IRIS RECOGNITION SYSTEM

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***Abstract*-This paper presented an iris recognition system in order to verify both the uniqueness of the human iris and also its performance as a biometric identification. A biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Iris recognition is regarded as the most reliable and accurate biometric identification system available. The iris recognition system consists of an automatic segmentation system 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 then normalized into a rectangular block with constant dimensions to account for imaging inconsistencies. Finally, the phase data from 1D Log-Gabor filters was extracted and quantized to four levels to encode the unique pattern of the iris into a bit-wise biometric template. The Hamming distance was employed for classification of iris templates, and two templates were found to match if a test of statistical independence was failed.**

Keywords: **iris, pupil, Log-Gabor.**

1. INTRODUCTION

1.1 Biometric Technology

A biometric system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, the retina, and the one presented in this thesis, the iris. 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. 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.

1.2 Human iris

The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. A front-on view of the iris is shown in figure 1.1. The iris is perforated close to its center by a circular aperture 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 .The iris consists of a number of layers, the lowest is the epithelium layer, which contains dense pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two iris muscles. The density of stromal pigmentation determines the color of the iris. The externally visible surface of the multi-layered iris contains two zones, which often differ in color. An outer ciliary zone and an inner papillary zone, and these two zones are divided by the collarets – which appears as a zigzag pattern.

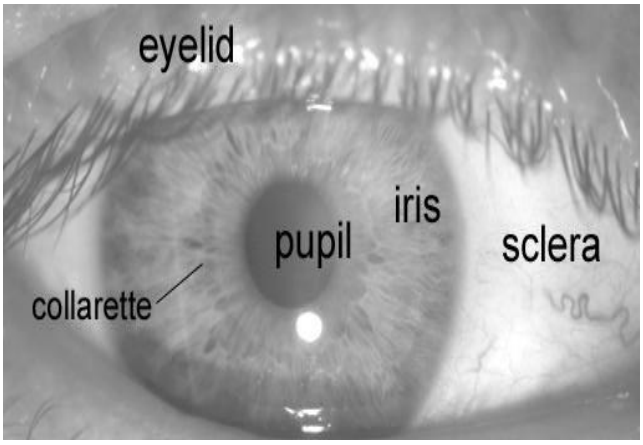


Figure 1.1 – A front-on view of the human eye.

Formation of the iris begins during the third month of embryonic life. The unique pattern on the surface of the iris is formed during the first year of life, and pigmentation of the stroma takes place for the first few years. Formation of the unique patterns of the iris is random and not related to any genetic factors. The only characteristic that is dependent on genetics is the pigmentation of the iris, which determines its color. Due to the epigenetic nature of iris patterns, the two eyes of an individual contain completely independent iris patterns, and identical twins possess uncorrelated iris patterns.

1.3 Iris Recognition

The iris is an externally visible, yet 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. This biometric template contains an objective mathematical representation of the unique information stored in the iris, and allows comparisons to be made between templates. When a subject wishes to be identified by an iris recognition system, their eye is first photographed, and then a template created for their iris region. This template is then compared with the other templates stored in a database until either a matching template is found and the subject is identified, or no match is found and the subject remains unidentified.

2. LITERATURE SURVEY ON BIOMETRIC SYSTEM.

2.1 Background

Research on biometric methods has gained renewed attention in recent years brought on by an increase in security concerns. The increasing crime rate has influenced people and their governments to take action and be more proactive in security issues. This need for security also extends to the need for individuals to protect, among other things, their working environments, homes, personal possessions and assets. Many biometric techniques have been developed and are being improved with the most successful being applied in everyday law enforcement and security applications. Biometric methods include several state-of- the-art techniques. Among them, iris recognition is considered to be the most powerful technique for security authentication in present context.

Advances in sensor technology and an increasing demand for biometrics are driving a burgeoning biometric industry to develop new technologies. As commercial incentives increase, many new technologies for person identification are being developed, each with its own strengths and weaknesses and a potential niche market.

2.2 Biometric Security

- The term "Biometrics" is derived from the Greek words "bio"(life) and "metrics"(to measure) (Rood and Hornak , 2008).Automated biometric systems have only become available over the last few decades, due to significant advances in the field of computer and processing. Although biometric technology seems to belong in the twenty first century, the history of biometrics goes back thousands of years. The ancient Egyptians and the Chinese played a large role in biometrics history. Today, the focus is on using biometric face recognition, iris recognition, retina recognition and identifying characteristics to stop terrorism and improve security measures. This section provides a brief history on biometric security and fingerprint recognition
- During 1858, the first recorded systematic capture of hand and finger images for identification purposes was used by Sir William Herschel, of India, who recorded a handprint on the back of a contract for each worker to distinguish employees (Komarinski, 2004).
- Sir Francis Galton, in 1892, developed a classification system for fingerprints using minutiae characteristics that is being used by researchers and educationalists even today. Sir Edward Henry, during 1896, paved way to the success of fingerprint recognition by using Galton's theory to identify prisoners by their fingerprint impressions. He devised a classification system that allowed thousands of fingerprints to be easily filed, searched and traced. He helped in the first establishment of fingerprint bureau in the same year and his method gained worldwide acceptance for identifying criminals (Scottish Criminal Record Office, 2002).
- The concept of using iris pattern for identification was first proposed by Ophthalmologist Frank Burch in 1936 (Iradian Technologies, 2003). During 1960, the first semi-automatic face recognition system was developed by

Woodrow W. Bledsoe, which used the location of eyes, ears, nose and mouth on the photographs for recognition purposes. In the same year, the first model of acoustic speech production was creased by a Swedish Professor, Gunnar Fant. His invention is used in today's speaker recognition system (Woodward et al, 2003).

- The first automated signature recognition system was developed by North American Aviation during 1965 (Mauceri, 1965). This technique was later, in 1969, used by Federal Bureau of Investigation (FBI) in their investigations to reduce man hours invested in the analysis of signatures. The year 1970 introduced face recognition towards authentication. Goldstein et al. (1971) used 21 specific markers such as hair color, lip thickness to automate the recognition process. The main disadvantage of such a system was that all these features were manually identified and computed.
- During the same period, Dr.Joseph Perkell produced the first behavioral components of speech to identify a person (Woodward et al, 2003). The first commercial hand geometry system was made available in 1974 for physical access control, time and attendance and personal identification. The success of this first biometric automated system motivated several funding agencies like FBI Fund, NIST for the development of scanners and feature extraction technology (Ratha and Bolle, 2004), which will finally lead to the development of a perfect human recognizer. This resulted in the first prototype of speaker recognition system in 1976, which was developed by Texas instruments and was tested by US Air Force and the MITRE Corporation. In 1996, the hand geometry was implemented successfully at the Olympic Games and the system implemented was able to handle the enrollment of over 65,000 people.

3. PROBLEM STATEMENT

Conventionally passwords, secret codes and PINs are used for identification which can be easily stolen, observed or forgotten. In pattern recognition problems, the key issue is the relation between inter-class and intra-class variability objects can be reliably classified only if the variability among different instances of a given class is less than the variability between different classes. For example in face recognition, difficulties arise from the fact that the face is a changeable social organ displaying a variety of expressions, as well as being an active 3D object whose image varies with viewing angle, pose, illumination, accoutrements, and age. So as an alternative we propose to use biometrics (iris recognition) system to identify an individual.

4. Iris Recognition Method

4.1. The Iris Recognition Process

The IR recognition method is described in 4 steps:

- Image Acquisition: Obtaining the eye image
- Segmentation: To locate the iris region in image
- Normalisation: To achieve invariance to iris size, position and different degree of iris dilation for matching different iris patterns at later stage
- Feature Encoding & Matching: To extract as many discriminating features as possible from the iris and result in an iris signature, or template, containing these features

4.2. Image Acquisition

The image is acquired from an online database of eye images. Two public databases were chosen to perform tests upon:

- the UBIRIS database and
- the CASIA database

The former was selected for utilizing standard equipment, and the latter was selected to provide for a comparison.

4.3. Segmentation Technique

The principal of the segmentation technique is to locate the iris region in the eye image. This involves locating the internal borderline between the pupil, the small aperture, and the iris region and the exterior borderline between the iris and the sclera, the white colored part of the eye. In most models, these boundaries, which might not be perfectly circular, are modeled as two un-concentric circles.
Iris, the pigmented region of the eye, can be separated from the sclera, the white area of the eye, but is lighter than the pupil. Segmentation techniques are based on this assumption simplifying the process to a large extent. This variation in intensity is employed to threshold the iris image using upper and lower intensity limits. This threshold image can be further studied by a circular edge detector determining the edges of sclera with iris and iris with a pupil. As a result, iris region is segmented from the rest of eye image. Although this approach simplifies the edge detection step, but in the way introduces the problem of finding safe threshold levels.

4.4. Normalization

After the segmentation technique is executed, normalization is performed in all studied iris recognition systems to obtain:

- invariance to iris size,
- position and
- different degrees of pupil dilation

when matching different iris patterns at a later stage.

4.5. Feature Extraction

The encoding, or feature extraction, aims to segregate as many refined features as could be allowed from the iris template and results in an iris signature, or trademark indication, containing these segregated features. The principal aim of matching process between two templates is to enhance the contingency of ann accurate match for authentic detection tries and minimize inaccurate and invalid matches for a charlatan. In other words, images of the same iris taken at different times should be identified as being the same person, and images from different irises should be marked as coming from different individuals.

5. Implementation And Procedure

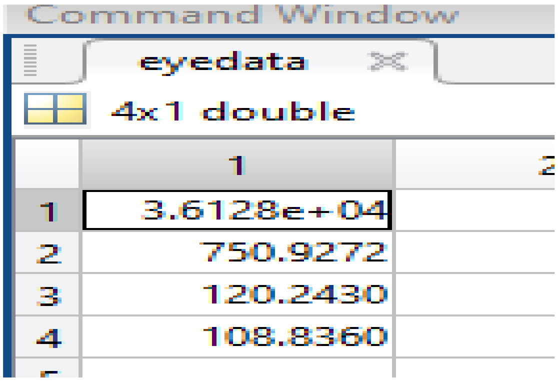
The evaluation methods of images were performed and studied.
For thresholding, the image is required to be converted to Grayscale.
The image is then transferred to function called thresholding.
Based colour difference of iris from sclera, iris can be segmented using the method based on thresholding.
The small region of connected pixels are removed which are not necessary for operation.
Some part of pixels might have been removed that has left a hole in the image, is compensated to avoid any holes in the image.
This will return the threshold image to the main program.
For segmentation, connected component is calculated for the image. Providing threshold image as input and using 8 connectivity.
This will create a structure called cc that will store 4 fields:

- Connectivity: already mentioned it to be 8 for the 2D image as it provides more accurate output.
- Image size: It is also fixed while normalizing and resizing to 512x512
- NumObjects: Number of distinct objects or components found in the image.
- PixelIdxList: It is a 1-by-NumObject cell array where the kth element in the cell array is a vector containing linear indices of the pixel in the kth object.

This structure provides the information about the number of connected components.
This number of connected components along with the information of all the pixels defining the connected region, assist in extracting features.
The property of image regions needs to be studied; Arrays like Area, Perimeter, MajorAxis, MinorAxis are initialised to 0. Using the information from connected components, the property of the image is studied using a Matlab function called region props.
The property is stored in the array.
The mean of these properties is stored in array called eye data.
The first data being mean of area, then mean of perimeter, next is mean of major or axis, and lastly mean of minor axis.
To clearly visualize the distinct pattern of iris, Histogram Equalisation and Gaussian filter are employed.
And finally canny edge detection for determining the edge.
This edge detection is highly affected by noise and disturbances caused while capturing the picture and also due to eyelashes.

6. Evaluation

To scrutinize the performance of the iris recognition system, on the whole, tests were performed to locate the best detachment, so that the false match and false acknowledge rate is limited, and to affirm that iris recognition can perform precisely as a biometric for identification of individuals. And additionally affirming that the framework gives precise recognition, the analysis was also supervised. In order to verify the uniqueness of human iris patterns by deducing the number of connected components present in the iris template portrayal.
There are a number of parameters in the iris recognition system, and optimum values for these parameters were required in order to provide the best recognition rate. These parameters include:
1. Connected component: cc
The 1-by-NumObect PixelIdxList containing linear indices of the pixel
2. Number of connected components: n
3. Properties of image: k (structure)
4. The mean value of all these data are compiled: eyedata.



Command Window

eyedata

4x1 double

	1	2
1	3.6128e+04	
2	750.9272	
3	120.2430	
4	108.8360	

Fig:6.1 Data set

All these data provide a means of studying the unique feature of the biometric template, here template being iris.

6.1. Comparison Study:

The main aim of an iris recognition system is to have the capacity to accomplish a distinct segregation of intra-class and inter-class Hamming Distance distribution. With clear segregation, a partition Hamming distance value can be picked which enables a choice to be made while contrasting two templates. If the HD between two templates is not as much as the separation point, the templates were created from a similar iris and a match is found. Generally if the HD is more than the separation point the two templates are considered to have been produced from varying sources.

Intra-Class and Inter-Class Hamming Distribution with overlap

For the encoding procedure the yields of each filter ought to be autonomous, so that there are no connections in the encoded layout, or else the filters would be repetitive. For maximum independence, the band-widths of each filter must not cover in the recurrence space, and furthermore the centre frequencies must be spread out.
One element, which will notably influence the identification rate is the radial and angular resolution practiced amid normalisation, since this decides the measure of iris pattern information, which goes into encoding the iris layout.
The ideal number of template shifts to represent rotational irregularities can be controlled by inspecting the mean and standard deviation of the intra-class distribution. Without template shifting the intra-class Hamming Distance distribution will be all the more arbitrarily distributed, since templates, which are not appropriately aligned, will deliver HD values proportionate to contrasting inter-class templates. As the quantity of shifts increases, the mean of the intra-class distribution will focalize to a constant value, since all rotational irregularities would have been represented for.

Mean of Intra-class Hamming Distance Distribution vs Number of Shifts

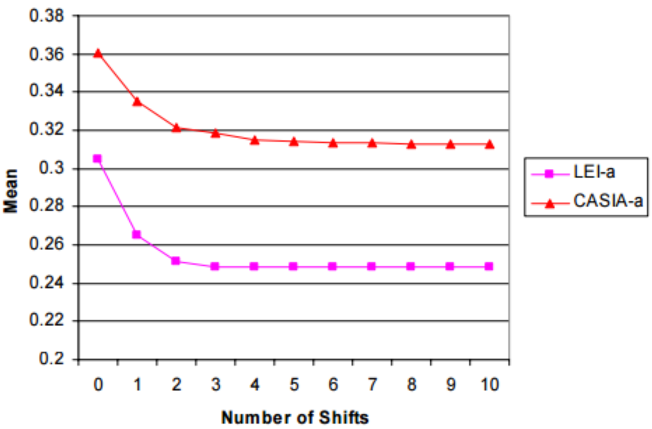


Fig 6.1 Mean vs NOS

Mean of the intra-class Hamming distance distribution as a function of the number of shifts performed.

Standard Deviation of Intra-class Hamming Distance Distribution vs Number of shifts

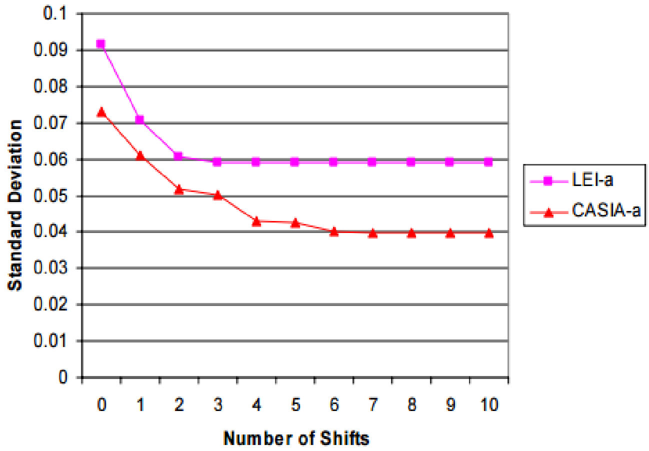


Fig 6.2 SD vs NOS

Standard deviation of the intra-class Hamming distance distribution as a function of the number of shifts performed.

6.2. Encountered Issue Depiction

Limitation of imaging the iris is due to the anatomical features of the eye in addition to the noise introduced in the imaging environmental condition. Eyelids together with eyelashes usually congest ad hinder a significant portion of the iris, and this issue must be recognized and tackled in every sturdy iris recognition method. Also, when capturing the picture of eyes under less than perfect conditions, the resolution of the image might be inadequate, and artefacts are unavoidably introduced into the image as noise and blurring due to poor focus.

Occlusion And Hinderance

The eyelids cover the eye to limit light from going into the eye when required. This is an issue for IR when imaging the eye with visible light, as in the state is while employing standard cameras. The issue can be unravelled by illuminating the eye with light outside the visible range of the spectrum.

Eyelid clogging causes two issues:

- In finding the eye in the image as eyelashes disrupt the circular configuration of the iris region in the image, and
- The eyelid can bring about a substantial portion of the iris pattern to be covered during the template extraction process and hence render it invalid.

Like the eyelids, eyelashes cause issues in both localization and in the template extraction, although to a lesser degree. Eyelashes are, in contrast with the eyelids, considerably harder to recognize because of their unstructured nature.

Noise And Disturbances

Iris imaging is a type of assessment, and all the analysis are subjected to faults which can be modelled and handled as disturbances. The noise produced by the imaging sensors and the surrounding electronics is often treated and as white and additive.

Reflection

The cornea is the outermost transparent portion. This transparent layer protects the eye and admits and helps to focus light waves as they enter the eye. It reflects much of the light is causing a considerable amount of specular reflection. Light sources and surrounding light areas projects on the transparent surface of the eye. These reflections results in in complication in the IR process, clogging the iris pattern and making the location of the eye difficult to estimate as these reflections disfigure the actual structure of the eye.

Data Loss While Compression

When saving the image data to a file, lossy compression is often used. This introduces information loss and can result in artefacts as visible image blocks and a loss of high-frequency information in the iris pattern.

7. Scope and Applications

- Computer login as password
- Secure access to bank account as ATM
- Premises access control (home, office, laboratory).
- Forensics: birth certificates ; tracing missing or wanted person
- Credit card authentication
- Secure financial transactions(e-commerce)
- Anti-terrorism
- Any existing use of keys, cards, PINs or password

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