow method is useful. This method is used to calculate the image optical flow field and perform the clustering processing according to the optical flow distribution characteristics of image [10]. In this context, this basic method is called optical flow. By using optical flow method, we can get the complete moment information but it requires large quantity of calculations.

### 2.3 Background Subtraction

Background modeling is initial step for background subtraction method. It is achieved by constructing a background model. The reference model is obtained by using the background modeling. The reference model which is useful in background subtraction, in that to determine possible changes in the frame every video sequence is compared with reference frame. Existence of moving objects is detected by changes between current video frames and the reference model in terms of pixels [11]. Algorithm of Background subtraction is simple. As the external environment changes, it is more sensitive. For the background subtraction two types of algorithms are available [12].

#### A. Recursive process

In the case of a recursive technique no buffer is used. Based on each input frame a single background model is updated. This means that in the current model an error could be cause from frames of the distant past. This reduces the storage space, as there would be no necessity of memory to buffer the data. There are some recursive process that comprises median and Kalman filtering, and Gaussians Mixture.

#### B. Non-recursive process

A sliding-window approach is useful for the estimation of a background in non-recursive process. There are various types of non-recursive process such as frame differencing, median and linear predictive filtering [13].

## 3 Object Classification Methods

Classification of object can be done based on their shape, motion, texture and color.

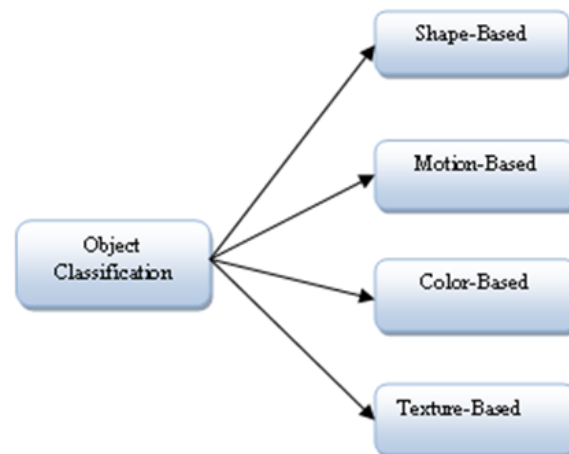


Fig.1.3 Classification of object

### 3.1 Shape-Based Classification

Shape based classification means matching a pattern. For classifying moving objects the different descriptions information about the shape representation of box, points and blob are stored. Accuracy and performance measurements of shape features are explored[14].

### 3.2 Motion-Based Classification

Classification of Motion-based is used to detect the moving object. For object classification, optical flow is also useful. Analyzing rigidity and periodicity of moving entities, residual flow can be used.

### 3.3 Color-Based Classification

Color is easy to be acquired and under viewpoint changes color is relatively constant. For detecting and tracking the object color is not appropriate technique. Detecting and tracking the vehicles in real-time, the histogram-based approach is used. As a real-time tracking frameworks color has been generally utilized [15]. For

tracking the objects, proposed an image sequence based moving object tracking with surveillance system [16].

### 3.4 Texture-Based Classification

Texture is represented by using the texture descriptors. In this observation is done using the histograms of region borders and region homogeneity. Various different types of texture descriptors are edge histogram descriptor, texture browsing descriptor and homogeneous texture descriptor.

## 4 Object Tracking Methods

Object tracking is the process of finding any object of interest in the video to get the useful information by keeping tracking track of its orientation, motion and occlusion etc. Detail description of object tracking methods which are discussed below. Commonly used object tracking methods are point tracking, kernel tracking and silhouette tracking [17].

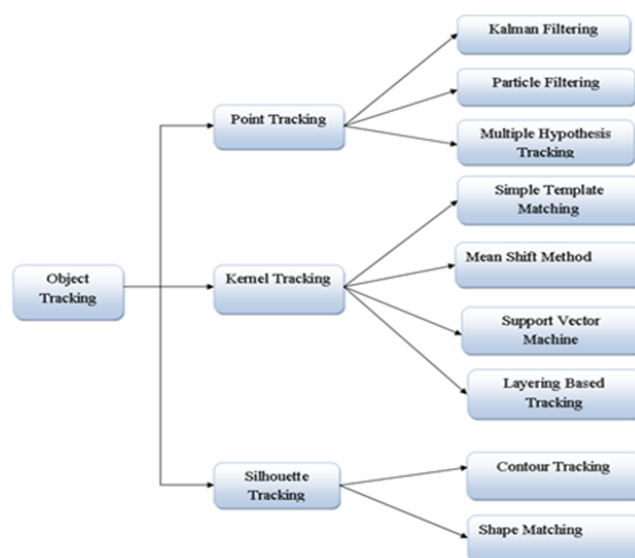


Fig.1.4. Categorization of Object Tracking

## 4.1 Point Tracking

In the point tracking technique, by using points moving objects are represented. In case of occlusions and false detection of object point tracking is complex problem [18]. Point Tracking is simple and useful for tracking very small objects. Point tracking can be classified as Kalman filtering and particle filtering.

### A. Kalman Filtering

Kalman filter uses Optimal Recursive Data Processing Algorithm. In Kalman filtering based on criteria optimal point will be taken [19]. A series of quantities which is observed over the period that contain noise is used by Kalman filtering algorithm and estimates of unknown variables are produces. To obtain a statistically finest estimate of the underlying system state, the Kalman filter operates recursively on streams of noisy input data [20]. Kalman filter algorithm is mainly consisting of two steps, prediction, and correction. The prediction step produces estimates of the current state variables along with their uncertainties. Then, the result of the next step is observed and the estimates are updated. Since it is a recursive algorithm, in real time only the previous value and present value are adequate to estimate. Kalman Filter deal with handling noise, it gives optimal solutions and tracking is applicable only for single.

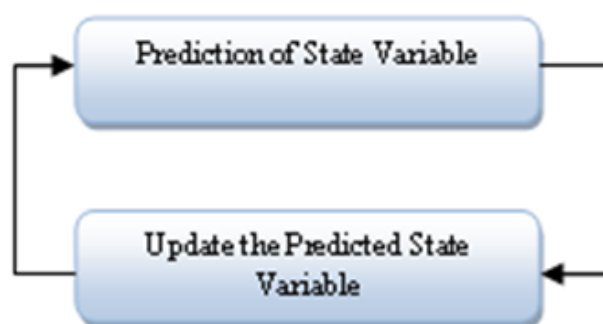


Fig 1.4.1 Kalman Filter Basic Steps

### B. Particle Filter

Before moving to the next variable, particle filter generates all the models for that variable. When variables are generated dynamically algorithm has an advantage and there can be confoundedly many variables. It allows for new process of re-sampling. One constraint to the Kalman filter is the assumption of state variables are normally distributed. Therefore, the Kalman filter is poor approximations of state variable. This restriction of the Kalman Filter can be overcome by the particle filtering. Particle filter uses contours, color features or texture mapping. It also consists of two Steps: First step is prediction and second step is update as same as Kalman Filtering method.

### C. Multiple Hypothesis Tracking (MHT)

Recognition of motion correspondence is done by means of only two frames and always there is a partial chance of an incorrect correspondence. We acquired better tracking, if several frames have been observed. MHT is an iterative algorithm. This algorithm starts with the parent hypothesis set. The set of hypotheses of the previous iteration is known as parent hypothesis set. Every hypothesis represents a group of disconnect tracks. Multiple Hypothesis Tracking deals with the tracking the multiple objects, calculating of optimal solutions and it also handles occlusions [21].

## 4.2 Kernel Based Tracking Approach

By computing the moving object Kernel tracking is performed. Using the geometric shapes like rectangle and ellipse Kernel tracking is represented. In the Kernel Based Tracking approach object parts will be left outside of the shape which is defined and background parts exist inside. This is one of the restrictions to the Kernel Based Tracking approach that can detect non-rigid object and rigid objects. There are various tracking methods present in Kernel tracking approach:

### A. Simple Template Matching Method

Template matching method is used when finding small portion of video or an image in digital image processing that match a template image. In video examining (ROI) regions of interest, a brute force method of template matching is used. In template matching, the frame sequence which is detached from the video is verified with a reference image. Using this technique, we can track only single object in the video. In this method, only transformation of motion can be done. Simple Template Matching deals with single object tracking and Partial occlusion.

#### **B. Mean Shift Method**

From moving object define Interested Region by segmentation and then tracking the object, from one frame sequence to another is the task of Mean Shift Method. In an initial frame by using the rectangular window Region of interest is defined. The object which is tracked is separated from background by using this algorithm. Chamfer distance transform will be improved the accuracy of target. Using the Bhattacharya coefficient minimizing the distance among two color distributions is done also by Chamfer distance transform. The drawbacks of this method are only single object can be tracked. Within the frame if the object is moving with very high speed then it cannot track that object.

#### **C. Support Vector Machine (SVM)**

A classification method which provides a set of positive and negative training values is SVM. For SVM, tracked image object contain the positive samples and object which is not tracked contain the negative samples. But the necessity of physical initialization and necessity of training it can handle single image. Mostly for classification and regression Support vector machines are used. SVM can deal with only single object tracking and cannot handle partial occlusions.

#### **D. Layering Based Tracking**

To track multiple objects layering based tracking technique is used. Under the kernel based tracking this method is used. In this method, each layer consists of shapes such as rectangle,

ellipse based on that shape, the object is tracked in that layer. Layering Based tracking deals with multiple images tracking, it can handle the full occlusion of object.

### 4.3 Silhouette Based Tracking Approach

By using geometric shapes, we cannot define objects such as head, hands and shoulders because these objects having composite shapes. Silhouette based approach is used for complex shapes tracking. Silhouette tracking divided into contour tracking and shape matching.

#### A. Contour Tracking

In Contour tracking method, from the previous frame the contour of the object is taken and calculate contour of another frame that is iteratively proceeds. Contour tracking is performed in two steps. First, by using state space models we can counter motion and shape of an object. The second approach is optimized technique such as gradient descent for curtailing the contour energy, thus developing the contour. To track objects of irregular shapes this method can use.

#### B. Shape Matching

The Shape based method is same as shape matching method. But, for shape tracking we use shapes instead of classifying the object. It is also same to template matching, because for tracking purpose the shape is compared with the shape stored in the available data set. Shape Matching is deal with Edge based template, occlusion handling performed in with Hough transforms techniques. Summary of tracking techniques are as shown in Table 1.1.

| Sr. No | Methodology             | Occlusion | Optimal Result | Training Rules | Number of Object Tracking |
|--------|-------------------------|-----------|----------------|----------------|---------------------------|
| 1      | Kalman Filter           | No        | Yes            | No             | Single                    |
| 2      | Particle Filter         | Yes       | Yes            | No             | Multiple                  |
| 3      | MHT                     | Yes       | Yes            | No             | Multiple                  |
| 4      | Template Matching       | Partial   | No             | No             | Single                    |
| 5      | Mean Shift              | Partial   | No             | No             | Single                    |
| 6      | SVM                     | Partial   | No             | Yes            | Single                    |
| 7      | Layering Based Tracking | Full      | No             | No             | Multiple                  |
| 8      | Contour Matching        | Full      | Yes            | Yes            | Multiple                  |
| 9      | Shape Matching          | No        | No             | No             | Single                    |

Table 1.1 Comparison of different video object tracking methods

## 5 Conclusion and Future Scope

In this paper, the different phases of object tracking have been studied. In object tracking approaches, finding out the movement of the object is critical. The movement of object tracking problem classifies such as point, kernel and silhouette based tracking. Our findings from the studied literature, the frame differencing and background subtraction methods are suitable for object detection due to their easy implementation. For static background, Frame differencing performs well, and also provide low computational time and high accuracy. Object can be categorized based on motion, shape, color, and texture. Texture based and Color based are most widely used because they provide higher accuracy and low computational time. In contours based tracking or kernel based tracking detection is require only when object appears first, while point tracking comprises detection in every frame sequence. Contour based tracking is used to track the multiple objects. It provides the optimal result and it

also handles the occlusion.

In future, the moving object can be tracked by computing motion vectors using block matching motion estimation algorithms.

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