Chapter 6 Improved Illumination Independent Moving Object Detection Algorithm Applied to Infrared Video Sequences

ABSTRACT

Performance of the moving objects detection algorithm on infrared videos is discussed. The algorithm consists of two phases: the noise suppression filter based on spatiotemporal blocks including dimensionality reduction technique for a compact vector representation of each block and the illumination changes resistant moving object detection algorithm that tracks the moving objects. The proposed method is evaluated on monochrome and multispectral IR videos.

1. INTRODUCTION

The performance of motion detection algorithm introduced in previous chapters is evaluated here. The main goal is to demonstrate that the novel technique is capable of successfully detecting moving objects in infrared videos.

Moving objects detection methods are in most of the cases pixel based (Jain, 1977), (Remagnino, 2002). Authors in (Stauffer, 2000) propose technique based on adaptive Gaussian mixture model of the color values distribution over time at a given pixel location. This approach is adopted but with a major difference that the computation is based on the spatiotemporal blocks. The standard input of pixel values are avoided as they are known to be noisy and the main cause of instability of video analysis algorithms. In contrast, the application of principal components instead of original vectors is expected to retain useful information while suppressing successfully the destructive effects of noise (Jolliffe, 2002). Consequently, the proposed technique (Pokrajac, 2003) provides motion detection robust to various types of noise that may be present in infra-red video sequences.

The pixel and region levels are combined to a single level texture representation with 3D blocks and the image processing is being performed on such spatially-temporally filtered pixels. A given video is decomposed into overlapping spatio-temporal blocks, e.g., 7x7x3 and 7x8x3 blocks centered at each pixel, and a dimensionality reduction technique is applied to obtain a compact representation of color or gray level values of each block as a single scalar value. The principal component analysis is applied and the dominant

eigenvector (corresponding to the largest eigenvalue) is used to obtain the coefficients of 3D filter that is employed on every current frame. Such filtered images are subsequently treated with the moving detection algorithm based on pixel value.

The application of principal component projection instead of original pixels is expected to retain useful information while suppressing successfully the destructive effects of noise. Proposed technique provides motion detection robust to various types of noise that may be present in infra-red video sequences.

2. IMPROVED NOISE RESISTANT ILLUMINATION INDEPENDENT MOVING OBJECT DETECTION ALGORITHM

The technique for moving object detection consists of two major phases:

- 1. Image filtering of a current frame with the noise removal filter coefficients extracted with the PCA analysis.
- 2. Detection of moving objects applying the pixel based method for moving object detection resistant to illumination changes.

A given video is treated as three-dimensional (3D) array of gray pixels with two spatial dimensions *X*, *Y* and one temporal dimension *Z*. We use spatiotemporal (3D) blocks represented by *N*-dimensional vectors, where a block spans (2T+1) frames and contains N_{BLOCK} pixels in each spatial direction per frame $N = (2T+1) \times N_{BLOCK} \times N_{BLOCK}$, which can be found in the literature mentioned in the references. To represent the block vector by a scalar while preserving information to the maximal possible extent, principal component analysis, sample mean and covariance matrix of representative sample of block vectors corresponding to the considered types of movies are estimated and

the first eigenvector of the covariance matrix **S** (corresponding to the largest eigenvalue) is used that represents the coefficients of the 3D filter that suppresses the noise. The 3D filter can be emulated by three 2D filters applied on frames z-1, z and z+1.

The last phase of the proposed method implies the application of a pixel based algorithm for moving object detection and tracking. The pixel variance is calculated in order to estimate the potential movement in the observed area incorporating the illumination compensation coefficient. The algorithm performs the analysis in time and space domains simultaneously, contributing to its resistance to the illumination changes and reducing the false detection, i.e. artifacts. Estimated pixel variances for three successive pairs of frames are averaged and the obtained average value is thresholded in order to determine the presence of moving objects. This represents temporal aspect of analysis. The time analysis, additionally to space analysis, helps with correct moving object detection and augments the precision of the algorithm. Details of the algorithm are provided in previous sections.

3. EXPERIMENTAL RESULTS

The performance of the proposed approach on two infrared video sequences is demonstrated in this section. The first sequence, *RoofCam*, is obtained from Ohio State University Thermal Pedestrian Database. Video was captured using a Raytheon 300D thermal sensor core with 75 mm lens. Camera was mounted on an 8-story building overlooking a pedestrian intersection on the OSU campus. Image size is 360x240 pixels and was captured at varying sampling rates. The second sequence, *RocketLounch*, is false color thermal infrared sequence of Spitzer Telescope launch (25 August 2003 at 1:35:39 a.m. EDT from Cape Canaveral Air Force Station in Florida) taken from 3km distance. 4 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: <u>www.igi-global.com/chapter/improved-illumination-independent-moving-</u> object-detection-algorithm-applied-to-infrared-video-sequences/94125

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