IRIS RECOGNITION SYSTEM

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Abstract: A biometric framework gives automatic identity proof of an individual based on unique characteristics or features of the individual. As demands on secure identification are hiking and as the human iris gives a pattern that is phenomenal for identification, the utilization of inexpensive equipment could help iris recognition turn into another standard in security framework. Iris recognition is viewed as the most reliable and precise biometric identification framework available. A test situation depending upon the open source code can be built to measure the performance of iris recognition techniques, image quality, and acceptance rate. In this project, the image quality of images as data from a database acquired from a standard camera is surveyed, the most imperative issue areas recognized, and the overall general recognition performance measured. The principal point of this project is to study the unique pattern of the iris in the eye. When imaging the iris under not as much as perfect condition antiquities in image occur such as different type of noise and reflections from light sources, artifacts that introduce error in the iris recognition process, influence the execution.

Key Words: Image Processing, Iris, Biometric, Feature Extraction

1. INTRODUCTION

1.1. BIOMETRIC TECHNOLOGY

A biometric framework gives automatic recognition of an individual based on certain unique characteristics or feature possessed by them. Biometric frameworks have been developed based on fingerprints, facial elements, voice, hand geometry, handwriting, the retina, and the iris.

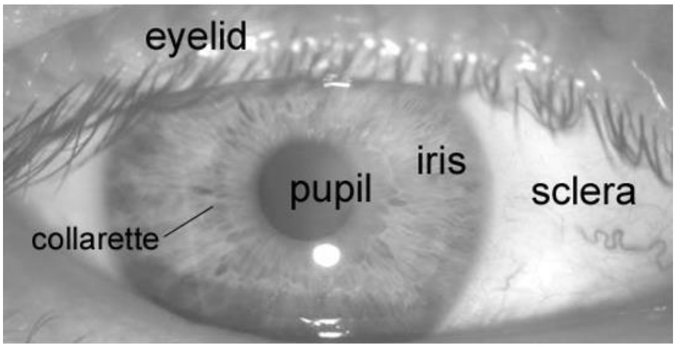
The biometric framework works by:

a. Capturing a specimen of unique feature
b. Transforming the specimen using couple of numerical models into biometric layout
c. This biometric format will provide a standardized, efficient and profoundly segregating portrayal of feature
d. Comparison with other layouts to determine identity

A decent biometric is described by utilization of an element that is; thoroughly unique – so that the possibility of any two individual having a similar characteristic will be insignificant, immutable – so that the feature remains unfluctuating over the period of time, and be adequately obtained– so as to provide suitability to the user, and avert dispersion of the feature.

1.2. The Human Iris

Iris is the pigmented region of the eye. It is a circular sinewy diaphragm separating the two regions of the eye. It extends from ciliary muscle across the eyeball in front of the lens. It has a small circular aperture in the middle through which the light enters the eye, which is called pupil. The iris controls the amount of light entering the eye by contracting or relaxing the eye muscle, and hence contracting or dilating the pupil.



[Figure 1] Iris

The particular pattern in the iris region is formed during the elementary term of life, and stromal pigmentation occurs in the following couple of years.The incidental process of formation of the unique patterns of the iris is not related to any genetic factors. The only characteristic that depends on ancestral genes is the pigmentation of the iris, giving eye its color. As a result leading to an autonomously independent pattern of the two eyes of an individual. Furthermore, identical twins acquire non-germane iris patterns.

1.3. Iris Detection

The iris is a well-protected part of the eye, although it is externally visible whose unique self-generated pattern remains stable throughout adult life. These key factors which make the Iris suitable as a biometric for identifying individuals.

Image processing frameworks can be used unique feature and pattern extraction along with converting it into the biometric template from the digital image of the eye, which can be later stored in the database. This biometric template contains a physical-mathematical representation of the unique information stored in the iris and allows comparisons to be made between models.

When a client prefers to be distinguished and identified by an iris recognition system:

- The image of eye needs to be acquired and is photographed(Image acquisition),
- A template is generated for eyes' iris region for biometric identification.
- This template is studied in regard with the other templates stored in a database for comparison until either a matching model is found or no match is detected.
- If a match is recognized, the client is declared identified and acknowledged
- If no match is recognized, the client remains unidentified and anonymous.

2. Objective

The purpose of this project will be to implement an iris recognition and identification system which can authenticate the claimed performance of the methodology. The development tool used will be MATLAB®, and emphasis will be only on the software for exhibiting recognition, and not hardware for capturing an eye image. MATLAB® provides an excellent RAD(Rapid Application Development) environment, with its image processing toolbox, and high-level computing techniques. Two sets of eye images from different databases are considered to confirm the certainity of system programming. The two database being:

- CASIA: a database of 756 greyscale eye images courtesy of The Chinese Academy of Sciences – Institute of Automation, and
- LEI: a database of 120 digital greyscale images courtesy of the Lion's Eye Institute.

3. Iris Recognition Method

3.1. 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

3.2. 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.

3.3. 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 thresholded 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.

3.4. 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.

3.5. 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.

4. 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 thresholded image to the main program. For segmentation, connected component is calculated for the image. Providing thresholded 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 k^{th} element in the cell array is a vector containing linear indices of the pixel in the k^{th} 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 regionprops.

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.

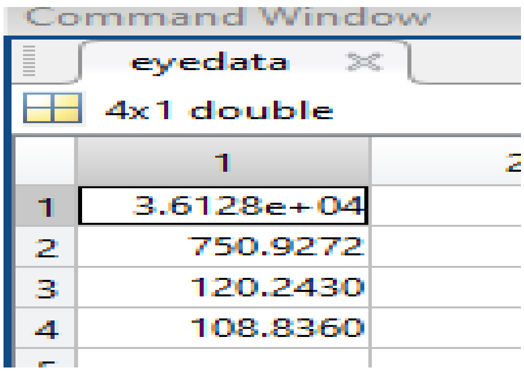
And finally canny edge detection for determining the edge. This edge detection is highly affected by noise and disturbances caused while capturing the picture and also due to eyelashes.

5. 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



[Figure 2] Data set

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

5.1. Comparison Study:

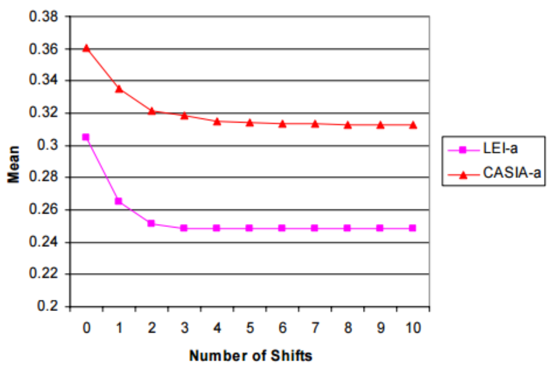
The main aim of an iris recognition system is to have the capacity to accomplish a distinct segregation of intra-class and inter-class Hamming Distance distribution. With clear segregation, a partition Hamming distance value can be picked which enables a choice to be made while contrasting two templates. 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.

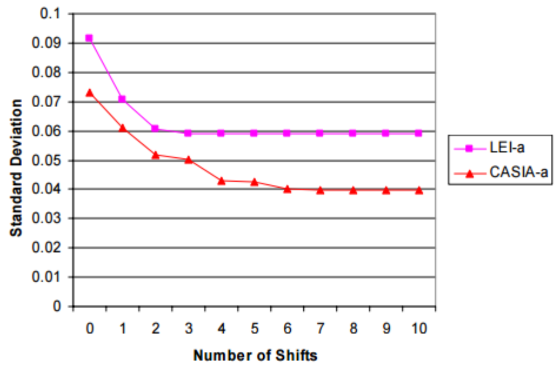
Mean of Intra-class Hamming Distance Distribution vs Number of Shifts



[Figure 3]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



[Figure 4] SD vs NOS

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

5.2. 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 artifacts 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 unraveled 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 modeled 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 artifacts as visible image blocks and a loss of high-frequency information in the iris pattern.

6. Result And Discussion

6.1. Summary Of Result

By using the test results, it can be concluded that an IR system can be constructed using standard equipment, and the performance of such a system would depend on the nature of the images acquired. Regarding the image quality, the light level turned out to be the most important image quality factor followed by focus, reflections, disturbances and level of occlusion and hindrance.

7. Future Work

The RAD environment used here can be combined with GUI that is again connected to a database.

The GUI will perform the operation like displaying images and messages accordingly when it is compared to the database. If the image is to identified, the GUI will provide a platform to compare to already stored data in the database. And if it is to be stored, then transfers the data to the database.

The suitable database being MySQL and environment being MATLAB for performing the image processing techniques.

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