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Object Tracking Scheme: Concept and Method

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ABSTRACT

Object tracking is an important task within the field of computer vision. In its simplest form, tracking can be defined as a method of following an object through successive image framesto determine its relative movement with respect to other objects. In other words, a tracker assigns consistent labels to the tracked objects in different frames of video. In this paper, we would like to provide basically concepts and methods for object tracking scheme.

Keywords: Object Tracking, Points, Skeleton Model, Feature Presentation, Motion Region Estimation,

I. Introduction

In this section, we will describe the object shape representations [1, 2] commonly employed for tracking. In a tracking scenario, an object can be defined as anything that is of interest for further analysis. Objects can be represented by their shapes.Object representations are usually chosen according to the application domain. For tracking object, which appear very small in an image, point representation is usually appropriate. For objects whose shapes can be approximated by rectangle or ellipse, primitive geometric shape representations are more appropriate. For tracking objects with complex shapes, for example, humans, a contour or silhouette based representation is appropriate.

- ✓ **Points:**The object is represented by a point, that is a centroid as shown in Fig. 1a or by a set of points as shown in Fig. 1b. The point representation is suitable for tracking objects that occupy small regions in an image.
- ✓ **Primitive geometric shapes:**Object shape is represented by a rectangle, ellipse (see Fig. 1c and Fig. 1d) primitive geometric shapes are more suitable for representing simple rigid objects, they are also used for tracking non rigid objects.
- ✓ **Object silhouette and contour:**Contour representation defines the boundary of an object (see Fig. 1g and Fig. 1h). The region inside the contour is called the silhouette of the object. Silhouette and contour representations are suitable for tracking complex non rigid shapes.
- ✓ **Articulated shape models:**Articulated objects are composed of body parts that are held together with joints.For example, the human body is an articulated object with legs, hands, head feetconnected by joints. In order to represent an articulated object, one can model the constituent parts using cylinders or ellipses as shown in Fig. 1e.
- ✓ **Skeletal models:**Object skeleton can be extracted by applying medial axis transform to the object silhouette. This method is commonly used as a shape representation for recognizing objects. Skeleton representation can be used to model both articulated and rigid objects.

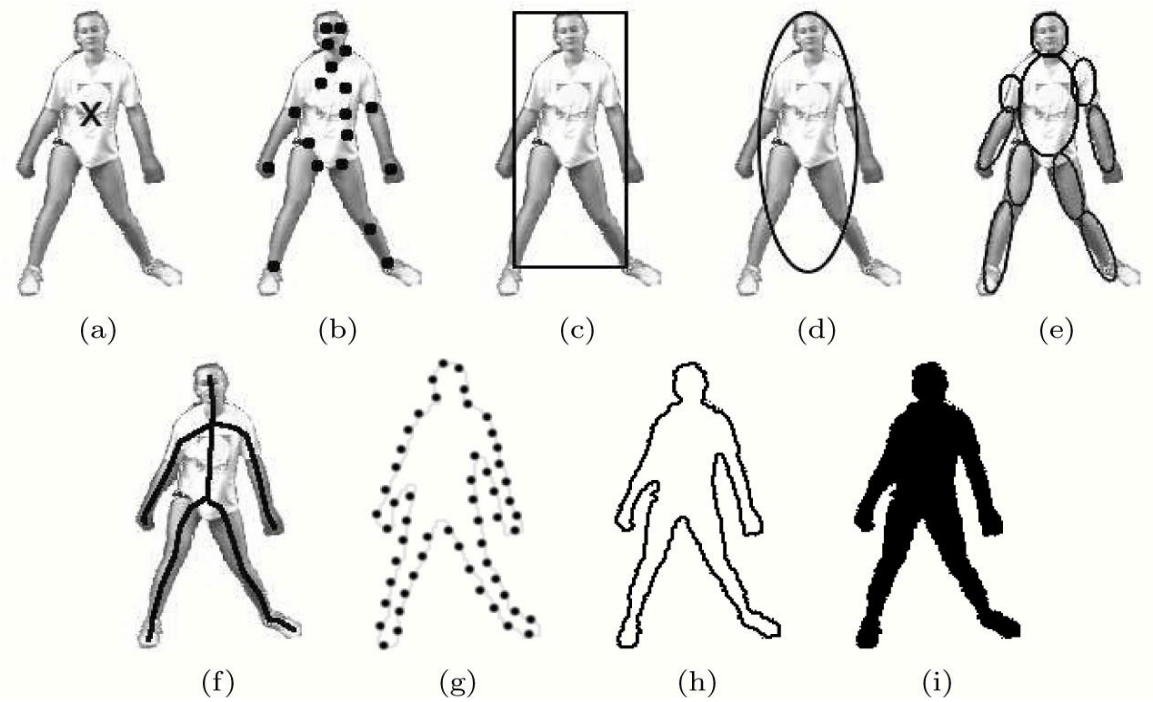

Fig. 1: Object representations, (a) centroid, (b) multiple points, (c) rectangular patch, (d) elliptical patch, (e) part-based multiple patches, (f) object skeleton, (g) complete object contour, (h) control points on object contour, (i) object silhouette.

II. Features-Based Tracking

Selecting the right features plays a critical role in tracking [3]. The most desirable property of visual feature is its uniqueness so that the objects can be easily distinguished in the feature space. In general, many tracking algorithms use these features. The details of visual features are:

- ✓ **Color:** The apparent color of an object is influenced primarily by two physical factors,1) the spectral power distribution of the illuminant and 2) the surface reflectance properties of the objects. In image processing, the **RGB** (red, green, blue) color space is usually used to represent color.
- ✓ **Edges:** Object boundaries usually generate strong changes in image intensities. Edge detection is used to identify these changes. Algorithms that track the boundary of the objects usually use edge as the representative feature.
- ✓ **Optical Flow:** Is a dense field of displacement vectors which defines the translation of each pixel in a region. It is computed using the brightness constraints, which assumes brightness constancy of corresponding pixels in the consecutive frames.
- ✓ **Texture:** Texture is the measure of the intensity variation of the surface which quantifies properties such as smoothness and regularity.

(a) (b) (c)

Fig. 2. Feature Examples, (a) RGB image, (b) Edge image, and (c) optical flow image.

III. Object Tracking Scheme

An accurate and fast background subtraction techniquefor object tracking in still camera videos. Regions of motion in a frame arefirst estimated by comparing the current frame to a previous one. A samplingre-samplingbased Bayesian learning technique is then used on the estimated regions to

perform background subtraction and accurately determine the exactpixels which correspond to moving objects. An obvious advantage interms of processing time is gained as the Bayesian learning steps are performed only on the estimated motion regions, which typically constitute only a small fraction of the frame. The technique has been used on a variety of indoor and outdoor sequences, to track both slow and fast moving objects, under different lighting conditions and varying object-background contrast. This algorithm presents robust system that achieves both (1) high speed and (2) high degrees of sensitivity compared to existing techniques. To achieve these objectives a two steps tracking system has been used:

- Motion Region Estimation [4]
- Bayesian Sampling Resampling [5]

Motion Region Estimation: The Block Matching Algorithm (BMA) is a standard way of encoding video frames. A simplified variation of the BMA algorithm is used for determining regions of each frame which have had motion relative to a reference frame. Such regions have been called regions of motion.Each incoming frame is divided into non-overlapping blocks of equal size. Each block is compared to the corresponding block in the reference frame and the Sum of Absolute Difference (SAD) is determined for the block.The reference frame may be chosen to be a few frames before the current frame, to account for slow moving objects.

Fig 3. Result of motion region estimation

Bayesian Sampling-Resampling: A 'sampling-resampling' technique given by Smith and Gelfand. This suggests easy implementation strategies and computational efficiency while implementing Bayesian learning. Pixel observations at a particular spatial pixel location are expected to form certain number of clusters. The parameters of these clusters are thought to have probabilistic distributions of their own. These distributions are updated via a Bayesian 'Sampling-Resampling' learning technique to obtain posterior distributions.

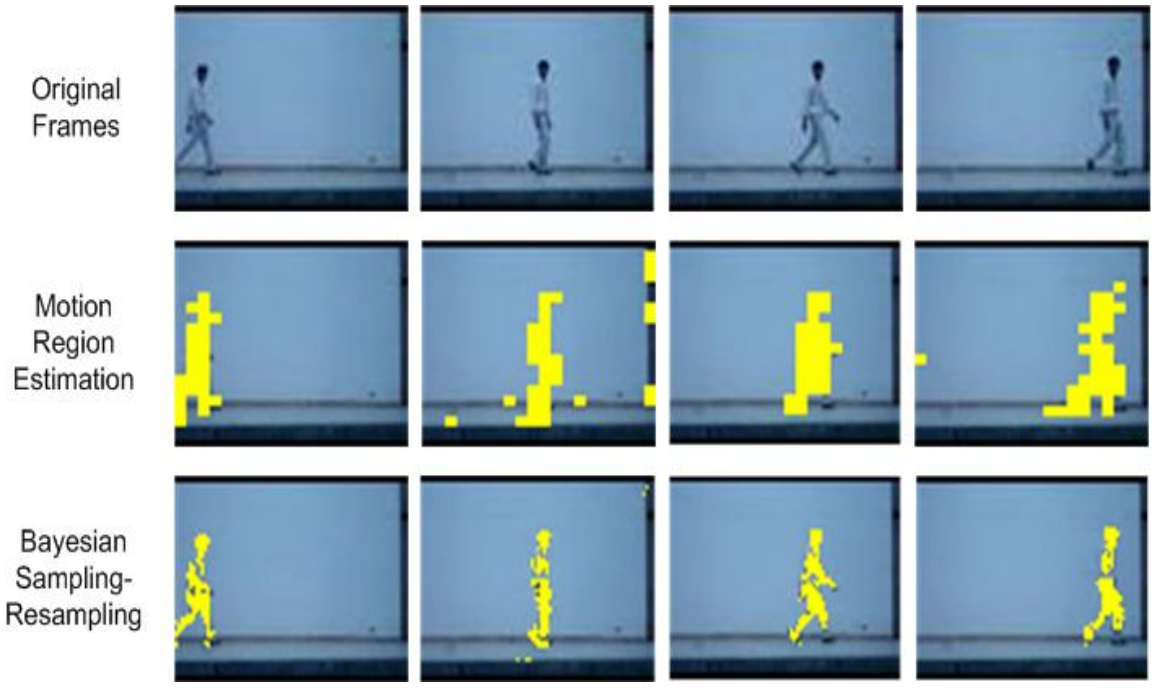

Fig. 4. The first row shows original frames from a video sequence. The second row shows the results of motion region estimation. The third row shows the final BayesianSampling-Resampling results.

CONCLUSION

Object tracking means tracing the progress of objects as they move about in visual scene. Object tracking, thus, involves processing spatial as well as temporal changes. Certain features of those objects have to be selected for tracking. These features need to be matched over different frames. Significant progress has been made in object tracking.

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