Object Tracking in Video Scenes

INTRODUCTION

Object tracking can be defined as the process of segmenting an object of interest from a video scene and keeping track of its motion, orientation, occlusion etc. in order to extract useful information.

Object tracking in video processing follows the segmentation step and is more or less equivalent to the *'recognition'* step in the image processing. Detection of moving objects in video streams is the first relevant step of information extraction in many computer vision applications, including traffic monitoring, automated remote video surveillance, and people tracking. There are basically three approaches in object tracking. *Feature-based methods* aim at extracting characteristics such as points, line segments from image sequences, tracking stage is then ensured by a matching procedure at every time instant. *Differential methods* are based on the optical flow computation, i.e. on the apparent motion in image sequences, under some regularization assumptions. The third class uses the *correlation* to measure interimage displacements. Selection of a particular approach largely depends on the domain of the problem.

Applications of object tracking

Some of the important applications of object tracking are:

1. **Automated video surveillance**: In these applications computer vision system is designed to monitor the movements in an area, identify the moving objects and report any doubtful situation. The system needs to discriminate between natural entities and humans, which require a good object tracking system.

2. **Robot vision**: In robot navigation, the steering system needs to identify different obstacles in the path to avoid collision. If the obstacles themselves are other moving objects then it calls for a real-time object tracking system.

3. **Traffic monitoring**: In some countries highway traffic is continuously monitored using cameras. Any vehicle that breaks the traffic rules or is involved in other illegal act can be tracked down easily if the surveillance system is supported by an object tracking system.

4. **Animation**: Object tracking algorithm can also be extended for animation.

RELATED WORK

Many researchers have tried various approaches for object tracking. Nature of the technique used largely depends on the application domain. Some of the research work done in the field of object tracking includes:

1. *Gyaourova, C. Kamath, S. and C. Cheung* has studied the block matching technique for object tracking in traffic scenes. A motionless airborne camera is used for video capturing. They have discussed the block matching technique for different resolutions and complexities [5].

2. *Yoav Rosenberg and Michael Werman* explain an object-tracking algorithm using moving camera. The algorithm is based on domain knowledge and motion modeling. Displacement of each point is assigned a discreet probability distribution matrix. Based on the model, image registration step is carried out. The registered image is then compared with the background to track the moving object [6].

3. *A. Turolla, L. Marchesotti and C.S. Regazzoni* discuss the camera model consisting of multiple cameras. They use object features gathered from two or more cameras situated at different locations. These features are then combined for location estimation in video surveillance systems [7].

4. One simple feature based object tracking method is explained by *Yiwei Wang, John Doherty and Robet Van Dyck.* The method first segments the image into foreground and background to find objects of interest. Then four types of features are gathered for each object of interest. Then for each consecutive frames the changes in features are calculated for various possible directions of movement. The one that satisfies certain threshold conditions is selected as the position of the object in the next frame [3].

5. *Çiˇgdem Eroˇglu Erdem and Bülent San* have discussed a feedback-based method for object tracking in presence of occlusions. In this method several performance evaluation measures for tracking are placed in a feedback loop to track nonrigid contours in a video sequence [8].

Steps in object tracking

The process of object tracking is summarized in the block diagram below:

Basic steps in object tracking can be listed as:

- Segmentation
- Foreground / background extraction
- Camera modeling
- Feature extraction and tracking

Segmentation

Segmentation is the process of identifying components of the image. Segmentation involves operations such as boundary detection, connected component labeling, thresholding etc. Boundary detection finds out edges in the image. Any differential operator can be used for boundary detection [1,2]. Thresholding is the process of reducing the grey levels in the image. Many algorithms exist for thresholding [1,2]. Refer [2] for connected component labeling algorithms.

Foreground extraction

As the name suggests this is the process of separating the foreground and background of the image. Here it is assumed that foreground contains the objects of interest. Some of the methods for foreground extraction are,

Use of difference images In this method we use subtraction of images in order to find objects that are moving and those that are not. The result of the subtraction is viewed as another grey image called *difference image*. Three types of difference images are defined [1].

- Absolute accumulative difference image is given by f(x,y) = f(x,y) +1 ……if $|g(x,y,t_{i+1}) - g(x,y,t_i)| > T$
- Positive accumulative difference image is given by f(x,y) = f(x,y) +1 ……if $g(x,y,t_{i+1}) - g(x,y,t_i) > T$
- Negative accumulative difference image is given by f(x,y) = f(x,y) +1 ……if $g(x,y,t_i) - g(x,y,t_{i+1}) > T$

The following figures illustrate the three difference images.

A gap-mountain method described in [3] can then be applied to identify image blocks that are moving and those that are not moving. The gap-mountain method works as follows- Consider a difference image shown in the adjacent figure. A gap is a sequence of consecutive black pixels and mountain is a sequence of consecutive white pixels. If width of a mountain in a particular

row is greater than a preset threshold then we assume that a moving object is present in that row. Similar technique is the algorithm proceeds by dividing the image into smaller sub images (or sub matrices) until each sub matrix contains exactly one object. In the adjacent figure by choosing proper thresholds we can detect the presence of two blocks.

CONCLUSION

From the discussion, it can be seen that object tracking has many useful applications in the robotics and computer vision fields. Several researchers have explored and implemented different approaches for tracking. The success of a particular approach depends largely on the problem domain. In other words, a method that is successful in robot navigation may not be equally successful in automated surveillance. Further there exists a cost/performance trade off. For real time applications we may need a fast high performance system on the other hand offline applications we may use a relatively cheap (and slower in performance). It can also be seen from the diverse nature of the techniques used that the field has a lot of room for improvement.