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A Moving Target Detection Method Based on Improved Frame Difference Background Modeling

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Abstract: Background modeling is the key technology for moving target detection implemented with the background difference method. The conventional background modeling methods cost large amount of calculation time, in order to improve the speed and precision of the model, this paper presents an improved Frame Difference Background Modeling. The frame difference background modeling was initialized by Selective Averaging method, on the basis of this, Moving objects is detected by background difference method. This kind of modeling method separated the moving targets and got the average of the background area, reduced the influence of moving target to background. The experimental results show that the method needs less prior video sequences and the background of the extracted is more accurately, the effect of the moving target detection is better.

Keywords: Frame difference background modeling, moving target identification, selective averaging method.

1. INTRODUCTION

The background difference method [1] is a kind of widely used moving object detection algorithm. Relative with the frame difference method [2], background difference method can detect more complete moving target, relative the optical flow method [3], this method is simple, needs less amount of calculation and meets the requirements of real-time. Background difference method gets the current image subtracting the background image extracted beforehand, extracts the moving object by using the theory of the relative motion between the moving target and background and by using the difference between background pixels pixel with the target area pixels pixel. Therefore, to extract the accurate background image (background modeling) [4] is the key to success for background difference method. This paper analyzes the commonly used kinds of background modeling method and improves the frame difference background modeling on the basis of the traditional method, puts forward the new method for initialization, and proves its feasibility by experiments.

2. COMMON BACKGROUND MODELING METHODS AND ANALYSIS

2.1. The Average Method

According to the principle that the background image appearing probability is higher than foreground image appearing probability, average method [5] takes the moving target as noise and gradually eliminate foreground image by taking the average. The statistics for the pixel values of the same location in the video time sequence show that the frequency of background's emergence is bigger than the foreground's, so it will be easier to filter out foreground after average, the result is close to the background image. With the increase of sampling number of image, the results for extracting the background are better, at the same time, the average method will eliminate some noise based on pixel averaging. The experiment is shown in Figs. (**1** and **2**).

Fig. (1). Take an average of 60 frames.

2.2. The Median Method

The median background modeling method [6], is an extension of the median filter. This algorithm takes N images on the timeline, sorts pixel values in the corresponding position of the N frame, intermediates values as a background image pixel values, and builds the model for the background image. From a statistical standpoint, the number of occur-

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Fig. (2). Take an average of 80 frames.

Fig. (3). Medium value of 60 frames.

Fig. (4). Medium of 80 frames.

Fig. (5). Medium of 110 frames.

rences of background pixels is big while the number of occurrences of target pixels is little, The method takes the target image pixel values as noise elements and removes it by using the principle of median filter. The experiment is shown in Figs. (**3-6**).

The experiment is shown in Figs. (**3-5**). The three images are the background modeling effect by using median method corresponding 60 frames, 80 frames, 110 video images.

It can be seen that the median method has no goals ghosting, the effect is better than the average method. However, Median background modeling method needs sorting and calculating, the time required for longer. In the 60 s and 80 frames, there are obviously moving target in the background t, until 110 frames, the target has not been completely eliminated.

2.3. Mixed Gaussian Background Modeling Method

Video image can be divided into moving targets and the background of two parts, there are dual waves on the gray-level histogram of image, because of the dissimilarity between the background's pixel gray level and the moving target's pixel gray level, a wave is on behalf of the moving target gray value, another is on behalf of the center of the background gray value, This is the single gaussian model. But in reality, the background image is more complex, the algorithm could be affected by light, the interference of other tiny objects, the histogram can present more peaks. Single gaussian model cannot express the complicated changes, the gaussian mixture model [7] simulates the change of each pixel in image with 3 to 5 gauss models and updates model after a new frame. the algorithm matches the current each pixel in the image with the gaussian mixture mode, if successful, this point is as the background pixels, or is as the foreground pixels.

The experiment is shown in Figs. (**6** and **7**). We can see from the experimental results, at the beginning of the background modeling, background image is fuzzy and unstable, even has target shadow, along with the continuous renewal of the background image, background model is gradually stable. In the initial time of background modeling, background image target has obvious ghosting, time modeling needs a long time to be improved gradually. This method of modeling need more data and run slower, the real-time performance is not very good.

Fig. (6). Gaussian mixture background model.

Fig. (7). A frame in the video image.

2.4. The Frame Difference Background Modeling Method

The principle of this kind of modeling method [8]: In the process of updating background, the algorithm sets weights of different sizes to the background and the current frame image, makes the current frame part weight coefficient small and makes the background weight coefficient of the moment before bigger. The algorithm finds moving target area by the difference between the current frame image and the previous frame, the background of the movement area was replaced by the background of previous time, while the current frame's weight and the previous frame's weight is added for updating the non-movement area, the background can be updated over time.

In the common background modeling method, mean value method is simple, but is sensitive to environmental changes. Median method needs large computation, background modeling takes a long time. For Gaussian mixture background modeling method, the initial result is bad, because of large amount of calculation. It needs a period of time to update and get the ideal background image. In this paper, we improves the frame difference background modeling on the basis of the traditional method, puts forward the new method for initialization, and proves its feasibility by experiments.

3. OBTAINING THE INITIAL BACKGROUND IMAGE BY SELECTIVE AVERAGING METHOD

Traditional frame difference background modeling method chooses the first frame or the N frames image for the average as the initial background. In general, we can't shoot a completely image without moving object in reality as a background, and it does not meet the requirements of intelligent detection. But if we choose the first frame of the image containing moving object, We will see the shadow of moving object at early time to get the background. It will be disappear after a period of iteration [9]. So at the beginning, the frame differential background modeling method must have a background image without target information. Traditional average background modeling method takes more than 100 frames to get a picture of a background image accurately. Here we put forward Selective Averaging method to obtain difference modeling of the early background image.

Principle of Selective Averaging method is put forward on the basis of the original average method for background modeling. In the adjacent two frames, The area with changing pixel values is moving target area, the region with relatively stable pixel values is background region [10]. By using traditional frame difference method with threshold selection, the image background region and prospect area is distinguished. The moving target pixel is set to zero, the part of background pixels remain the same.

The choice of threshold can be selected through the experiment. The general background pixels change little. We can obtain the threshold according to the actual situation with the experiment.

If we want to get a complete background images, choose N frames of a video, compare two frames by frame difference method [11], get the continuous sequence background images.

The process of selective average method is as follows:

(1) The background sequences is obtained by using the frame difference method. The target area is set to 0, background region remain the same:

$$B_i(x,y) = \begin{cases} 0, if \left| f_i - f_{i-1} \right| \rangle T \\ f\ (x,y), if \left| f_i - f_{i-1} \right| \le T \end{cases} \quad (1)$$

(2) Obtaining the number of the background image sequences with pixels not equaling to 0 :m(x, y).

(3) Taking the average background image sequences for average

$$B(x,y) = \frac{1}{m(x,y)} \sum_{i=1}^{N-1} B_i(x,y) \quad (2)$$

4. THE STEPS OF IMPROVED FRAME DIFFERENCE BACKGROUND MODELING

(1) Obtaining the initial background image

(2) Choosing the iteration parameters $i = 1$;

(3) Getting the difference image (such as Figs. (**8** and **9**))

Fig. (8). Frame 3 and 4 frame difference.

Fig. (9). Frame 6 and 7 frame difference.

$$BW(x,y)_i = \begin{cases} 1, if abs(I_i - I_{i-1}) \geq T \\ 0, if abs(I_i - I_{i-1}) \langle T \end{cases} \quad (3)$$

The selection of threshold is artificial certain numerical value, can be obtained with practice experience. I_i is the first i frame and $I_{i-1}$is the first (i-1) frame, respectively. BW_i is the difference image.

(4) Background updating

The background image is got by selective average method. Background region and moving target area of the current image is distinguished According to frame differential method. In Moving target area, the background part need not to be update, the background region of previous frame image keep the same. In Background region, the background part is updated by adding the background of the previous frame and current frame image which has a weight [12].

$$B_i(x,y) = \begin{cases} B_{i-1}(x,y), if BW(x,y) = 1 \\ (1-\alpha)B_i(x,y) + \alpha I_i, if BW_i(x,y) \end{cases} \quad (4)$$

(5) Iterative operating

i=i+1, return (4).

By separating moving object and summering the average for the background region, Selective averaging method reduces the motion target's influence on the background, and makes the influence of extracting background results more accurate. The prior video sequences become less.

Select the appropriate frames to get the initial background image, If the number of frames is too little, the results of selective averaging method will appear holes [13]. If the number of frames is too much, it will not only waste of resources but also increase the burden of computation. And, too long time, light, environmental change and other factors will influence the accuracy of the results. Generally, choose it according to the rate of movement of the object and the size of target. It is advisable to make all areas of video images display background

5. THE EXPERIMENTAL RESULTS OF BACKGROUND MODELING

Simulation results are shown in Figs. (**10** and **11**). Fig. (**3**) is the result of modeling background got by the traditional frame difference background modeling method, Fig. (**4**) is the picture of the improved frame difference background modeling. The shadow of motion can be seen obvious through the traditional method, and modeling is not accurate. The improved modeling method reduces the influence of the sports information, and gets the ideal background.

Fig. (10). The background got by frame difference background modeling.

6. MOVING OBJECT RECOGNIZING

The principle of moving object recognition is obtaining the background image through improved frame difference background model, and combining with the background difference method for moving targets, implement moving target detection. Make binary images of moving targets for morphological operation [14], remove the small target has nothing to do with the moving target, populate the target internal hole, connect the target part of fracture after threshold seg-

mentation [15], make the image more complete. Moving target identification of the main steps is as follows:

Fig. (11). The background got by the improved frame difference background modeling method.

1). Obtaining the background image $b_i(x, y)$ by the improved frame difference background modeling method.

2). Computing the difference between the current frame image and the background image.

$$D_i(x,y) = \left| f_i(x,y) - b_i(x,y) \right| \tag{5}$$

3). Getting binary image: Obtain appropriate threshold by experiment. Set value greater than the threshold for '1', and set value less than the threshold for '0". the binary image of target is obtained [16].

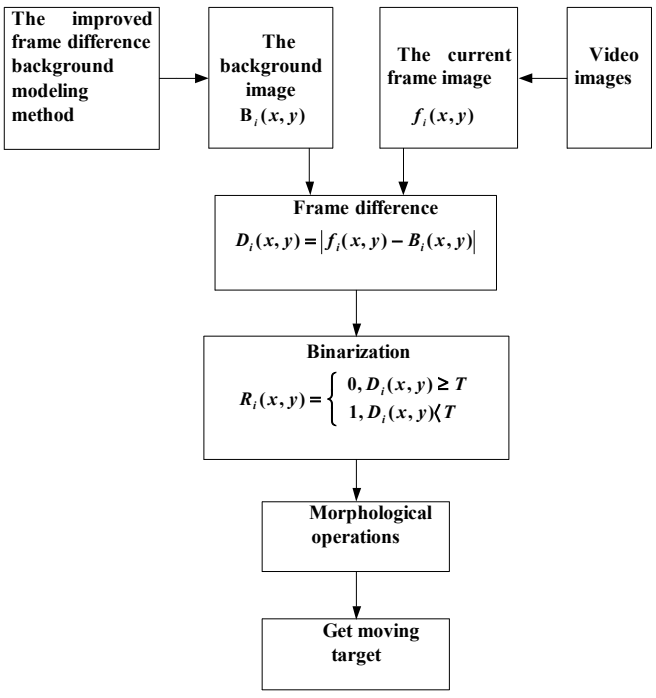

Fig. (12). Flow chart of moving target identification.

$$R_i(x,y) = \begin{cases} 1, D_i(x,y) \geq T \\ 0, D_i(x,y) < T \end{cases} \tag{6}$$

4). Make binary images of moving targets for morphological operation, remove independent pixels, and make them more complete.

The flow chart of the moving object recognition is shown in Fig. (**12**).

7. THE EXPERIMENTAL RESULTS AND ANALYSIS

Simulation results are shown in Figs. (**13-16**). The effect of the algorithm is validated by the experiment. Apply the background image got by the improved frame difference background modeling to the background difference method for target detection, and get the binary images of moving targets. In the Fig. (**14**), We can see the complete target is extracted. Using smaller circular structure in Fig. (**14**) image for an open operation, removing scattered noise pixels around the moving target. Fig. (**15**) is effect after processing. With a larger structural elements on a closed operation, fill the target within the pixels, get complete target image template, so as to realize the detection of moving target (Fig. **16**).

Fig. (13). A frame in the video image.

Fig (14). Binary image.

Fig. (15). Image after the opening operation.

Fig. (16). Image after the closing operation.

CONCLUSION

In this paper, the traditional frame difference background modeling is improved, the moving target recognition is realized on this basis. by selective averaging method, the frame difference background modeling was initialized by Selective Averaging method, The influence of the movement information is reduced, The speed of modeling was improved, the effect of the moving target detection is better.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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