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Iris Recognition System for Biometric Recognition

Mradul Agrawal, Dharmil Sanghavi, Shreyal Gelani

***Abstract*— Several systems require identification or authentication of a person's identity before granting access to resources requiring clearance. With the ever evolving technological advances, biometrics is one of the most promising techniques in human recognition. Biometrics tends to identify a person by his physical and/or his behavioural characteristic**

Among the various biometric technologies, iris recognition has received increased attention due its high reliability and efficiency. Iris recognition is a biometric authentication technology that uses pattern recognition techniques based on iris characteristics. It has proved to be one of the most efficient technique among the various others.

In this paper summaries of various other papers have been put down along with the comparisons of methods and algorithms used by the authors in their respective papers. A lot of algorithms for each stage of iris recognition will be discussed and compared. The combination of the best algorithms will, in the end, be put together to propose a highly efficient iris recognition biometric system.

***Index Terms*—Iris, Biometric, Identification.**

I. INTRODUCTION

There are several body characteristics of a human body such as voice, face etc which are used for thousands of years to recognize and identify each other. For example in mid-19th century police department in Paris developed an idea of measuring number of body measurement in order to identify criminals. But soon after towards the end of the 19th century fingerprint recognition was gaining popularity like wild fire. Major Law enforcement departments started the practice of booking the fingerprints of criminals and storing it in a database. Later the leftover fingerprint from the crime scene would be lifted and matched against all those in the database to find a hit. Although biometrics emerged from its extensive use in law enforcement to identify criminals, it is being used today to establish person recognition in a number of civil applications apart from criminal ones.

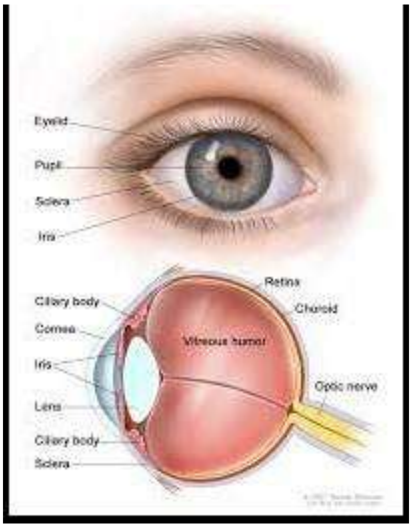
Biometric techniques can be classified into three categories: Biological such as blood, odor, saliva, Behavioural such as signature, keyboard typing, gait and morphological iris, retina, fingerprint, face, hand geometry. Most time a combination of different systems prove to be very helpful in making the system efficient.

Identification and Verification are the two main categories of automated biometrics personal identification system. Process of identification is also termed as one to many comparison. In process of identification, it is often desirable to be able to discover the origin of certain biometrics information to prove or disprove the association of Individual. In a process of verification (1-to-1 comparison), the comparison result determines whether the identity claims shall be accepted or rejected. Among all biometric techniques, Iris recognition stands out because of its accuracy and high reliability. Since it is the only internal organ that can be viewed from the outside without making people feel like their privacy is being intruded it is very useful for their practical applications. Hence iris recognition is one of the few techniques that has more scope than most others.

Mradul Agrawal, B.Tech Computer Engineering, Mumbai, India
Dharmil Sanghavi, B.Tech Computer Engineering, Mumbai, India
Shreyal Gelani, B.Tech Computer Engineering, Mumbai, India

II. FEATURES OF THE IRIS

The iris is very fine, circular structure in the eye. It is responsible for controlling the size of the pupil and thus controls the amount of light reaching the retina by adjusting the diameter of pupil. The colour of the eye is given by the colour of iris. They have stable and distinctive features for identification. They are stable with age. Extremely data rich physical structure having large number of features. Its inherent isolation and protection from the external environment. It is impossible to access and modify data without unacceptable risk to vision. This important feature of iris make it a very plausable solution to most security matters.



III. IRIS RECOGNITION STAGES

Iris image capture

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Image pre-processing

⇩

Feature extraction

⇩

Template matching

IV. Brief Description

The following sub-segments are a summary of a few research papers and a brief description of methods and algorithms used in each one of them.

4.1 Iris recognition system for biometric identification

There are several steps involved which firstly incudes image acquisition then pre-processing is done followed by feature extraction and finally template matching for identifying the individual. First the quality of each input image in the sequence is evaluated and a clear image from such a sequence is selected for subsequent recognition**.** The results show that the proposed method outperforms the current methods both in terms of accuracy with low EER and response time. Experiments are performed using iris images obtained from CASIA and MATAB application which is easy and efficient tool in image recognition.

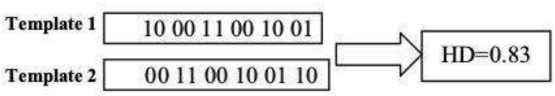
In the first stage of image acquisition a specially designed sensor is used to capture a sequence of images. Due its small size and colour capturing all the features under normal light is a challenge and thus infrared light and a CCD camera is used for the purpose. The resolution is fixed and the type is changed to JPEG and tune it into black and white mode for more specific details. The camera is placed at a distance of 3-10 inches in front of the subject.

In the pre-processing stage the images are transformed to gray level. Histogram equalization is used to enhance the original iris image. The pixels located in the region of the pupil are usually always darkest and hence their values are very close to zero. The minimum of histogram would show the region of darkest pixels which would be in the form of a line i.e. the diameter of the inner boundary circle hence giving the

$$G(f) = \exp\left(\frac{-(\log(f/f_0))^2}{2(\log(\sigma/f_0))}\right)$$

approximate location of the centre.

For the next step of segmentation and noise cancellation, canny edge detection and Hough transformation is applied. Since iris images captured from different people would probably be in different sizes due to the environmental factors and illumination.
The next stage of iris recognition would be normalization. The purpose of this stage is to bring all images to one form for

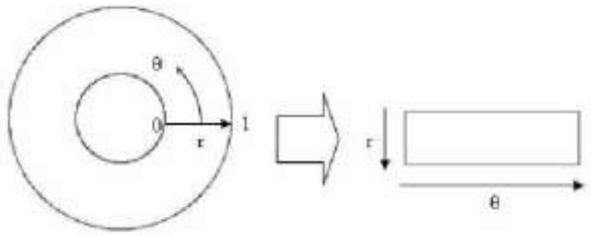


easy comparison. The variations like optical size, iris orientation and position of the inner components of the eye are different for different people, hence this stage of recognition.
The next stage is feature extraction which uses the inner boundary of the iris and centre of the pupil to draw concentric circle all the way to the outer boundary of the iris. The space between concentric circles would be analysed for statistical feature computation.
The last stage is feature matching which is performed by comparing the code obtained and the template iris code that was developed during enrolment.

4.2 Human iris recognition for biometric identification

This paper presented an iris recognition system in order to check the efficiency of such technology and see if the claimed popularity is worth it. To begin with an automatic segmentation algorithm which would facilitate the localization process and cancel out the noises. Circular and linear Hough transformations were used to localise iris and pupil images and barricading eyelids respectively. Thresholding was also utilized for helping with the process of noise cancellation. The Daugman's rubber sheet model was used to carry out the process of normalization. Then 1D-logic filters were used to extract the code and hamming distance to match the code.

Daugman's rubber sheet model: The model remaps each point within the iris region to a pair of polar coordinates. It is used to perform the normalization process for the iris image to remap and unwrap the iris region from the Cartesian coordinates and produce a non-concentric polar representation



The advantage of the homogenous sheet model is that it considers pupil dilation, imaging distance and non-concentric pupil displacement. But the drawback of the rubber sheet model is that it does not account for rotational incongruity.

Log-Gabor Filters for feature encoding: Gabor filters are used to obtain localised frequency information. Images are better coded by filters that have Gaussian transfer function when viewed on the logarithmic frequency scale. The frequency response of a Log-Gabor filter is given as:

Where f represents the centre frequency and sigma gives the bandwidth of the filter.

For matching hamming distance was chosen as the metric for recognition. The algorithm used accounts for noise and uses a technique of masking the noise. Only those bits that correspond to the'0' bits will be used for computation.

Illustration oh hamming distance calculation is shown above.

4.3 A new localization method for iris recognition based on angular integral projection function

In this paper they proposed an efficient iris localization method based on the angular integral projection function to facilitate localization. First stage is dedicated to finding the approximate pupil centre. Then two sets of radial boundary

points are detected for the inner and outer boundaries of the iris. The proposed algorithm focuses mainly on the improvement of accuracy and speed. Algorithm adopts boundary point detection followed by curve fitting.
Projection function:

1. Integral projection functions: Image integral projection functions have been used widely for the detection of the boundary between image regions. This focuses on vertical and horizontal projections i.e. it detects the boundary of different image regions on the vertical and horizontal direction.

2. Angular integral projection function: This is used for boundary points in all other directions i.e. excluding horizontal and vertical. This actually includes horizontal and vertical because this comprises of a formula that requires one to input the angle, which would be 0 and 90 for horizontal and vertical respectively.

4.4 Daugman's algorithm method for iris recognition- A biometric approach

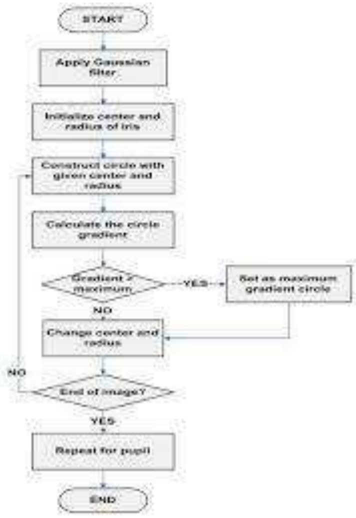
This paper focuses mainly on the stage of segmentation. This is used for the localization of the iris region and eliminate all noise like eyelashes, reflection, etc. In this paper Daugman's algorithm for the process of segmentation has been used. The templates are taken from the CASIA database and the further elimination of noise is done from the images. Daugman's rubber sheet model is used to eliminate discrepancies in the iris image. The normalised iris image is then convolved using 1D Log-Gabor filter and the output is phase quantized to produce a bit-wise biometric code. The feature matching process is carried out by using the hamming distance, which gives the measure of how many bits match or disagree with the template. If the hamming distance is zero then the templates match perfectly.

Daugman's algorithm is the most cited method for segmentation that is used. The assumption here is that both the pupil and iris are circular in structure. This paper cites two pre-processing operations in order to improve the image contrast and help in the final result.
The first pre-processing operation was histogram equalization which helps improve the contrast between eye regions which would improve the task of segmentation.
The second pre-processing operation was binarization which maximizes the separability between the iris regions and the remaining ones.

The major disadvantage of this method is that it is highly dependent on the chosen threshold. The change in image characteristics will change the result.

$$\max_{(r,x_0,y_0)}\left|G_\sigma(r)*\frac{\partial}{\partial_r}\oint_{r,x_0,y_0}\frac{I(x,y)}{2\pi r}ds\right|$$

The above formula is called the daugman's integro differential equation. This is used to find the contour of the pupil and that of the iris external boundary. The major disadvantage here would be the problem of illumination because the pixel values will then defeat the entire equation. This is the only loophole to the equation.



V. COMPARISONS

The difference lies in the methods and algorithms used in different stages of the process. One paper focused mainly on the segmentation while a few others emphasised on the process of localization. The prominent algorithms and methods used in different papers will be listed down and the best of them will be taken forward and used as a method of iris recognition in the final review paper.

The different algorithms for different stages of iris recognition are as follows:

PREPROCESSING ALGORITHMS:

- **Edge detection algorithm- Canny edge detection**

It filters out noise in the original image before trying to locate and detect any edges. This is done with the help of a Gaussian filter that modifies the input signal by convolution with a Gaussian function. Gaussian filter can be computed using a simple mask. Once a suitable mask has been calculated, the Gaussian smoothening can be performed using standard convolution methods. The mask is slid over the image, manipulating a square of pixels at a time.

The next step includes find the edge strength by taking the gradient of the image. The sobel operator that creates an image emphasising edges performs a 2D spatial gradient measurement on an image.

Now the edge direction is found which is further followed by Hysteresis which involve breaking up of an edge contour which is caused by the operator output fluctuating above and below the threshold.

The main advantage being with this method is that it can detect weak edges and is robust to noise.

- **Hough transform**

Hough transform is a technique that is used to isolate features of a particular shape within an image. This

algorithm is usually used to detect regular curves such as lines, ellipses, circles, etc.
The main advantage is that it is unaffected by boundary noise and tolerant of gaps in feature boundary description.

 AIPF

This method helps in detecting the inner and outer boundary points of iris. This algorithm requires pupil centre detection which is found by detecting the centre of mass of the eye. Projection functions which are integral projection functions and angular projection functions are then put to use.

 Normalization using daugman's rubber

Sheet model

The homogenous rubber sheet model which is devised by Daugman's remaps each point within the iris region to a pair of polar co-ordinates(r, theta) where r is on the interval [0, 1] and theta is angle from (0,2pi).

The main advantage is that the rubber sheet model takes into account size inconsistencies and pupil dilation in order to produce a normalized representation with constant dimensions.

FEATURE EXTRACTION METHODS

- **Wavelet approach**

This is used to capture the local iris features and though efficient is a little time consuming.

- **Extraction of statistical features**

Using the centre of the pupil and inner edge, we can draw various sizes of lines like concentric circles with which the statistical features are computed. Variance, standard deviation and pixel correlation are used for this stage of computation.

• Feature encoding was applied by convolving the normalized iris pattern obtained with 1D Log-Gabor wavelet .2D normalized patterns are split into a number of 1D signals. Each row corresponds to a circular ring on the iris region. Instead of the radial one the angular direction is taken, which corresponds to columns of normalized pattern. The features are extracted in codes of 0 and 1.

FEATURE MATCHING

Hamming distance

The iris code is paired with the one developed during enrolment and matched by checking the hamming distance between the two feature vectors. This helps with the comparison which says that more the hamming distance lesser is the probability of it belonging to the same individual.

VI. CONCLUSION:

Most prominent algorithms and methods in the papers I have read up till now have been summarised and the important methods have been put down in this document. The best algorithm that fits into each stage of the iris recognition process.

The best algorithm for image processing is canny edge detection because it's efficiency in quality and least attenuation due to noise. This should be followed by Hough transformation to amplify the efficiency. This will act as a failsafe for canny edge detection. The normalised rubber sheet model will also be used to carry out the process of normalization. Feature extraction method will use the NeuWave method. The next and last phase of feature matching will use the method of feature matching.

For future work, I would like to test the algorithms practically to understand the efficiency of them all. The basic steps of the entire process of iris recognition remains the same in all papers. The steps being image acquisition, image pre-processing, feature extraction, template matching and the final stage of authentication or identification. Another scope I would like to cover is the use of multimodal biometric system. I would like to integrate iris and retinal systems for increased security.

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REFERENCES

[1] J. G. Daugman's. Biometric personal identification system based on iris analysis. U.S. Patent No. 5,291,560, 1994
[2] J. G. Daugman's: High confidence visual recognition of persons by a test of statistical independence. IEEE Transactions on Pattern Analysis
[3] J. Daugman's. How iris recognition works. Proceedings of 2002 International Conference on Image Processing, Vol. 1, 2002.
[4] Chinese Academy of Sciences – Institute of Automation. Database of 756 Greyscale Eye Images. http://www.sinobiometrics.com Version 1.0, 2003
[5] "Recognition of Human Iris Patterns for Biometrics Identification"-This project is submitted for the Bachelor of Engineering degree of the School of Computer Science and Software Engineering, The University of Western Australia, 2003 BY LIBOR MASEK