An Improved LBP Feature Based Moving Object Detection

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Abstract. Moving object detection (MOD) is strongly restricted by the change of dynamic background. In this paper, a novel MOD algorithm based on improved Local Binary Patterns (LBP) is proposed. Firstly, the LBP is improved to overcome the shortcomings of LBP operator. Then the improved LBP is used in MOD to extract moving object in natural scenes. The experimental results show that the proposed MOD method can extract moving object more accurately.

1. Introduction
MOD is an essential content of computer vision [1]. There are many challenges in natural scenes for MOD such as illumination changes, swaying leaves, and shadow changes [2]. Generally, the method commonly used for MOD includes: the multi features fusion method, the difference method and the optical flow method [3-5]. Many classic model are used for MOD such as the Gaussian Mixture Model (GMM) model [6], the ViBe model [7] and the LBP based model [8]. The GMM model requires many training frames to determine the parameters. So in the case of insufficient training image frames, the detection results of GMM will contain a lot of noise [6]. The ViBe [7] model used the random sampling points in the neighbor of the pixels in the initial frame to construct the background model. Vibe algorithm is simple and efficient, but 'ghosts' will appear in the results when moving objects appeared in the initial frame.

The method of background model using Local Binary Pattern (LBP) is proposed [8]. The LBP operator is the description operator of the texture feature, which has the characteristics of gray scale invariant. However, the LBP is sensitive to noise. Thus, in this paper, a novel MOD algorithm based on improved LBP is proposed. Firstly, the LBP is improved to overcome the shortcomings of LBP operator. Then the improved LBP is used in MOD to extract moving object in natural scenes.

2. Proposed method
2.1 The improved LBP
LBP is a kind of texture operator which is always used to describe the local texture feature. It is often used for background modeling because of its robustness under illumination changes. The LBP can be computed by the following formula [8]:

\[ LBP(x, y) = \sum_{i=0}^{N-1} s(g_i - g_{i'}) \times 2^i \]  

(1)

\[ s(x) = \begin{cases} 
1, & x \geq 0 \\
0, & x < 0 
\end{cases} \]  

(2)
where $g_c$ and $g_p$ represents respectively the gray value in $(x_c, y_c)$ and the neighborhood of the $(x_c, y_c)$ on a circle region. As can be seen from the above formula, the value of LBP is only related to the relative size of the center pixel and the adjacent pixels. Illumination can only change the pixels’ gray value. However, if the gray value of adjacent pixel is close to central one, noise may change the relative size of the center and adjacent pixels. It means that the basic LBP is sensitive to noise.

In this paper, first of all, an improved LBP operator is proposed. Assuming that $B_c$ represents the gray value in $(x_c, y_c)$ in the reference frame (in this paper, reference frame is the background model frame). $g_r + \Delta g$ represents the gray value in $(x, y)$ in the present frame. In order to ensure that the relative size of the center pixel and its neighboring pixels are not changed, this paper assumes that the change of neighboring pixels' gray value of $(x, y)$ in current frame should be $\Delta g$. As mentioned above, the formula for improving LBP can be written as:

$$ILBP(x_c, y_c) = \sum_{p=0}^{p-1} s(g'_p - g_c) \cdot 2^p$$  \hspace{1cm} (3)

where $Th_1$ is the noise threshold.

As mentioned in the previous section, the noise threshold can be used to determine the cause of the difference between the ideal gray and the real gray value. If the difference is less than the threshold, then the effect of noise is considered, otherwise the effect of moving object is considered. Therefore, the selection of threshold is important.

2.2 Improved LBP feature based MOD

The first step is to extract the foreground region of moving objects, and then realize the accurate classification of pixels in the foreground region. On the basis of the above sections, the foreground pixels can be extracted by a simple probabilistic model.

Firstly, before the extraction of foreground pixel, the background is initialized according to the method in [9].

Secondly, the foreground region is estimated by the KDE model [10].

Thirdly, an overlapping window structure is used to divide the foreground region into equally sized windows.

Then, the improved LBP histogram of the window is calculated.

Finally, all the foreground pixels are extracted by histogram matching.

3. Experiments

The result of the comparison between the improved LBP and the traditional LBP is shown in Figure 1. Figure 1 (a) and 1 (d) are 416th and 426th frames of the video, respectively.

As we can see, the same position on the two frames is respectively provided with a black block. The LBP normalized histogram of pixels in the black block are shown in Figure 1 (b) (c). The improved LBP normalized histogram of pixels in the black block are shown in Figure 1 (c) (f). Compare with 1 (b) and 1 (e), it can be found that the LBP histogram of the same background in different frames is different due to the influence of noise. The similarity of 1 (c) and 1 (f) shows that the improved LBP has a good effect on noise elimination.
The proposed method is compared with GMM [6] and ViBe [7]. The results of detection are shown in Figure 2. As we can see from Figure 2 (b), the detection results of GMM algorithm has accurate target contours, but the surface of the extracted foreground has ‘holes’. Figure 2 (c) is the detection results of ViBe algorithm. The detection result of ViBe is limited to the number of sampling points. Only the sampling points tend to infinity, the scene can be accurately described, but it is not possible in practical applications. The detection results in Figure 2 (d) illustrate that the proposed algorithm not only eliminates the interference of the dynamic background pixels, but also detects more complete moving object.

Figure 2. The experiment result: (a) Original frames; (b) GMM; (c) ViBe; (d) The proposed method.

4. Conclusion
In this article, an improved LBP based MOD algorithm is proposed. The experiments show that the proposed method can extract moving object more accurately.

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