Iris Data Indexing Method Using Biometric Features

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Abstract
A biometric system provides identification of an individual based on a unique feature or characteristic possessed by the individual. Among the available biometric identification system, Iris recognition is regarded as the most reliable and accurate one. Demands are increasing to deal with large scale databases in these applications. The Segmentation in boundary detection, edge Mapping, circular Hough Transform, extracting Region of interest (Eyelash and noise removal), circle detection. In a module of Person Identification system using Iris Recognition. The iris recognition system consists of a segmentation that is based on the Hough transform and is able to localize the circular iris and pupil region, occluding eyelids and eyelashes and reflections. The extracted iris region was normalized into a rectangular block with constant dimensions to account for imaging inconsistencies. Finally, the data from Gabor filters was extracted and quantized to encode the unique pattern of the iris into a biometric template. To improve the efficiency of computational method and accuracy of classification, the Difference metric and subtraction method was employed. It was observed that this method classify the images with better accuracy. The Hamming distance was employed for classification of iris templates. The iris recognition is shown to be a reliable and accurate biometric technology.

Keywords
Gabor Filter Process, Image Recovery, Iris Biometric, Personal Verification

I. Introduction

The advances in Information technology and the increasing requirement of security issues have resulted in a rapid development of person identification based on biometrics. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, the retina, and the one concentrated and presented in this paper, the iris. Iris is regarded as the reliable and accurate technique because iris forms during gestation period itself and remains the same for the rest of one's life and it is unique for individuals. Iris is well protected and extremely difficult to modify. Biometric systems work by first capturing a sample of the feature, such as recording a digital sound signal for voice recognition, or taking a digital color image for face recognition, or taking a digital color image for iris recognition. The sample is then transformed using some sort of mathematical function into a biometric template.

The biometric template will provide a normalized, efficient and highly discriminating representation of the feature, which can then be objectively compared with other templates in order to determine identity. Most biometric systems allow two modes of operation. An enrolment mode for adding templates to a database, and an identification mode, where a template is created for an individual and then a match is searched for in the database of pre-enrolled templates.

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.

II. Principle Process

Data sets of eye images will be as inputs to the system. Composed of three stages
Segmentation
- Normalization
- Feature Extraction and matching

A. Segmentation

The first step of the image process algorithm is to extract the iris from the input eye contained image. For approximation, the iris area is considered as a circular region between two circles. After the boundaries of both the outer and inner circles are defined, the iris region is then located. The circular Hough Transform is adopted in this work to search for the boundaries. Eyelids are detected by fitting two lines using the linear Hough Transform, and eyelash is isolated by a simple threshold technique.

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The success of segmentation depends on the imaging quality of eye images. 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 stage 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.

Segmentation of iris consists of mainly of three stages. The first stage is extracting the valid region from the input eye samples (size: 800x600). The second stage is removal of eyelashes and noises and the third stage is circle detection.

1. Extracting Region of Interest

The input eye samples are converted into gray scale image for further processing. Initially window size is set as 400. By applying threshold on both forward and backward from the middle portion of eye sample, some of the unwanted portions are eliminated. The valid inner and outer circles are shown with eyelashes and sclera region in the below given figure.

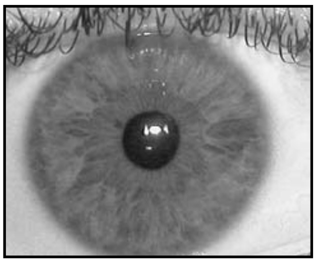

Fig. 1:

2. Eyelash and Noise Detection

For isolating eyelashes, a simple thresholding technique is used, since analysis reveals that eyelashes are quite dark when compared with the rest of the eye image. The isolated eyelash eye image is shown in figure.

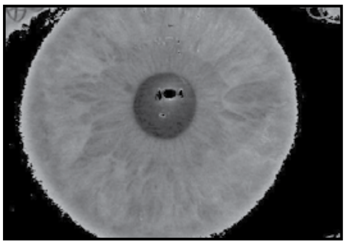

Fig. 2:

3. Circle Detection

For circle detection circular huff transform is used. Inner and outer circle regions are detected as shown in figure

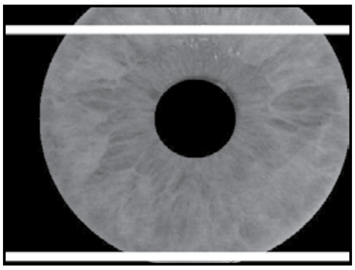

Fig. 3:

III. Proposed Process

In this process proposed approach is shown by following figure.

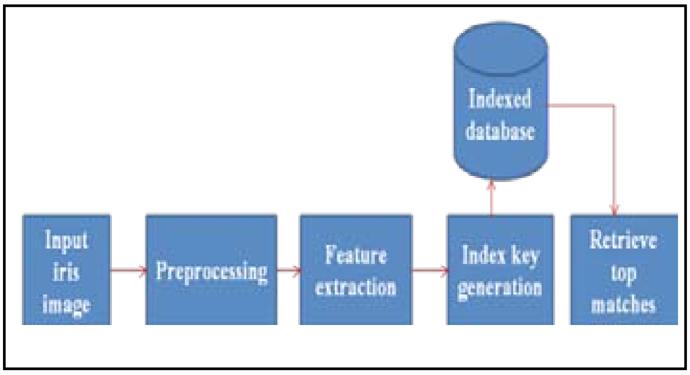

Fig. 4:

A. Preprocessing

The first stage of iris recognition is to isolate the actual iris region in a digital eye image. The iris region, shown in fig. 1 can be approximated by two circles, one for the iris/sclera boundary and another, interior to the first, for the iris/pupil boundary. The eyelids and eyelashes normally occlude the upper and lower parts of the iris region. Also, specular reflections can occur within the iris region corrupting the iris pattern. A technique is required to isolate and exclude these artifacts as well as locating the circular iris region.

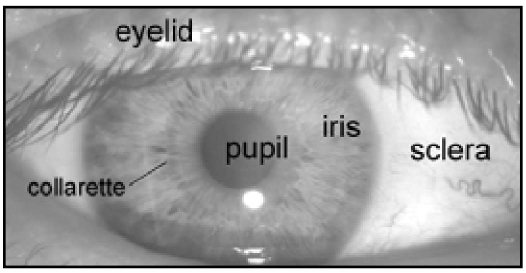

Fig. 5:

1. Normalization

Irises from different people may be captured in different size, and even for the iris from the same person, the size may change because of the illumination and other factors. Such elastic deformations in iris texture affect the results of iris matching. For the purpose of achieving more recognition results, it is necessary to compensate for these deformations. Iris ring is unwrapped to a rectangular block of texture of a fixed size. The distortion of the iris caused by pupil dilation can thus be reduced.

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination. Other sources of inconsistency include, varying imaging distance, rotation of the camera, head tilt, and rotation of the eye within the eye socket. The normalization process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location.

Another point of note is that the pupil region is not always concentric within the iris region, and is usually slightly nasal. This must be taken into account if trying to normalize the 'doughnut' shaped iris region to have constant radius. The segmented iris images are normalized into a fixed size with 512x64. The polar coordinates are transformed into rectangular coordinates.

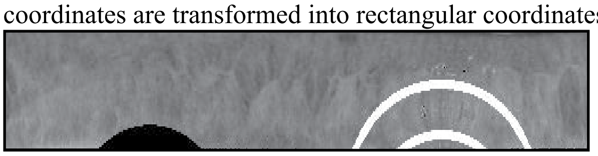

Fig. 6:

Fig. 7 shows the post normalization and it represents Histogram Equalization of a Normalized Eye image.

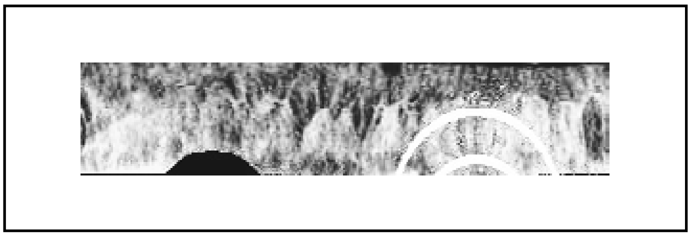

Fig. 7:

B. Feature Extraction

The iris has a particularly interesting structure and provides abundant textual information. So, it is desirable to explore representation methods which can capture local underlying information in the iris. From the viewpoint of texture analysis, the local spatial patterns in an iris mainly involve frequency information and orientation information. But the orientation is not a crucial factor when analyzing the characteristics of a small iris region such as 10x10 region. That is, in a small iris region, frequency information accounts for the major differences of the irises from different people. To capture the majority of useful information of the iris is in specific frequency band, a bank of circular symmetric filters can be used.

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.

In the spatial frequency domain, we can extract the information of an image at a certain scale and at a certain orientation by using some specific filters, such as multichannel Gabor filters. Gabor filter based methods have been widely used in computer vision, especially for texture analysis. Gabor elementary functions are Gaussians modulated by oriented complex sinusoidal functions. The difference between Gabor filter and Circular symmetric filter lies in the modulating sinusoidal functions. The former is modulated by an oriented sinusoidal functions, whereas the latter a circular symmetric sinusoidal function.

C. Index Key Generation

Gabor filters are able to provide optimum conjoint representation of a signal in space and spatial frequency. A Gabor filter is constructed by modulating a sine/cosine wave with a Gaussian. This is able to provide the optimum conjoint localization in both space and frequency, since a sine wave is perfectly localized in frequency, but not localized in space. Modulation of the sine with a Gaussian provides localization in space, though with loss of localization in frequency. Decomposition of a signal is accomplished using a quadrature pair of Gabor filters, with a real part specified by a cosine modulated by a Gaussian, and an imaginary part specified by a sine modulated by a Gaussian. The real and imaginary filters are also known as the even symmetric and odd symmetric components respectively. The centre frequency of the filter is specified by the frequency of the sine/cosine wave, and the bandwidth of the filter is specified by the width of the Gaussian.

1. Gabor Function

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = \exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\cos\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

$$x' = x\cos\theta + y\sin\theta$$

and $y' = -x\sin\theta + y\cos\theta$

D. Database Creation

1. Hamming Distance

The Hamming distance gives a measure of how many bits are the same between two bit patterns. Using the Hamming distance of two bit patterns, a decision can be made as to whether the two patterns were generated from different irises or from the same one.

In comparing the bit patterns X and Y, the Hamming distance, HD, is defined as the sum of disagreeing bits (sum of the exclusive-OR between X and Y) over N, the total number of bits in the bit pattern.

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

Since an individual iris region contains features with high degrees of freedom, each iris region will produce a bit-pattern which is independent to that produced by another iris, on the other hand, two iris codes produced from the same iris will be highly correlated. If two bits patterns are completely independent, such as iris templates generated from different irises, the Hamming distance between the two patterns should equal 0.5. This occurs because independence implies the two bit patterns will be totally random, so there is 0.5 chance of setting any bit to 1, and vice versa. Therefore, half of the bits will agree and half will disagree between the two patterns. If two patterns are derived from the same iris, the Hamming distance between them will be close to 0.0, since they are highly correlated and the bits should agree between the two iris codes.

The Hamming distance is the matching metric employed by Daugman, and calculation of the Hamming distance is taken only with bits that are generated from the actual iris region.

E. Storing Iris Biometric Index Key

1. Weighted Euclidean Distance

The weighted Euclidean Distance (WED) can be used to compare two templates, especially if the template is composed of integer values. The weighting Euclidean distance gives a measure of how similar a collection of values are between two templates. This metric is employed by Zhu et al and is specified as

$$WED(k) = \sum_{i=1}^{N} \frac{(f_i - f_i^{(k)})^2}{(\delta_i^{(k)})^2} \qquad (2)$$

Where fi is the ith feature of the unknown iris, and fi(k) is the ith feature of iris template, k, and δi(k) is the standard deviation of the ith feature in iris template k. The unknown iris template is found to match iris template k, when WED is a minimum at k.

F. Retrieving the Best Match

After feature extraction, an iris image is represented as a feature vectors. To improve computational efficiency and classification accuracy the difference metric and subtraction is adopted for classification.

1. Difference Metric

The deviations in the post normalized images were calculated by applying pixel differencing method to the databases. Let g(i,j) and f(i,j) are the two different databases. Difference (d (i, j)) is calculated by the following equation (1),

d (i, j)= g(i,j) - f(i,j)/ Imax

[p (i, j) & q (i,j)] --------- two different databases

Imax -------- Max. pixel Intensity

IV. Experimental Results

The pixel by pixel comparison is done for the images. Fig. 1 & 2 shows interclass and intraclass distribution. Interclass distribution results in deviation of 0 to 35% whereas in the case of intra class distribution, difference is nearly from 0.005% to .5%

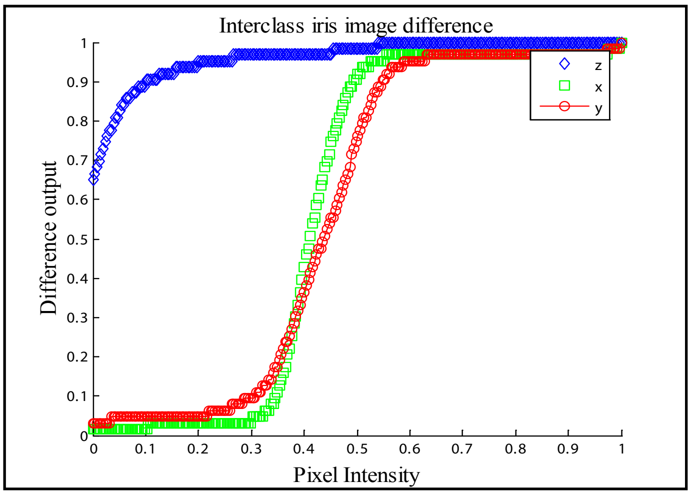

Fig. 8: Interclass Post Normalized Iris Image Difference

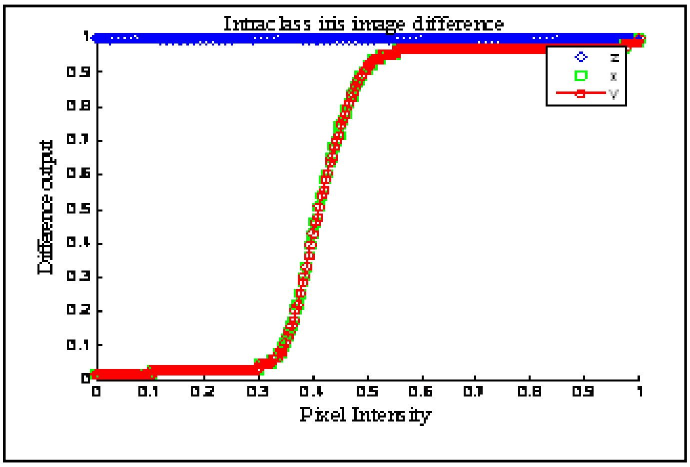

Fig. 9: Intraclass Post Normalized Iris Image Difference

Table: 1 Mathematical Representation

S.No	Data base	mean	Std.	covariance	decidability
1.	Data base-1	0.3894	0.0694	1.2293	0.049
2.	Data base-2	0.3838	0.765	1.4788	

V. Conclusion

This project forms a module of Person Identification using Iris Recognition systems. An Iris recognition system presented here, which was tested using grayscale eye images in order to verify the claimed performance of iris recognition technology.

Firstly, an automatic segmentation algorithm was presented, which would localize the iris region from an eye image and isolate eyelid, eyelash and reflection areas. Segmentation was achieved through the use of the circular Hough transform for localizing the iris and pupil regions, and the linear Hough transform for localizing occluding eyelids. Thresholding was also employed for isolating eyelashes and reflections.

Next, the segmented iris region was normalized to eliminate dimensional inconsistencies between iris regions. This was achieved by unwrapping the iris image into a rectangular block with constant polar dimensions.

Finally, features of the iris were extracted by convolving the normalized iris region with 1D Gabor filters. The difference metric was chosen matching metric, which gave a measure of how far the deviation disagreed between images. Also, subtraction based classification was employed for matching. Here intensity values of the images are taken as the parameter and the classified results are analyzed.

An improvement could be made in the speed of the system. The most computation intensive stages include performing the Hough transform, and calculating deviation values between images to search for a match. Since the system is implemented in MATLAB

References

[1] S. Dey, D. Sam anta,"An efficient and accurate pupil detection method for iris biometric processing", Int. J. Comput. Applicat., Vol. 32, No. 2, 2010, pp. 141–148.

[2] S. Dey, D. Sam anta,"An efficient approach to iris detection for iris biometric processing", Int. J. Comput. Applicat. Technol., vol. 35, no.1, 2009, pp. 2–9.

[3] S. Dey, D. Sam anta,"Iris Data Indexing Method using Gabor Energy Features", IEEE Transactions on Information Forensics and Security, Vol. 7, No. 4, August 2012.

[4] Libor Masek,"Recognition of Human Iris Patterns for Biometric Identification", BE Dissertation, University of Western Australia, 2003.

[5] W. Kong, D. Zhang,"Accurate iris segmentation based on novel reflection and eyelash detection model", Proceedings of 2001 International Symposium on Intelligent Multimedia, Video and Speech Processing, Hong Kong, 2001.

[6] Shenglin Yang, Ingrid Verbauwhede,"Secure iris verification", ICASSP 2007

[7] Daniel Schonberg, Darko Kirovski,"EyeCerts", IEEE Transaction on information forensics and security, Vol. 1, No. 2, June 2006

[8] J. Daugman,"How iris recognition works", Proceedings of 2002 International Conference on Image Processing, Vol. 1, 2002.