An Efficient authentication By Iris Using Log Gabor Filter and Neural network

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Abstract

Iris recognition is one of the reliable and more stable biometric recognition for authenticating person which is very interesting and active topic in research and practical application. Iris recognition system consists of localization of the iris region and generation of data set of iris images followed by iris pattern recognition. In this paper, 2D wavelet transform is applied to the raw image to reduce the size then the localization of the iris region is done by using Circular Hough transform (CHT). The Log Gabor filter is employed to extract the iris features from the normalised image. It is represented by a data set. Using this data set a Neural Network (NN) is used for the classification of iris patterns. The adaptive learning strategy is applied for training of the NN. The results of simulations illustrate the effectiveness of the neural system in personal identification.

Keywords: *Iris, Identification, Log-Gabor, Neural Network (NN), Circular Hough transform (CHT).*

1. Introduction

The term "Biometrics" refers to a science involving the statistical analysis of biological characteristics. This measurable characteristic, biometric, can be physical, such as eye, face, retina vessel, fingerprint, hand and voice or behavioural, like signature and typing rhythm. Biometrics, as a form of unique person identification, is one of the subjects of research that is growing rapidly [1]. The advantages of unique identification using biometric features are numerous, such as fraud prevention and secure access control. Biometrics systems offer great benefits with respect to other authentication techniques. In particular, they are often more user friendly and can guarantee the physical presence of the user [1]. Iris recognition is one of the most reliable biometric technologies in terms of identification and verification performance.

The iris is the colored portion of the eye that surrounds the pupil as depicted in Fig. 1.It controls light levels inside the eye similar to the aperture on a camera. The round opening in the centre of the iris is called the pupil. The iris is embedded with tiny muscles that dilate and constrict the pupil size. It is full of richly textured patterns that offer numerous individual attributes which are distinct even between the identical twins and between the left and right eyes of a person.

An iris recognition system can be decomposed into three modules: an iris detector for detection and location of iris image, a feature extractor and a matcher module. In this paper, we focus our investigation on a new iris feature extraction and representation approach to further implement an iris recognition system with low complexity and high performance. Firstly, in order to reduce system complexity, we use 2-D wavelet transform [2-3] to obtain a low resolution image and localize pupil position. In our experiments, the wavelet permits to further reduce the system complexity. Finally, the log Gabor filter algorithm is regarded as feature extraction methods. A NN (Neural Network) is regarded as classifier model.

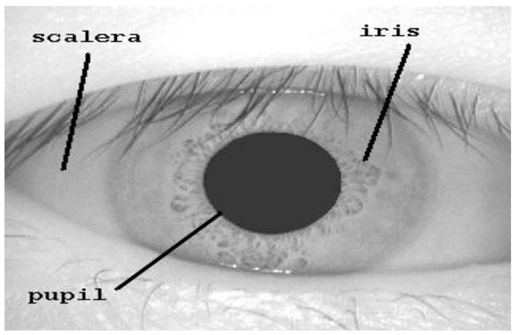

Fig. 1 Image of the eye.

2. Steps Involved In Proposed Method

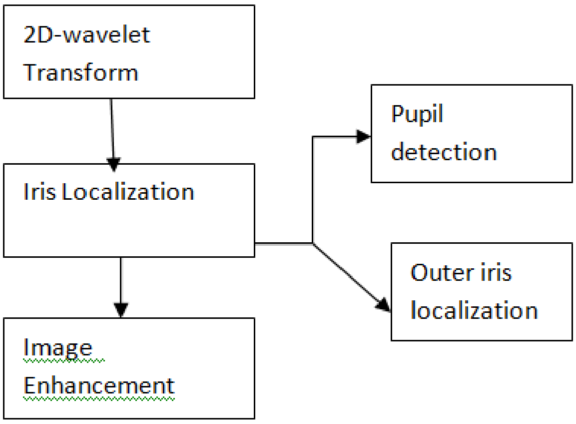

Fig. 2 Methods Used In Preprocessing

2.1 Iris Localization

$$G_{abs} = G_{Vertical} + G_{Horizontal}$$

The acquired iris image has to be preprocessed to detect the iris, which is an annular portion between the pupil (inner boundary) and the sclera (outer boundary). The first step in iris localization is to detect pupil which is the black circular part surrounded by iris tissues. The centre of pupil can be used to detect the outer radius of iris patterns. The important steps involved are:

1. Pupil detection
2. Outer iris localization

2.1.1 Pupil Detection

The iris image is converted into gray scale to remove the effect of illumination. As pupil is the largest black area in the intensity image, its edges can be detected easily from the binarized image by using suitable threshold on the intensity image. But the problem of binarization arises in case of persons having dark iris. Thus the localization of pupil fails in such cases. In order to overcome these problems Circular Hough Transformation [5] for pupil detection can be used. The basic idea of this technique is to find curves that can be parameterized like straight lines, polynomials, circles, etc., in a suitable parameter space. The transformation is able to overcome artifacts such as shadows and noise. The approach is found to be good particularly dealing with all sorts of difficulties including severe occlusions [6].

The procedure first finds the intensity image gradient at all the locations in the given image by convolving with the sobel filters. The gradient images ($G_{vertical}$ and $G_{Horizontal}$) along x and y direction, is obtained by kernels that detect horizontal and vertical changes in the image. The sobel filter kernels are

$$G_{vertical}=\{-1\ -2\ -1;\ 0\ 0\ 0;1\ 2\ 1\}$$
$$G_{horizontal}=\{-1\ 0\ 1;-2\ 0\ 2;-1\ 0\ 1\} \quad \textbf{(1)}$$

The absolute value of the gradient images along the vertical and horizontal direction is obtained to form an absolute gradient image using the equation (2)

$$G_{abs} = G_{Vertical} + G_{Horizontal} \quad (2)$$

Where $G_{vertical}$ is the convolution of image with $G_{vertical}$ and $G_{horizontal}$ is the convolution of image with $G_{horizontal}$. The absolute gradient image is used to find edges using Canny [7]. The edge image is scanned for pixel (P) having true value and the center is determined with the help of the following equations

$$xc = x - r * \cos(\theta)$$
$$yc = y - r * \sin(\theta) \quad \textbf{(3)}$$

Where x, y are the coordinates at pixel P and r is the possible range of radius values, θ ranges from [0:π].

For a particular value of r, the values of xc and yc are obtained and stored in an accumulator and the accumulator counter is incremented every time the values of xc and yc satisfy image dimension criteria. The maximum value of accumulator counter gives the centre of the pupil along with the radius as shown in Fig.3 (a) and 3(b).

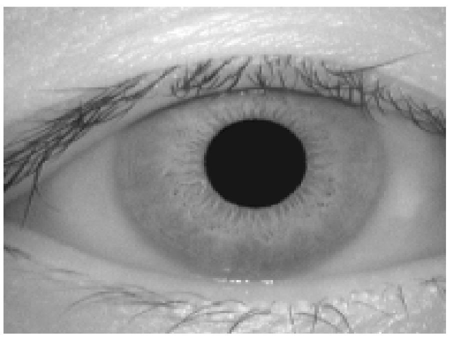

Fig. 3 (a) Original Image

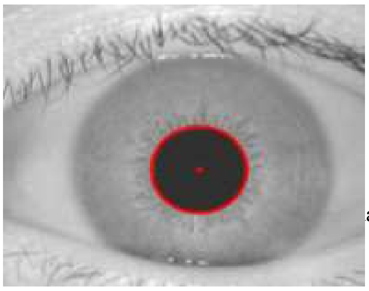

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Fig. 3 (b) Detection of inner boudary

External noise is removed by blurring the intensity image. But too much blurring may dilate the boundaries of the edge or may make it difficult to detect the outer iris boundary, separating the eyeball and sclera. Thus a special smoothing filter such as the median filter [8] is used on the original intensity image. This type of filtering eliminates sparse noise while preserving image boundaries.

2.1.2 Outer Iris Localization

After filtering, the contrast of image is enhanced to have sharp variation at image boundaries using histogram equalization as shown in Fig. 4(a). This contrast enhanced image is used for finding the outer iris boundary by drawing concentric circles, as shown in Fig. 4(b), of different radii from the pupil centre and the intensities lying over the perimeter of the circle are summed up. Among the candidate iris circles, the circle having a maximum change in intensity with respect to the previous drawn circle is the iris outer boundary. Fig. 4(c) shows an example of localized iris image.

(a) (b) (c)

Fig. 4(a) Contrast enhanced image,(b) Concentric circles of different radii,(c) Localized Iris image

3. Feature Extraction

A typical iris recognition system consists of pre-processing steps including segmentation, normalization using Daugman's rubber sheet model and image enhancement [4]. Segmentation is the process by which the inner and outer boundaries of the iris are localized in an image of the eye. Normalization transforms the points within the iris to polar coordinates (r,θ), where r represents the radial distance from the iris-pupil boundary to the iris-sclera boundary, and θ represents the angle subtended by a pixel relative to the horizontal axis. This transformation model accounts for the scaling due to pupil dilations and different diameters of the iris across subjects. The pixel at location (x, y) within the iris image I is transformed to polar coordinates using the following mapping [4].

$$(\mathrm{I}(x(r,\theta), y(r,\theta)) \Rightarrow \mathrm{I}(r,\theta) \quad (4)$$

where, $x(r, \theta)$ and $y(r,\theta)$ are pixel positions within the circular disk defined as the linear combination of points on the pupillary boundary ($x_p(\theta)$, $y_p(\theta)$) and limbus boundary ($x_s(\theta)$, $y_s(\theta)$). Thus,

$$x(r,\theta) = (1 - r)xp(\theta) + rx_s(\theta) \quad (5)$$

$$y(r, \theta) = (1 - r)yp(\theta) + ry_s(\theta) \quad (6)$$

To localize the inner and outer boundary of iris in the captured iris image. And then, the localized iris region is transformed into polar coordinate (Fig.5) to compensate iris image deformation due to the variation of pupil size in the conditions of iris acquisition. In fact, the features of the iris are extracted based on the polar coordinate. Features are extracted using a bank of log Gabor filters.

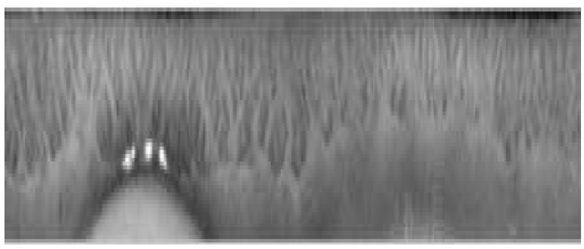

Fig. 5 Result of polar Transformation

3.1 Gabor and Log Gabor Filters

Gabor filters are directly related to Gabor wavelets. In general the expansion is not applied for Gabor wavelets, which requires Biorthogonal wavelets, it may be time consuming. Therefore a filter bank consists of Gabor filters with various scales and rotation is created also effective for analyzing different phased features like abrupt ridges or edges. This filter convolved with signal, resulting in Gabor space. Gabor space is very useful in image processing applications such as iris recognition, face etc. In the case of Daugman's algorithm a Gabor wavelet transform is used, the result is set of complex numbers which carry local amplitude and phase information about iris pattern. Most amplitude information is discarded which ensures that template remains largely unaffected by changes in illumination of camera gain.

3.2 Gabor Transform

It is the special case of the short time Fourier transform, which is used to determine the sinusoidal frequency and phase content of local sections of a signal as it changes over time.

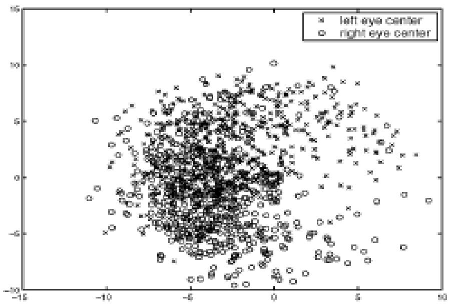

Fig. 6(a) X-Real, Y-Imaginary Complex Frequency Responses For High Frequency

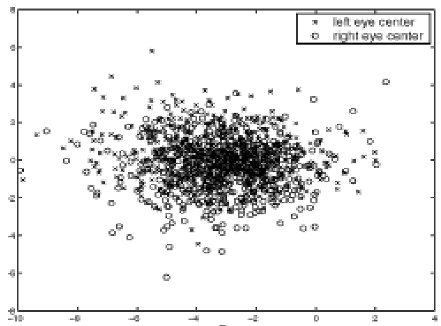

Fig. 6(b) X-Real ,Y-Imaginary Complex Frequency Responses For Low Frequency

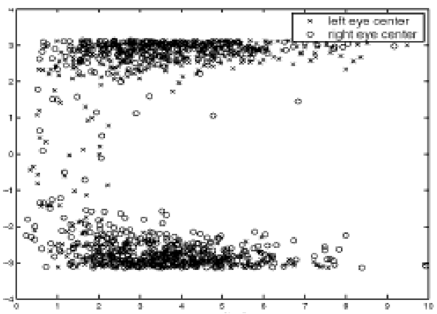

Fig. 6(C) Magnitude(x) and Phase(y) response for high Frequency

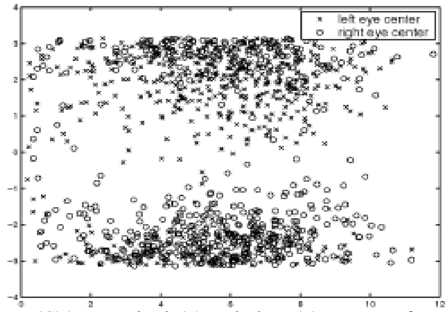

Fig. 5(C)) Magnitude(x) and Phase(y) response for Low Frequency

Due to the smooth shape of the Gabor filters, the behavior of their complex responses is also typically smooth as demonstrated in Fig. 5 which shows responses for the real objects used in [16]–[18]. In Fig. 5, filter responses from left and right eye centers, which should be roughly symmetric, are plotted on two frequencies at zero orientation. Complex responses in Fig. 5(a) and (b) forms smooth clusters, a result which can be used in the classifier selection.

3.3 Generation Of Feature Vector (V) Or Descriptor

The average absolute deviation of gray values in the response of each filter is then calculated using equation

$$V = \frac{1}{N}\left(\sum |f(x_0, y_0) - \mu|\right) \qquad (8)$$

N -represents the number of pixels in the response,
μ -is the mean of the response,
f(x, y)- is the value of response at point x and y.

A sample of the iris feature vector is shown below

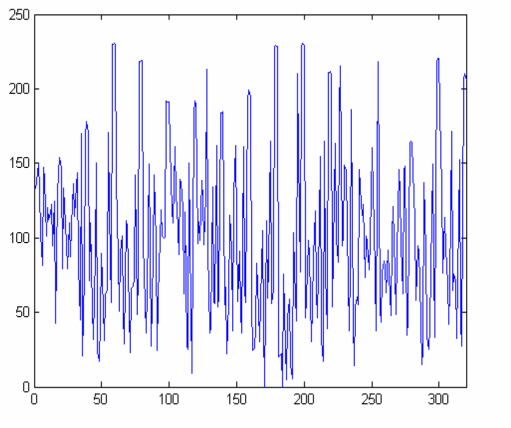

Fig. 6 sample of the iris feature vector

Log-Gabor filters basically consist in a logarithmic transformation of the Gabor domain [23] which eliminates the annoying DC-component allocated in medium and high-pass filters. The DC component is reduced by the use of log Gabor filters which is shown in Fig.

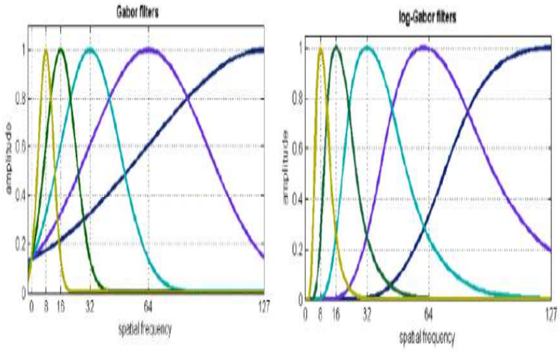

Fig. 7(a) The frequency response of Gabor filters (b)log-Gabor filters (right).

4. Matching

For simplicity, iris matching is based on computing then Euclidean distance (ED) between the corresponding feature vectors. The ED is defined in the following equation.

$$\mathrm{ED} = \frac{1}{N}\sum_{i=1}^{N}\left(f_i^k - f_i\right)^2 \qquad (9)$$

N - Size of the feature vector
f_i -i^{th} feature component of unknown sample
f_i^k - i^{th} feature component of i^{th} class

5. Experimental Result

Identification mode, a nearest-neighbour classifier, decision based on the minimum Euclidean distance, was employed for matching with samples divided into training and testing groups. The number of training samples was made variable and an identification rate was calculated each time. The performance of our algorithm has been compared with the even-symmetric Gabor filtering algorithm proposed in [2]. The detailed results are shown in Table I below

Table I: Comparison of proposed method with the conventional method

IRIS NUMBER	CONVENTIONAL METHOD	PROPOSED METHOD
24	73.07%	100%
27	70.47%	100%
80	70.45%	97.54%
108	65.67%	96.40%

This database was collected from Chinese Academy of Science. The proposed method has been tested in both identification (1: N) and verification (1: 1) modes. To test the proposed algorithm in the verification mode, the samples were divided into two groups for training and testing. The training group is used to generate a template codebook. Next, each sample image of the testing set was then compared with all images in the template codebook. The matching was done using Euclidean distance. The distribution of the genuine or authorized matches and that of the imposter matches were then estimated, and shown in the figure below

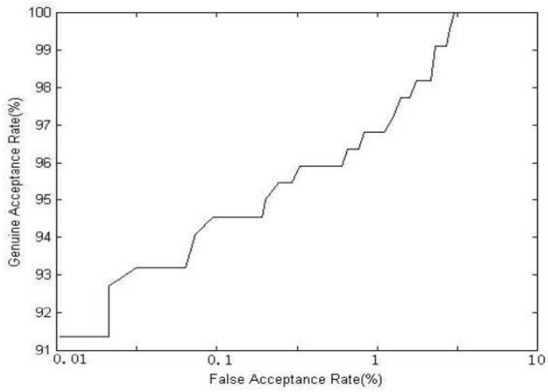

Fig. 8 ROC Curve For Verification

A total of 20 different eyes (i.e. different iris classes) were tested and for each iris seven images were used. This makes up a total of 140 experiments. The system was so trained to four images and remaining three images of each class were used as test images. The graphical representation reflects that as the number of training images is increased the rate of failure is decreasing as system is better trained.

6. Conclusion

The proposed method produces an uncorrelated and less redundant representation for iris texture compared with the ordinary Gabor filters. Tracking of local and global features of iris images are correctly obtained High identification results produced that are useful large databases and access control. In Future our work includes tracking more local information content distribution of the iris images and also for improving the accuracy of the system.

Reference:

[1] T. Mansfield, G. Kelly, D. Chandler, and J. Kane, “Biometric product testing final report,” Nat. Physical Lab., Middlesex, U.K., 2001.
[2] J. Daugman, “High confidence visual recognition of persons by a test of statistical independence,” IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 15, no. 11, Nov. 1993,pp. 1148-1161.

[3] J. Daugman, “Demodulation by Complex-Valued Wavelets for Stochastic Pattern Recognition,” Int’l J. Wavelets, Multiresolution and Information Processing, vol. 1, no. 1, 2003, pp. 1-17.
[4] 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, no.1,, 1996 pp. 1-8.
[5] W. Boles and B. Boas hash, “A human identification technique using images of the iris and wavelet transform,” IEEE Trans. Signal Process. vol. 46, no. 4, 1998, pp. 1185–1188.
[6] L. Ma, T. Tan, Y. Wang, and D. Zhang, “Local Intensity Variation Analysis for Iris Recognition,” Pattern Recognition, vol. 37, 2004, pp. 1287-1298.
[7] L. Ma, T. Tan, Y. Wang, and D. Zhang, “ Efficient iris recognition by characterizing key local variations,” IEEE Transactions on Image Processing, vol. 13, no. 6, June, 2004, pp. 739- 750.
[8] W. Boles and B. Boas hash, “A Human Identification Technique Using Images of the Iris and Wavelet Transform,” IEEE Trans. Signal Processing, vol. 46, no. 4, 1998, pp. 1185-1188.
[9] S. Lim, K. Lee, O. Byeon, and T. Kim, “Efficient Iris Recognition through Improvement of Feature Vector and Classifier,” ETRI J., vol. 23, no. 2, 2001, pp. 61-70.
[10] L. Ma, Y. Wang, and T. Tan, “Iris Recognition Based on Multichannel Gabor Filtering,” Proc. Fifth Asian Conf. Computer Vision, 2002, vol. 1, pp. 279-283.
[11] E. Rydgren, T. Ea, F. Amiel. "Iris features extraction using wavelet packets", 2004 International Conference on Image Processing, ICIP 2004, pp. 861-864.
[12] A.Sigüenza, M. Tapiador, “Tecnologías Biométricas Aplicadas a la Seguridad”, Editorial Ra-Ma. 2005.
[13] M. Adam, F. Rossant, F. Amiel, B. Mikovikova, T. EA, “Eyelid Localization for Iris Identification”, Radioengineering, VOL. 17, NO. 4, December 2008, pp. 82-85.
[14] D. Mirza, I. A. Taj, A. Khalid, “A robust eyelid and eyelash removal method and a local binarization based feature extraction technique for Iris Recognition System”, IEEE,2009.
[15] J.-K. Kamarainen, V. Kyrki, M. Hamouz, J. Kittler, and H. Kälviäinen,“Invariant Gabor features for face evidence extraction,” in Proc. IAPRWorkshop Mach. Vision Applicat., Nara, Japan, 2002, pp. 228–231.
[16] M. Hamouz, J. Kittler, J.K. Kainarainen, and H. Kälviäinen, “Hypotheses-driven affine invariant localization of faces in verification systems,” in Proc. Int. Conf. Audio- and Video-Based Biometric Person Authentication, 2003, pp. 276–284.
[17] M. Hamouz, J. Kittler, J.-K. Kamarainen, P. Paalanen, and H.Kälviäinen, “Affine-invariant face detection and localization using GMM-based feature detector and enhanced appearance model,” Proc. 6th Int. Conf. Autom. Face Gesture Recognit, 2004, pp. 67–72.

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