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A NOVEL APPROACH FOR IRIS BIOMETRIC IDENTIFICATION SYSTEM WITH IMPROVED RECOGNITION RATE

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ABSTRACT : *The Iris biometric method is the most prominent method for identification of individual. Many researchers have been presented iris recognition approaches from decade but a fully appropriate solution for real world scenario is not implemented yet. There are two main issues. First is no perfect technique to operate on non-ideal iris images with greater accuracy. Second one is creation of system with more security on the current real world conditions. In this Paper, the above mentioned problems are solved to an extent.*
A Secured and Accurate iris pattern encoding technique is used tomake highly protected encoded binary pattern for iris image. Discrete Wavelet Transform and Nonsubsampled contourlet transformation are used for this purpose. Beside this security feature, the proposed technique is using best combinations of algorithm for deliver more accuracy as compared to conventional scheme of iris biometric recognition. In Our approach CASIA and IIT Delhi iris database are used as input images. Iris area of eye image is extracted by Hough Transformation and canny edge detection to attain good recognition rate. In normalization process, Daugman's rubber sheet model is used. This normalized template is then used to extract unique features by Gabor filter and these features are then encoded by the use of DWT and NSCT as mentioned earlier. At last stage the combination of Normalized Correlation coefficient and Hamming Distance are used to achieve better recognition rate. So in every stage of iris biometric recognition system all approaches and algorithms are accomplished very well and deliver higher accuracy as compared to existing iris recognition system.

KEY WORDS : Biometric system, Iris recognition system, Segmentation, Canny edge detection, Hough transformation, Segmentation, Normalization, Daugman's rubber sheet model, Feature encoding, Hough Transformation, Discrete Wavelet Transform, Nonsubsampled Contourlet transform, template encoding, Hamming Distance, Normalized correlation coefficient, Recognition Rate

1. INTRODUCTION

At the time of access of security areas as airports, ATM, financial and corporate office etc., the human identity must be verified by using the identity cards and security credentials. Sometime these methods are not safe because they can lost or theft by someone [1].to remove this disadvantage, biometric methods are used for personal identification at large scale. Iris recognition method is most suitable method than other biometric methods like fingerprint, retina and face texture [2].

The outer view of an eye image is shown in figure 1.There is a dark region at the center of image which is known as pupil and used to control the amount of light entering in the eye. Outer region of the pupil is known as Iris. The structure of iris has unique features that used to identify any person with high accuracy. The main task in processing of iris recognition is to extract the iris region from eye image which is affected by lower and upper eyelashes and eyelids. Different segmentation techniques are used to identify the inner and outer boundary of iris.

Iris anatomy:

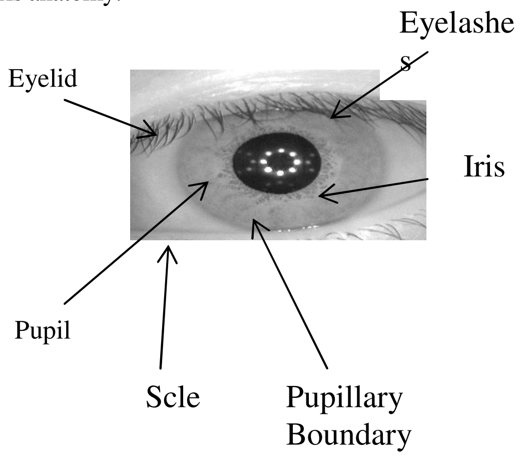

Figure 1: An eye image from database [3].

2. GENERAL FRAMEWORK OF IRIS RECOGNITION

The structure of iris recognition system is illustrated below in figure 2.

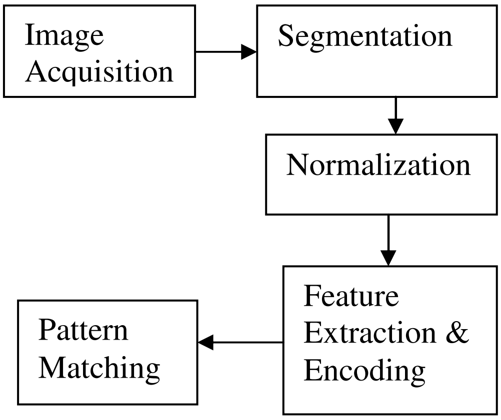

Figure 2 : Iris recognition system

A. Image Acquisition

In image acquisition stage specially designed digital camera are used to capture the image of iris. Commonly the radius of pupil lies between 0.1 to 0.8 times radius of iris [4].the main task this stage is to capture an eye image which is appropriate for segmentation and feature extraction so better results are achieved[5].

B. Iris Segmentation

The main iris region is defined by its inner and outer boundary. Iris segmentation is used to identify these boundaries. Importance of this step is that further processing of iris recognition system is performed on iris image which is produced by iris segmentation method [6]. In this stage actual iris part is extracted from whole eye image.

C. Normalization

In this stage, a fixed dimension iris image is generated by remapping the image coordinates. This remapping is performed by transforming coordinates from Cartesian to polar [7].Actually the size of pupil and iris are vary due to changing in illumination and amount of light entering in eye So, several eye images of same person may show difference in size of pupil. These variations are also caused by difference in environment condition where image is captured. This problem leads degradation in recognition rate or template matching. So Daugman's rubber sheet model is used to overcome this inconsistency and provide fixed size template for all eye images.

D. Feature Encoding

Feature encoding is most important phase in iris recognition because it determine the exact pattern, feature and characteristics of iris image these are used to distinguish and identify iris image [8].the normalized template is encoded in this part. Gabor filter, wavelet transformation and some other encoding methods are used.

E. Template Matching

Template matching is the final stage of iris biometric recognition system. In this phase a comparison is held between captured iris encoded template and stored iris template [9].the hamming distance algorithm, Euclidean distance and Normalization coefficient are used to perform this comparison. This step checks whether processed templates are same or not.

3. OBJECTIVE

The main objective of our research work is to provide the new approach for iris biometric recognition to give improved security in iris template encoding and better recognition rate with fast calculations. The main objectives are:

- Enhancement in the segmentation phase to identify iris area correctly so improved recognition rate is attained.
- To perfume feature encoding in more effective method to deliver highly protected iris pattern of least size.
  Use the best combination of methods in segmentation, normalization and feature encoding with pattern matching to achieve overall high performance system with minimum error rate.

4. PROPOSED METHOD

In our method there are two type of database is used. The first one is IITD iris database and other one is CASIA database. IITD Database has 224 persons iris image and sizes of these images are 320x240 pixel. In CASIA Database, 2639 images are captured from 249 persons. In the proposed algorithm, Hough transform is used for iris localization and noise area removal. These areas are affected by eyelashes and eyelids. Canny edge detection method is used to identify horizontal and vertical edge map. After the segmentation process the daugman's rubber sheet model is used for normalization in which Cartesian coordinates of image are converted into polar coordinates. As studied in literature survey, feature encoding performed by wavelet transform has some disadvantages that they cannot extract feature related to directionality and anisotropy. To overcome these limitation we use Nonsubsampled contourlet transformation. The Nonsubsampled contourlet transformation extracts directional information and help to generate better encoded template which provide better recognition rate.

In our project feature extraction is performed by Hough Transform and encoding is performed by using hybridization of Discrete Wavelet Transform and Nonsubsampled Contourlet Transformation. In last stage Normalized Correlation coefficient and

Hamming Distance are used to identify the iris template are from same eye or not. The main algorithm of our method is presented here:

Iris recognition Algorithm:
Input images from CASIA and IITD iris database

1. Input images from CASIA and IITD iris database.
2. Take iris image Z with the dimension of m * n from CASIA or IITD database .as an input where m and n represents the rows and column of the Iris image.
3. An edge map of the input image is produced with the help of the canny edge detection algorithm.
4. After that, the segmented iris image is generated by performing the Hough transformation on the generated edge map. It is done by finding the outer and inner periphery on the edge map developed by the canny edge detection technique.
5. The angular coordinates of the iris image are transformed into the polar coordinated by performing the normalization on the segmented iris image. It is implemented with the help of Daugman's rubber sheet model which generates iris template of the rectangular size.
6. The feature encoding is the next step where filter values as coefficients are developed by applying the 1D log Gabor filter on the segmented iris region.
7. After this DWT is applied to output of Gabor filters which decomposed image in four parts. The approximation pixel intensity part is used as the input for Nonsubsampled Contourlet transformation. Here, the iris images are divided into the frequency sub bands by using Laplacian Pyramid and Directional Filter Bank. The iris image is decomposed into the low pass and band pass image by using Laplacian Pyramid. Then the Directional Filter takes band pass image as an input and transforms it into high pass image. The Nonsubsampled Contourlet transformation is most suitable technique for such type of iris image due to its small size and multidirectional information with smooth contour content. Secondly, the NSCT represents the edge information in lesser number of coefficients in comparison to the other transformation. Every decomposed iris image is multiplied with the value of the Log Gabor coefficient.
8. The better secured encoded pattern is developed by multiplying the output of NSCT with the resultant coefficients. The original iris image is obtained by implementing the inverse NSCT and after inverse DWT on resultant image.
9. The Binary string is developed of the encoded iris pattern.
10. Hamming distance of the encoded iris pattern is determined to decide whether two iris templates belong to the same person or not. To do this, a certain value called threshold of the hamming distance is determined. The two iris templates belong to the same person if the values of the hamming distance is lower than the pre defined threshold value otherwise these two iris template belong to the different persons.
11. Finally, the Normalized Correlation coefficient is determined to identify the similarity between two iris templates. The value of NCC will be one if the two iris images are similar otherwise the value of NCC will varies from zero to one depending upon the similarity level.

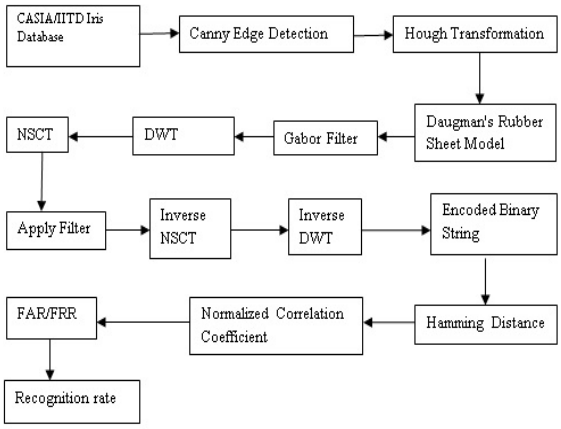

Figure 2 : Flow Chart of Proposed algorithm

5. RESULT AND DISCUSSION

A. Introduction

The proposed technique entitled as "A Novel Approach for Iris Biometric Identification System with Improved Recognition Rate" has been proposed in previous section. Now this section shows the results and analysis of system accuracy with its performance. we have executed iris recognition system many times to evaluate the performance of proposed scheme and here the summarized result is presented and evaluates the efficiency and robustness of proposed iris recognition system by comparing its performance related parameters with the existing system parameters.

B. Database

In the experiment we use IITD and CASIA database for input iris image. IITD and CASIA database have different type of iris image some of them are heterogeneous image, some images having different level of noise and some have other artifacts. The images of iris database are captured in less constrained capturing environment. This database has both ideal and non-ideal images. For our experiment these all situation are suitable because it gives all real time testing condition.

C. Evaluation Metrics

Recognition Rate is the main evaluation parameter of iris recognition system. It is computed by using False Accept rate, False Reject rate, Hamming distance and Normalized Correlation.

1. Hamming Distance

$$HD = \frac{1}{N}\sum_{j=1}^{N} X_J XOR Y_J$$

Using XOR operation between two binary template hamming distanceis calculated and the result is declared weather both template same or not [7].if value of hamming distance is low that mean both template are same and if it is high then they are from different eye image.

2. Normalized Correlation(NC)

For checking similarity feature between two iris templateNCC is useed. This is represented as

$$\frac{\sum_{m=1}^{x}\sum_{n=1}^{y}[I(m.n)I'(m,n)]}{\sqrt{\sum_{m=1}^{x}\sum_{n=1}^{y}[I(m,n)] \quad [I'(m,n)]}}$$

Where I(m,n) and I'(m,n) are two iris images which are to be matched. The value of coordinates (m,n) will be 1 to x and 1 to y respectively.NC will be lies between 0 and 1. if the value of NC is equal to 1 then it means two templates are exactly same. If it is zero means both templates are exactly opposite. So the value of NC is as near to 1 indicate the more similarity between iris templates.

Where I(m,n) and I'(m,n) are two iris image for matching.

3. False Reject Rate (FRR)

FRR is the false reject rate that is the rate on which iris templates of same iris image are unmatched. FRR is calculated among intraclass comparison of iris image. FRR(%)=$\frac{\text{Number of false rejected}}{\text{total number of authentic attempts}}$x100

4. False Accept Rate(FAR)

FAR is number of wrongly matched iris template of different eyes. It is calculated in interclass comparison of eye image.

FAR (%) =$\frac{\text{Number of false accepted}}{\text{total number of imposter attempts}}$x100

5. Equal Error Rate(EER)

EER is the threshold value which is use to evaluate the system performance. It is calculated by finding the midpoint where FAR and FRR meet in ROC plot. The robustness of system against the impostor attempt can be checked by EER.

6. Receiver Operating Characteristics (ROC)

ROC curve is a graphical representation of the relationship of False Reject rate and False Accept rate. It also used to view the summarize format of system performance by generating value of EER.

7. Recognition Rate(RR):

Iris recognition rate or accuracy of system is defined as the number of successful recognition of iris biometric over the total attempt of template matching. If the recognition rate is high then system recognize iris very efficiently.

RR = $\frac{\text{total number of correct matching}}{\text{total number of matching}}$ x100

D. Experimental Setup

In our experiment the iris recognition technique is performed on two eye images. The iris regions of these two iris images are compared with each other and if it is matched then it shows that these two images are of same eye otherwise they are from different eyes. The tool MATLAB 14a (8.3.0.532) is used to implement this proposed work. As discussed above CASIA and IITD iris databases are used as input image and segmentation is performed by canny edge detection and Hough transformation due to their high efficiency in segmentation process.

Then Daugman's rubber sheet model is used in normalization to convert angular coordinates of iris region into polar coordinates system. Feature encoding provide security feature to protect normalized template by applying DWT and NSCT. When NSCT is applied in both DFB decomposition and LP decomposition, 'pkva' filters are exploited . The number of pyramidal levels chosen are two (1,2). At each pyramidal level, the number of directional sub bands is set to 2, 4 and 8 respectively. These steps are performed for both eye imsge. in last stage hamming distance and NCC are calculated.

E. Simulation Results

The CASIA and IITD database provides good segmentation result. Because these eye image are captured for iris recognition research work so pupil boundary and sclera boundary are clearly identified. In our experiment 1081 comparisons from IITD database and 400 comparisons from CASIA database are performed. As our calculation, this method gives 99.35 percentage recognition rate from IITD database and 99.75 percentage recognition rate from CASIA database which is higher than existing systems.

TABLE I.

RECOGNITION RATE AT DIFFERENT THRESHOLD OF HAMMING DISTANCE WHEN NCC IS .9950

Total Comparison 1081(IITD)			
NCC .9950			
Hamming Distance	Total Successful matches	Total unmatched	overall Recognition Rate
0.2	1066	15	98.612396
0.25	1070	11	98.982424
0.3	1074	7	99.352451
0.32	1074	7	99.352451
0.34	1071	10	99.074931
0.35	1061	20	98.149861
0.36	1058	23	97.87234
0.4	1036	45	95.837188
0.45	984	97	91.026827
0.5	902	179	83.441258

Total Comparison 400(CASIA)			
NCC .9950			
Hamming Distance	Total Successful matches	Total unmatche d	overall Recognition Rate
0.2	384	16	96
0.25	385	15	96.25
0.3	399	1	99.75
0.32	399	1	99.75
0.34	399	1	99.75
0.35	400	0	100
0.36	395	5	98.75
0.4	372	28	93
0.45	365	35	91.25
0.5	358	42	89.5

TABLE II.

COMPARISON OF RECOGNITION RATE WITH CONVENTIONAL ALGORITHMS AND PROPOSED ALGORITHM

IITD DATABASE

Sr. No.	Researcher	Algorithm	Recognition Rate	Year
1	Abhineet Kumar[10]	2D DCT	98.46	2016
2	Shekar B H[13]	Particle Swarm Optimization and Fuzzy c means clustering	98.96	2017
3	Proposed Algorithm	DWT and NSCT	99.35	2018

Sr. No.	Researcher	Algorithm	Recognti on Rate	Year
1	Daugman[16]	Gabor Filter	99.9	2004
2	Charles O Ukpai[9]	Dual tree complex wavelet transform	98.86	2015
3	Nanik Suciati[11]	Statistical Moments of Wavelet Transform	93.5	2016
4	Proposed Method	DWT and NSCT	99.75	2018

TABLE III.

COMPARISON OF FAR AND FRR OF CONVENTIONAL METHODS WITH PROPOSED METHOD IN IITD DATABASE

Researcher	FAR	FRR
Tisse[14]	1.84	3.00
Li Ma[15]	0.02	1.98
Daugman[16]	0.01	0.09
HamedRanjzad[17]	1.6	2
FebusReikdj G. Cruz[18]	2.22	4.44
Proposed method	0.36	.94

6. Conclusion and Future Scope

Iris recognition is the highly attractive research area over last decade due to increased requirement of security features in iris template and increment in accuracy. The rich and unique feature of iris pattern makes it highly acceptable biometric based authentication system. Yet the use of low quality iris images and security of iris templates are still challenging task in this area.

In this report the security problem of iris template is solved and improvement in recognition rate is performed very well by proposed approach. Few issues and challenges discussed in first chapter are being undertaken in the proposed work which affects overall performance of iris recognition system. Segmentation, normalization and feature encoding are some steps which are discussed in the proposed method and implemented in a new way which provide better results. In this thesis we focused on all these three steps but our main task is to encode normalized iris template and provide better recognition rate. Template encoding is performed by DWT and NSCT very well and achieve recognition rate up to 99.35 in case of IITD and 99.75 in CASIA Database. Pattern matching is also most important part of any biometric identification system. Here for pattern matching the combination of Hamming distance and Normalized coefficient threshold is used to identify the correct iris template match. The result section provides validation of implementation of proposed work by showing encouraging performance as compared to other iris recognition systems.

The proposed iris recognition system work very well with high accuracy and recognition rate. it also enhance the iris template security but still there are some issues and challeges which are need to be solve. average recognition rate still 99.35 and 99.75 it may be reach to 100 percent and provide accurate result. processing of real time captured image with high accuracy is still challenging task. So these are some area in which further research is required to overcome these issues.

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