Eye Positioning Based on Template Matching Algorithm

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Abstract

Eye positioning based on template matching algorithm is proposed in this paper,The algorithm is divided into three steps. First of all, eye preliminary is positioned by template matching method based on the modified Hausdorff distance criterion, and then the Sobel operator is used to extract contour in the preliminary positioning area. Finally, accurate positioning is realized by the statistical positioning. The experimental results show that the method proposed is feasible.

Keywords

Eye positioning, Template matching, Hausdorff distance.

1. Introduction

In daily life, the human face is the most common complex image pattern, so face recognition become the important content of image recognition. It not only has a broad application prospects, but also has great economic value. Many methods are proposed for face recognition. But the face such as eyes and other parts have very complex features, how to detect and locate the human eyes becomes a key part of face recognition. In many applications such as identity recognition, it is a very important task to recognize the local characteristics of the human eye. In this paper, the image recognition algorithm of eye positioning algorithm were studied by the template matching method and the human eye positioning is realized by gray and shape of eyes, and the feasibility of this method was verified by experiments

2. Eye positioning based on template matching

2.1 Modified Hausdorff distance

Hausdorff distance is generally used to the face tracking in video sequences [1], and it is similar with eyes positioning processs. Hausdorff distance is first used to compare the digital image by Huttenlocher et al. Experiments show that compared with the traditional maximum likelihood criterion, Hausdorff distance criterion has a higher recognition rate under the condition of small angle rotation and illumination uneven et al. Therefore, in this paper, modified Hausdorff distance is used to realize the human eye positioning.

Hausdorff distance is defined as follows: given two finite sets $A=\{a_1,a_2,...,a_p\}$ and $B=\{b_1,b_2,...,b_q\}$, the definition of Hausdorff distance between A and B as follows:

$$H(A,B)=max(h(A,B),h(B,A)) \tag{1}$$

Where $h(A,B)=\max_{a\subset A}\min_{b\subset B}\|a-b\|$, $\|\cdot\|$ represents a norm defined on the set A and B , $\|s\|=\sum_{i=1}^{n}s_i$

Hausdorff distance is directly used to measure the similarity of the two images, which is easy to be disturbed by noise. In fact, the different H (A, B) can be obtained from the different h (A, B), Therefore, Dubuisson et al investigated the performance of 24 different distances under the noise condition, and a conclusion is drawn that the modified Hausdorff distance is defined by the following formula, which have the best ideal effect.

$$H'(A,B) = max\left(h(A,B), h(B,A)\right) \tag{2}$$

Where

$$h(A,B) = \frac{1}{N_a}\sum_{a\subset A} \min_{b\subset B} \|a-b\| \tag{3}$$

N_a is the point number in A, where h (A, B) represents the average minimum distance of each point in A to that in B.

In this paper, modified Hausdorff distance is used as the template matching criterion, and the accuracy was significantly higher than that using the criterion of maximum similarity matching method

2.2 Sobel operator edge extraction

The following two convolution kernel is used in the Sobel operator, the operation result is a edge magnitude image

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \qquad \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Figure 1 Two convolution cores of Sobel operator

The edge extraction effect by the Sobel operator is as follows

Figure 1 Edge detection effect by Sobel operator

As can be seen from the figure 1, the edge information of the image has been strengthened and the gray level information of the continuous region belonging to the image background is removed after the Sobel operator processing.

Therefore, it is effective to use the Sobel operator to extract the eye contour in the region that is obtained in the preliminary positioning [4].

2.3 Accurate positioning

After an edge magnitude image can be obtained after Sobel operator processing. On this basis to achieve the human eye positioning, the binaryzation should be carried on the image

Assuming the original image $f(i,j)$, set a suitable threshold T, binarized image is $e(i,j)$,

$$e(i,j) = \begin{cases} 0 & f(i,j) \le T \\ 1 & f(i,j) > T \end{cases} \tag{4}$$

Where 1 represents the background area after the segmentation, 0 represents binarization area after the segmentation. The target regions under normal circumstances are the eye pupil, iris , corneal profile, and sometimes a few random granular noise, who are randomly distributed, so the effects on the eye positioning are little. The image binarization processing can make the eye area information arise remarkably, which can improve recognition accuracy and the recognition speed.

After binarization, the target area is binary image, the background region is 1, the eye contour area is 0. In computing the center position of these contours, for the sake of simplicity, the statistical positioning method is used. The binary image is regarded as 1D sequence $E=\{e_1,e_2,...,e_N\}$,where $e_i \subset \{0,1\}$, N represents total pixel number in that block image. Given the horizontal and vertical coordinates of each pixel are x_i and y_i respectively. The image along the axis is divided into two regions, in each region, the average position of the contour points is

$$X=\frac{\sum_{j=0}^{N'} x_j}{N'}, \quad Y=\frac{\sum_{j=0}^{N'} y_j}{N'} \tag{5}$$

The position of the eyes center is obtained by the two formulas[5].

3. Experimental results and analysis

Experiments is carried on Yale face image library and 165 images are tested. Each image size is 155 × 195 pixels with 256 gray levels. Template size is 90 ×18 pixels. The original image and the template have been made the illumination compensation. The following images are a human face and the matching template.

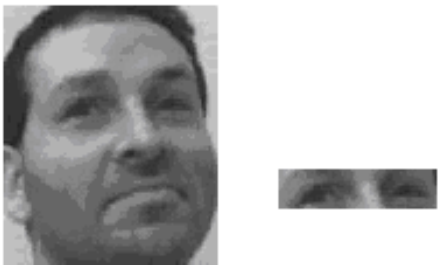

Figure 2 An example of a human face and its template

Preliminary positioning. The results are as following. Where the selected area by the dotted line is the preliminary location of the human eye.

Figure3 Preliminary eyes positioning by template marching

Accurate positioning. On the basis of step 1, the Sobel operator is used to extract the edge in the dotted line area. The results are as follows

Figure 4 Edge extraction

Finally, the central region of the human eye with statistical methods, the results are as follows. Among them, the red cross center on behalf of the final output of the system to locate the results of the eye. Finally, statistical method is used to position the central region of the human eye, the effect is shown as following. The red cross represents the final positioning result.

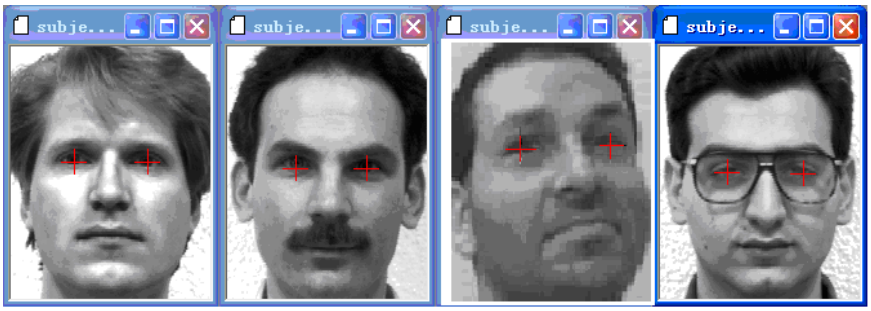

Figure 5 Accurate positioning

The total 165 images are tested in the Yale face image database. Template matching by the maximum likelihood criterion is used to realize the preliminary positioning, positioning accuracy rate is 78.18%. Template matching by the modified Hausdorff distance criterion, positioning accuracy rate is 82.42%. Compared with the traditional template matching method， the Template matching by the modified Hausdorff distance criterion is feasible.

4. Conclusion

In this paper, a human eye positioning algorithm based on template matching is proposed. A template matching method is used to preliminary position the eye region, the Sobel operator is used to extract eye feature and finally statistical positioning algorithm is used to accurately position the eyes.In the proposed algorithm, an modified Hausdorff distance is used as the template matching criterion, the experimental results show that the matching criterion proposed is feasible.

Reference

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