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Implementation of Iris Recognition Using Circular Hough Transform and Template Generation

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Abstract**—** Iris recognition is considered as one of the reliable technique in biometric system to gain higher security. In this paper research is focusing on an efficient iris recognition technique. Iris of an eye image is segmented, unwrapped into a rectangular strip and normalized. Normalized iris is transformed into polar coordinate and filtered. A mask is applied for noise suppression and encoded using encoding technique. This encoded iris pattern features are extracted and template is generated. This final template is stored in the database and input image template pattern is matched using pattern matching technique. This experiment uses two standard database images CASIA V1.0 and IITD, the performance measure FAR and FRR for different threshold values is considered for the evaluation of the system.

Keywords**—** FAR, FRR, Feature Extraction, Wavelets Transform

I. INTRODUCTION

Biometric is referred as the statistical analysis of biological characteristics. Biometric characteristics are classified as physical and behavioural. Physical characteristics are obtained from eye, face, retina, fingerprint, palmprint and finger knuckle whereas behavioural characteristics are obtained from signature, voice and gait. The advantage of biometric system is to restrict security breach and guarantee the presence of the person. This type of system is very handy and user friendly [5].

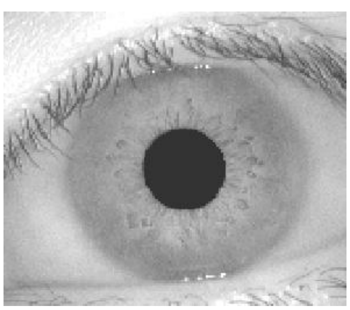

Figure 1 Human eye image

Biometric system based on iris recognition is one of the best recognition systems due to uniqueness of iris pattern and remain unchanged throughout the life. The human eye is an internal organ which is highly protected inside bone structure and it is composed of iris, pupil, sclera etc. The iris is the circular portion that is thin diaphragm lies between the lens and the cornea. Iris surrounds the pupil of the eye and the tiny muscle dilate it constricts the size of the pupil for controlling the exposure to the illumination [2, 7, 5]. Iris feature are unique and more stable compared to other biometric trait features even no two identical twins iris are same. Probability of becoming same of two iris are calculated as low as 10^{72} [5, 8, 9].

II. RELATED WORK

Iris recognition has got attention of lots of researcher worldwide on account of its uniqueness in texture feature which remain unchanged in lifetime and number of research paper published as described below.

The estimation of the area of iris is done before extraction of the feature and it is the critical part of the iris recognition process. In [10] proposed 2D Gabor filter for texture feature extraction of iris image and [11] proposed 1D wavelet transform feature extraction technique from iris. In [12] Gabor and Morlet wavelets based feature extraction technique is proposed for iris texture feature. In [13] presented a comparative analysis of various iris feature extraction techniques and different size of templates. In [14], binary representation of iris is done before feature extraction and number of filters is applied before extraction of feature from unwrapped rectangular strip of iris image. In [15], a binary iris template is generated by using relative intensities of image.

In [16], Iris template is generated by applying quantized data from 1D Log-Gabor filter.

III. IRIS RECOGNITION SYSTEM

In iris recognition system it has number of stages, the block diagram of the iris recognition system shows various stages applied in it. The first stage is iris image acquisition and it is followed by the preprocessing, the preprocessing stage enhances the iris image by using some morphological operations. The third stage is segmentation, in this stage the iris region is detected by using Circular Hough transform (CHT). In fourth stage the iris is normalized and in fifth stage iris features are extracted and in final and sixth stage matching of input iris feature image is done with the features stored in the database.

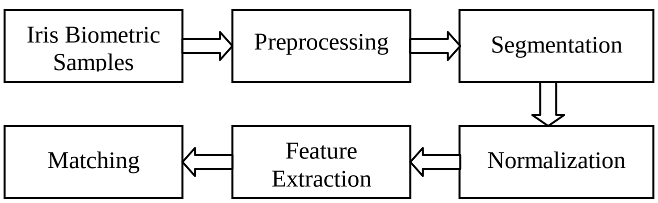

Figure 2: Iris recognition system block diagram

A. Segmentation: The below images are showing iris localization figure 3 is the input image and figure shows the iris is localized. Before segmentation the iris region must be localized which determines the iris region which is to be segmented by the help of two circles, the inner circle is drawn on iris/pupil boundary and the outer circle is drawn on the iris sclera boundary. For iris localization the standard vision algorithm Circular Hough Transform is applied which detected the two circles in the eye image [17].

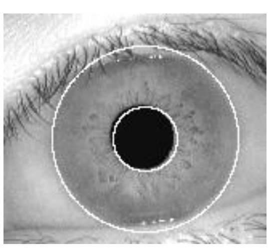

Figure 3: Input Eye Image

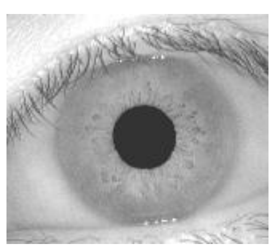

Figure 4: Iris Segmented

B. Normalization: The irises are distinct in size in distinct person as well as in same person due to the size of the pupil and the distance between iris capturing camera and the eye. The matching result of the iris may get affected severely due to variation in size of iris. To overcome this problem the localized iris is transformed into polar coordinate. Mapping of each point in the iris image is done with the polar coordinates (r,θ) where r is the radius of iris and θ is the angle of rotation anticlockwise. The polar coordinated unwrapped iris image is shown in the image below [5].

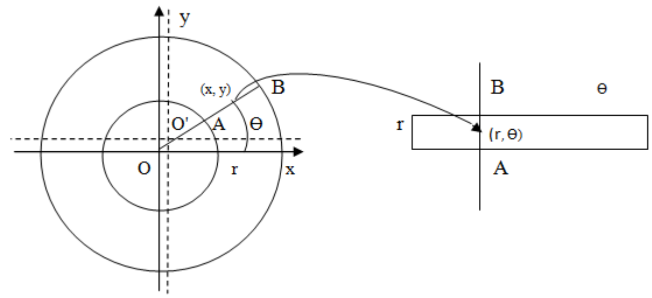

Figure 5: Rubber sheet model

The normalized iris unwrapped rectangular image is shown below in figure 6 and the polar coordinated iris image is shown in figure 7.

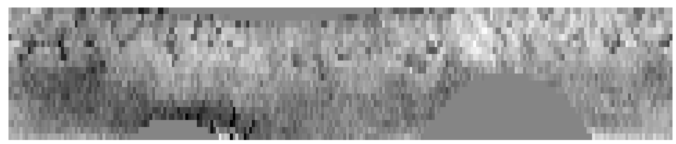

Figure 6: Normalized Iris

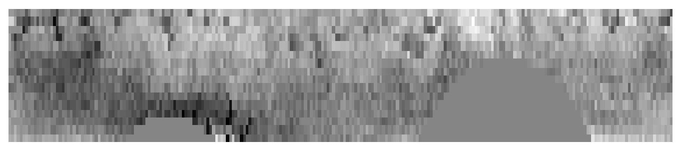

Figure 7: Polarized Iris

C. Image Enhancement: Histogram equalization of the polarized image is done before image enhancement. The image is enhanced by applying Gaussian filter, the enhanced image got the uniform intensity in pixel and the iris image got equal illumination. The image enhancement is done to remove unwanted noise. Noise should not get considered while performing the feature matching using hamming distance calculation. While calculating the hamming distance between two coordinate points of the corresponding image if noise get calculated then the matching result would not be proper hence the image is enhanced. The filtered image is shown below.

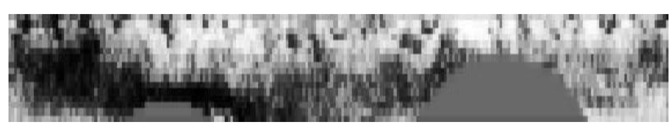

Figure 8: Gaussian Filter Image

D. Feature Extraction Approach: For accurate recognition of an individual the most discriminating information as a feature extracted from iris. Due to the sensitivity of raw iris to translation, rotation, blurring and non-uniform illuminations increases intra-class differences and possibly it may lead to inter class variation [2, 5], hence the significant features of iris is encoded to generate template and these templates are compared. The image of the generated template is given below.

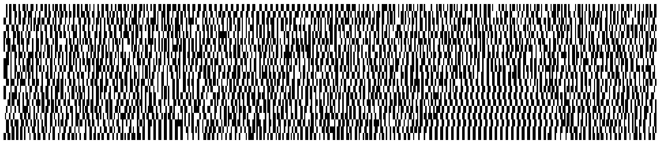

Figure 9: Iris template

E. Template Matching: Humming distance is calculated for matching the template generated with the template stored in database. The humming distance calculates the differences between the two similar pixel coordinates of the two different templates. The equation given below is used to calculate humming distance.

$$HD=\frac{1}{N}\sum_{j-1}^{N} Xj(XOR)Yj \quad (1)$$

Humming distance is used to calculate the similarity between the two templates by calculating the difference between the corresponding pixels of the two templates, if the difference is zero means the two templates are same and the person get identified or recognized [3, 19]. For achieving rotational invariance while computing the humming distance at bit level, Daugman modified the humming distance formula. The performance measure considered here are FRR and FAR for both the dataset CASIA v1.0 and IITD. FAR is false acceptance rate, where an unauthorized person gets falsely recognized and FRR is falsely rejection of authorized person [3, 19].

IV. EXPERIMENTAL RESULTS

In this experiment following two databases are used. CASIA Iris Database: Iris images of CASIA V1.0 (CASIA-IrisV1) were captured with a homemade iris camera. Eight 850nm NIR illuminators are circularly arranged around the sensor to make sure that iris is uniformly and adequately illuminated. The CASIA Iris Image Database Version 1.0 (CASIA-IrisV1) includes 756 iris images from 108 eyes. For each eye, 7 images are captured in two sessions with self-developed device CASIA close-up iris camera, where three samples are collected in the first session and four in the second session. All images are stored as BMP format with resolution 320*280. IITD Iris Image Database: This iris image database mainly consists of the iris images collected from the students and staff at IIT Delhi, India. This database has been acquired in the Biometrics Research Laboratory during January - July 2007 using JIRIS, JPC1000, and digital MOS camera. The acquired images were saved in bitmap format. The database of 2240 images is acquired from 224 different users. All the subjects in the database are in the age group 14-55 years comprising of 176 males and 48 females. The resolution of these images is 320 x 240 pixels and all these images were acquired in the indoor environment. The below mentioned tables show the FAR and FRR for the data sets CASIA v1.0 and IITD dataset [20, 21].

Table 1: FAR and FRR for CASIA-V1.0 dataset

Threshold	FAR (%)	FRR (%)
0.20	0.000	99.129
0.25	0.000	81.527
0.30	0.000	36.542
0.35	0.000	0.017
0.40	0.005	0.238
0.45	7.599	0.000
0.50	98.378	0.000

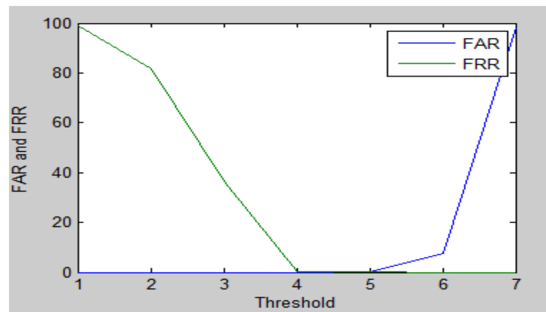

Figure 10: FAR and FRR for CASIA-V1.0 dataset

Table 2: FAR and FRR for IITD dataset

Threshold	FAR (%)	FRR (%)
0.20	0.000	79.045
0.25	0.000	74.232
0.30	0.000	29.681
0.35	0.000	0.012
0.40	0.005	3.923
0.45	3.462	0.000
0.50	92.269	0.000

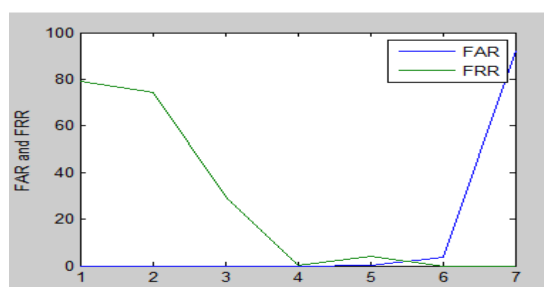

Figure 11: FAR and FRR for the IITD database.

IV. CONCLUSION

In this iris recognition technique all the experiment carried out on CASIA V1.0 and IITD dataset. The obtained result outperforms the standard result published by previous researchers. In the performed experiment on IITD dataset for threshold value 0.35 it is observed that FAR=0.000 and FRR=0.012 whereas for the dataset CASIA V1.0 it is observed that FAR= 0.000 and FRR=0.017 hence in this research work it is claimed that the FAR and FRR is reduced and the performance of iris recognition in terms of rate of recognition is improved at this threshold value.

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