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Implementation and Comparison of Kernel and Silhouette Based Object Tracking

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Abstract

Object tracking in video sequences is one of the important ongoing exploration areas in the field of computer vision. Computer vision is an arena that comprises methods for acquiring, processing, analyzing images and also covers the essential technology of automatic image analysis which is used in various fields. The aim of object tracking is to find the trajectory of the target objects through a number of frames from an image sequence. Object Tracking is identification of interesting object, especially on tracking of walkers or moving vehicles. Tracking is an interesting problem owing to, object occlusion, varying of illumination, unexpected object motion and camera motion. Normally many algorithms were developed for successful tracking. Object Tracking is mainly classified of three stages: object extraction, object recognition and tracking, and decisions about activities. In this paper we have implemented some algorithms and comparison table are analyzed.

Keywords: Object extraction, Object recognition, Object tracking, Overlapping, Color model, Noise, Region of Interest (ROI), Background Subtraction

I.INTRODUCTION

Object tracking is a method of segmenting an interesting region from a video scene and observance of its motion, positioning and direction. To make tracking fascinating and efficiency, high-powered computer and high performance of a video camera. Major phases in Object Tracking: interesting objects are detection in video such objects are tracked from frame to frame and recognize their activities by analysis of tracking sequence [1].

An Object tracking algorithm is to label the tracked object constantly in ongoing frames of a video. Most of the problems in tracking are changes of illumination, Overlapping objects and shape of complex objects. Every Problem will be solved in order to avoid failure of the tracking algorithm [2].

Object tracking is mainly two approaches in: *Feature-based methods* aim to take out the features such as points, line segments from image structures, tracking stage will be ensured by a matching procedure at every time instant. *Different methods* are based on the optical flow computation, i.e. difference of motion in image sequences, under certain regularization rules.

Some of the essential applications of object tracking are:

- *Computerized video surveillance*: the movements in an area are monitored by automated vision system.
- *Robotic vision* : to recognize different obstacles in the path to avoid overlapping
- *Traffic monitoring*: In specific countries highway traffic is constantly observed using cameras. The surveillance system is supported by an object tracking system, to identify the breaking rules made of vehicles or any other unlawful act.
- *Animation*: Object tracking algorithm can also be prolonged for animation.
- *Gesture Identification:* Identification of human parts like eye, hand, face etc. [1].

Effective tracking surveillance tool are:

- Automatic segmentation of every vehicle from the background and from other vehicles so that all vehicles are detected.
- Appropriate detection of all categories of road vehicles like motorcycles, cars, buses, trucks etc.
- Function under a widespread range of track conditions like light track, congestion, varying speeds in different lanes.
- Function under a wide variety of lighting conditions like luminous, gloomy, nightfall, rainy, etc. [3].

Complexity of Tracking mainly due to:

- Loss of pixel information due to conversion of 3D to 2D images.
- Presence of Noise in an Image
- Motion and shape of complex objects
- Overlapping of partial and fully object.
- Features of rigid and non- rigid object (color and texture. Etc.).
- Change of climatic condition.
- Change in Scene illumination.

Almost object motion is smooth with no abrupt changes for all tracking algorithms. Limitation of object motion to be of constant velocity or a constant acceleration based on a priori evidence. Prior info about the number of counts and the size of objects or the appearance and shape of an object can also be used to make simpler the problem [4].

II. RELATIVE APPROACH

The main idea of tracking is to find the trajectory path of a moving object in each frame. An object detection tool is required for every tracking method either in every frame or first object appears in the video. Based on the information of color features and performance in the single frame, the objects are tracked. Most of the tracking mechanism uses temporal information to avoid the false deduction.

In this paper we have examined some algorithms with implementation and comparison study. Since there are a large number of objects tracking techniques available,
On the basis of ,

- Which object representation is appropriate for tracking?
- Which image feature must be used?
- In what way must the motion, appearance, and shape of the object to be demonstrated?

Based on the above information there are three basic approaches for object tracking,

- *Point tracking approach.*
- *Kernel tracking approach.*
- *Silhouette tracking approach*.

There are a variety of tracking methods existing base of this Kernel tracking approach. Some of the important methods include Mean-shift method, Eigen tracker, KLT, Appearance tracking, layering and Support vector machine [1].In this paper we have implemented mean shift, Cam shift and Simple template matching and analyzed the features of tracking

1 Kernel based tracking:

In this type of tracking the kernel refers to the object representations of rectangular or ellipsoidal shape and object appearance. The objects are tracked by calculating the motion of the kernel on each frame. These algorithms differ in terms of the appearance representation used, the number of object tracking, and the technique used for estimation of object motion.

These methods are divided into following sub-categories, namely,

• Tracking Using Template and Density-Based Models.

• Tracking single objects and multiple objects.

Steps for kernel tracking:

• Probabilistic distribution of the target object is obtained in first frame using *color feature*.

• Compare the distribution of the first frame with consecutive frame.

• Bhattacharya coefficient is used to find the *degree of similarity* between the frames.

• Loop will continue till the last frame.

From real-time, representation of objects by means of geometric shape is very usual. But one of the limits of geometric shapes is that parts of the objects may be left outside of the definite shape while parts of the background may exist inside it [5].

2 .Silhouette based tracking:

Some object will have complex shape such as hand,fingers,shoulders that cannot be well defined by simple geometric shapes. Silhouette based methods afford an accurate shape description for the objects. The aim of a silhouette-based object tracking is to find the object region in every frame by means of an object model generated by the previous frames.

This model can be in the method of a color histogram, the object contour or object edges. The Fig 1 (a) shows a flexibility of tracking by tracing the edges and Fig 1(b) show the grid position encodes the Euclidean Distance between a grid position. In this paper we have implemented contour matching and analyzed the features of contour tracking.

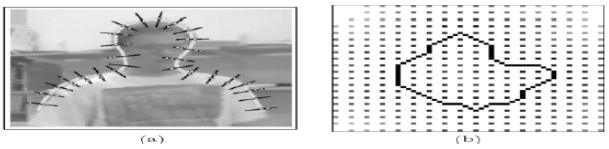

Fig 1. (a)Edge observations along the contour normal, (b) Each grid position encodes the Euclidean Distance between a grid point and the point on the contour.

III. TRACKING METHODOLOGIES.

1. Mean Shift

The task is to first define a Region of Interest (ROI) from moving Object by segmentation and then tracking the object from one frame to the next. Region of interest is defined by the rectangular window in a first frame. By this algorithm tracked object is separated from the background. The accuracy of target representation and localization will be improved by Chamfer distance transform.

Minimizing the distance amongst two color distributions using the *Bhattacharya coefficient* is also done by Chamfer distance transform [6]. *The histogram* is used to identify the graphical representation of the digital image. *Back projection* is used to calculate the histogram Model of a feature and then used it to find this feature in the image. Create a *histogram* for the frame. *Back Projection* is called for a selected ROI of the frame. Finding the positions of a particular object in the subsequent frame [7].

Steps involved in Mean Shift based tracking:

- Choose the radius of a rectangular box.
- Choose the center location of window[8]
- Repeat
    1. Selecting the *color features* by the normalized probability density function of the target object and tracking the same object in upcoming frame.
    2. Bhattacharyya coefficient is used for finding the degree of similarity of every frame.
- The loop will flow till the last frame [1].

Mean shift is used in color-based object tracking because it is simple and robust. The best results can be achieved if the following conditions are fulfilled:

- The target object is mainly composed of one color.
- The target object does not change its color.
- Illumination does not change dramatically.
- There are no other objects in the scene similar to the target object.
- The color of the background differs from the target object.
- There is no full occlusion of the target object.

a. Implementation of Mean Shift*:*

We have implemented mean shift tracking using OpenCV. We verified this implemented algorithm on the video containing the object in the every frame. Object is

selected using the mouse event function in OpenCV. Once the object has been selected they are tracked for upcoming frames. Here they are some frame screenshot are taken any attached below. They contain tracking of object of different frames. During the tracking more than one object is selected and performs noise removal, overlapping of objects. Here information on rectangle box for every object will not be lost because it will overcome the problem of occlusion.

In figure 2, a video of a two person moving are tracked in upcoming frames of 50×50 percentage .

Here tracking is based on color feature. Once the object is selected, it will be tracked for upcoming frames. This tracking of the object remains till it vanishes completely from the frame. Overlapping is achieved in following output. Rectangle bound will be captured for further processing

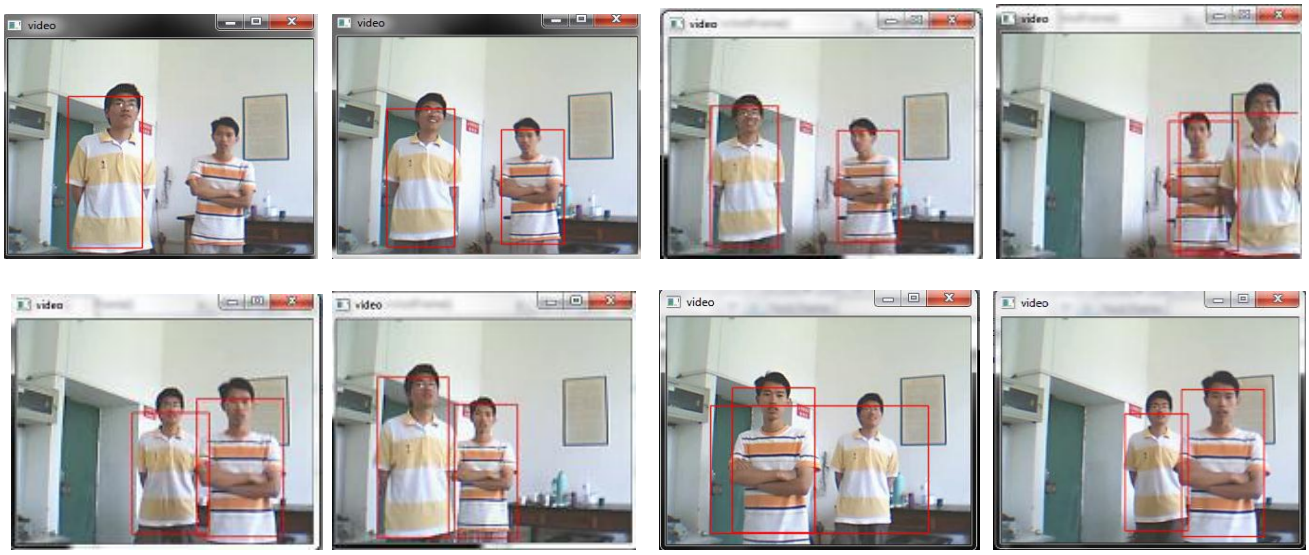

Fig 2.Tracking multiple object using mean shift in sequence of frame.

2. CamShift:

Camshaft (Continuously Adaptive Mean Shift) algorithm is established on basis of adaptation of mean shift that specified a probability density image, finds the mean (mode) of the distribution by iterating in the direction of maximum increase in probability density. Camshaft algorithm has recently gained significant attention as an efficient and robust method for visual tracking. A number of trails have been made to accomplish strong, high and effective performance target tracking. It is a low complexity algorithm for tracking and undergoes independent of the features representative the target. It first creates a model of the chosen hue using a color histogram and uses the Hue Saturation Value (HSV) color system that resembles to projecting average RGB color space along its principal diagonal from white to black [9]. The camshaft is able to handle the dynamic distribution by altering the size of the target window for the succeeding frame.

a. Implementation of Cam Shift:

We have also implemented mean shift tracking using OpenCV. We verified this implemented algorithm on the video containing the object in the every frame. The object is selected using the mouse event function in OpenCV. Once the object has been selected they are tracked for upcoming frames. Here they are some frame screenshot are taking any attached below. During the tracking histogram is drawn for a selected ROI of the frame. In figure 4, input is loaded from webcam of 50×50 percentage of every frame .This tracking of the object remains till it vanishes completely from the frame.

Fig 3. Tracking object using a Cam shift in sequence of frame.

3 Simple Template Matching:

It is a simple way of tracking wit reference image. Template matching is a brute force method of examining the Region of Interest in the video. In template matching, a reference image is verified with the frame that is separated from the video. Tracking can be done for single object in the video and overlapping of object is done partially. Template Matching is a technique for processing digital images to find small parts of an image that matches, or equivalent model with an image (template) in each frame. The matching

procedure contains the image template for all possible positions in the source image and calculates a numerical index that specifies how well the model fits the picture that position. The matching is done pixel by pixel. Here the reference image is taken from the video and they are compared with the successive frames in the video.

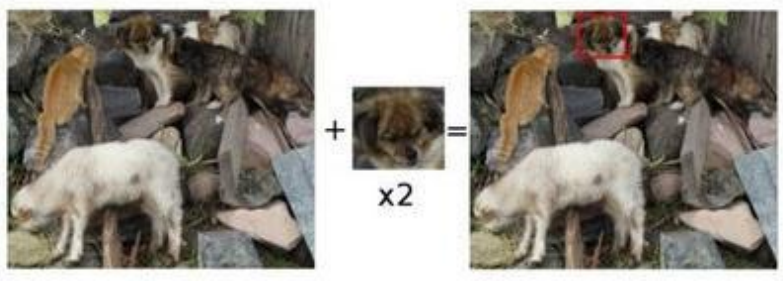

Fig 4. Simple Template Matching.

a. Implementation of Simple Template Matching:

We have also implemented Simple Template Matching tracking using OpenCV only. Once the reference image is taken from the input. In figure 5&6, they are compared with upcoming frames of video. Here they are some frame screenshot are taken and attached below. During the tracking, a reference image is compared for every frame and it is done pixel by pixel. This tracking of the object remains till it vanishes completely from the frame.

Fig 5. Simple Template Matching demo with Reference Image

Fig 6. Simple Template Matching demo with Reference Image

4. Contour Tracking:

Contour tracking methods, in contrast to shape the matching methodology. Iteratively progress a primary contour in the previous frame to its new position in the current frame. This contour progress requires that certain amount of the object in the current frame overlay with the object region in the previous frame. Contour Tracking can be performed using two different approaches. The first approach uses state space models to model the contour shape and motion. The second approach directly evolves the contour by minimizing the contour energy using direct minimization techniques such as gradient descent. The most significant advantage of silhouettes tracking is their flexibility to handle a large variety of object shapes. Contour-based approaches, the silhouette is denoted either *explicitly or implicitly*. *Explicitly* defines the boundary of the object by a set of control points. *Implicit* representation defines the silhouette by means of a grid (Fig 1 a & b*)*.

Handling Occlusion is an important aspect of silhouette tracking methods. Another important aspect of contour tracking is ability for dealing with object split and merges [4].

a. Implementation of Contour Tracking:

We have also implemented Contour Tracking using OpenCV. After loading the input, they are converted to frames. Once they grab the frames, initial frame will be converted to grayscale value. Compute the absolute difference between the frames. Applying of the convolution kernel for the grayscale image is made. Find the contour for the moving pixel and apply rectangle box for those pixels. Once they are changing in the initial frame to the next frame, the contour of rectangular box is made in that area. In the below fig 8,tracking of fan in upcoming frames are shown and they are tracked by the bounding box or rectangle region .This tracking of the object remains till it vanishes completely from the frame.

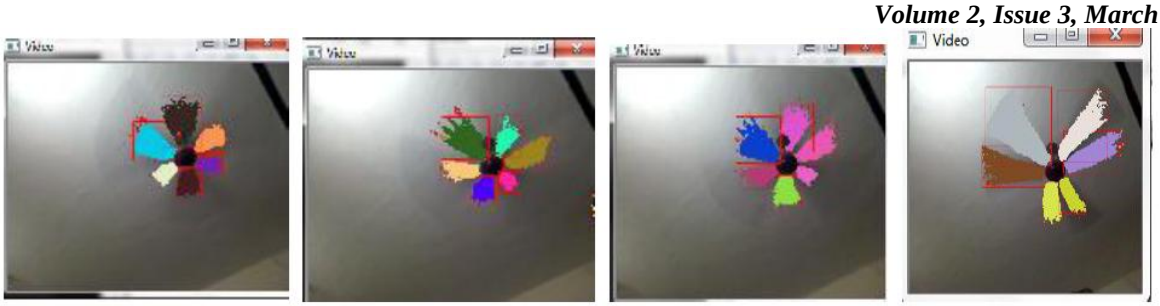

Fig: 7: Contour Tracking for Sequence of frames.

S.no	Methodologies	*Mean shift*	*Cam Shift*	*Simple Template Matching*	*Contour Based Tracking*
1.	Category	Kernel based	Kernel based	Kernel based	Silhouette based
2.	No of object tracked	M	S	S	M
3.	Color Based	√	√	×	×
4.	Noise Content	×	×	×	√
5.	Overlapping	F	F	P	F
6.	Flexibility	P	P	P	F
7.	Template Based	√	√	√	×
8.	Complex Object	P	P	P	F
9.	Manual initialization	√	√	√	×

Table:1 Qualitative Comparison for Tracking methodologies.(S:single,M:multiple,P:partial,F:full, Symbols √ and × denote whether the tracker can or cannot handle overlapping).

. IV. CONCLUSION

In this paper, we present an implementation of some of object tracking methods. The object is tracked mainly on the bases of *object extraction, object recognition and tracking, and decisions about activities.* We mainly classify objects tracking approach as *point tracking, kernel based tracking, and silhouette based tracking.* For illustration, the point trackers involve detection in every frame; while geometric area or kernel based tracking or contours-based tracking requires detection only when the object first appears in the scene. During the study, Mean shift tracked in basis of color, Noise content is less and overlapping of images or object is managed.

Complex object is also partially tracked by the mean shift algorithm. In the case of Cam Shift, it is similar to mean shift that is tracked based on color but flexibility is partial in this algorithm. In the case of Template matching, taking the reference image comparing with upcoming frames. Contour based Tracking will track multiple object wit fully overlapping and flexibly but not based on color. Experimental Results of *Mean shift, Cam shift, Template matching and Contour based tracking are done and* comparison table are prepared with that results. Results are shown with different frames with their positions of tracking. We believe that, this article can give valuable understanding into this significant research topic and encourage new research

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