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Iris Recognition Using Graphical User Interface

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ABSTRACT: This paper explains the Iris recognition system developed by John Daugman and attempts to implement the algorithm in Matlab, with a few modifications. Firstly, image pre-processing is performed by extracting the iris portion of the eye image. Secondly, extracted iris part was then normalized, and Iris Code is constructed using 1D Gabor filters. Finally two IrisCodes were compared to find the Hamming Distance, which is a fractional measure of the dissimilarity. Experimental image results show that unique codes can be generated for every eye image.

KEYWORDS: Iris Recognition, Iris Segmentation, Iris Normalization, Gabor filter, Hamming distance, Image-preprocessing, GUI.

I.INTRODUCTION

Biometrics consists of methods for uniquely recognizing humans based upon one or more intrinsic physical or behavioural traits. The biometrics is the science and technology of measuring and analyzing biological data. In information technology, biometrics refers to technologies that measure and analyze human body characteristics, such as fingerprints, eye retinas and irises, voice patterns, facial patterns and hand measurements, for authentication purposes. Biometrics can be divided to two main classes [1, 2].
1) Physiological: These are related to the shape of the body. Examples include, but are not limited to fingerprint, face, DNA, palm print, hand geometry, iris, which has largely replaced retina, and scent.
2) Behavioural: These are related to the behaviour of a person. Examples include, but are not limited to typing rhythm, gait, and voice.

Verification: It is one to one comparison of a captured biometric with a stored template to verify that the individual is the one who he claims to be. If the two samples match well enough, the identity claim is verified, and if the two samples do not match well enough, the claim is rejected. Verification can be done accompanied with a smart card, username or ID number.
In a verification decision context there are four possible outcomes normally called:-
a) False Accept Rate (FAR) or False Match Rate (FMR) or False Positive (FP):

- Occurs when the system accepts an identity claim, but the claim is not true.
- The proportion of impostor attempts whose Hamming Distance (HD) is below a given threshold.

b) Correct Accept (CAR) or True Positive (TP) or True Accept (TA):

- Occurs when the system accepts, or verifies, an identity claim, and the claim is true.

c)False Reject (FRR) or False Non Match Rate (FNMR) or False Negative (FN):

- Occurs when the system rejects an identity claim, but the claim is true.
- The proportion of genuine or authentic attempts whose HD exceeds a given threshold.

d) Correct Reject (CRR) or True Negative (TN) or True Reject (TR):

- Occurs when the system rejects an identity claim and the claim is false.

Identification: It is one to many comparisons of the captured biometric against a biometric database or gallery in attempt to identify an unknown individual. The identification only succeeds in identifying the individual if the comparison of the biometric sample with a template in the database falls within a previously set threshold [3, 4].
As verification mode, in identification decision context there are four possible outcomes normally called like verification:-

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a) False Accept Rate (FAR) or False Match Rate (FMR) or False Positive (FP):

- Occurs when the system says that an unknown sample matches a particular person in the gallery and the match is not correct.
- The rate at which a matching algorithm incorrectly determines that an impostor's biometric sample matches an enrolled sample.
- The proportion of impostor attempts whose HD is below a given threshold.

b) Correct Accept (CA) or True Positive (TP) or True Accept (TA):

- Occurs when the system says that an unknown sample matches a particular person in the gallery and the match is correct.

c) False Reject (FR) or False Non Match Rate (FNMR) or False Negative (FN):

- Occurs when the system says that the sample does not match any of the entries in the gallery, but the sample in fact does belong to someone in the gallery.
- The proportion of genuine or authentic attempts whose HD exceeds a given threshold.
- The rate at which a matching algorithm incorrectly fails to determine that a genuine sample matches an enrolled sample.

d) Correct Reject (CR) or True Negative (TN) or True Reject (TR):

- Occurs when the system says that the sample does not match any of the entries in the gallery, and the sample in fact does not.

II.PROPOSED METHODOLOGY

The modules of an iris biometrics system generally following Daugman's approach depicted in Figure.1[5].

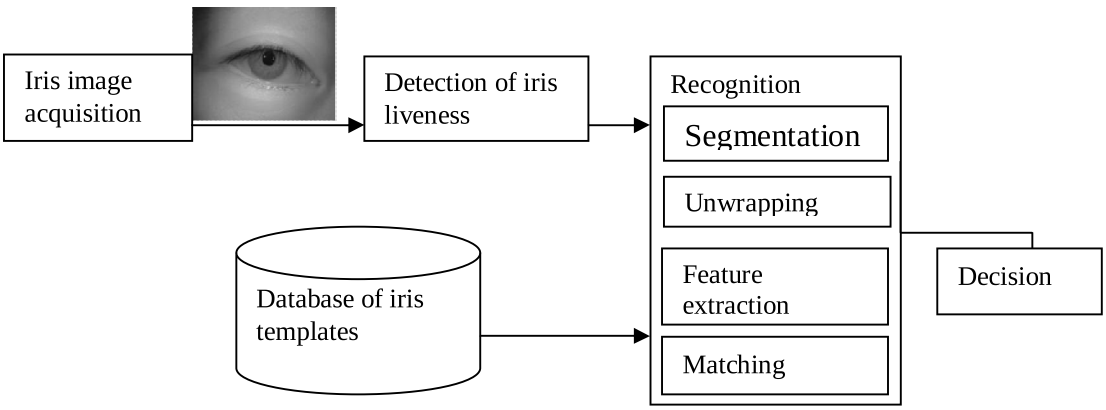

Figure.1: Stages of iris recognition system.

Iris Image Acquisition: Image acquisition is considered as the most critical step for the development of an iris recognition system since all the subsequent stages depend highly on the image quality. A specifically designed sensor is used to capture the sequence of iris images. An iris image capturing device considers the following three key factors 1) The lighting of the system, 2) The position of the system, and 3) The physical capture system.

Iris liveness Detection: In order to avoid the forgery and the illegal usage of iris biometric features, the detection of iris liveness ensures that the captured input image sequence comes from a live subject instead of an iris picture, a video sequence, a glass eye, and other artifacts. The utilization of the optical and physiological characteristics of the live eye is considered as the most important aspects for the assurance of the liveness of the input iris image sequence.

Recognition: The accuracy of the iris recognition system depends on this module. This module can be further subdivided into four main phases: segmentation, normalization or unwrapping, feature Extraction, and matching. In the first phase, the iris region is segmented from the captured eye image. Secondly, the segmented iris region is unwrapped

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in order to avoid the size inconsistencies. Thirdly, the most discriminating features are extracted from the unwrapped image and finally, the extracted features are used for matching with the iris templates already stored in the database.

Proposed Model: The 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 [6] filters was extracted and quantized to four levels to encode the unique pattern of the iris into a bit-wise biometric template. The flow chart of proposed model depicted in figure.2.

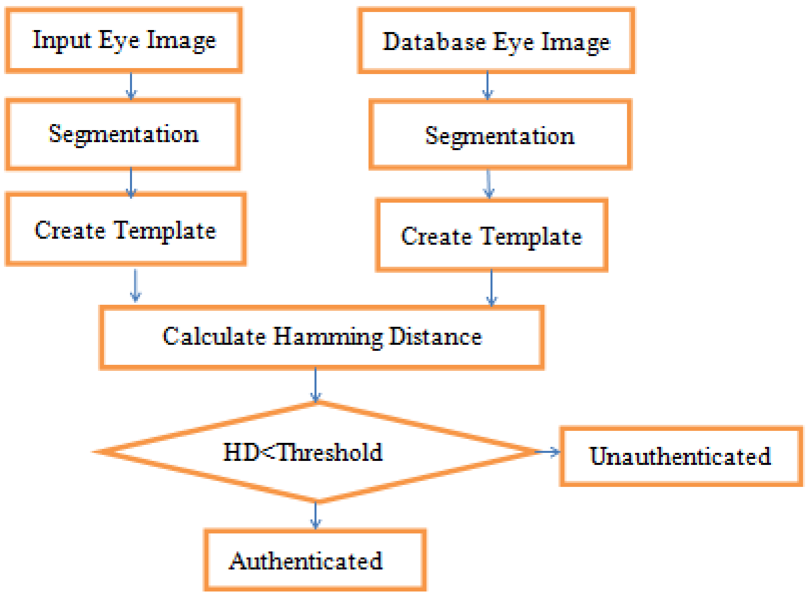

Figure.2: Flow chart of proposed model.

Initially an automatic segmentation algorithm was presented, which would localize the iris region from an eye image and isolate eyelid, eyelash and reflection areas. Automatic segmentation was achieved through the use of the circular Hough transform for localizing the iris and pupil regions, and the linear Hough transform for localizing occluding eyelids. Thresholding was also employed for isolating eyelashes and reflections.
The segmented iris region was normalized to eliminate dimensional inconsistencies between iris regions. This was achieved by implementing a version of Daugman's rubber sheet model, where the iris is modeled as a flexible rubber sheet, which is unwrapped into a rectangular block with constant polar dimensions.
Finally, features of the iris were encoded by convolving the normalized iris region with 1D Log-Gabor filters and phase quantizing the output in order to produce a bit-wise biometric template. The Hamming distance was chosen as a matching metric, which gave a measure of how many bits disagreed between two templates. A failure of statistical independence between two templates would result in a match, that is, the two templates were deemed to have been generated from the same iris if the Hamming distance produced was lower than a set Hamming distance.

III.EXPERIMENTAL RESULTS AND DISCUSSION

Daugman'sintegro-differential operator: The Daugman'sintegro-differential module detects the pupillary and limbus boundaries and identifies the regions where the eyelids and eyelashes interrupt the limbus boundary's contour. The integro-differential operator is the traditional detection mechanism, although more recent work has promoted the use of active contours to account for nonconic boundary attributes [7, 8]. Figure.3 illustrates the Daugman'sintegro-differential operator.

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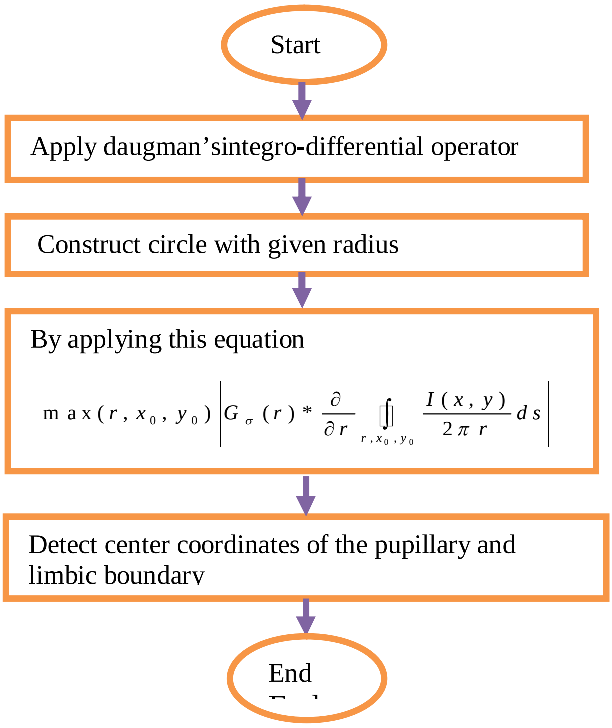

Figure.3: Daugman'sintegro-differential operator.

An integro-differential operator is defined as

$$\max(r, x_0, y_0) \left| G_\sigma(r) * \frac{\partial}{\partial r} \oint_{r,x_0,y_0} \frac{I(x,y)}{2\pi r} ds \right| \quad \ldots\ldots\ldots\ldots.. \quad (1)$$

Where I(*x*,*y*) is the image intensity at pixel location (*x*,*y*), *r* is the radius of the pupil, (x_0, y_0) is its center, and $G_\sigma(r)$ is the Gaussian smoothing function. Thus, the integro-differential operator searches for a circular boundary with radius *r* and center (x_0, y_0) that exhibits a maximum change in radial pixel intensity across its boundary.

Normalization: The normalization of iris regions a technique based on Daugman's rubber sheet model was employed. The center of the pupil was considered as the reference point, and radial vectors pass through the iris region. A number of data points are selected along each radial line and this is defined as the radial resolution. The number of radial lines going around the iris region is defined as the angular resolution. Since the pupil can be non-concentric to the iris, a remapping formula is needed to rescale points depending on the angle around the circle. This is given by

$$r' = \sqrt{\alpha}\,\beta \pm \sqrt{\alpha\beta^2 - \alpha - r_I^2} \quad \ldots\ldots\ldots\ldots \quad (2)$$

With $\alpha = o_x^2 + o_y^2$ ………….. (3)

$$\beta = \cos\left(\pi - \arctan\left(\frac{o_y}{o_x}\right) - \theta\right) \quad \ldots\ldots\ldots\ldots \quad (4)$$

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Iris segmentation: The first stage will be to develop an algorithm to automatically segment the iris region from an eye image. This will require research into many different techniques such as Daugman'sintegro differential operator, circular Hough transform, and active contour models [9, 10]. The flow chart is shown in figure.4.
Here we use circular Hough transform for detecting the iris and pupil boundaries. This involves first employing canny edge detection to generate an edge map. Gradients were biased in the vertical direction for the outer iris/sclera boundary. Vertical and horizontal gradients were weighted equally for the inner iris/pupil boundary. Kovesi'scanny edge detection which allowed for weighting of the gradients.

The range of radius values to search for was set manually, depending on the database used. For the CASIA database, values of the iris radius range from 20 to 50 pixels, while the pupil radius ranges from 10 to 25 pixels. In order to make the circle detection process more efficient and accurate, the Hough transform for the iris/sclera boundary was performed first, then the Hough transform for the iris/pupil boundary was performed within the iris region, instead of the whole eye region, since the pupil is always within the iris region. After this process was complete, six parameters are stored, the radius, and x and y center coordinates for both circles. Eyelids were isolated by first fitting a line to the upper and lower eyelid using the linear Hough transform. A second horizontal line is then drawn, which intersects with the first line at the iris edge that is closest to the pupil.

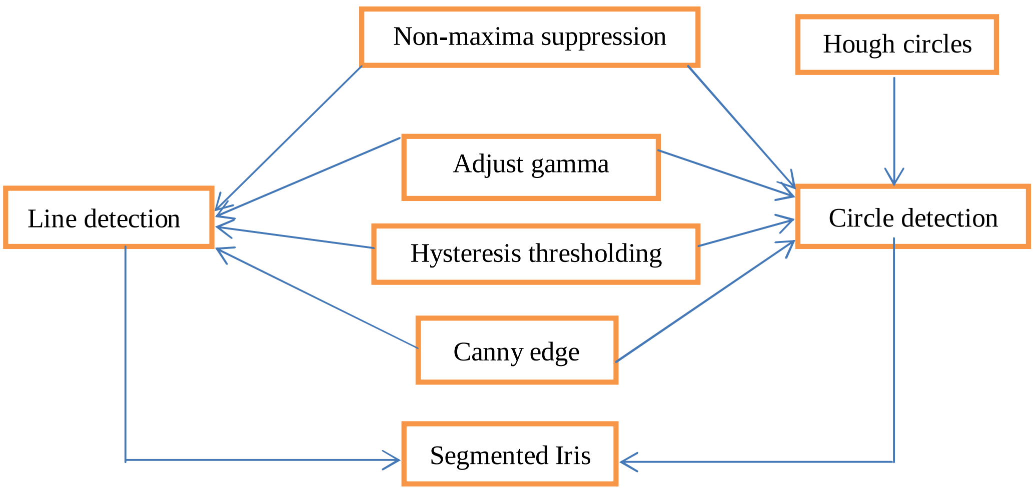

Figure.4: Flow chart of Iris Segmentation.

The horizontal line allows maximum isolation of eyelid regions. Canny edge detection is used to create an edge map, and only horizontal gradient information is taken. The linear Hough transform is implemented. This is a form of the Hough transform. If the maximum in Hough space is lower than a set threshold, then no line is fitted, since this corresponds to non-occluding eyelids. Also, the lines are restricted to lie exterior to the pupil region, and interior to the iris region. A linear Hough transform has the advantage over its parabolic version, in that there are less parameters to deduce, making the process less computationally demanding.

The figures.(5,6,7,8,9) shows step to step results obtained by using GUI and brief discussion was clearly done in above paragraphs.If we want to clear the database template features than click on the clear database.

The algorithm was tested on the database of 7129 images and calculated the accuracy for each database. The results are presented below the table.1.

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Database	Images	Accuracy
CASIA	1200	98.33%
IIT DELHI	2240	98.21%
MMU	1440	97.22%
UBIRIS	1865	96.51%
PALACKY UNIVERSITY	384	78.12%

Table.1: Accuracy for different databases.

Figure.5: MATLAB GUI

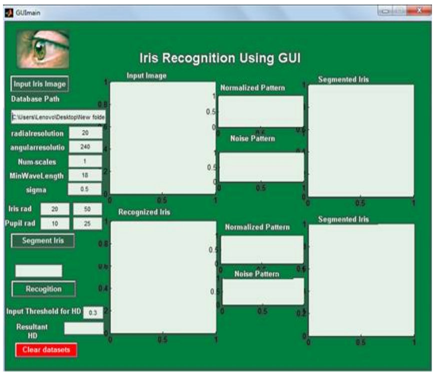

Figure.6: Set database path

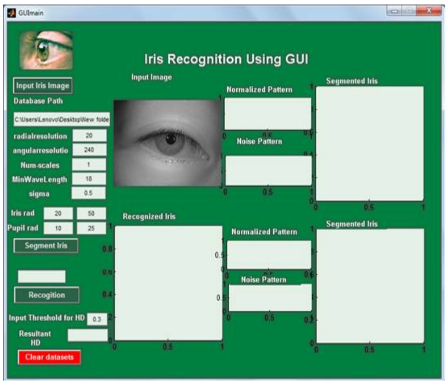

Figure.7: Select test Image

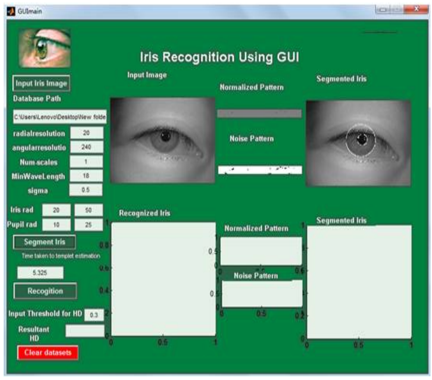

Figure.8: Segment Iris and Pupil

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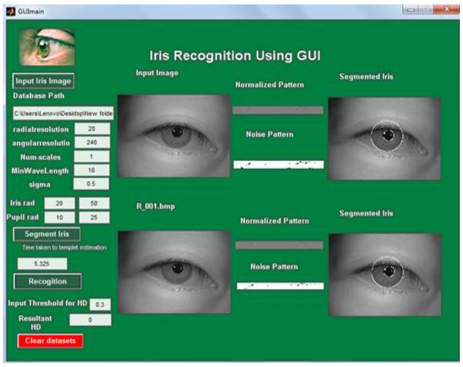

Figure.9: Recognize the data base image

IV.CONCLUSION

The paper has presented an iris recognition system, in which segmentation was done using Daugman's algorithm. The comparison was done in the Segmentation stage and based on accuracy and higher efficiency rate. This comparison was made in order to evaluate the impact of different segmentation methods on the overall performance of the recognition process. Properly detecting the inner and outer boundaries of iris texture is important for all iris recognition systems. Pattern recognition of iris consists of an automatic segmentation that is based on the Hough transform, which would localize the iris region from an eye image and isolate eyelid, eyelash and reflection areas. Thresholding was also employed for isolating eyelashes and reflections. Next, using Daugman's algorithm the segmented iris region was normalized to eliminate dimensional inconsistencies between iris regions. This was achieved by implementing a version of Daugman's rubber sheet model, where the iris is modelled as a flexible rubber sheet, which is unwrapped into a rectangular block with constant polar dimensions. Finally, features of the iris were encoded by convolving the normalized iris region with 1D Log-Gabor filters and phase quantizing the output in order to produce a bit-wise biometric template. The Hamming distance was chosen as a matching metric, which gave a measure of how many bits disagreed between two templates. A failure of statistical independence between two templates would result in a match, that is, the two templates were deemed to have been generated from the same iris if the Hamming distance produced was lower than a set Hamming distance.

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