Robust Precise Iris Detection

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Abstract

In this paper, a robust method is developed to precisely detect iris of both eyes. The method does not put any restrictions on the background. The method is based on AdaBoost for face and eye candidate points detection. Candidate points are post-processed and an iris pair is selected using mean crossing function and a convolution template.

I. Introduction

Robust eye detection is essential for many applications such as face recognition systems, human-computer interaction, and attentive user interfaces (like driver assistance systems).

We evaluated our proposed structure for iris localization on two public databases. Extensive experimental results verified the effectiveness, efficiency and robustness of the proposed method. Figure 1 shows the steps in localizing center of eyes when applied to one of the test data.

II. Face and eye candidates detection

Iris detection can be simplified by first detecting the face in an input image. For face detection, Viola's method [1] is used. By changing the training data and increasing the false-positive rate of the algorithm, we build an eye candidate detector.
Figure 1(b-c) shows face region extracted and candidate points respectively.

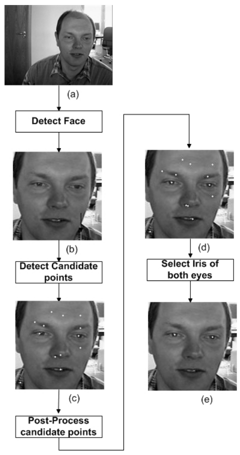

Figure 1. Steps of the proposed algorithm

III. Selecting the iris pair from candidate points

3.1 Seperability Template

Seperability template proposed by [2] is utilized in a novel way to shift the candidate points within a small size of neighborhood. Seperability value for each point in the neighborhood is determined by varying the radius in a range $[r_L\ r_U]$. The point in the neighborhood which gives maximum seperability is considered as the new candidate point which replaces the old candidate point. We find the seperability values for each new candidate point as well as its corresponding optimal radius R [3]. Figure 1(d) shows the new candidate points.

3.2 Mean Crossing function

A rectangular subregion is formed around each iris candidate. The size of the subregion is depicted in figure 2(b).

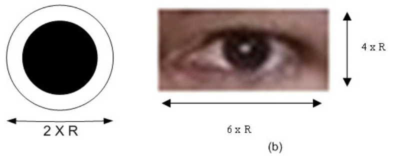

Figure 2. (a) Convolution template. (b)subregion

The subregion is scanned horizontally and the mean crossing function [4] for pixel(i, j) is computed as follows:

$$\mu C(i,j) = \begin{cases} 1 & ;\text{If } I(i,j) \geq \mu + A \text{ then If } I(i,j+1) \leq \mu - A \\ 1 & ;\text{If } I(i,j) \leq \mu - A \text{ then If } I(i,j+1) \geq \mu + A \\ 0 & ;\text{otherwise} \end{cases} \quad (1)$$

where A is a constant. We verified by our experiment that A = 10 gives best results.

The horizontal mean crossing value for the subregion is given by

$$\mu C_{subregion} = \sum_{i=1}^{M}\sum_{j=1}^{N} \mu C(i,j) \quad (2)$$

In a similar way, vertical mean crossing function is evaluated and both are added together to get final mean crossing value for the subregion.

3.3 Convolution with edge image subregion

Edge image subregion around the candidate point is convolve with the convolution kernel shown in figure 2(a). The greater the value from the convolution, the more is the probability that the candidate point will be an iris.

3.4 Fitness of iris candidate

We define the fitness of an iris candidate by the following eq.

$$fitness(C_x) = \frac{\mu C_{subRegion}(C_x)}{\sum_{i=1}^{N} \mu C_{subRegion}(C_i)} + \frac{Conv(C_x)}{\sum_{i=1}^{N} Conv(C_i)} + \frac{Seperability(C_x)}{\sum_{i=1}^{N} Seperability(C_i)} \quad (4)$$

Where N is the total number of candidate points, $\mu C_{subRegion}(C_j)$, $Conv(C_j)$, $Seperability(C_j)$ are mean crossing value, convolution result and seperability values for candidate C_j respectively.

Candidate pair with the maximum fitness is taken as the iris pair according to the following eq.

$$Pair(Cx,Cy) = fitness(C_x) + fitness(C_y) \quad (5)$$

IV. Experimental Results

Experimental results obtained on Yale and BioID database are tabulated in table 1. Most of the errors occur due to the closed eyes, partially closed eyes and bright reflection on glasses. Figure 3 shows some of the successful results and in figure 4 some unsuccessful results are shown.

Database	Result	
	All Database	Only Open Eye Images
Yale(165 images)	92.6%	94.4%
BioID(1521 image)	93.7%	95.8%

Table 1

Figure 3. Successful iris detection

Figure 4. Unsuccessful iris detection

References

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