Person authentication using human Iris recognition

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Abstract

Biometrics refers to the authentication of an individual's identity based on his physical or behavioral traits. The iris is one of the biometrics stands out among other biometric techniques because of its unique features like stability and accuracy.In this paper,developed a method to iris recognition which consist of segmentation stage that is based on Canny Edge Detection and Circular Hough Transform,and it is able to localization of the inner and outer boundaries of the iris region.The iris images are then normalized so as to transform the iris region to have fixed dimensions in order to allow comparisons. Feature encoding has been used to extract the most discriminating features of the iris and is done using a Wavelets Transform. Finally, the biometric templates are compared using Hamming Distance which tells us whether the two iris images are same or not. The CASIA-Iris-Interval database that collected by Chinese Academy of Sciences-Institute of Automation using for checking the performance of the method and implemented on MATLAB® language.

Keywords: Iris recognition ,pattern recognition, biometric identification, Wavelets Transform.

التحقق من هوية الشخص باستخدام قزحية العين

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الملخص

تشير القياسات الحيوية (Biometrics) للمصادقة والتحقق من هوية الفرد بالاعتماد على صفاته الفيزيائية أو السلوكية. وتُعد القزحية (Iris) واحدة من هذه القياسات الحيوية التي تبرز من بين التقنيات الحيوية الأخرى لما لها من ميزات فريدة مثل الاستقرار والدقة. فقد كشفت الدراسات والتحاليل المجهرية استحالة وجود شخصين لهما نفس قزحية العين حتى في حالة التوائم وأيضا لا يوجد تشابه بين العين اليمنى واليسرى لنفس الشخص.

في هذا البحث، طورت طريقة لتمييز القزحية تتكون من مرحلة التقطيع (Segmentation) والتي تتم باستخدام Canny Edge Detection و Circular Hough Transform ، وينتج عن هذه المرحلة تحديد الحدود الداخلية والخارجية لمنطقة القزحية. ثم يتم تطبيع (Normalized) صور قزحية العين وذلك لتحويل منطقة القزحية الى منطقة ثابتة الابعاد من أجل السماح بإجراء المقارنات. اما في مرحلة ترميز الخاصية (Feature Encoding) فتم استخدام التحويل المويجي Wavelets (Transform) لاستخراج الميزات الأكثر تمييزا للقزحية. وأخيرا، تتم مقارنة نماذج القياسات الحيوية باستخدام (Hamming Distance) الذي يخبرنا ما إذا كانت الصورتين للقزحية هما نفسهما أم لا.

تم فحص اداء الطريقة المقترحة باستخدام قاعدة بيانات (CASIA-Iris-Interval) والتنفيذ بلغة الماتلاب MATLAB® language (Version 7.11.0.584 – R2010b).

1. Introduction

Biometrics technology plays important role in public security and information security domains. Using various physiological characteristics of human, such as face, facial thermograms, fingerprint, iris, retina, hand geometry etc., biometrics accurately identify each individual and distinguishes one from another [1].

A good biometric is characterized by use of a feature that is; highly unique so that the chance of any two people having the same characteristic will be minimal, stable so that the feature does not change over time, and be easily captured in order to provide convenience to the user, and prevent misrepresentation of the feature.

The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. The iris is perforated close to its center by a circular opening known as the pupil. The function of the iris is to control the amount of light entering through the pupil, and this is done by the sphincter and the dilator muscles, which adjust the size of the pupil. The average diameter of the iris is 12 mm, and the pupil size can vary from 10% to 80% of the iris diameter. Figure (1) shows a front-on view of the iris [2].

The iris is an externally visible and it is a protected organ whose unique epigenetic pattern remains stable throughout adult life. These characteristics make it very attractive for use as a biometric for identifying individuals. Image processing techniques can be employed to extract the unique iris pattern from a digitized image of the eye and encode it into a biometric template, which can be stored in a database[3].

Iris recognition is one of important biometric recognition approach in a human identification is becoming very active topic in research and practical application. Iris recognition consists of the iris capturing, pre-processing and recognition of the iris region in a digital eye image. Iris image pre-processing includes iris localization, normalization, and enhancement. Each of these steps uses different algorithms. In iris localization step, the determination of the inner and outer circles of the iris and the determination of the upper and lower bound of the eyelids are performed. The inner circle is located between the iris and pupil boundary, the outer circle is located between the sclera and iris boundary. A variety of techniques have been developed for iris localization. In [4-7], the system with circular edge detector, in [3] a gradient based Hough transform are used for localizing the iris. Also circular Hough transform [8,9], random Hough transform are applied to find the iris circles and complete the iris localization. In [3,10] Canny operator is used to locate the pupil boundary.

Various algorithms have been applied for feature extraction and pattern matching processes. These methods use local and global features of the iris. Using phase based approach [4-7], wavelet transform zero crossing approach [11,12], Gabor filtering [10], texture analysis based methods [8,11-13] the solving of the iris recognition problem is considered. In [14,15,16] independent component analysis is proposed for iris recognition.

Daugman [4-7] used multiscale quadrature wavelets to extract texture phase structure information of the iris to generate a 2,048-bit iris code and compared the difference between a pair of iris representations by computing their Hamming distance. Boles and Boashash [11] calculated a zero-crossing representation of 1D wavelet transform at various resolution levels of a concentric circle on an iris image to characterize the texture of the iris. Iris matching was based on two dissimilarity functions. Sanchez-Avila and Sanchez-Reillo [12] further developed the method of Boles and Boashash by using different distance measures (such as Euclidean distance and Hamming distance) for matching. Wildes et al. [8] represented the iris texture with a Laplacian pyramid constructed with four different resolution levels and used the normalized correlation to determine whether the input image and the model image are from the same class.

Figure (1): A front- on view of the human eye .

2. Structure of the proposed Iris Recognition Method

Generally, iris recognition method is composed of many steps, Figure (2) depicts the steps of this method.

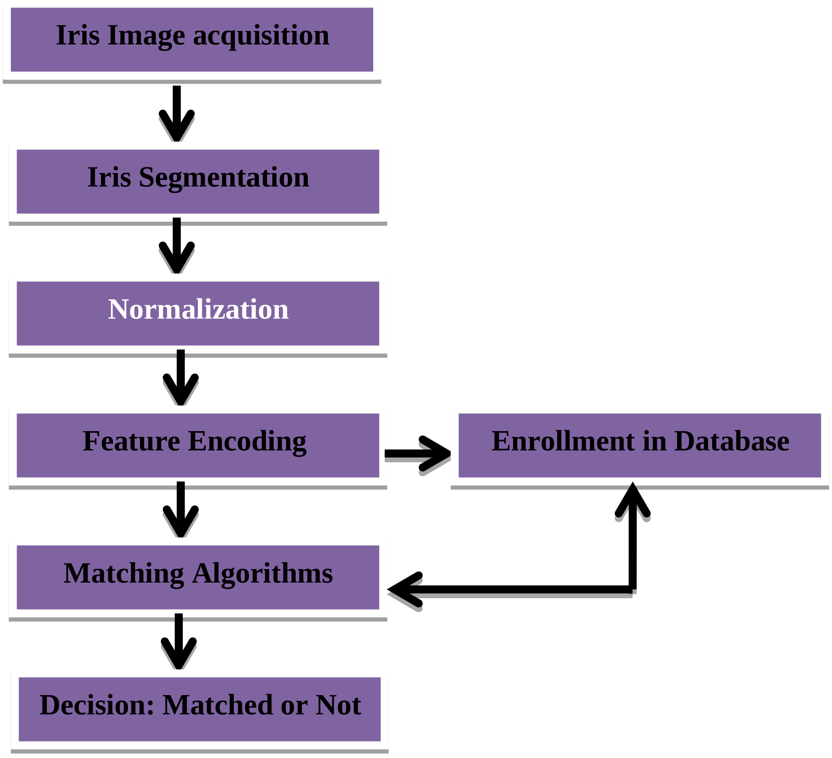


Figure (2): Structure of the Iris Recognition Method

2.1 Iris Image acquisition

Capturing images of iris is the first step of an iris-based recognition method. The success of the other recognition steps depends on the quality of the images taken from iris during the image acquisition step. In the present work used **CASIA-Iris-Interval**.

CASIA iris image database (version 4.0) (CASIA-Chinese Academy of Sciences Institute of Automation) is the Chinese Academy of Sciences - Institute of Automation eye image database contains a total of 54,601 iris images from more than 1,800 genuine subjects and 1,000 virtual subjects. All iris images are 8 bit gray-level JPEG files, collected under near infrared illumination or synthesized. Some statistics and features of **CASIA-Iris-Interval** are given in Table (1),see example of iris images in CASIA-Iris-Interval in Figure (3) [17].

Table 1: Statistics of CASIA-Iris-Interval.

Characteristics	CASIA-Iris-Interval
Sensor	CASIA close-up iris camera
Environment	Indoor
Session	Two sessions for most iris images
Attributes of subjects	Most are graduate students of CASIA
No. of subjects	249
No. of classes	395
No. of images	2,639
Resolution	320*280
Features	Cross-session iris images with extremely clear iris texture details

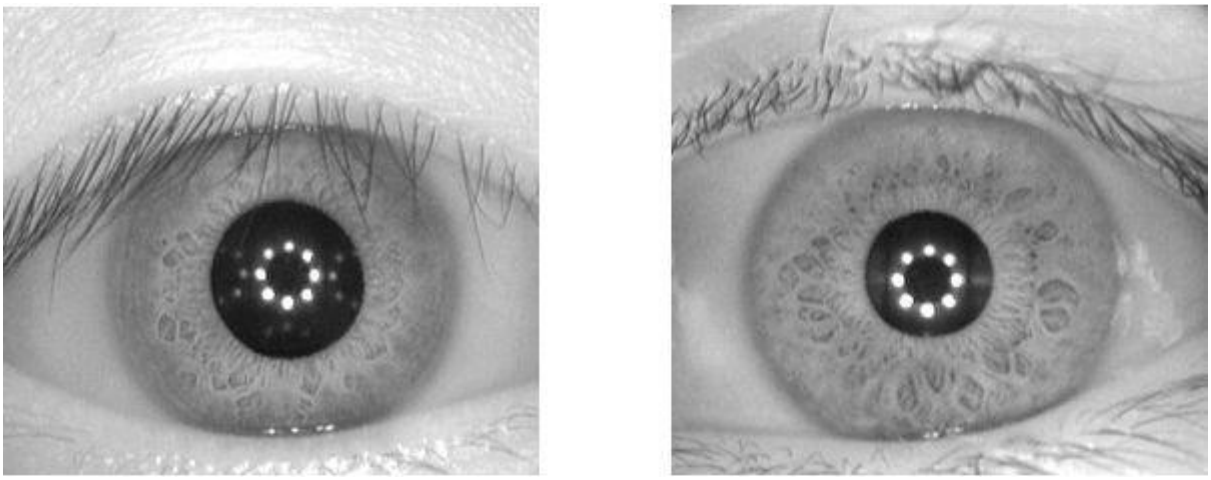
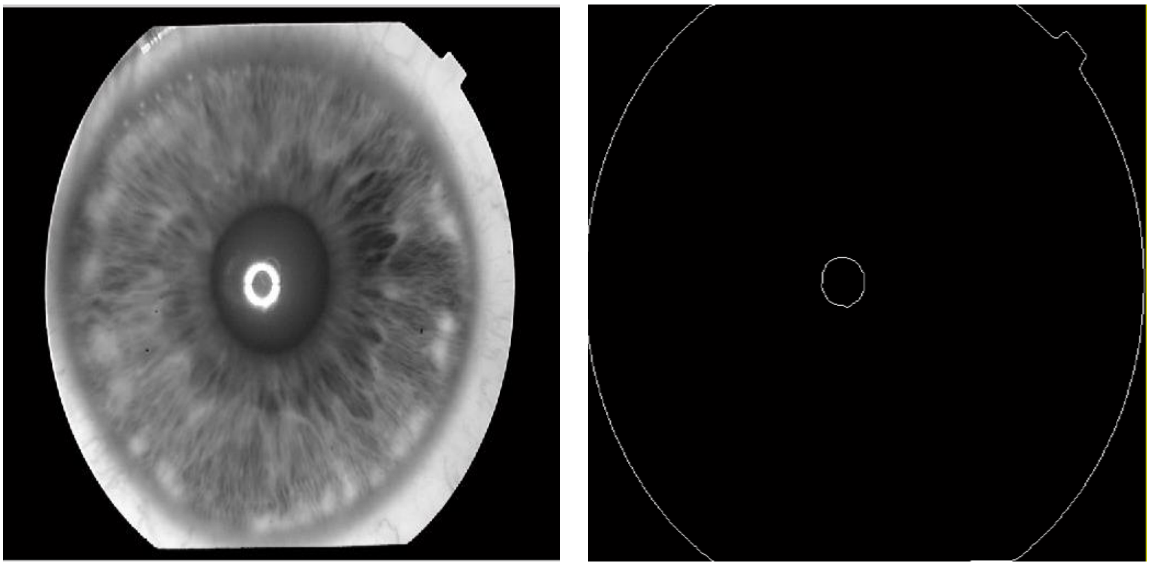


Figure (3): Example iris images in CASIA-Iris-Interval.

2.2 Iris Segmentation

An eye image contains not only the iris region but also some unuseful parts, such as the pupil, eyelids, sclera, and so on. For this reason, at first step, segmentation will be done to localize and extract the iris region from the eye image. Iris localization is the detection of the iris area between pupil and sclera. So we need to detect the upper and lower boundaries of the iris and determine its inner and outer circles as shown in Figure (4). A number of algorithms has been developed for iris localization. Some of them are based on the Hough transform. An iris segmentation algorithm based on the Canny Edge Detection scheme and circular Hough transform is applied in this step.

The success of segmentation depends on the imaging quality of eye images. Also, persons with darkly pigmented irises will present very low contrast between the pupil and iris region if imaged under natural light, making segmentation more difficult. The segmentation step is critical to the success of an iris recognition system, since data that is falsely represented as iris pattern data will corrupt the biometric templates generated, resulting in poor recognition rates.



(**a**) (**b**)

Figure (4): a: Original Iris image, b: Image after detect the Iris boundary.

2.3 Normalization

The irises captured from the different people have different sizes. The size of the irises from the same eye may change due to illumination variations, distance from the camera, or other factors. At the same time, the iris and the pupil are non-concentric. These factors may affect the result of iris matching. In order to avoid these factors and achieve more accurate recognition, the normalization of iris images is implemented. In normalization, the iris circular region is transformed to a rectangular region with a fixed size. With the boundaries detected, the iris region is normalized from Cartesian coordinates to polar representation. This operation is done using the Daugman's rubber sheet model. Figure (5) shows template generated after normalization.

After that, the normalized iris image contains eyelashes as a part of original eye image and it acts as a noise data, so it causes difficulty in iris recognition stage. In order to remove this noise (eyelash), an algorithm was proposed to crop the iris template to one fourth of its size. After finding a region where there are eyelashes, which is limited to a value between (50-110) pixels,(30) P threshold was added in order to overcome the area of eyelashes and moving into adjacent areas. Then, a 2-D median filtering was added to enhance the template more and in order to eliminate the remnants of the existing noise to configure good template before entering into the next stage for the feature extraction.

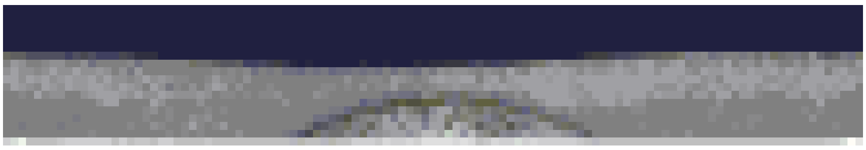


Figure (5): Template generated after normalization .

2.4 Feature Encoding

In order to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted. Only the significant features of the iris must be encoded so that comparisons between templates can be made. Most iris recognition systems make use of a band pass decomposition of the iris image to create a biometric template.

The template that is generated in the feature encoding process will also need a corresponding matching metric, which gives a measure of similarity between two iris templates. This metric should give one range of values when comparing templates generated from the same eye, known as intra-class comparisons, and another range of values when comparing templates created from different irises, known as inter-class comparisons. These two cases should give distinct and separate values, so that a decision can be made with high confidence as to whether two templates are from the same iris, or from two different irises.

The Wavelet transform is used to extract the feature of normalized iris image, wavelet coefficients vectors are used as a feature for iris recognition. There are four types of wavelet coefficients e.g. approximate, horizontal, vertical and diagonal detail can be used, here simple Haar wavelet , Daubechies and Coiflet are used. Figure (6) shows four levels of Haar decomposition.

The main advantages of wavelet is that they have a varying window size, being wide for slow frequencies, and narrow for the fast ones, thus leading to an optimal time-frequency resolution in all the frequency ranges.

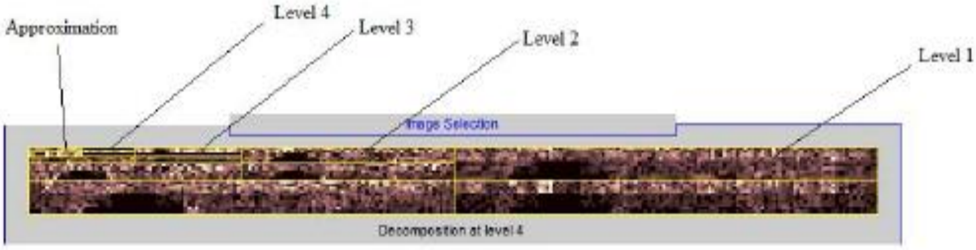


Figure (6): Four levels Haar decomposition

2.5 Matching Algorithms

Hamming distance is used as a matching algorithm to compare two biometric templates. It gives us knowledge of the number of bits that are same in two bit patterns. Upon using hamming distance we are able to decide whether two patterns were generated from the same iris or from different irises.

For comparing the two bit patterns X and Y , the hamming distance is defined as the sum of the exclusive-or (XOR) between X and Y over N , the total number of bits present in the bit pattern.

$$HD = \frac{1}{N}\sum_{j=1}^{N} X_j (XOR) Y_j \qquad \textbf{(1)}$$

3. RESULTS

We implemented our method on 344 preprocessed iris images using MATLAB® (version 7.11.0.584 – R2010b) in a computer with CPU Intel(R) Core(TM) i3 CPU M 350 @ 2.27GHz (4 CPUs), ~2.3GHz, 4096MB RAM memory and Operating System: Windows 7 Home Premium 64-bit (6.1, Build 7600). These test data are obtained from CASIA iris database (CASIA-IrisV4-Interval). Each of the iris images is matched against all other test data, which consist of images of the same iris and also different irises. And the recognition rate achieved with the proposed method is 98.45% ,98.7% and 84.25 for Haar wavelet , Daubechies and Coiflet respectively. Threshold has been set to compute False Acceptance Rate (FAR) and False Reject Rate (FRR). We have calculated FAR and FRR as follows:

$$FAR = \frac{No.of\ false\ acceptance}{Total\ no.of\ impostors} \quad (2)$$

$$FRR = \frac{No.of\ false\ Rejections}{Total\ no.of\ impostors} \quad (3)$$

Table (2) shows the results of the verification test of the proposed method. The verification test shown that the optimum threshold for the proposed algorithm is 0.40 .

Table 2: Results Of Verification Test.

Wavelet Transform	%FAR	%FRR
Haar	0	0.73
Daubechies	0	0.62
Coiflet	0	1.34

4. Conclusion and Future Work

The proposed method is a multi-resolution approach based on Discrete Sub-band Transform for iris texture analysis and recognition. Wavelet family (mother wavelet) used are Haar, Daubechies and Coiflet wavelet. Coefficients obtained from the decomposition of are then converted to binary codes to be used on calculation of Hamming distance for matching purpose.

Haar, Daubechies and Coiflet wavelet decomposition are rather simple compare to Gabor wavelet, because of its computational simplicity and lesser parameters are involved in determining the accuracy of the method. In this method, according to the results obtained by the above experiences, the Daubechies filter was the best in time and error compared with the Haar filter and Coiflet.

In the future work, we like to design a fusion system which will be the combination of iris, face and fingerprint with the same feature extraction technique.

5. References

[1] A. Jain, R. Bolle and S. Pankanti ,Biometrics: Personal Identification in a Networked Society, eds. Kluwer, 1999.

[2] Z. W. Abbas, " Human Iris For Identification and Verification", M.Sc. Thesis, University of Technology, November, 2005.

[3] L. Masek, "Recognition of human iris patterns for biometric identification", B.Sc. thesis, University of Western Australia, 2003.
[4] J. Daugman, Biometric Personal Identification System Based on Iris Analysis, United States Patent, no. 5291560, 1994.
[5] J. Daugman, “Statistical Richness of Visual Phase Information: Update on Recognizing Persons by Iris Patterns,” Int’l J. Computer Vision, vol. 45, no.1, pp. 25-38 , 2001
[6] J. Daugman, “Demodulation by Complex-Valued Wavelets for Stochastic Pattern Recognition,” Int J. Wavelets, Multiresolution and Information Processing, vol.1, no.1, pp.1-17, 2003.
[7] J. Daugman, “How Iris Recognition Works”, University of Cambridge, 2001.
[8] R.Wildes, J.Asmuth, G.Green, S.Hsu, R.Kolczynski, J.Matey, and S.McBride .“A Machine-Vision System for Iris Recognition” Machine Vision and Applications, vol.9, pp.1-8, 1996.
[9] R.Wildes .“Iris Recognition:An emerging Biometric Technology’, Proc.IEEE, vol.46, no.4,pp.1185-1188,1998.
[10] W. Boles and B. Boashash, “A Human Identification Technique Using Images of the Iris and Wavelet Transform,” IEEE Trans. Signal Processing, vol. 46, no. 4, pp.1185-1188, 1998.
[11] L.Ma, Y.H.Wang, T.N.Tan, “Iris recognition based on multichannel Gabor filtering”. Proceedings of the Fifth Asian Conference on Computer Vision, Australia, pp.279-283, 2002.
[12] C. Sanchez-Avila and R. Sanchez-Reillo, “Iris-Based Biometric Recognition Using Dyadic Wavelet Transform,” IEEE Aerospace and Electronic Systems Magazine, pp.3-6. , 2002
[13] Roger F.Larico Chavez, Yuzo Iano, Vicente B.Sablon. Process of Rec ognition of Human Iris: Fast Segmentation of Iris. www.decom.fee.unicamp.br/~rlarico/iris/ localizationiris.pd
[14] Ya-Ping Huang, Si-Wei Luo, En-Yi Chen. An Efficient Iris Recognition System. Proceedings of the First International Conference on Machine Learning and Cybernetics, Beijing, November, 2003.
[15] Yong Wang, Jiu-Qiang Han. Iris Recognition Using Independent Component Analysis Proceedings of the Fourth International Conference on Machine Learning and Cybernetics, Guangzhou, 2005.
[16] V.Dorairaj, N.Schmid, and G.Fahmy. “Performance Evaluation of Iris Based Recognition System Implementing PCA and ICA Techniques”. Proc. SPIE 2005 Symp. On , Orlando, 2005.
[17] http://biometrics.idealtest.org/