International Journal of Computer Science and Engineering Communications,
Volume.5, Issue.4 (2017): Page.1668-1674
www.ijcsec.com

Development of Human Iris Recognition System Through Iris Perception Algorithm

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Abstract:: *Security and checking of individuals are essential for a wide range of areas of our lives. Biometric identification provides a valid alternative to old and astute checking mechanisms. The aim of this work is to implement a system using iris perception algorithm to surge iris recognition system. An iris recognition framework uses a pattern matching technique to compare two iris images and to create a match score that reflects their uniqueness. Authentication and security is required when there is a need to know whether the person is claimed to be authorized or not. In this study, iris biometric recognition system has been implemented in MATLAB environment that uses the iris perception algorithm for segmentation and matching. More than 20 features have been extracted through iris perception algorithm. Encoding of both feature and noise encoding outputs has been achieved. Time taken to identify iris was within ~3.89 seconds which is (12 seconds) less than the existing edge detection algorithm. Experimental simulation results were analyzed on the basis of (False Acceptance Rate) FAR, (False Rejection Rate) FRR and found better outcome. Implementation of iris perception algorithm in iris recognition system provides accuracy up to 99.12% on the basis of FAR and FRR which is 1.21% greater than the existing edge detection algorithm.*

Keywords: *Iris Perception, Segmentation, Normalization, CRR, FRR, FAR.*

1. INTRODUCTION

Iris recognition is a sort of biometric system that can be used to identify a person by getting the details and discovering the patterns of the iris. The iris is the most reliable form of recognition because of the specialty of its pattern. Iris recognition techniques distinguish a person by getting the details mathematically and the unique patterns of iris are compared with the existing one in the database. A biometric system provides an automatic identification of an individual based on the characteristic possessed by the individual. Iris recognition system regarded as the most reliable and accurate biometric identification system available. Properties like resolution, motion blur, noises, occlusion or light reflections can be used to measure the quality of the sample images. A biometric system usually functions by first capturing a sample of the feature, such as capturing a digital colour image of a face to be used in facial recognition or recording digitized sound signal to be used in voice recognition. The sample may then be refined so that the most discriminating features can be extracted and noises in the samples were reduced. The samples were then transformed into a biometric template using some sort of mathematical function. The biometric template was a normalized and efficient representation of the sample which can be used for comparisons. In fact, such methods called biometrics do not require knowledge and tokens, it become more convenient and friendly to users. Biometric systems usually

have two modes of operations. One is the enrollment mode which used for adding new templates into the database and the other is the identification mode used for comparing a template created for an individual, who wants to be verified with all the existing templates in the data base. An effective feature extraction method would not be able to obtain useful information which is not segmented accurately. Experiments are being performed using sample iris images obtained from UPOL database. As MATLAB application is very easy and efficient when compared to other tools in image manipulation.

2. OBJECTIVES OF THE RESEARCH WORK

The objectives of the research works are as follows:

- The human iris recognition system is to implement an iris perception algorithm for time consumption.
- Encoding of both feature and noise outputs achieved.
- More than 20 features have been obtained from histogram equalized eye image database can give up to 100 % accuracy of the recognition system.
- Performance accuracy using FAR and FRR of iris perception based recognition system was better among the iris recognition systems.
- Implemented iris recognition system provides an enhanced level of security and the time taken to identify iris was within ~3.89 seconds. The performance evaluated by this algorithm, has given accurate results.

Authentication was required when we need to know about a person who they claim to be authorized or not. It's a procedure which involves a person making a claim about their identity and then providing evidence to prove it. In this research, iris biometric identification system has been presented that uses iris perception algorithm for segmentation, binarization, and cropping. Feature extraction was done by normalization and feature encoding process followed by matching process based on hamming distance classifier. Each blocks function is briefly discussed as follows: Image acquisition: Initially iris photo was taken through camera. Pre-processing: involving edge detection, contrast adjustment. Segmentation: including localization of iris boundaries. Normalization: the transformation from polar to cartesian coordinates. Feature extraction: noise removal and generating iris code. Classification and matching: involves comparing and matching codes. The study of this research work includes the implemented iris perception algorithm. This innovative algorithm was suited well for optimal edge detection method. It works mainly on three principles, reducing the error rates, works well for localizing the edges and to enhance the old edge detection methods. In this study, iris biometric system works on iris perception algorithm and effective way of edge detection technique, which provides better recognition, localization, and matching results. From the above said databases, around nine hundred eye images were taken the experiment at different timings from UPOL database and five hundred eye images from Aravind Eye Hospital, Ariyankuppam, Pondicherry. Two eye images of a person were taken randomly along with its fields. A single image was randomly selected and its features were stored in the database, and those images are called as registered listed images and others are unregistered listed image and as an outcome of total of one thousand and four hundred eye images were used for experiment.

3. IMPLEMENTATION OF IRIS PERCEPTION ALGORITHM

Iris perception algorithm implementation starts with (i): - Input iris image which is taken for acquisition. The segmentation using Hough Transform (HT) procedure is applied on the image (i) and

(b_n) Boundary is detected. Then Gaussian normalization is applied on Radius R. Later gradient formula is applied on R which gives [gx, gy]. The gx, gy is taken for Gaussian formula. If the result is applied to Gabor Filter form (GFF) Else normal existing edge detection algorithm is applied. GFF creates featured vector with scales and orientations at (0 & 80^0 angles). Calculate two irises from the same class and compare between two feature vectors. Conceptualizing using Daugman's developed step by step pseudo code approach which is proposed to perform matching process using Hamming Distance. Hamming distance is beneficiary as it performs XOR operation on Boolean vectors.

Start
Select the input image (i)
Apply Hough Transform Segmentation on (i) and
Find Boundary (bn).
Apply Binarization on bn.
For all the row and columns in matrix (i)
Convert in to corresponding bit pattern (0 & 1)
Apply Gaussian Normalization on R.
Apply gradient formula on R. This will give [gx, gy].
gx, gy are taken in to Gaussian Formula.
If result is apply convert ion to Gabor filter form.
Else
Normal Existing Edge Detection Algorithm will be executed.
GFF creates FV with Scales and orientations
Apply Hamming Distance Formula
If HD <= Threshold, then the Matching is Successful
Else
HD > Threshold, then the Matching is Unsuccessful
Stop.

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- Compare Query image feature vector with stored image feature vector of database.
- Hamming Distance is calculated for each image feature vector.
- Finally Calculate minimum Hamming Distance.

If Hamming Distance between two feature vectors is greater, difference between them is also greater. Two similar irises will fail the test since the difference between them will be small. The Hamming Distance (HD) between two Boolean vectors is defined in the equation:

$$HD=\frac{1}{N}\sum_{j=1}^{N} C_A(j) \oplus C_B(i) \quad (1)$$

Where CA and CB are the coefficients of two iris images, N is the size of the feature vector, Ex-OR is the Boolean operator that gives a binary 1 if the bits at the position j in CA, CB are different and 0 if they are similar. Statistical analysis is performed based on parameters such as computational Time, Feature vector size, FAR, FRR, Accuracy and Match Ration. Calculate computational time for system with testing dataset of images and different wavelet transforms are used to find feature vector. Considering threshold value 0.32 which is maximum hamming distance threshold that exists between two irises belonging to the same person tested on up to 3 million iris images by Daugman (1994) "Biometric personal identification system based on iris analysis",

- If HD<= Threshold then Match successful.
- If HD> Threshold then Match unsuccessful

Authentication and security are required when there is a need to know whether the person is claimed to be authorized. In this research work, iris biometric recognition system has been implemented in MATLAB environment that uses the iris perception algorithm for segmentation, and matching. Feature extraction was done for normalizing and encoding, followed by matching process based on Hamming Distance classifier. In the Iris perception algorithm, the first step of iris recognition system is image acquisition followed segmentation in which it can be performed by both algorithms either by edge detection algorithm or by iris perception algorithm. In the third step normalization and gradient formula was applied. After feature extraction a template was prepared which can be used for pattern matching step. Either the result was a circular contour form the detection can be done with a canny edge detection algorithm or if it is a featured vector we can use the iris perception algorithm.

In the next step comparison of two iris patterns was done to check whether the person matches with the images in the database using Hamming Distance (HD) formula. HD was applied to the coefficient of the two iris patterns and the image was checked whether it matches or not. In this research work we have taken randomly chosen featured vectors based on the result, it was found that Featured Vector 10 (FV10) with scales 6 and Orientations 8 having the highest CRR % of 96.01%. So FV 10 has chosen the best among the five featured vectors. Using FV10 calculated FRR and FAR in the below table with threshold values. FRR and FAR are used to measure the accuracy. FRR measures the probability the enrolled individual not been identified.

Table - I Results based on FV 10 at different threshold

Reference Threshold For FV 10	FAR%	FRR%	Accuracy%
0.2	0.56	1.2	99.12
0.3	0.2	56	71.9
0.4	0.2	19	90.4
0.5	10	1.8	89
0.6	99.44	0.52	50.02

FAR is the measure of the probability in the biometric system is not correct. We can accept as an access attempt by an unauthorized user. FAR is the ratio of the number of false acceptances divided by the number of identification attempts. FAR, FRR and accuracy are calculated on the basis of the following formulas,

$$(\%)\ FAR = \frac{\text{No. of false acceptence Individuals}}{\text{Total no of Individual samples}} * 100\% \qquad (2)$$

$$(\%)\ FRR = \frac{\text{No. of false rejected individuals}}{\text{Total no of Individual Samples}} * 100\% \quad (3)$$

$$(\%)\ Accuracy = (100 - (FAR(\%) + FRR(\%))/2) \quad (4)$$

Based on the results, the feature vector FV10 (s=5, O= 8) with many features and with a Correct Recognition Rate (CRR) of 96.01% was chosen as the best among five randomly chosen featured vectors of the images. So by using Featured vector FV10 we have calculate the FAR and FRR at the different reference threshold ranging from 0.2 to 0.6.

Table - II Accuracy of edge detection versus iris perception algorithm

Parameters Used	Iris recognition using existing edge detection algorithm	Iris recognition using iris perception algorithm
FAR	99.12%	99.44%
FRR	1%	0%
Accuracy	97.91%	99.12%

Results were taken and analyzed on False Acceptance Rate and False Rejection Rate. It was found that a better outcome has been achieved. The implemented Iris Perception Algorithm for human iris recognition system was better than the previous algorithm which can be evaluated by calculating the accuracy. Results were reported in the form of FAR and FRR which are obtained for the different values of threshold is calculated. The iris perception algorithm was allowed to measure the FAR and FRR to compare the performance. The accuracy of the implemented algorithm for iris recognition is 99.12 %, which was greater than the existing algorithm at the rate of 1.21% accuracy. The probability of enrolled individuals not been identified in the iris recognition system, the false rejection rate FRR is 0% by implementing iris perception algorithm which is the best result in the survey of FRR% in the existing algorithms. The algorithm in this study was successfully executed for iris segmentation, and matching process was done with HD formula with less loss of features. The success of segmentation depends on the imaging quality of eye images. A small attempt was made by using iris perception algorithm for recognition. By using the segmentation method and matching images from database has given up to 100 % accuracy to the iris recognition system.

Performance of Iris Perception based iris recognition system was better than the Canny based edge detection iris recognition system which was calculated by calculating accuracy using FAR and FRR. Accuracy was calculated for iris perception algorithm and compared with the accuracy of the existing edge detection algorithm. The best results was observed by smoothing out the image using Gaussian Normalization and up to 28 features have been achieved. The proposed technique is also very efficient in terms of time consumption. The time complexity of the technique is given in Table-III. So Iris Perception it takes less than 4 seconds to segment out an IRIS from an eye image, which is much less than the computationally intensive technique of Circular Hough Transform. Classification or matching results, feeding different number of features reduced, have been presented in Table III In this research work an attempt is made to develop a simple and efficient method for iris recognition using simple

segmentation method. Using 20 or more curvelets coefficients, obtained from histogram equalized (Left side) eye images of UPOL database, can give up to 100 % accuracy of the recognition system. After the successful experiments and the encouraging results achieved, it can be claimed that the proposed system is capable of fast and efficient iris identification. In the proposed system, UPOL database have been used for IRIS images. The system could be extended to other databases e.g. CASIA Database.

Table - III Matching results and time consumption chart

No: of features	% of accuracy	Segmentataion accuracy	Total images in the database & time for segmenting the whole database	Average segmentation time for one image	Total time for identification of iris
5	81.2%	88.59%	1200 Sets of Images & 1446.36 Seconds	0.02 Seconds	~3.89seconds
11	97.3%	90.58%	28	98.8%	100%
28	98.8%	100%	**Note:** It takes less than 3.89 seconds to segment out an IRIS from an eye image. Statistics from Table 3 shows that 28 features are enough to obtain the maximum.		

4. RESULTS AND DISCUSSION

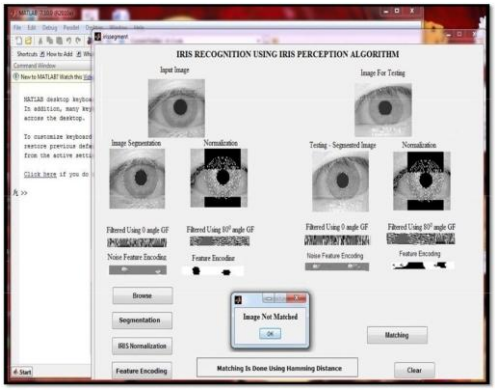

Fig.1 Iris recognition using iris perception algorithm for not matched image

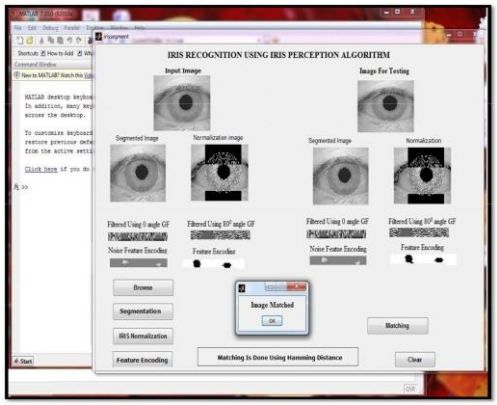

Fig.2 Iris recognition using iris perception

Algorithm for matched image

In this research work, an attempt was made to develop a simple and efficient method for iris recognition. More than 20 features have been obtained from histogram equalized eye image database can give up to 100 % accuracy of the recognition system shown in Table - III. The time consumption of the system is also very low, as it can identify an iris within ~3.89 seconds. This time includes segmentation, feature extraction, feature detection and classification time. Finally, the captured image was checked against a previously stored iris template in the database and time taken to identify iris is approximately within four seconds. After the successful experiments, the results were encouraging, and it can be claimed that the iris perception algorithm was capable of fast and efficient iris recognition. Moreover, average time consumption of the system could be improved by changing /

improving the segmentation technique and other classifiers may also be used to evaluate the system. The system presented in this study is able to perform iris recognition in an accurate manner, but there are still some issues which need to be addressed. First of all, the automatic segmentation was not perfect, since it could not successfully segment the iris regions for all of the eye images in the two databases. In order to improve the automatic segmentation algorithm, a more elaborate eyelid, and eyelash detection system could be implemented.

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