A Review On Iris Recognition Systems

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***Abstract*— Biometrics recognition system uses the physiological and behavioral traits in uniquely identifying an individual. Among various biometrics, Iris recognition system with high accuracy and perfection in matching has widely proved to be efficient at identifying the individual. The Iris texture being not same for the left and right eye of the same person and varying even between the eyes of the twins makes it more secured way of authentication when compared with other Biometric recognition system. This paper provides various methods and algorithms and their effect on performance. This paper presents most widely used iris recognition algorithms**

Keywords*— *Iris recognition preprocessing, segmentation, normalization, feature extraction, matching.

I. INTRODUCTION

Biometrics is a secure, reliable authentication tool for systems where access to the system is provided by recognizing the person based on either physiological or behavioral characteristics [5]. The physiological characteristics are fingerprint, Iris, hand geometry and face while behavioral characteristics are signature, voice, ECG and keystroke dynamics. Biometric recognition is based on assets which cannot be forgotten, disclosed, stolen or lost unlike the traditional authentication systems like passwords or PIN's. Iris is the most promising aid in biometric recognition system because of its reliability, uniqueness and stability over the lifecycle [12]. Even genetically identical twins will be having different Iris textures [21].

II. BACKGROUND CONCEPTS

A. *Iris Anatomy*

The front view of the eye has two distinct regions: cornea and sclera. Cornea covers both pupil and iris, where iris is a transparent membrane and aqueous humor, which provides an individually distinguishable pattern or texture. Pupil is the central aperture of iris, which is dark in color when compared to iris. Sclera is white or pale white in color comprising interwoven fibers. Figure 1 shows the front view of a human eye.

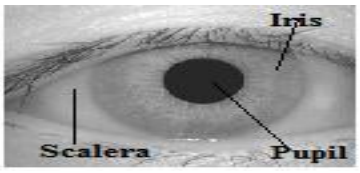

Fig. 1. Front view of a human eye.

B. *Iris Recognition Stages*

The different stages in iris recognition system are:

- Image acquisition: This captures a photo of the eye of an individual.
- Pre-processing: This stage basically consists of reducing the noise, contrast adjustment, eyelid and eyelash occlusion.
- Segmentation: In this stage it performs identification of iris inner and outer boundaries.
- Normalization: This stage includes polar transformation to Cartesian coordinates of the iris image.
- Feature extraction: Here it determines the unique texture for individual identification.
- Matching: Compares with the matching of iris code being saved in the database.

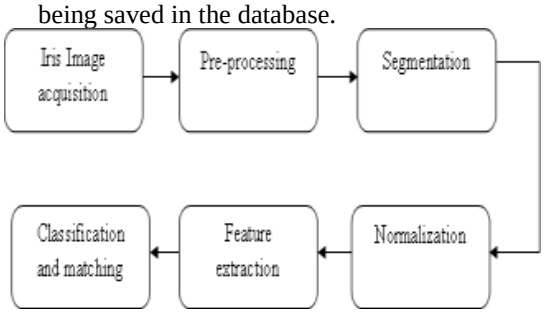

Fig. 2. Stages of Iris Recognition System

III. REVIEW OF RELATED WORK

A. *Publicly available database*

This section provides information about publicly available database with contribution from various authors or institutions. Many Iris databases are available for educational and research works. Iris image databases such as CASIA which is most commonly used public dataset. CASIA-IrisV4 [21] is released on biometrics ideal test. CASIA IrisV1 [22] has the advantage is that the region of pupil has uniform intensity because of photographical editing. UBIRIS [23] database has noisy images constructed from 241 subjects during acquisition by the University of Beira Interior. UPOL [24] database contains 3 x 128 left and right iris images. The irises are scanned by TOPCON TRC50IA optical device connected with SONY DXC-950P 3CCD camera, constructed by two authors Michal Dobeš and Libor Machala.

B. Related work

Many researchers and authors have proposed different techniques to overcome the drawbacks of traditional Iris recognition system.

Most of the commercial Iris recognition system uses patented algorithm developed by John Daugman[20][21]. Daugman used integro-differential operator in his algorithm to find inner and outer boundaries of Iris, including the detection of upper and lower eyelid boundaries. Daughman's rubber sheet model is used for Normalization where in the circular Iris region is unwrapped into rectangular block of fixed dimension. Feature extraction is performed using 2- D Gabor and hamming distance is used for code matching. 1 in 4 million is the theoretical false match probability in this method.

Narote et al.[19], proposed an optimal wavelet transform after evaluating the performances of various mother wavelets in feature extraction of an iris image. A fifth level decomposition is done for the normalized image and feature extraction is performed using different mother wavelets like: Daubechies, Haar, Coiflet, Biorthogonal and Symlet. These wavelet transforms are applied on different co-efficient levels such as vertical, horizontal, diagonal and also their combinations, with this an optimal wavelet transform is recognized and its performance is evaluated. SCOE Iris V1 database was used to perform experiment, which has a dataset of 2750 images from 275 subjects.

Smereka[18] (2010), proposed a method with the capability of reliably segmenting non-ideal images, which is affected with factors like blurring, specular reflection, occlusion, lighting variation, and off-angle images. Haar wavelet transform and contour filter was used to pre-process the image and Circular Hough Transform and Hysteresis thresholding is used to detect the edges of the iris. ICE database was used for experiment to check the performance.

Farouk[17] (2011), proposed a method based on Gabor wavelet decomposition and elastic graph matching. In this proposed method, iris is segmentation is performed using circular Hough transform. Gabor wavelets were used to decompose the texture information which is followed by a technique called elastic graph matching to identify the similarity and dissimilarity between any two iris codes. Experiment is tested using CASIA V3 and UBIRIS database.

Najafi and Ghofrani[16] (2011), proposed that after the segmentation and normalization of an iris image, the collarette part of the image is extracted and enhanced by applying median filter, histogram equalization and 2-d wiener filters. New feature extraction method based on Curvelet and Ridgelet transforms was proposed and these transforms creates smaller binary codes with higher accuracy rates. Experiment was tested using images from CASIA database.

Rashad et al.[15], proposed a statistical pattern method known as local binary pattern (LBP) along with histogram properties for feature extraction of iris and then to design a feature vector. This feature information is given as an input to the neural network based classifier known as combined LVQ. After doing the comparative study on this, author determined that this system has higher accuracy rate compared to other systems used in the comparative study.

P. Radu et al.[14], proposed an iris recognition method which is designed to deal with colour iris images with noise by applying score level fusion between different channels of the iris image. The proposed method is tested with three colour iris image datasets, where the images are captured using professional cameras in both constrained and less cooperative environment, and also the iris images captured from mobile phone. Experiment is tested using UBIRIS V1 dataset and for iris segmentation new method has been used, 2D Gabor wavelet is used to extract features and Hamming distance algorithm is used for matching codes.

Sathish et al.[13], proposed a multi algorithmic iris recognition system, where the iris segmentation is carried out by the following steps; Initially a Gaussian smoothing function and then histogram equalization is applied which improves the contrast of iris image. Canny edge detector and then probabilistic Circular Hough Transform are used for iris segmentation. Daugman's rubber sheet model is used to normalize the segmented iris and then by decomposing 2-d Gabor filters features were extracted from the normalized image. Hamming distance matching classifier called Feed forward neural network (NN) algorithm is used to obtain match score. Experiment is tested using CASIA database.

Mayuri Memane et al.[11], proposed a method where iris recognition is performed using discrete wavelet transform (DWT). It includes collection of iris database, prforming pre-processing along with separation of pupil, normalization and feature extraction. Polar to rectangular conversion is performed during Normalization, and then the features are extracted using DWT from the normalized image. It generates horizontal, vertical, approximate and diagonal coefficients. These are compared with the stored features using hamming distance.

Li Liu et al.[10], proposed a novel approach for texture classification, by generalizing the local binary pattern (LBP) approach. Local patches are extracted from two different and complementary types of features like pixel intensities and differences. The intensity of the central pixel (CI) and those of its neighbors (NI) is considered by the intensity-based features; while radial-difference (RD) and the angular-difference (AD) are computed for the difference-based features. Inspired by the LBP approach, CI-LBP and NI-LBP are the two intensity-based descriptors, and RD-LBP and AD-LBP are the two difference-based descriptors are developed. These four descriptors can be readily combined to form joint histograms to represent textured images since they are in the same form as conventional LBP codes. Experiments have been conducted on three challenging texture databases (CUReT, Outex and KTHTIPS2b). The result from Outex shows significant improvements over the classical LBP approach. KTHTIPS2b gives the best classification result compared to the result obtained on CUReT.

Vanaja Roselin at el.[9], proposed a scanning algorithm through which extraction of pupil part is done successfully and defines iris part more efficiently with less complexity. Iris part is consists of textures which are desired for authentication purpose of a person and each textures are represented as feature vectors and stored in database. Proposed method focuses on extraction of features using five

level decomposition technique implemented with db2, db4 and haar and achieves high accuracy with reduced error rates. Due to reduced errors and lower half part of the iris is considered, proposed method can be used for huge databases like Aadhar because of reduced time for feature extraction and has less complexity with lowered mathematical burden on the system and also improves the accuracy. Experiment is performed using CASIA Iris database. The following result is achieved with this method EER=0.03%, CRR=99.97%.

Z.Z. Abidin et al.[8], proposed a feature extraction technique using several edge detection operators based on the epigenetic traits. Edge detection operators such as Canny, Sobel and Prewitt operators were applied to extract the features from the iris. More accurate results were obtained using Canny operator. By applying these operators, the PSNR (peak signal-to-noise ratio) values of iris texture information were calculated before and after processing. Experiments are performed using CASIA database, on the conclusion part, this method found that iris recognition system could achieve higher accuracy rates by applying proper edge detection techniques.

Rajeev Gupta et al.[7], proposed an effective segmentation method to deal with the highly noisy iris images captured in non-ideal environments and less constrained conditions. In this method, Canny Edge Detection, Circular Hough Transform, K-Means Clustering, and some other algorithms are used to treat the expected noises such as specular reflection and iris obstructions which reduces the error percentage. Experiment is performed using CASIA-IrisV4 database.

Rai et al.[6], proposed a method for code matching based on combination of two algorithms to achieve better accuracy rate. Circular Hough transform is used to extract the iris image and then finding the zigzag collarette region after which detecting and removing the eyelids and eyelashes by using parabola detection technique and trimmed median filters. 1-d Log Gabor filters and Haar wavelets are used to extract features from the zigzag collarette region of iris. Extracted features were recognized with the combination of support vector machine and hamming distance approach. Experimental results shows the remarkable recognition rate when features were extracted from the specific region of the iris, where more complex patterns are available followed by combining support vector machines and Hamming distance approach for feature recognition.

Pournima Ghanmode et al.[4], proposed an Iris recognition method which consists of pre-processing eyelash occlusion using extreme point identification approach, feature extraction is performed using mean thresholding technique. The matching of iris code is performed by the combination of hamming distance and fragile bit distance. Proposed method achieved a good recognition rate with EER=.0845%, CRR=98.3264%.

Yang Hu et al.[3], proposed a method for optimal generation of iris codes for iris recognition. This method demonstrates that the traditional iris code is the solution of an optimization problem, where the distance between the feature values and the iris codes is minimized. This method also shows that more effective iris codes can be obtained for the optimization problem by adding terms to the objective function. The two additional objective terms have been investigated; the first objective term which exploits the spatial relationships of the bits in different positions of an iris code. The second objective mitigates the influence of less reliable bits in iris codes. For the optimization problem these two objective terms can be individually applied, or in a combined scheme.

Sunil S Harakannanavar1 et al. [1], proposed a method were the iris and pupil boundaries are detected using circular Hough transform and normalization is performed by using Dougman's rubber sheet model. The fusion is performed in patch level. For performing fusion, the image is converted in to 3x3 patches for mask image and converted rubber sheet model. Patch conversion is done by sliding window technique. So that local information for individual pixels can be extracted. The final features of iris images are extracted by block based empirical mode decomposition as low pass filter to analyse iris images. Finally the database images and the test image are compared using Euclidean Distance (ED) classifier. The experimental results shows 100% accuracy on CASIA V1.0 database compared with other state-of-art methods.

IV. OBSERVATIONS

A Following observations are made by studying the above papers:

- Preprocessing is performed using Canny operator, Hough Transform, histogram equalization, threshold function for eyelid occlusion & to detect reflection.
- Iris segmentation is mostly performed using Integro differential operator, Canny edge detector, Circular Hough Transform, 2-D log Gabor filter and many more methods.
- Iris Normalization is performed using Daughman's rubber sheet model
- Feature extraction is performed by using Haar wavelet Transforms, 2D Gabor wavelets, 1D Log-Gabor wavelets and 2D Log- Gabor wavelets, Local Binary Pattern, Discrete Wavelet transform, Principal component Analysis.
- Matching is performed by using Hamming distance, elastic graph matching, Support Vector Machines.

The performance rate of various existing algorithms for iris recognition system [2] given in Table 3.1. The accuracy of algorithms are tested using MATLAB and CASIA Iris Image Database. CASIA Iris Image Database is a public domain dataset. The database contains 758 iris images from 106 persons for testing. For 8 images of eye captured with 4 samples as training and remaining 4 samples taken for testing the accuracy is obtained by the error rates which are EER (Equal Error Rate), FAR (False Acceptance rate), FRR (False Rejection Rate).

Author	Techniques	Recognition Rate
Rangaswamy et al., [7]	DWT+ED	97.5%
Charan S G [8]	2D-DCT + ED	98.66 %
Ujwalla Gawande et al., [9]	LBP + NN	97 %
Ankita Satish et al., [10]	Gabor filter + ED	95 %
Sunil S Harakannanavar 1 et al. [1]	Block based EMD + ED	100%

Table 3.1 Comparisons of Iris Systems for CASIA V1.0 database.

V. CONCLUSION

Iris recognition has gained a greater attention due to its uniqueness, stability over the years and difficulty in forging the Iris. This paper presents the review of various existing methods. The Iris recognition system is one of the best and secure method for authentication. The uniqueness of the Iris and low probability of a false rejection or false acceptance all contribute to the benefits of using Iris recognition system.

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