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Segmentation of Moving Object in Video Using Background Registration and GMEC

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Abstract: ***Emerging multimedia applications demand content-based video processing. Video has to be segmented into objects for content-based processing. A number of video object segmentation algorithms have been proposed such as semiautomatic and automatic. Semiautomatic method adds burden to users and also not suitable for some applications. Automatic segmentation systems are still a challenge, although they are required by many applications. The proposed work aims at contributing to develop a system to segment video objects automatically from the background given a sequence of video frames. The proposed work will identify and solve different problems in change detection like uncovered background, global motion of background, temporary poses. In the proposed work we will try to resolve the issue of moving camera and uncovered background. For moving camera we will use Affine Motion Model. To resolve the issue of the Uncovered Background we will use Background Registration Technique. The proposed work will try to resolve the issue of temporary poses by integrating the region based segmentation with the system. To improve the resulting change detection masks, a post-processing method is used to fill open areas inside object regions with uniform intensity. To improve the boundary of segmentation masks, morphological operations will be used.***

Keywords: Video Segmentation, Background Registration, Global Motion Estimation and Compensation, Object Detection.

1. Introduction

Video segmentation, which extracts the shape information of moving object form the video sequence, is a key operation for content-based video coding. Two methods are mostly used in video object segmentation, one is semi-automatic, in which some kind of user intervention is required to define the semantic object and other one is automatic, where segmentation is performed without user intervention, but usually with some a priori information. Automatic segmentation of video objects is required by most applications, especially those with real time requirements.

A number of Video object Segmentation algorithms have been proposed, most aiming to specific applications, and trying to fulfill specific requirements. Promising results have been obtained so far in semiautomatic methods, since there is also human assistance in the segmentation process. However, the human assistance involved in these methods is not required because it adds burden to users and also it is not suitable for some applications. On the other hand, fully Automatic Segmentation (AS) systems are still a challenge, although they are required by many applications.

Many automatic segmentation systems are designed for specific problems and with simplified assumptions like videos with fixed background. So it is necessary to have flexible automatic segmentation system for different types of videos. Most of the existing AS systems involves complex techniques. Also each stage of the segmentation process involves computationally intense operations to obtain good segmentation results Thus, reducing the complexity of the techniques involved is required while keeping accuracy of segmentation results. This can be done by selecting efficient algorithms with reduced computational intensity in each step of the segmentation process. Accuracy of segmentation can be improved by applying post-processing.
In this paper, an efficient video segmentation algorithm that can handle situations with any object motion, uncovered background, issue of temporary poses and issue of moving camera is proposed.

2. Related Work

A number of video segmentation algorithms have been proposed. Automatic video object segmentation algorithms developed are roughly classified into three types: the edge-feature based segmentation, spatial-temporal based segmentation, and change detection based segmentation. This section provides a critical review of the various approaches available for video segmentation.

[1] Kim and Hwang(2002) utilises Canny edge detector to find edge information of each frame and it can obtain correct segmentation object for stable moving-object, but this approach will require an absolute background from video sequence and involve a computation-intensive processing.

[2] Dailianas (2011) compared several segmentation methods and introduce a filtering algorithm in order to limit the false detections. Mandal (2011) focused on methods working in compressed domain.

[3] Hoynck M, Unger M and Ohm J-R. (2004) presents automatic segmentation of MOs in natural video sequences. This approach utilizes global motion estimation and compensation in combination with spatial image segmentation and segment-based diffusion of local MI.

[4] Guo J, Kim J and Kuo CCJ. (1999) combined colour and motion features for foreground and background separation. Global motion of background is done according to colour

similarity using a non-parametric gradient-based iterative colour clustering algorithm called the mean shift algorithm. Moving regions are then identified by a motion detection method, which is developed based on frame intensity difference.

[5] Munchurl kim, Jae Gark Choi (2002) uses a watershed transform to separate a frame into many homogeneous regions. It can obtain a good result of segmentation with high accurate boundaries, but it will suffer over-segmentation due to noise. Though this problem can be solved by smoothing the image previously, it will reduce the performance of the algorithm.

3. Proposed System

The block diagram of proposed system is shown in Fig. 1. Mainly the system is divided into three parts: Global Motion Estimation and Compensation (GMEC) , Baseline Mode and Region based Segmentation.

There are five parts in baseline mode: *Frame Difference*, *Background Registration*, *Background Difference*, *Object Detection*, and *Postprocessing*.

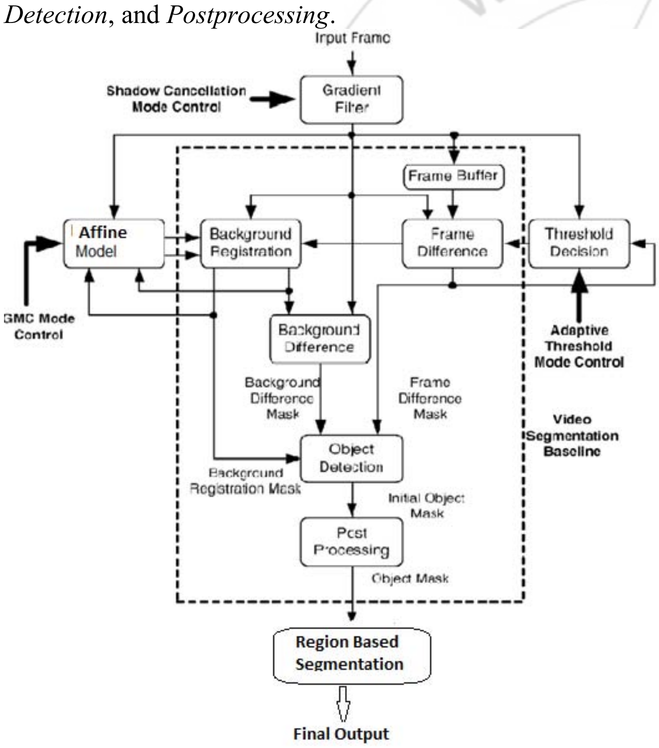

Figure 1: Block diagram

3.1 Global Motion Estimation and Compensation (GMEC)

For video sequences that contain camera motion, which causes GMOB, this global motion is compensated by the Motion estimation and compensation blocks. These are the **Forward GMEC** and **Backward GMEC** blocks in Figure 2. There are three phases of the motion estimation and compensation process proposed in this design:
1) Dense motion vector estimation
2) Parameter estimation
3) Motion Compensation or Frame warping

Dense motion vector estimation: For the dense motion vector estimation, a three-level Hierarchical block based algorithm is used for its compromised performance in computational complexity, speed and accuracy. Mean pyramids are constructed using the simple averaging equation .Then the pyramidal images are searched from top to bottom using MAD for block matching criterion. A full search within two pixels distance around the concerned block is done for better accuracy of matching block. The most commonly used 16x16 pixels block size is used at level-0 of the hierarchy. The process is shown in Fig.2

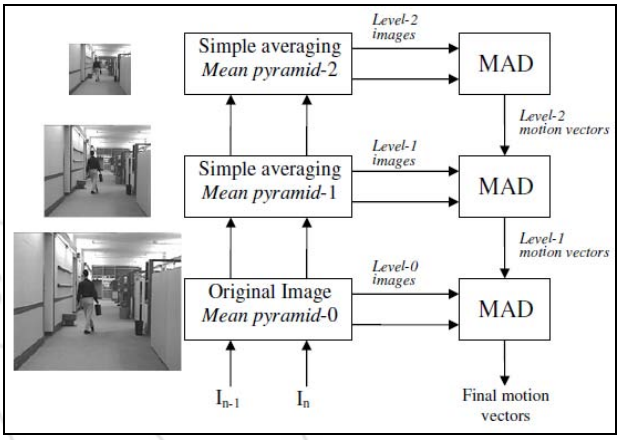

Figure 2: Three-level hierarchical mean pyramid based ME

Parameter estimation: The six parameter motion model, the affine model is used for the global motion. For estimation of the affine parameters, the least squares minimization criterion over the background frame is used to minimize the error between the dense and parametric model motion vectors. The previous background mask Bn-1 is used to estimate the background part of the current frame where the global motion is valid.

Frame warping: The parameters estimated from the above step are used to align the previous/next frame to the current frame. In this process, a new frame is calculated from previous frame by transforming the coordinates of the pixels of the previous frame into a new Position.

3.2 Baseline Mode

There are five parts in baseline mode: *Frame Difference*, *Background Registration*, *Background Difference*, *Object Detection*, and *Postprocessing*.

A.Frame Difference

In *Frame Difference*, the frame difference between current frame and previous frame, which is stored in *Frame Buffer*, is calculated and thresholded. It can be presented as

$$FD(x,y,t) = |I(x,y,t) - I(x,y,t-1)|$$
$$FDM(x,y,t) = \begin{cases} 1 & \text{if } FD \geq Th \\ 0 & \text{if } FD < Th \end{cases}$$

where FD is frame data, is frame difference, and FDM is *Frame Difference Mask*. Note that there is a parameter TH needed to be set in advance. The method to decide the optimal is shown in Section VI. Pixels belonging to are viewed as "moving pixels."

B. Background Registration

Background Registration can extract background information from video sequences. According to , pixels not moving for a long time are considered as reliable background pixels. The procedure of *Background Registration* can be shown as

$$SI(x,y,t) = \begin{cases} SI(x,y,t-1)+1, & \text{if } FDM = 0 \\ 0, & \text{if } FDM = 1 \end{cases}$$

$$BG(x,y,t) = \begin{cases} I(x,y,t), & \text{if } SI(x,y,t) = Fth \\ BG(x,y,t-1), & \text{else} \end{cases}$$

Where SI is Stationary *Index* and BG is the background information.

C. Background Difference

The procedure of *Background Difference* is similar to that of *Frame difference*. What is different is that the previous frame is substituted by background frame BG . After *Background Difference*, another change detection mask named *Background Difference Mask(BDM)* is generated. The operations of *Background Difference* can be shown by

$$BD(x,y,t) = |I(x,y,t) - BG(x,y,t-1)|$$

$$BDM(x,y,t) = \begin{cases} 1, & \text{if } BD \geq Th \\ 0, & \text{if } BD < Th, \end{cases}$$

Where BD is background difference, BFD is background frame and BDM is *Background Difference Mask* respectively.

D. Object Detection

Both of FDM and BDM are input into *Object Detection* to produce *Initial Object Mask (IOM)* . The procedure of *Object Detection* can be presented as the following equation.

$$IOM(x,y,t) = \begin{cases} BDM(x,y,t), & \text{if } BI(x,y,t) = 1 \\ FDM(x,y,t), & \text{else.} \end{cases}$$

E. Postprocessing

The *Initial Object Mask* generated by *Object Detection* has some noise regions because of irregular object motion and camera noise. Also, the boundary may not be very smooth. Therefore, there are two parts in Postprocessing: noise region elimination and boundary smoothing.

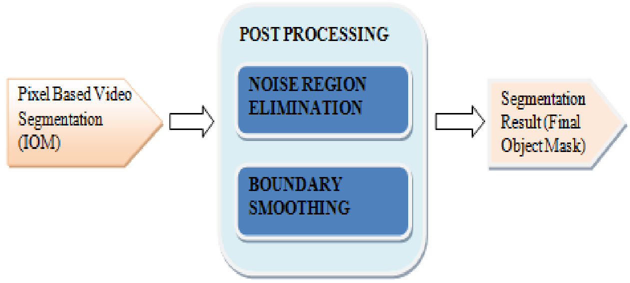

Figure 3: Post processing block diagram

3.3 Region Based Segmentation

The Algorithm Partition the image into regions with common features suitable for further analysis. The Extracted Region Are Uniform with respect to some characteristic, such as intensity, color, texture.

4. Conclusion

Thus the proposed work will solve the issue of uncovered background and moving camera and temporary poses. The issue of the Uncovered Background will be solved by Background Registration Technique. Issue of moving camera will be solved by Global motion estimation and compensation. Issue of temporary poses will be solved by integrating Region Based segmentation with the system.

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