A Robust Moving Object Segmentation for Illumination Change

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Abstract: An efficient algorithm to segment the moving object is very important in the surveillance system. In general, the change detection by comparing brightness value is a good and simple method, but it shows a poor performance under illumination change. Therefore, we propose the segmentation algorithm to extract effectively the object in spite of the illumination change. A good segmentation performance is demonstrated by the simulation result.

1. Introduction

The conventional video segmentation can be roughly divided into the two categories; one utilizes the spatial homogeneity and the other uses the change detection from temporal information. The segmentation techniques based on the spatial homogeneity simplify an image by using morphological filters, and then decide the region boundary [1]. The other segmentation techniques extract the moving objects by using a change detection mask from the consecutive frames [2]-[4].

The object segmentation technique just using the difference of brightness value is a simple scheme, however, it has difficulty in extracting an accurate object region under the variable illumination condition. The object segmentation based on the edge information is quite efficient for the variable illumination conditions, on the contrary, is more sensitive to noise. Kim et al. obtained the object by partitioning an object into the moving region and the still region by using edge [4].

This paper presents an efficient algorithm to extract the moving object even if illumination change occurs in the surveillance systems. There are three modes to extract the object according to circumstances. The first mode uses the difference between the background and the current frame while the available background frame exists. With a moment of illumination change the second mode is applied. In last mode the object is extracted using both the difference of the consecutive frames and the background removal method, simultaneously the background generation process makes steady progress until new background frame is achieved.

2. Proposed Algorithm

We propose the adaptive extraction algorithm in the surveillance system. In the system the camera is fixed and background is stationary. The block diagram of the proposed method is shown in Fig. 1.

2.1 Decision for illumination change

This paper proposes the separate processing modes based on illumination change. Thus each mode requires the criterion for illumination change. The reminder except for the object region in the current frame is used to determinate the criteria for illumination change. If the mean of brightness value in the reminder is higher than the threshold, the illumination change is occurred.

2.2 The extraction mode

2.2.1 Background difference

In this mode, the object is created from the difference between the background and the current frame. This background difference method shows a good performance as well as little computation complexity. In this case, the frame difference has a lot of background noises. This drawback can be overcome using edge information. Then, the edge information of the background difference performed by using the canny operator becomes the robust edge information for the noises. This method efficiently extracts the shape information of object in video sequences having lots of noise in the stationary background. The edge of difference $OE_{1n}$ is defined as follow:

$$OE_{1n} = \phi_{Cn-B} = \theta(VG^k | Cn-B|) \tag{1}$$

$C_n$ and $B$ are the current and the background frame respectively. The $\phi$ represents the canny edge detection. The $OE_{1n}$ denotes the spatial edge information of the object in this step.

2.2.2 Background removal

As the illumination suddenly is changed, the background difference method can’t generate the reliable object. Therefore, we use the current frame edge and the background edge both of which have less sensitiveness in the illumination change. In this mode, we obtain the $DoE_n$ of difference $[Cn-\phi B]$. The process obtaining the initial object is defined as

$$OE_{3n}(i,j)= \begin{cases} 1, & \text{if } ((DoE_n(i,j) > Tr) \text{ and } (FEn(i,j) > Tc)) \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

where $DoE_n(i,j)$ is the frame difference which obtained both from the background and the current frame, $FE_n(i,j)$ is the current edge frame. $Tr$ indicate 10 in simulation. $Tc$ is the threshold value from Otsu’s binary algorithm.

2.2.3 Frame difference

This sub-section describes the extracting method of the object when the brightness of the background region is not changed and the reliable background frame is not generated. The process of generating background makes steady progress through registering the elements of the background in each frame. If the reliable background frame is constructed finally, the background difference method is performed to obtain the initial object. The edge of the frame difference is defined as

$$EoFD_n = \phi |Fi - F_{n-1}| \tag{3}$$

where $F_n$ and $F_{n-1}$ are the current and the previous frame respectively. This result frame has boundary of the object that happens to the object motion. We select the pointer that the position of the $EoFD_n(i,j)$ is equal to the position of the current frame edge $FE_n$. Thus, this pointers, $EP_n$ contain the only information having any motion in the current frame. Moreover this mode is used the background removal method for the sufficient edge information. The acquired edge of an object is defined as follows: