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## Biometric Feature Extraction for Iris Scans

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### Abstract

This paper generally seeks to demonstrate understanding and use of iris scans for biometric identification. Salient features of iris are identified, their extracts analyzed critically by use of a software. The software for extraction of the features is developed on MATLAB platform. Already prepared iris scans are used due to lack of scanners and/or very high resolution cameras that would have otherwise assisted to obtain the required distinct features for comparison. The program developed would compare two iris images a time and determine if they came from same individual; what we are referring to as matching. A computer vision algorithm based on The Hough Transform is made use of in determining circles present in the image which are essentially the iris and pupil. The region of interest from which the unique features are obtained would be located between papillary and limbic boundaries. Papillary (between iris and pupil) while limbic boundary is the one demarcating the iris and sclera. The comparison entails first determining codes of the two iris images through generation of separate biometric template for them then using encoding procedure. Hamming distance calculation between the iris codes determines if they match.

### I. INTRODUCTION

Biometrics is the science of automated recognition of persons based on one physiological or behavioral characteristic. It would be mainly for the purposes of either identification or verification.

Biometric feature extraction for iris scans is referred to as iris recognition in this text. Iris recognition entails use of the distinct iris patterns to identify an individual from another as no two sets of iris can be the same. Of note is that even left and right set of iris from the same individual would differ. It is thus a reliable biometric method that would be appropriate in wide range of application[1], [2].

The best of biometric system are those capable of using distinct unique characteristics in their identification to distinguish the samples used. It ensures no chance is given two different individual to possess the same unique characteristics. The system developed extracts salient features of an iris and compares it with those from another to establish if they came from same individual. The mathematical abstraction that does this is well covered in length under the software implementation section.

The problem requires one to first familiarize self with biometrics identification techniques with bias in use of iris scans. Those salient features that contribute to iris

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uniqueness and distinguish an individual from another would need to be identified. Software is then to be developed and used for extracting the features in question for mainly identification purposes[3], [4].

Issues to do with security will forever be prioritized in organizations and companies. Forgery and imposters never cease and most have gone notch higher in breaching and defeating most installed systems.

This paper would be quite instrumental in helping stop this problem where other measures have failed. Iris comparisons to provide verification would be reliable due to efficiency and uniqueness as their patterns differ among individuals[5], [6].

Other biometrics technique like fingerprint recognition would be helpful in authentication though as compared to iris, they could be easily forged.

The industry of application mainly desires quick and accurate results in verification of subject's identity. Iris scan procedure offers this option as it takes only 10-15 seconds to extract and do comparison.

With advance in technology nothing can be left to chance especially in fighting fraud. Iris scans if used properly would serve as a good alternative to most systems mainly those biometric in nature. Organizations only incur huge costs at installation and setting up of the equipment but would thereafter save a lot in terms of security investment.

## II. SYSTEM DESIGN

This section describes the process of system design. It outlines the many different modules developed to perform various functions. They are then integrated based on what each of the blocks is supposed to achieve. All of them would point to the main module that controls the entire program.

### A. System functionality requirement

The paper entails development of software that would help distinguish variety of scanned iris images. Images will be in a central database from which the program is expected to access on user's request for iris identification. The system is expected to achieve a number of things and take into account the need for end user to easily understand its operation. Some of main requirements are given below:

1. The program should generate a biometric template of iris image fed into it.
2. It is important that wide range of scanned iris images formats be accepted (Jpeg, gif).
3. The software needs to be interactive enough especially when pointing out to user errors; example: due to image format not being supported by system.
4. System should prompt user for only one image at time and reject multiple request at the same time for easier comparison and matching.
5. Program should eliminate errors due to occlusions of eyelid and eyelashes in extracting the desired salient features for identification.
6. It is desired that the end user comfortably uses the system without need to fully understand logic behind.

The overall design would be modeled based on the concept; user interacting through a graphical user interface (GUI) with the biometric system that links to a database containing the iris images. This means the architecture of the program can be divided into 3 main layers:

1. GUI. This is responsible for display of dialogues, prompting user to perform number of things and relays information to models based on data from user. It responds to user request through linking with logic layer.
2. Model layer will basically keep track of requests from user and respond accordingly based on logic of the program.
3. Program logic layer contains the system implementing functions.

The layers and their relationships are depicted in Fig.1.

The software is developed on MATLAB platform. This high level language is selected as its image processing toolbar is appropriate and powerful enough to handle the scanned iris images effectively. Chinese Academy of sciences-Institute of Automation (CASIA) huge data set provides the scanned images for comparison[7].

### B. Program logic

An iris image is accepted by the system then compared with those in the database to establish existence of a match. The iris images undergo automatic segmenta-





Fig. 1. System layers.

tion to identify the iris and pupil positions within the eye. After identifying the two, we isolate through addition of concentric circles to demarcate the boundary. The result will be isolation of the region of interest. This is what we refer to as localization. We then normalize this region prior to encoding. Two iris codes are as a consequence generated. Calculation of Hamming Distance (HD) between two iris codes determines whether the iris image captured is a better match with any of the ones in the database. We compare two irises at a time. The flowchart in Fig. 2 indicates the logic operation of system developed.

### C. The procedure

#### 1) Input iris

This simply accepts an iris image already scanned for comparison. For lack of data acquisition machine, images are obtained from the Chinese Academy of Sciences huge data set [7]. The site was able to provide a number of already clearly scanned iris images taken at close proximity. This ensures absence of reflections thus eliminates computational errors.

#### 2) Iris localization

Localization process is performed by a number of algorithms in different modules. We have one which is a circle generator that adds weights into a Hough accumulator array. Hough transform is used for finding circles in the image. The edge of iris image undergoes canny edge detection method. A module is then developed for returning the coordinates of a circle in an image by use of the Hough transform and canny edge detection to create the edge image.

Line and circle coordinates are determined to be used for returning pixel coordinates of a circle defined by a given radius and x, y coordinates. Image gamma adjustment is performed to enhance contrast of bright region (for image gamma value range 0-1) and also enhance contrast in dark region (for values >1).

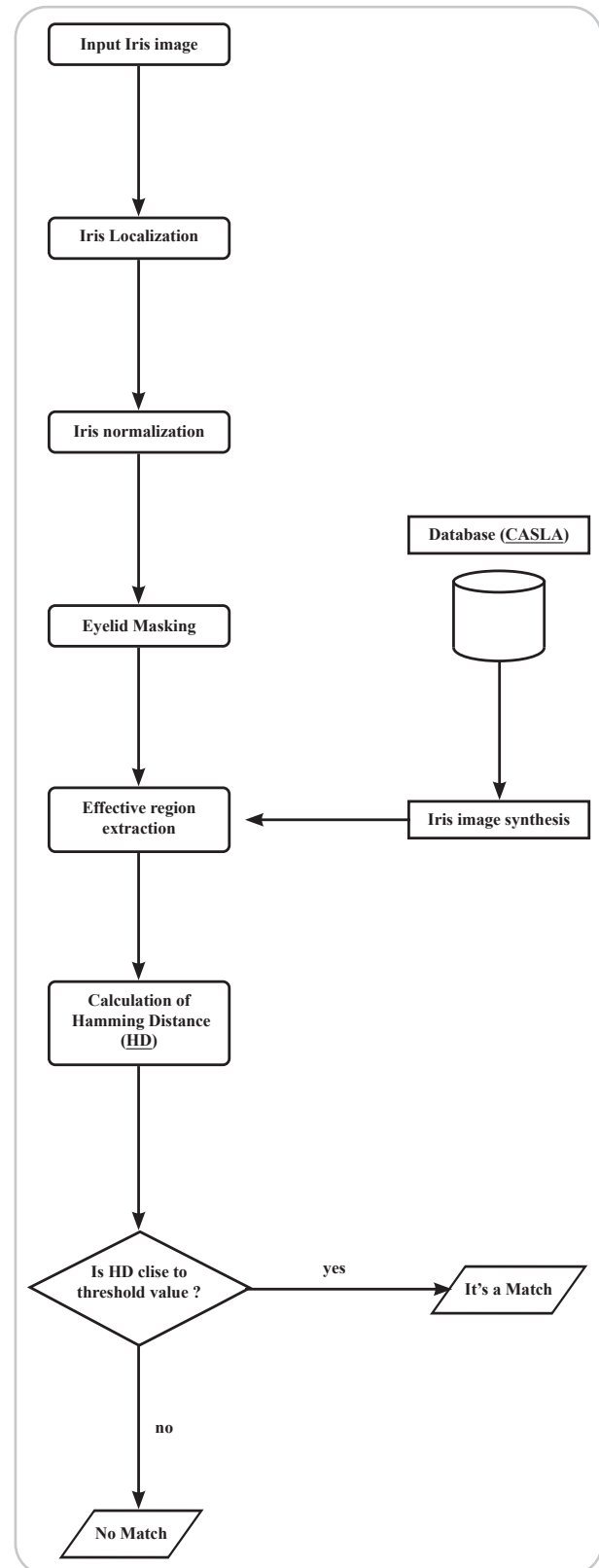


Fig. 2. Flowchart of iris recognition algorithm.

Hysteresis thresholding of an image is performed. Here, all pixels with values above a given preset threshold are marked as edges. Module for actual iris segmentation and also used for noise elimination such as ones arising from occluding eyelids and eyelashes is also included.

### 3) Iris normalization and encoding

Normalization of the iris image is performed by unwrapping the circular region into a rectangular block of constant dimensions. Effect of scale difference in iris images could be evident and to prevent this, we normalize prior to encoding. Normalization helps compensate for iris deformation. We unwrap the image to a rectangular block of a fixed size. The eyelid region is then masked by darkening it.

The iris image is transferred from Cartesian coordinates to polar image coordinates using Daugman rubber sheet model. The conversion is important since the papillary and limbic boundaries are modeled as ellipse and circle respectively thus polar coordinates would be appropriate to define them.

Each row of an image is convolved by use of 1D Log-Gabor filters. A biometric template is then to be generated from the normalized iris image. We illustrate how to encode a given iris image row. The encoding will generate bit vector codes for the iris that would be used for comparisons in the matching stage.

The output of the Gabor filter has both real and imaginary part. After decomposition by 1D log Gabor filter, the phase angle of each output is quantized to 2 bits.

### 4) Hamming distance (Matching)

This determines if the iris images are a match. Small HD between the codes is an indication of a better match. HD is defined as the number of different bits in the two codes divided by the total number of valid bits.

Another possible source of error would be rotations of iris which we overcome by use of circular shifting in the HD calculation. For instance when calculating HD between A and B, we fix code A and shift the code B from -15 degrees to +15 degrees with increment of 1.5 degrees. The minimum HD from these 20 shift positions is the desired one and used as the reported HD.

## III. RESULTS

### A. Samples used

The software is used to compare a total of 30 iris images obtained as mentioned earlier from The CASIA. One image at a time is accepted and automatic segmentation for it performed. After the extraction of the salient features, two iris images at a time are compared to establish if the samples came from same individual. An output in form of message box popped to indicate whether or not they match. 28 out of the 30 images processed gave perfect results as illustrated by one of the iris image in Fig. 3 and Fig. 4 at the segmentation level.

Notice the near perfect concentric circles in the segmented iris. This is an indication that the process is a success for the particular image.

The two images that failed the test resulted in displaced circles so that during extraction of features from segregated region, some distinct patterns with information are not included. We illustrate this in Fig.5 and Fig.6.

The automatic segmentation is not as perfect for this image as the previous one. It is evident from the location of circles for iris and pupil identification. This is due to little contrast in papillary and limbic boundaries that causes canny edge detection to fail.

### B. Noise elimination

Noise that results from eyelids and eyelashes is eliminated by marking them with Not-a Number (NaN) values which is seen here on the images as blackened regions as shown in Fig.7.

After segmentation which simply localizes the desired iris, normalization is applied prior to encoding. This ensures any images inconsistencies are taken into account as the extracted iris region is converted into a rectangular of constant dimensions for all iris images.

### C. Segmented iris

Fig.8 shows sample from an output of segmented iris that undergoes normalization after possible noise sources have been eliminated.

### D. Normalized template

The normalized template shown in Fig.9 is standard for all images thus unique features for all irises are able



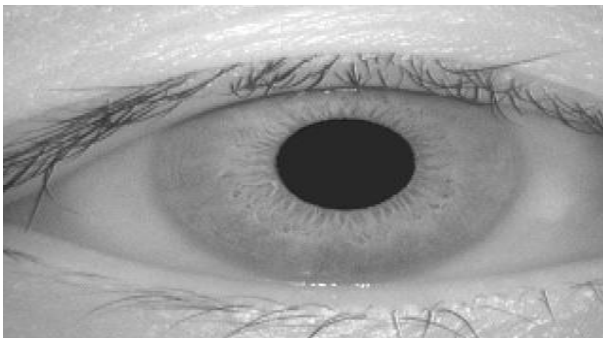


Fig. 3. Original image.

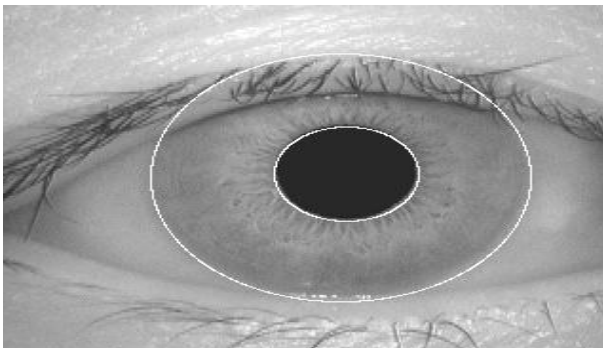


Fig. 4. Segmented image.

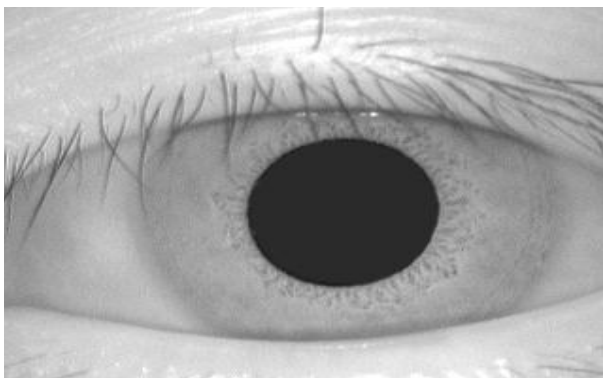


Fig. 5. Original image.

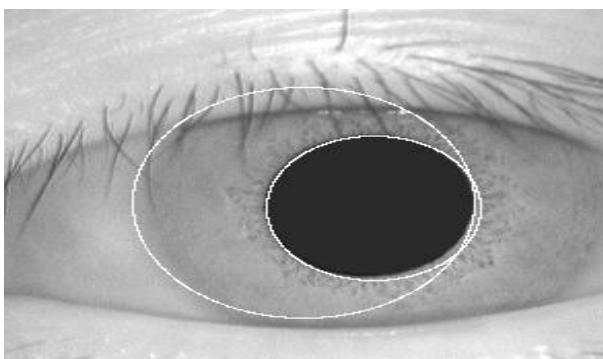


Fig. 6. Segmented image.

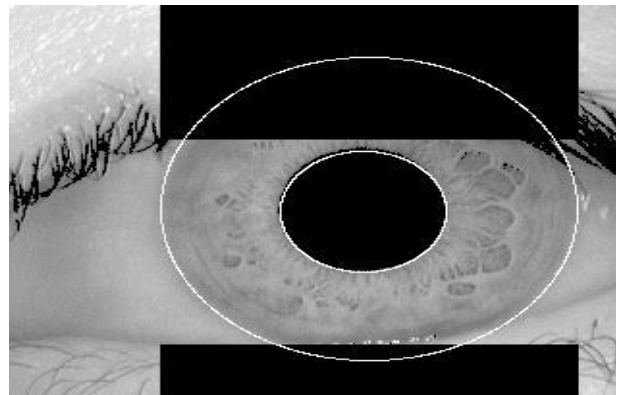


Fig. 7. Image-with noise elimination.

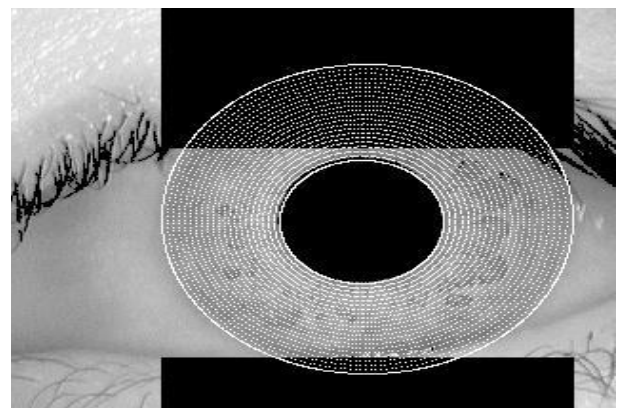


Fig. 8. Segmented iris showing area for normalization.



Fig. 9. Normalized template.

to be extracted without inconsistencies so that encoding and matching would be successful.

The final stage is the encoding of the two iris images provided after which their codes are compared with through calculation of HD. This determines whether the samples provided are a match.

The matching is also perfect for the 28 out of the 30 iris images used. Images taken from the same subject returned matching results just as anticipated while those from different sources did not match. The failed images would be due to canny edge detection method unable to spot the edges clearly due to little contrast in the boundaries to be detected.

#### *E. Sampled output images*

Figs.10-14 display the output which the system gave when performing the extraction procedure. The figures show sampled output that the biometric system produced for the automatic segmentation stage.

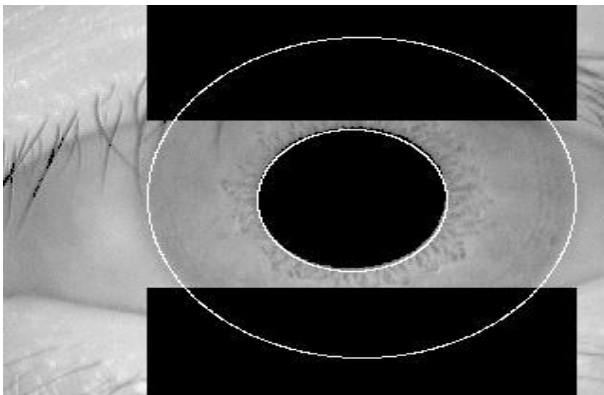


Fig. 10. Image (noise eliminated).

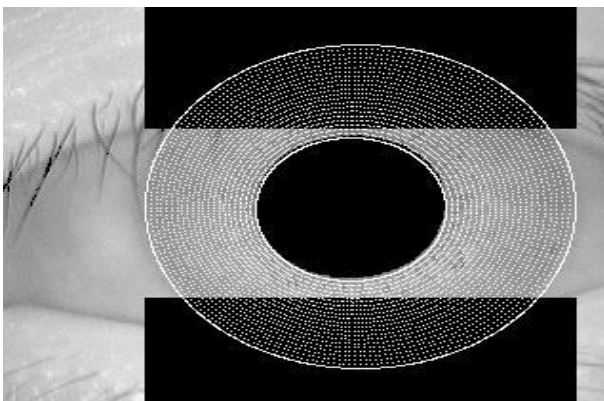


Fig. 11. Image (shows extracted area).



Fig. 12. Normalized region.



Fig. 13. Noise that is eliminated.

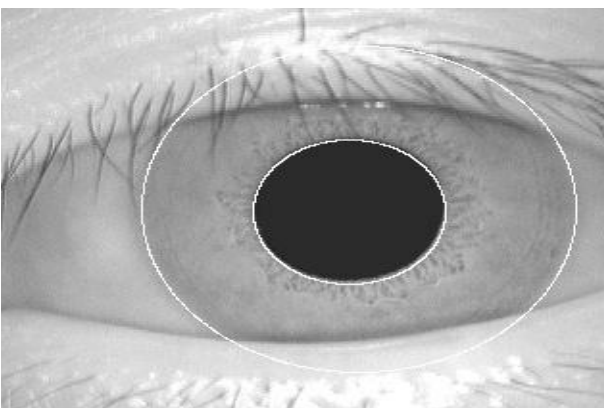


Fig. 14. Segmented iris.

#### IV. CONCLUSION

The biometric system developed has been able to successfully extract the unique patterns of iris template generated. It is these salient features that were essential to be used for distinguishing an iris image from another. Already scanned iris images were input and automatic segmentation performed on them. This process involved localization of the iris and pupil regions. The Hough transform was the computer vision algorithm used to identify the circles in the image and edges were detected using the canny edge detection technique. Once the region was clearly demarcated, it was normalized into a rectangular block of constant dimension. Gabor filters were then used to perform the encoding process after which pair of iris at a time was compared against.

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