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# A Comparative Analysis of Video Tracking Techniques

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## ABSTRACT

*In real-time application, mainly research is focused in video tracking system. It is commonly used in the fields of robotics, surveillance tracking, human to machine interface, etc. to take out the target status. There are several numbers of video tracking system is made to figure out the targeted region of object from the frame of given video. and its performance of tracking can affect by sudden illumination changes, shadowing effect and uneven background. Its most important task is to find and follow a moving object or multiple objects in image sequences or video. Normally there are three stages of analysis of video; detection of object, tracking of object, and object reorganization. This paper presents a brief analysis and comparative of various video object tracking techniques*

***KEYWORDS:*** *Object tracking, Video tracking, Object detection, and Video analysis*



## I. INTRODUCTION

In the field of computer vision and various research object tracking is an essential part . Object tracking aims at obtaining the trajectory over time of moving object in video sequences [31]. Applications like security, surveillance, clinical applications, education, entertainment, biomechanical applications, human robot interaction object tracking plays an vital role

### *1.1 Basic Steps of Object Tracking*

Object tracking in video frames is an main topic in the field of computer vision and various research fields. The basic step of object tracking is Fig.1. The first step to detect the objects which are presents in the input video frame. Objects are classified depending on what we want to track. Finally tracking of object takes place.

Object detection: Detection of an object in a given image or video.

- Object tracking: Tracking of object in each frameObject tracking complex due to

1. Shapes and Size of object in each frame may differ
2. Sudden occlusion of object in a video frame.
3. Noises and blur in input videoframe .
4. Luminance and intensity changes.

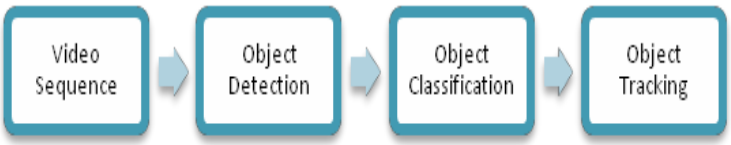



***Fig. 1 Flow Diagram of Basic steps in Object Tracking***

- Object Detection
- Object Classification
- Object Tracking.

## II. OBJECT DETECTION METHODS

Object Detection is to identify objects in the sequence of video and to cluster pixels of these objects. The techniques are Frame Differencing, Optical Flow and Background Subtraction. Initial stage is pre-processing stage, in image data can be done for extraction of feature. segmentation, foreground and/or background extraction, feature extraction [5-8].

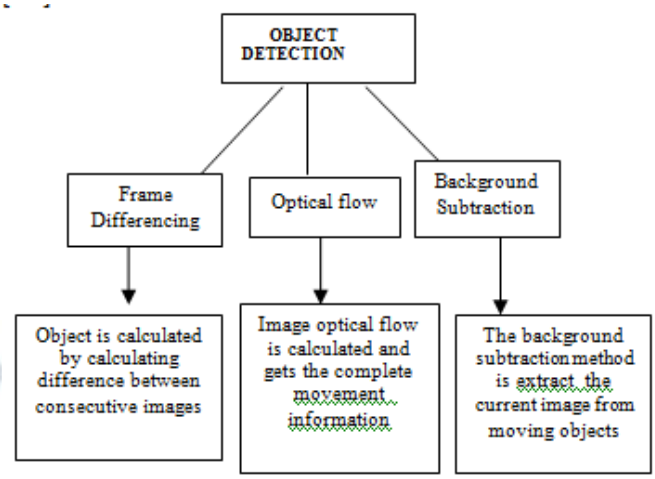



***Fig 2 Object Detection Methods***

**Table 1. Comparative Study of Object Detection Methods**

| Object Detection Method | | Basic Principle | Computational Time | Accuracy | Comments |
|---|---|---|---|---|---|
| Temporal Differencing | | Pixel wise Subtraction of Current & Backgroundframe | L | H | + Simple and easy to execute [1][2]<br>- Sensitive to dynamic changes.[3]<br>- For still objects background frame needed [2] |
| Background Subtraction | Frame Differencing | Differences between Current Frame and Background Frame | L - M | M - H | + background Subtraction are simple [3][4]<br>- Not applicable for real time applications [2] |
| | Approximate Median | Differences between Median frame & test frame | L - M | M | + background modeling are sufficient [4]<br>- Need a buffer with current pixel values [4] |
| | Running Gaussian Average | Pixels of object is Based on Gaussian probability | M - H | M | + Applicable for real time applications [4]<br>- computational time are more for Statistical calculations |
| | Mixture of Gaussian | pixels of object is based on multi-modal distribution | M - H | M - H | + little memory requirement [5]<br>- Cannot deal with objects with noise [7] |
| Optical Flow | | Uses optical flow distribution characteristics of pixels of object | M - H | H | + It can create complete movement information [9]<br>- need huge amount of calculations |

## III. OBJECT CLASSIFICATION METHODS

After the detection of object in a video sequence, the next process is to identify these objects and classify them according to our requirement. Classification of Object is done based on the parameter we select and the methods are defined as follows: shape-based classification, motion-based classification, color-based classification and texture-based classification. Each of the methods is explainedbelow.

### *A. Shape-Based Classification*

It is basedonshapeanalysis. It is the automatic analysis of geometric shapes to detectsimilarly shapedobjectsbycomparing against entries on a database. boundary based representation, volume based representation or point based representation of shapes is used. The simplified representation is called shape descriptor. A complete shape descriptor consists of all the information required to reconstruct the shape.

### *B. Motion basedclassification*

Its works according to periodicity of the motion. It can be easier to learn how the object moves and then classify it better. Motion based classification

used for both rigid and non-rigid objects. In rigid, tracking of object is easier and give details of periodicity in motion, a limited amount of periodicity has been predicted present in non-rigid objects. Optical flow is known method which used for motion-based classification.

**Table 2. Comparative Study of Object Classification Methods**

| Object Classification Method | Computational Time | Accuracy | Comments |
|---|---|---|---|
| Shape Based | L | M - H | • Pattern-matching approach used for appropriate templates.<br>• It does not suitable for dynamic situations<br>• It is not capable to find out internal movements well[12] |
| Motion Based | H | M | • No need predefined pattern templates<br>• Difficult to identify a non-moving human [12] |
| Color based | H | H | • Gives improved quality<br>• Computation time is High[14] |
| Texture Based | H | H | Gaussian Mixture Model is used to illustrate the color distribution within the series of images and segment the image into background and objects [14] |

C. *Colour-BasedClassification*

Color-based approach is based on analyzing the color features in an image. There are two main color features that are used to organize is based on color are spectral power distribution and object's surface. RGB colour space is used for representing color information but they are not a uniform color space so , L*a*b and L*u*v color space are used and its uniform in nature . HSV (Hue, Saturation, and Value) is a relatively uniform colour space.

*D. Texture-basedclassification*

It gives the information regarding structural arrangement of surfaces and their corresponding relationship to the surrounding environment. It have clear and useful information regarding the textural properties of images .

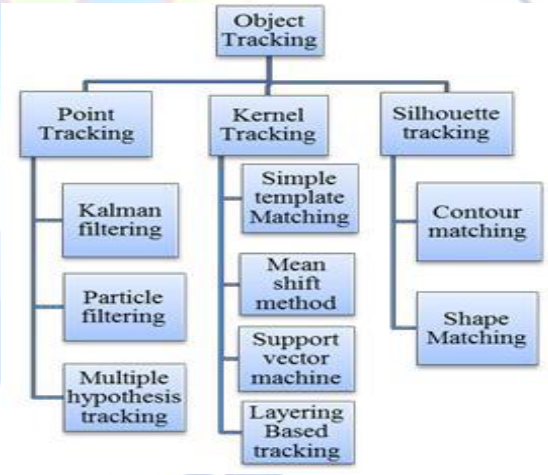
## IV. OBJECT TRACKING METHODS

After detection of the objects and Object classification , the next phase would be the actual tracking process. In [21], tracking is classified as the crisis of estimating the path of an object in the image plane as it moves around a scene. There are three methods of object tracking which are discussed in detail below. Which include point tracking, kernel tracking and silhouette tracking [18].

### 4.1 Techniques of tracking

There are main three mainly methods focused while tracking the object The techniques of object tracking are

- Point Tracking,
- Kernel Tracking
- Silhouette



| S.No. | Methodology | Type of Tracking | Algorithms used | ¥ | Occlusion Handling | Efficiency/ Measurement | Advantages | Limitation |
|---|---|---|---|---|---|---|---|---|
| 1 | Kalman Filter[32], [39] | Point Tracking | Kalman Filtering algorithm | S | No | Efficiency in terms of total time elapsed(in seconds) for processing certain frames | Used to track points in noisy images | State variables are normally distributed (gaussian) |
| 2 | MHT(Multiple Hypotheses Tracking) [32] | Point Tracking | MHT algorithm | M | Yes | Distance measure is calculated | Able to deal with entries of new object and exit existing object | Computationally exponential both in time and memory |
| 3 | Particle Filter based on Codebook background[32] | Point Tracking | Improved particle filtering algorithm | M | Yes | Get the min. Variance estimate, avg. Processing time/frame is 94ms | Solves the problem of particle degradation of traditional particle filter, the background color interference | --- |
| 4 | Dual – Tree Complex Wavelet transform [33] | Kernel Tracking | Dual-Tree CxWT algorithm | S | P | Centroid of the moving object bounding box in each frame is calculated | Good directional selectivity and shape matching | It uses real Filter |
| 5 | Daub Complex Wavelet transform [34] | Kernel Tracking | Daub CxWT algorithm | S | P | Min. Difference of energy of wavelet coefficients between frames | Reduced phase sensitivity and false tracking of objects, helps in preserving the edges | Object shape and size should not change b/w successive frames |
| 6 | Color Histogram[36] | Kernel Tracking | Histogram based algorithm | S | P | Search takes about 500ms and detection rate is 96.5% | Runs very fast, suitable for models having dominant colors | Spatial information of the target is lost, cannot give good performance when an object & its background have similar color |
| 7 | Contour Tracking[32] | Silhouette Tracking | Gradient Descent Algorithm | M | F | Region Statics is calculated using grid points | Object Shape is Implicitly modeled | --- |
| 8 | Shape Matching [32] | Silhouette Tracking | Hough Transform | S | P | TSV(Temporal Spatial Velocity) in 4D(x,y,u,v) image per frame is calculated | Less sensitive to appearance variations | It requires Training |

¥: number of objects being tracked; S: single object tracking; M: multiple object tracking;
F: full occlusion handling; P: partial occlusion handling; CxWT: Complex Wavelet transform

***Table 3. Comparative Study of Object Tracking Methods***

***Point Tracking:***

Objects are represented by points. Problems like occlusions, noises, blurs, illumination changes during tracking the moving objects.. Point methods has two categories namely deterministic method and Probabilistic methods . In deterministic method Correspondence Problem uses qualitative motion heuristics for object detection where as Probabilistic methods uses object measurement and uncertainties to establish correspondence .

***Silhouette Tracking:***

This tracking mainly used to locate the object region in each frame in video by Object model are created from previous frames .It can handle multiple object shapes from each frame.

***Kernel Tracking:***

Kernel tracking carried out by object shift form frame to frame .The object motion are in parametric motion or dense flow field that are computed in successive frames.

## V. Conclusion

We have analyzed the different steps involved while tracking an object from a video and the different category of methods performed in object detection, object classification and object tracking were briefly discussed. The Pros and cons of each methods were discussed. In the future, we plan to propose an novel algorithm to overcome the drawbacks of the existing object detection methods and tracking of objects in a video sequence with high potential to handle multiple objects and occlusions...

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