Chapter 8

Iris Recognition Based on 2D Wavelet and AdaBoost Neural Network

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8.1 Introduction

Biometrics refers to automatic identity authentication of a person on the basis of one’s unique physiological or behavioral characteristics. To date, many biometric features have been applied to individual authentication. The iris, a kind of physiological feature with genetic independence, contains an extremely information-rich physical structure and unique texture pattern, and thus is highly complex enough to be used as a biometric signature. Statistical analysis reveals that irises have an exceptionally high degree-of-freedom up to 266 (fingerprints show about 78) [1], and thus are the most mathematically unique feature of the human body, more unique than fingerprints. Hence, the human iris promises to deliver a high level of uniqueness for authentication applications that other biometrics cannot match.

Indeed, Daugman’s approach relies on the use of Gabor wavelets in order to process the image at several resolution levels. An iris code composed of binary vectors is computed this way and a statistical matcher (logical exclusive OR operator) analyzes basically the average Hamming distance between two codes (bit-to-bit test agreement) [2]. Some recent works follow this direction. Another approach, in the framework of iris verification, introduced by Wildes, consists of measuring the correlation between two images using different small windows of several levels of resolution [3]. Also, other methods for iris verification have been proposed, in particular relying on ICA [4].

The outline of this chapter is as follows. The method that uses a 2-D wavelet transform to obtain a low-resolution image and a Canny transform to localize pupil position is presented in Sect. 8.2. By the center of the pupil and its radius, we can acquire the iris circular ring. Section 8.3 adopts the Canny transform to extract iris texture in the iris circular ring as feature vectors and vertical projection to obtain a 1-D energy signal. The wavelet probabilistic neural network is a very simple classifier model that has been used as an iris biometric classifier and is introduced in Sect. 8.4. Two different extension techniques are used: wavelet packets versus Gabor
wavelets. The wavelet probabilistic neural network can compress the input data into a small number of coefficients and the proposed wavelet probabilistic neural network is trained by the AdaBoost algorithm. The experimental results acquired by the method are presented in this section. Finally, some conclusions and proposed future work can be found in Sect. 8.8.

8.2 Preprocessing

The iris image, as shown in Fig. 8.1, does not only contain abundant texture information, but also some useless parts, such as eyelid, pupil, and so on. We use a simple and efficient method to localize the iris. The steps are as follows.

1. A new image is the representation of the original image by 2-D wavelet, and its size is only a quarter of the original image. The wavelet coefficients are calculated by the formulas:

$$f(x,y) = \sum_k c_{j0}(k) \phi_{j0,k} + \sum_{j=1}^{\infty} \sum_k d_j(k) \phi_{jk}(x)$$  \hspace{1cm} (8.1)

$$c_{j0}(k) = \langle f(x), \phi_{j0,k}(x) \rangle = \int f(x) \phi_{j0,k}(x) dx$$  \hspace{1cm} (8.2)

$$d_j(k) = \langle f(x), \phi_{jk}(x) \rangle = \int f(x) \phi_{jk}(x) dx$$  \hspace{1cm} (8.3)

2. The edge of the pupil in the new image is detected by the Canny transform.

$$H_G = \int_{-W}^{W} G(-x)f(x)dx$$  \hspace{1cm} (8.4)

$$H_n = n_0 \left[ \int_{-W}^{W} f^2(x)dx \right]^{1/2}$$  \hspace{1cm} (8.5)

Fig. 8.1 An eye photo before processing