Motion Segmentation and Tracking

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Abstract

This paper presents a novel tracking based motion segmentation algorithm. The tracking is done by fitting successively more elaborate models of optical flow on the tracked region and the segmentation is done by extracting the regions of the image that are consistent with the computed model of flow. The method can track objects in image sequences with moving background, taken by a hand-held camera, tolerate up to 30 pixels interframe motion and takes 0.3 seconds per frame pair of size 320 x 240 pixels on a 500 Mhz Sun Blade 100 workstation.

Keywords: Motion Segmentation, Tracking, Optical Flow

1. Related Work

A tracking algorithm measures and predicts the motion of a moving object over time. Contours [8, 13] corresponding to the silhouette of moving objects are commonly used feature for tracking. The coherence of a moving region [5, 1] corresponding to the projection of a surface of the moving object is another good basis for tracking. Color [3, 9] of a moving object is also frequently used in tracking. Instead of tracking attributes belonging to the moving object, an orthogonal tracking approach is to find the moving objects in a dynamic scene by performing image difference on the image frames with known background [15]. In all of the above approaches, an initial representation of the to-be-tracked object or its background is given to the tracker as input and the role of the tracker is to measure and predict the motion of the moving object representation over time.

Meyer and Bouthemy [11] tracked the motion of regions computed by a motion segmentation algorithm over time assuming a model for the motion and change of shape of the regions. They used Kalman filtering to merge the prediction of the model with the actual measurements from the motion segmentation algorithm. This model can be best described as tracking based on motion segmentation whereas ours is best described as motion segmentation based on tracking.

Burt [2] identified and tracked the object by successively computing optical flow on a region, fitting an affine model on the computed flow, detecting outliers and warping the images. In a sense they fit two models on the optical flow data. One for the object and one for the background.

2. Algorithm

Our motion segmentation and tracking system automatically segments and tracks a region corresponding to the projection of a moving object given its input seed window. For every successive pair of image frames, the tracking stage fits successively more elaborate optical flow models on the tracked seed window and the segmentation stage detects the pixels whose changing intensity patterns are consistent with the model of optical flow. This is done by aligning all previous frames to the last one, computing a sum of squared differences statistic and thresholding. Aligning all previous frames is a computation intensive task, so in order to speed up the computation, we propose a statistic that encodes the history of the intensity pattern. We also propose a method to compute the per pixel threshold that takes into account the local image variation, the anticipated camera noise and the desired goodness of fit.

2.1. Input to system

The main input to the system is a window for the first image frame of the image sequence representing a region within the to-be-tracked object and its maximum interframe motion in pixels. The input window is the projection of a surface within the tracked object and hence its boundary must be inside the moving object. In our experiments, we use seed window of size 10×10 pixels. A small seed

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