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AUTOMATIC DEPENDENT SURVEILLANCE BROAD CASTINGWITH EYE IRIS SECURITY

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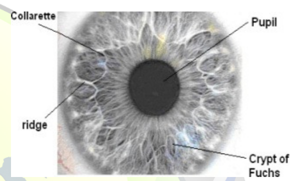
ABSTRACT

The interface of computer technologies and biology is having a huge impact on society. Human recognition technology research projects promises new life to many security consulting firms and personal identification system manufacturers. Iris recognition is consideredto be the most reliable biometric authentication system.

Very few iris recognition algorithms were commercialized. The method proposed in this paper differed from the existing work in the iris segmentation and feature extraction phase. Digitized grayscale images of Chinese Academy of Sciences – Institute of Automation (CASIA) database were used for determining the performance of theproposed system. The circular iris and pupil of the eye image were segmented using Morphological operators and Hough transform. The localized iris region was then normalized in to a rectangular block to account for imaging inconsistencies. Finally, the iris code was generated using 2D GabberWavelets. A bank of Gabber filters has been used to capture both local and global iris characteristics to generate 2400 bits of iris code. Measuring the Hamming distance did the matching of the iris code. The two iris codes were found to match if the hamming distance is below 0.20. The experimental results show that the proposed method is effective and encouraging.

INTRODUCTION

The colored part of the eye (iris) contains delicate patterns that varyrandomly from person to person, offering a powerful meansof identification" – John Daugman. The mathematical advantage of iris pattern is that its



pattern variability among different persons I s enormous. The iris consists of a variable sized hole called pupil. It works in the same way as a camera aperture, automatically adjusting the size of the pupil to control the amount of light entering

The eye based on external conditions. The average diameter of the iris is 12 mm, and the pupil size can vary from 10% to 80% of the iris diameter.

It is apparent that irises show complex random patterns, created by arching ligaments, furrows, ridges, crypts, rings, sometimes freckles as well as corona and a zigzag collaret. Muscles constrict and dilate the pupil to control the amount of light entering the eye, since the back of the iris is covered with dense black pigment.The spatial patterns that are apparent in the iris are unique to each individual. The different

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anatomical structures that exist in the body of each Individual result in the uniqueness of the iris pattern.The iris pattern is as distinct as the patterns of retinal blood vessels. Iris is a highly protected internal organ and hence it is less vulnerable to external damage and its patterns are apparently stable throughout the life.Iris is the only internal organ that is visible externally.Images of the iris can be acquired from distances of up to about 3 feet (1 meter). Iris patterns can have up to 249 independent degrees of freedom. This high randomness in the iris patterns has made the technique more robust and it is very difficult to deceive an iris pattern. Unlike other biometric technology Iris recognition is the most accurate, non-invasive, and easy-to-use biometric for secure authentication andpositive identification.

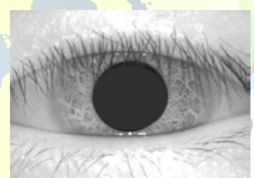
The concept of automated iris recognition has been first proposed by Flow and Safir in 1987, though an attempt to use iris to human identification can be traced back to as early as 1885. John Daugman developed the first Iris recognition system in 1994. Later, similar work has been investigated, such as Wilde's, Boles', and Lim's, which differed either in feature extraction or pattern matching methods.

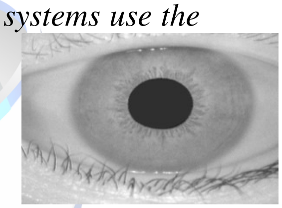
Daugman used multi-scale Gabor wavelets to demodulate the texture phase information. He filtered the iris image with a family of Gabor filters and generated 2048-bit complex valued iris code and then compared the difference between two iris codes by computing their Hamming distance. His work is most widely implemented in the available systems in the world. Boles and Boas hash generated one-dimensional 1- D signals by calculating the zero-crossings of wavelet transform at various resolution levels over concentric circles on the iris.

RELATED WORKS

Comparing the 1-D signals with model features using different dissimilarity functions did the matching. Wilds et al. [3] 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 thesame class. Lim et al. method was based on key local variations. The local sharp variation points denoting the appearing or vanishing of an important image structure are utilized to represent the characteristics of the iris.

He used one-dimensional intensity levels to characterize the most important information and position sequence of local sharp variation points are recorded using wavelets. The matching has been performed using exclusive OR operation to compute the similarity between a pair of position sequences. The existing systems use the





ideal eye images with less occluding parts for their testing. An example of an ideal eye image is shown in the Figure 2 (a).

However the real time image of the eye can be captured with a lot of occluding parts, the effect of such occluding parts may result in the false non-matching. Some of the problems are outline below.

Figure (a) ideal image b) Occluded eye image

1. Eyelids and eyelashes bring about some edge noises and occlude the effective regions of the iris This may leads to the inaccurate localisation of the iris, which results in the false non-matching.

2. The corneal and specular reflections will occur on the pupil and iris region. When the reflection occurs in the pupil from

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iris/pupil border, the detection of the innerboundary of the iris fails.

3. The orientation of the head with the camera may result in the orientation of the iris image to some extent. The proposed system uses a technique to overcome theseproblems.

OVERVIEW OF PROJECT

The interface of computer technologies and biology is having a huge impact on society. Human recognition technology research projects promises new life to many security consulting firms and personal identification system manufacturers. Iris recognition is considered to be the most reliable biometric authentication system. Very few iris recognition algorithms were commercialised. The method proposed in this paper differed from the existing work in the iris segmentation and feature extraction phase. Digitised greyscale images of Chinese Academy of Sciences – Institute of Automation (CASIA) database were used for determining the performance of theproposed system. The circular iris and pupil of the eye image were segmented using Morphological operators and Hough transform. The localised iris region was then normalised in to a rectangular block to account for imaging inconsistencies. Finally, the iris code was generated using 2D Gabor Wavelets. A bank of Gabor filters has been used to capture both local and global iris characteristics to generate 2400 bits of iris code. Measuring the Hamming distance did the matching of the iris code. The two iris codes were found to match if the hamming distance is below 0.20. The experimental results show that the proposed method is effective and encouraging.

MODULE DESCRIPTION

The proposed system consists offive steps as shown in the Figure 3 below, Image acquisition, segmentation of the iris region, Normalization of the iris region, extraction of the iris code and matching theiris code. Each of the five steps is briefly discussed below.

IMAGE ACQUISITION

The iris is a relatively small organ of about 1cm in diameter . In order to make theiris recognition system to work efficiently a high-quality image of the iris has to be captured. The acquired image of the iris must have sufficient resolution and sharpness to support recognition. Also, it isimportant to have good contrast in the interior iris pattern . The eye images captured under normal lighting conditions will result in poor quality images with lots of spatial reflections. However, images captured using infrared mera results in good quality images with high contrast and low reflections . The images used in the proposed system (CASIA database) were taken from such cameras.

IRIS LOCALISATION

The localization of iris involves detecting the Pupil/Iris boundary and the Iris/Sclera boundary. The pupil is segmented from other regions using morphological operators. The centre and radius of the pupilis used to detect the inner boundary of the iris. The outer boundary of the iris is detected using Hough transform.

PUPIL DETECTION

Pupil is a dark black circular region inan eye image. Hence pupil detection is equivalent to detecting the black circular region. The steps involved in detecting pupilis as follows,

- *The eye image is converted to a binary image using a threshold value of 40, that is, if the pixel value is less than 40 it is converted into 255 (white)and if the pixel value is greater than 40 it is converted in to 0 (black).*
- *The resulting image will contain the pupil and some other noises (pixels whose value is less than 40 for e.g.,*

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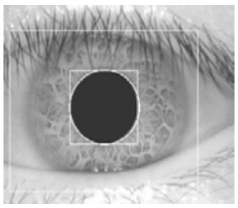
eyelash)

- *To remove these noises*



morphological erosion and dilation is applied over the image

a. b.

Figure 5.1 (a) Eye image Figure 5.1 (b) Segmenting the pupil

- *The hit and miss operator is applied to segment only the circle region in the image (Figure 4 (b)).*
- ***A bounding box is drawn by searching for the first black pixel from top, bottom and from the sides of the image.***
- *The length or breadth of the box gives the diameter of the pupil.*

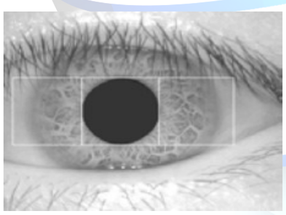


Figure 5.2 Bounding box around pupil

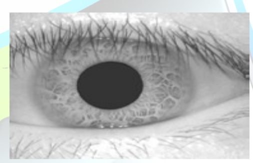
- *Since we are drawing the bounding box, the specular reflections near the pupil/iris border will not affect the detection of the pupil.Iris Detection: After detecting the pupil, the next task is to detect the iris/sclera border. Theiris/sclera region is low in contrast and may be partly occluded by eyelids and eyelashes.*

IRIS DETECTION

- *A bounding box of height equal to that of the pupil and width equal to up to eight times (as the size of the iris varies from 10% to 80% to that of the pupil) is drawn. Only regions within this bounding box are used to detect iris/sclera boundary.*

a) Bounding box iris

- *The contrast of the iris region is increased, by first applying Gaussian smoothing and then by histogram equalisation.*
- *Sobel edge detector is applied to find the edges of the enhanced image.*
- *Probabilistic circular Hough transform is applied to the edgedetected image to find the centre and*



radius of the iris using the equation (1).

- *Probablistic Hough transform is used to reduce the computation time.*

(x – a)2 + (y- b)2 = r2-----------------(1)

- *The CASIA database images have radius (r) in the range of 100 to 120. Hence in our work the radius parameter in the Hough transform is set between 95 and 125.*
- *The pupil and iris are not concentric. The center of the iris lies within the pupil area and hence the probability*

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that the centre of the iris lying in this area is high. Therefore the centre parameters (a,b) are taken to be the pupil area. This reduces the number of edge pixels to be computed.

b. c

b) Finding irises through Hough transform.

c) Iris and Pupil region in the image

- By applying Hough transform we can find the iris centre and radius.
- The Figure 6b and 6c shows the pupiland iris circles detected by the proposed system

IRIS NORMALISATION

The localised iris part is transformed into polar coordinates system to overcome imaging inconsistencies. The annular iris region is transformed into rectangular region. The Cartesian to polar transform of the iris region is based on the Daugman's Rubber sheet model. Dausman'srubber sheet model is used to unwrap the iris region. The steps are as follows,

- The centre of the pupil is considered as the reference point. The iris ring is mapped to a rectangular block in the anti-clockwise direction.
- Radial resolution is the number of data points in the radial direction. Angular resolution is the number of radial lines generated around irisregion.
- Radial direction is taken to be 64 data points and horizontal direction is 360data points.
- Using the following equation the doughnut iris region is transformed to a 2D array with horizontal dimensions of angular resolution and vertical dimension of radial resolution.

$I(x(r,\theta), y(r, \theta)) \rightarrow I(r, \theta)$....................(2)

Where $x(r, \theta)$ and $y(r, \theta)$ are defined as linear combinations of both the set of papillary boundary points. The following formulas perform the transformation,

$x(r, \theta) = (1-r)xp(\theta) + xi(\theta)$.......................(3)

$y(r, \theta) = (1-r)yp(\theta) + yi(\theta)$.......................(4)

$xp(\theta) = xp0(\theta) + rpCos(\theta)$ ....(5)

$yp(\theta) = yp0(\theta)+rpSin(\theta)$..........................(6)

$xi(\theta) = xi0(\theta) + riCos(\theta)$..........................(7)

$yi(\theta) = yi0(\theta) + riSin(\theta)$..........................(8)

where (xp, yp) and (xi, yi) are the coordinates onthe pupil and limbus boundaries along the θdirection.

- Normalisation produces the image of unwrapped iris region of size 360X64

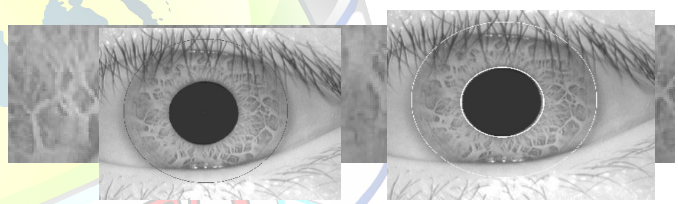

Figure 5.4 Iris Normalised into Polar coordinates

- The unwrapped image has very low contrastand has noises. To obtain a good feature extraction the texture must be clear and thecontrast must be high. Median filter isapplied to remove the noises and Histogram equalisation is used to increase the contrastof the normalised image.

Figure 5.5 Enhanced normalized Image

- The Figure 5.5 shows the enhanced normalized image after histogram equalization. It shows rich texture

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suitable for feature extraction

EXTRACTION AND MATCHING

The most discriminating features present in the iris region must be encoded in order to recognise the ndividuals accurately. Wavelet is powerful in extracting features oftextures. The template that is generated using wavelets will also need a corresponding matching metric, which gives a measure of similarity between two iris templates. This metric should give a range of values for intra-class comparisons, that is, templates generated from same eye, and another range of values for inter-class comparisons, that is, templates generated from different eyes. [2] discussed about the combination of Graph cut liver segmentation and Fuzzy with MPSO tumor segmentation algorithms. The system determines the elapsed time for the segmentation process. The accuracy of the proposed system is higher than the existing system. [4] discussed that Automatic liver tumor segmentation would bigly influence liver treatment organizing strategy and follow-up assessment, as a result of organization and joining of full picture information. Right now, develop a totally programmed technique for liver tumor division in CT picture. [6] discussed that Live wire with Active Appearance model (AAM) strategy is called Oriented Active Appearance Model (OAAM). The Geodesic Graph-cut calculation creates much better division results than some other completely programmed strategies distinguished in writing in the expressions of exactness and period preparing. The steps for feature extraction and matching is as follows,

- *The normalised iris image is divided into 8 parts of 45degrees interval each.*
- *Each part is further sub divided into 8 regions to form sixty-four small channels.*

0-45	46 -90	91-135	136-180	181-225	226-270	271-315	316-360

R

0-45	46 -90	91-135	136-180	181-225	226-270	271-315	316-360

Fig 5.6 Multichannel feature extraction

- *iii. From figure 9 it is apparent that the eyelids eyelashes can occlude theirises in theregions between 45 and 135 degrees, 270 and 315 degrees. Hence only the top twochannels in these regions are considered for the feature extraction. Therefore the iris isdivided in to forty channels, which are mostly not occluded, by eyelashesor eyelids.*
- *A bank of thirty Gabor filters is generated using the 2D Gabor wavelet equation,*

$G(x, y; \theta, \omega) = \exp\{-1/2\,[x'2 / \delta\, x'2 + y'2 / \delta y'2\,]\}\, \exp(i\omega(x+y))$ ……………. (9)

$x' = x \cos\theta + y \sin\theta$ …………………... (10)

$y' = y \cos\theta - x \sin\theta$ …………………… (11)

- *The frequency parameter is often chosen to be power of 2. In our experiments, the central frequencies used are 2, 4, 8, 16, and 32. For each frequency the filtering is performed at orientation 0, 30, 60, 90, 120 and 150 degrees. So, there are thirty filters with different frequencies and directions.*

- *A bank of thirty Gabor filters is applied over the forty channels to generate 2400 bits of information as shown in the figure below.*

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- *Figure 10 and Figure 11 shows the typical iris codes generated using theabove method.*

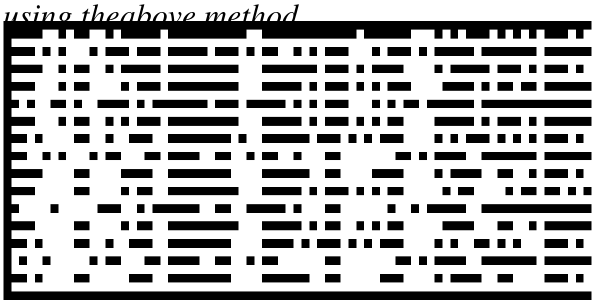

Figure5.7 .example of iris code

11001001100100100101011010110100010 1000

Figure5.8 .typical iris code.

- ***The two iris codes are compared by computing the hamming distance between them using the equationNHD***

$$= 1/N \sum_{J=1} X_j \text{ (XOR) } Y_j \ldots\ldots (12)$$

If the hamming distance is below 0.2 then the two irises belongs to the same eye. If it is greater than 0.2 then the two irises belongs to different person.

CONCLUSION

The paper presented an iris recognition system using Gabor filters, which was tested using CASIA eye images database in order to verify the performance of the technology. Firstly a novel segmenting method was used to localise the iris region from the eye image. Next the localised iris image was normalised to eliminate dimensional inconsistencies between iris regions using Daugman's rubber sheet model. Finally features of the iris region wasencoded by convolving the normalised iris region with 2D Gabor wavelets and phase quantising the output inorder to produce a bitwise biometric template Hamming distance was chosen as a matching metric, which gave a measure of how many bits disagreed between two templates. It was found from the experiments that the hamming distance between two irises that belong to the same eye is 0.20. It was found that nearly 82% of the intra class classifications were found correctly by the system.

Testing more samples of iris images could extend the study. Since the images in the CASIA database were mainly eyes of Chinese people the testing could be done for other ethnic groups. The images were all captured under infrared cameras, so that the specular reflections were minimum. The study could be extended to test the images taken under ordinary cameras. The eyes that have very low contrast between iris and pupil were not tested. "The process of defeating a biometric system through the introduction of fake biometri c samples is known as spoofing".Biometric liveness detection has become an active research topic and the project could be extended to determine if the iris image given are taken from the original eye or spoofed iris image.

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