

# A New Moving Object Detection Method Based on Frame-difference and Background Subtraction

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**Abstract.** Although many methods of moving object detection have been proposed, moving object extraction is still the core in video surveillance. However, with the complex scene in real world, false detection, missed detection and deficiencies resulting from cavities inside the body still exist. In order to solve the problem of incomplete detection for moving objects, a new moving object detection method combined an improved frame-difference and Gaussian mixture background subtraction is proposed in this paper. To make the moving object detection more complete and accurate, the image repair and morphological processing techniques which are spatial compensations are applied in the proposed method. Experimental results show that our method can effectively eliminate ghosts and noise and fill the cavities of the moving object. Compared to other four moving object detection methods which are GMM, VIBE, frame-difference and a literature's method, the proposed method improve the efficiency and accuracy of the detection.

## 1. Introduction

Moving object detection is always focused and difficult in the video sequence analysis. Many classic methods have been proposed in the long-term study of moving object detection, including inter-frame difference<sup>[1]</sup>, optical flow<sup>[2]</sup> and background subtraction<sup>[3]</sup>.

Recently, the combination of frame-difference and background subtraction for moving object detection has caused widespread attention<sup>[4]</sup>. An improved object detection method based on background model and inter-frame difference is proposed in [5], which reduced the amount of ghosts in the mixed Gaussian background subtraction and the serious cavities in the inter-frame difference and detected moving objects effectively under the condition of the background mutations. However, the detection is not accurate for complex environment. Literature [6] put forward a new moving object detection method, which calculated optical flow information with selecting the image representative Harris corner pixels, simplified the calculation of optical flow and three-frame difference method was introduced as a supplement, while the optical flow was more complex. Literature [7] presented a technique which improved the frame difference method by first classifying the blocks in the frame as background and others using correlation coefficient.

In this paper, a new moving object detection method is proposed. This method which combines the idea of background subtraction and frame-difference has the following new features: 1) the method proposed can greatly fill the cavities of the foreground object and eliminate the noise because it is a fusion method; 2) the algorithm of image combination is introduced; 3) image repair and morphological processing techniques were took into the method to repair the moving objects.



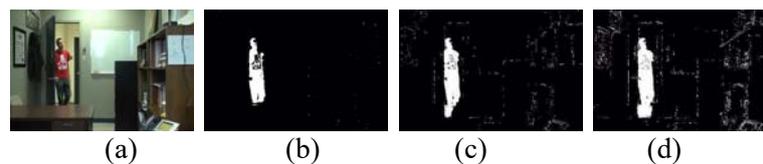
## 2. The new moving object detection method

In this paper, we propose an improved frame-difference. The improved frame-difference as the formula 1:

$$D(x, y, \Delta t) = |f(x, y, t) - f(x, y, t-1)| \oplus |f(x, y, t+1) - f(x, y, t-1)| \quad (1)$$

Where  $f(x, y, t-1)$ ,  $f(x, y, t)$  and  $f(x, y, t+1)$  are three adjacent images in the image sequence, the difference image is  $D(x, y, \Delta t)$ . The improved frame-difference which takes full advantages of the accumulation frame-difference<sup>[8]</sup> and the discontinuous frame-difference<sup>[9]</sup> can enhance the movement target and weak the impact of environmental factors and noise.

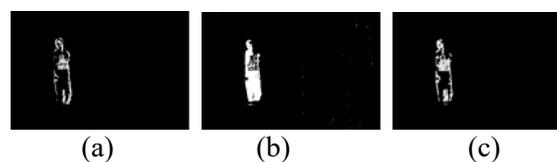
In the GMM background model, the quality of the foreground object is highly dependent on a fixed threshold. A high threshold may cause fragmented foreground objects, while a low threshold can result in noisy pseudo-foreground objects. While selecting an appropriate threshold for different frames is very difficult and also is not impractical. In this paper, we set different thresholds to produce three images and the result is shown in Fig.1. (a) is the original video, (b) is the foreground image which has a high threshold called SP, (c) is SS1 which has a low threshold and (d) is SS2 which has a lower threshold than SS1.



**FIGURE 1.** Example of difference thresholds. (a) Original video; (b) SP; (c) SS1; (d) SS2

Fig.1 shows that SP is mainly composed of important parts of the foreground and some fragment, SS1 and SS2 contain more detailed image information. In this paper, the foreground image produced by improved frame-difference is called F.

In most previous work, the combination of frame difference and background subtraction is based on the simple AND or OR operation to get the foreground objects. However, it does not suitable for some scenes because of much more noise. The follow image combination algorithm is used to solve this problem. This image combination algorithm is well summarized in Algorithm1. On account of F and SP contain important foreground information, first use the Algorithm1 to combine F and SP, as shown in the Fig.2, where FSP is the result of the combined of F and SP.



**FIGURE 2.** Combined image. (a) F; (b) SP; (c) FSP.

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### Algorithm1 image combination algorithm

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Input: two RGB images, one used as main picture, the other used as background.

Output: combined picture

Step 1: Convert the color image to array.

(i) Convert the color image to L\*a\*b color.

(ii) Convert main picture to Data  $X_0 = \{\{x_1, x_2 \dots\}, \{x_k, x_{k+1} \dots\}, \dots\}$ ; the background Data  $X_1 = \{\{y_1, y_2, \dots\}, \{y_k, y_{k+1} \dots\}, \dots\}$ ;

Step 2: Initial output Data  $X_2 = \{\{0, 0 \dots\}, \{0, 0 \dots\} \dots\}$ .

Step3: Literal all pixels in  $X_0$ , for a white pixel, check 3\*3 in  $X_1$ , if found any one not zero, set

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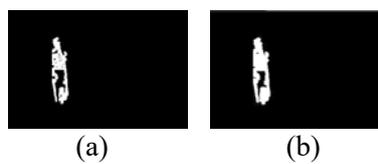
corresponding pixel in  $X_2$  with 255.

Step4: Literal all pixels in  $X_1$ , for a white pixel, check  $3*3$  in  $X_0$ , if found any one not zero, set corresponding pixel in  $X_2$  with 255.

Step 5: Convert  $X_2$  to image as result.

Although FSP has clearly eliminated noise and ghosts, there are still obvious cavities. Therefore, it is necessary to use the image repair to further process the foreground objects. FPS is repaired with the images which contains richer details. FPS is first improved by SS1, And then improved by SS2, then can get the repaired image. Repair processing is based on algorithm1.

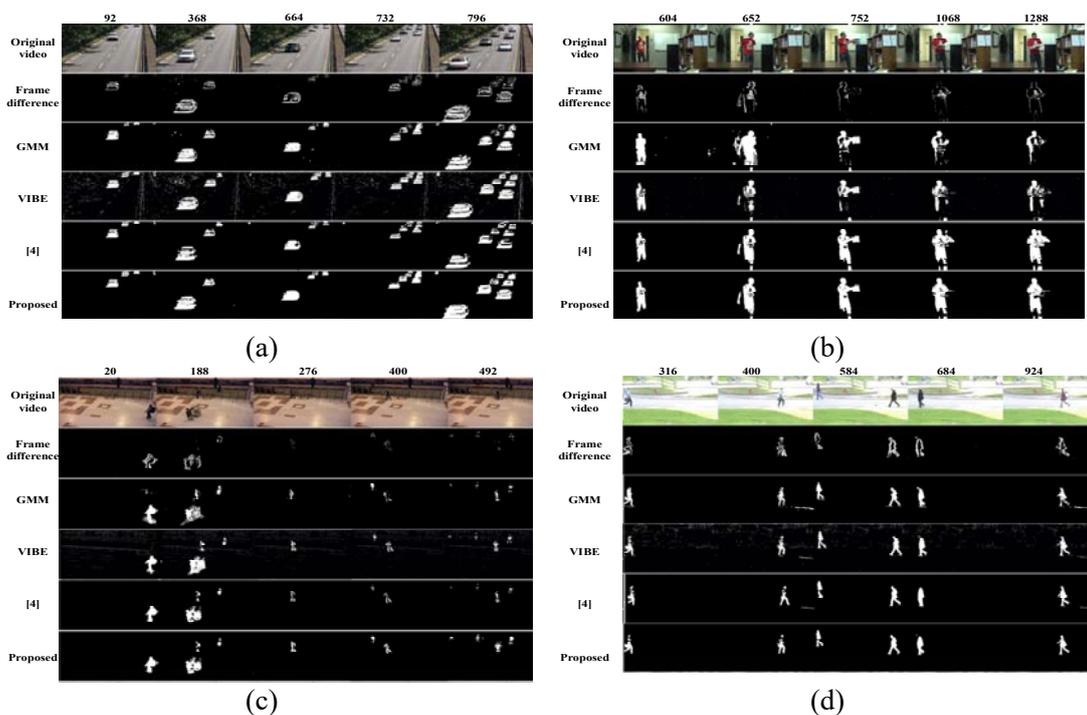
There are still some cavities after the image repair, we use expansion processing of morphological technique to eliminate cavities based on the basis of no increase noise. The result is shown in Fig.3, where (a) is the repaired image and (b) is the result of expansion.



**FIGURE 3** Expansion processing. (a)Repaired image; (b)The result of expansion processing.

### 3. Experimental results

In order to verify the effectiveness of the method, the experiment deals with four videos in the paper. The videos are taken from the Context Aware Vision using Image-based Active Recognition (CAVIAR) database [10]. We compare the proposed method against GMM, VIBE, frame-difference and literature [4]. The comparison result is shown in Fig.4, where (a) is Highway, (b) is Offers, (c) is PETS2006 and (d) is Pedestrians from CAVIAR. We chose five frames from every video to show the result. In (a), the second row is the results of frame-difference, the third row is the results of GMM, the fourth row is the results of VIBE, the fifth row is the results of [4], the last row is the results of the proposed method, and the first row of the picture is video frame, and it also applies to (b), (c) and (d).



**FIGURE 4.** Detection result. (a) Highway; (b) Office; (c)PETS2006; (d) Pedestrians.

The Fig.4 shows that the method proposed performs better than other methods. Although GMM and VIBE can accurately detect the moving target in most cases, it is difficult to detect the object which moves slowly because some of the pixels of the object become part of the background, and the quality of the foreground object is highly dependent on a fixed threshold. The frame difference can detect the moving target better, but the cavities are more serious. [4] is only do a simple AND operation between the frame-difference and the background subtraction, this will case small noise and ghosts because of the noise corresponding to the superposition. The method proposed in this paper can not only detect the slowly moving object, but also eliminate noise and ghosts and fill the cavities effectively.

#### 4. Conclusion

Background subtraction, optical flow, frame difference and some current improvement methods in recent years are introduced in this paper, and a new moving object detection method based on frame-difference and background subtraction is proposed, which introduces the image repair and morphological processing to the method. Finally, the results of multiple videos test show that the proposed method can eliminate noise and fill cavities quickly, and detect moving object more completely.

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