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A Novel Method for Person Identification Based on Iris

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***Abstract*-The biometric person authentication technique based on the pattern of the human iris is well suited to be applied to any access control system requiring a high level of security. In this paper, a iris-based biometric identification system that increases the accuracy and the performance of a typical human iris recognition system is proposed. This system detects, isolates, and extracts the iris region from the eye images. The phase responses, obtained from convolving the polar images with 1D log Gabor filter, are quantized to generate the binary iris templates which are compared using the similarity measures like Cosine similarity, Jaccard Coefficient and Pearson Correlation Coefficient. The proposed method takes images from CASIA Iris database V3.**

Keywords-Biometrics, Iris recognition, Circular hough transform, Log gabor filter, Similarity measures

I. INTRODUCTION

Biometrics is an automated method of recognizing a person based on a physiological or behavioral characteristic. The past of biometrics includes the identification of people by distinctive body features, scars or a grouping of other physiological criteria, such like height, eye color and complexion. The present features are face recognition, fingerprints, handwriting, hand geometry, iris, vein, voice and retinal scan. Biometric technique is now becoming the foundation of a wide array of highly secured identification and personal verification. As the level of security breach and transaction scam increases, the need for well secured identification and personal verification technologies is becoming apparent. A biometric system can be either an 'identification' system or a 'verification' (authentication) system, which are defined below:

Identification (1: n) One-to-Many: Biometrics can be used to determine a person's identity even without his awareness or approval such as scanning a crowd with the help of a camera and using face recognition technology, one can verify matches that are already stored in the database.

Verification (1:1) One-to-One: Biometrics can also be used to verify a person's identity. Such as one can allow physical access to a secured area in a building by using finger scans or can grant access to a bank account at an ATM by using retina scan [1].

Security and the authentication of individuals is necessary for many different areas of our lives, with most people having to authenticate their identity on a daily basis, Examples include ATMs, secured access to buildings. Iris recognition has become an active research topic in the area of pattern recognition because of its increasing demands in identity authentication. Iris is the colored part of the human eye surrounding the pupil, located behind the cornea and the aqueous humor, and is used as a biometric feature due to its unique textures [1]. Iris scanning and identifying technique was first developed by Daugman and was patented in 2007 [2]. Iris recognition has been deployed in various critical application areas, including homeland security, border control, web-based services, national ID cards, rapid processing of passengers, restricted access to privileged information, missing child identification, and welfare distribution.

Daugman's algorithm maps and transfers the iris to size invariant polar coordinates, and each region is demodulated using quadrature 2D Gabor wavelets to extract the 2-bit phase information. This system uses hamming distance (HD) between the Iris Codes as the similarity measure and takes the decision upon the condition of HD from two different irises being greater than a criterion. In computer science, a similarity measure or similarity function is a real-valued function that quantifies the similarity between two objects [2]. In thispaper, we use some similarity measures such as Cosine similarity, Jaccard Coefficient and Pearson Correlation, It is mainly used for calculate similarity between two iris images.

II. LITERATURE REVIEW

John Daugman (2007) Iris recognition begins with finding an iris in an image, demarcating its inner and outer boundaries at the pupil and sclera, detecting the upper and lower eyelid boundaries. Areas of the iris that are obscured by eyelids, eyelashes, or reflections from eyeglasses, or that have low contrast or a low signal-to-noise

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ratio, are detected by the image-processing algorithms and prevented from influencing the iris comparisons through bitwise mask functions. Then recognize the person by measure Hamming distance between two irises [2].

Richard P. Wildes (1997) introduced another approach for iris recognition using a diffuse source and polarization in conjunction with a low-light-level camera and Laplacian Pyramid for image pre-processing. He uses hamming distance (HD) between the Iris Codes as the similarity measure and takes the decision upon the condition of HD from two different irises being greater than a criterion. The True Positive Rate versus False Positive Rate curve, also known as Neyman–Pearson decision strategy curve [3].

P. Guptaet al. (1998) the inner pupil boundary is localized using Circular Hough Transformation. The technique performs better in the case of occlusions and images muddled by artifacts such as shadows and noise. The outer iris boundary is detected by circular summation of intensity approach from the determined pupil center and radius. The localized iris image is transformed from Cartesian to polar coordinate system to handle different size, variation in illumination and pupil dilation. Corners in the transformed iris image are detected using covariance matrix of change in intensity along rows and columns. All detected corners are considered as features of the iris image. For recognition through iris, corners of both the iris images are detected and total numbers of corners that match between the two images are obtained. The two iris images belong to the same person if the number of matched corners is greater than some threshold value [4].

Boles et al. (2005) proposed an iris recognition system which is designed to handle noisy condition as well as possible, variation in illumination and camera-to-face distance. This work is based on zero crossing of wavelet transform. This work apart from the iris location a normalization algorithm brings the iris to have the same diameter and the same number of data points. From the gray levels of the sample images one-dimensional signals are obtained and referred to as the iris signature. Then a zero-crossing representation is calculated based on the wavelet transform. These representations are stored as templates and are used for the matching algorithm. Then recognize the person by a modal based algorithm in which the original signatures of different irises to be recognized are represented by their zero-crossing representations [5].

Li Ma et al. (2002) have proposed in recent years, Gabor filter based methods which have been widely used in computer vision, especially for texture analysis. Gabor elementary functions are Gaussians modulated by sinusoidal functions. It's shown that the functional form of Gabor filters conforms closely to the receptive profiles of simple cortical cells, and Gabor filtering is an effective scheme for image representation. In this scheme, both the inner boundary and the outer boundary of a typical iris can approximately be taken as circles. However, the two circles are usually not co-centric. The method employed in this work for iris localization includes simple filtering, edge detection, and Hough transform. The proposed scheme of feature extraction is to map the iris ring to a rectangular block image, which is anti-clockwise, divided into eight sub images and then to analyze the eight sub images. Then the similarity between two iris images is estimated using Euclidean distance and comparison of threshold [6].

Tomasz Marciniak et al. (2012) proposed the separation of the iris from the whole eye area is realized during the segmentation. The algorithm detects first the outer edge of the iris, and then, limited to the area of the detected iris, it is looking for its inside edge. Using the same operator, but by changing the contour of the arc path, we can also look for the edges of the eyelids, which may in part overlap the photographed iris. Having successfully located the image area occupied by the iris, the normalization process has to ensure that the same areas at different iris images are represented on the same scale in the same place of the created code. Aims to extract the normalized iris distinctive features of the individual and to transform them into a binary code. In order to extract individual characteristics of the normalized iris, various types of filtering (Log-Gabor filter) can be applied. Then the similarity between two iris images is estimated using Euclidean distance and comparison of threshold [7].

III. Proposed Approach

A. *Core concept*

The proposed iris recognition methodology Canny Edge Detection method is applied for detecting the eye edges [8], Circular Hough Transform is applied for finding circles on the edge map [9, 10], 1D Log Gabor Filteris applied to extract the iris and its relevant features from edge map after applying the Circular Hough Transform [11]. Then similarity value is calculated using some similarity measures such as Cosine similarity, Jaccard Coefficient and Pearson Correlation. It has been mainly used for calculating similarity between two iris patterns. After getting the similarity result of iris pattern, the similarity of the two iris patterns will range from -1 to 1. The resulting similarity ranges from −1 meaning exactly opposite, to 1 meaning exactly the same, with 0 usually indicating independence, and in-between values indicating intermediate similarity or dissimilarity [12]. Fig. 1 shows a flow chart of proposed human identification based on iris. The resulted similarity value is compared to the threshold level, if the similarity value is greater than or equal to threshold level the person is matched or authorized, otherwise the person is a mismatch or unauthorized.

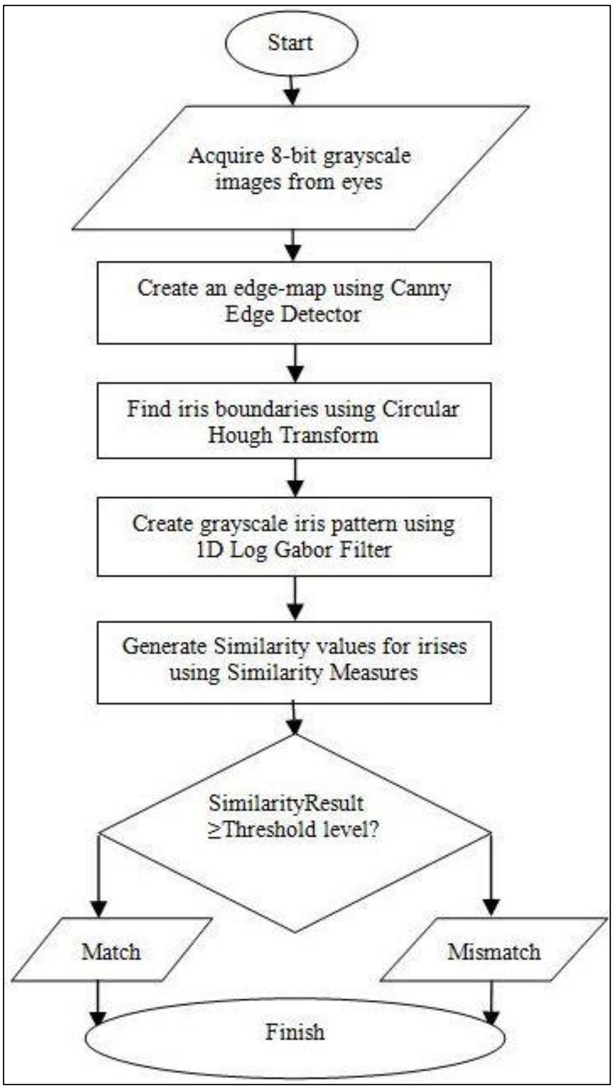

Figure 1. Flow chart of Proposed Human Identification Based on Iris

B. Image acuqisition

The system starts working with the acquisition of human iris images in near infrared illumination to avoid reflections in the iris region. For the testing purpose, the Iris database CASIA-IrisV3, provided by Chinese Academy of Sciences–Institute of Automation (CASIA). The captured image is stored in '.bmp' format and color image. An iris scanner is used to capture various human's eye, the images are stored in matrices of size 320×240 pixels (as sample eye shown in Fig. 2 (a)) [13]. The system starts working with the acquisition of human iris images in near infrared illumination to avoid reflections in the iris region. For the testing purpose, the Iris database CASIA-IrisV3, provided by Chinese Academy of Sciences–Institute of Automation (CASIA). The captured image is stored in '.bmp' format and color image. An iris scanner is used to capture various human's eye, the images are stored in matrices of size 320×240 pixels (as sample eye shown in Fig. 2 (a)) [13].

C. Core concept

The acquired image must be converted into color to gray scale image. Before extracting distinguishable features from the eye Images for creating binary iris templates, the images need to go through the pre-processing phase. At first, the iris region needs to be separated using an edge detection method. Due to its optimal performance and the noise reduction technique, Canny Edge Detector is used to create an edge-map of the captured eye image (as shown in Fig. 2 (b)) [8].

D. Circular Hough Transform

The Hough transform is a feature extraction technique used in image analysis, computer vision, and digital image processing. The purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure. The Hough Transform is a method for finding shapes in an image. The Circular Hough Transform has been implemented here, which is used to find circles within an image. Iris and pupil region obtained after applying Circular Hough Transform (as Shown in Fig. 2 (c)) [9, 10].

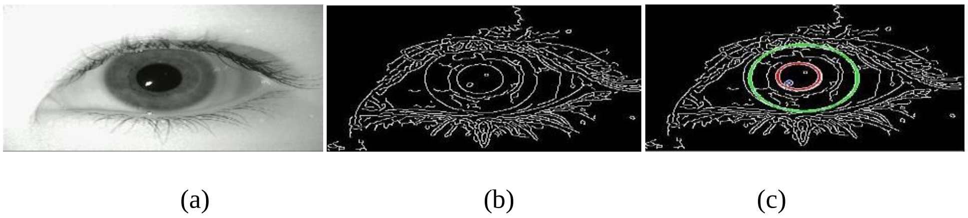

Figure 2. Various steps of output images. (a) Captured sample eye image (b) Edge-Map obtained after applying Canny Edge Detector (c) Iris and Pupil region obtained after applying Circular Hough Transform

E. Feature Extraction

In the feature extraction process, the proposed system uses 1D Log Gabor Filter to extract major and relevant iris features. A 1D Gabor filter, which can be obtained by modulating a sinusoid with a Gaussian [13]. Thus, the remapping of the iris region from (x, y) Cartesian coordinates to the normalized non-concentric polar representation modeled as following equations implemented [14, 15].

$$I(x(i,\theta), y(i,\theta)) \rightarrow I(i,\theta) \quad (1)$$

$$\text{With: } \begin{cases} x_p(\theta) = x_{po}(\theta) + r_p * \cos(\theta) \\ y_p(\theta) = y_{po}(\theta) + r_p * \sin(\theta) \end{cases} \quad (2)$$

$$\begin{cases} x_i(\theta) = x_{io}(\theta) + r_i * \cos(\theta) \\ y_i(\theta) = y_{io}(\theta) + r_i * \sin(\theta) \end{cases} \quad (3)$$

Where I (x, y) is the iris region image, (x, y) are the original Cartesian coordinates, (i, θ) are the corresponding normalized polar coordinates, where r_p and r_i are respectively the radius of the pupil and the iris, while $(x_p(\theta), y_p(\theta))$ and $(x_i(\theta), y_i(\theta))$ are the coordinates of the pupil and iris boundaries along the direction θ.

Figure 3. Rectangular representation of Iris

F. Matching

Matching the templates is the last process in the iris recognition system. The system uses various similarity measures such as Cosine similarity, Jaccard Coefficient and Pearson Correlation Coefficient.

G. Similarity Measures

A similarity measure or similarity function is a real-valued function that quantifies the similarity between two objects. In this paper, we use some similarity measures such as Cosine similarity, Jaccard Coefficient and Pearson Correlation, It’s mainly used for calculating similarity between two iris images. The similarity of the two images will range from 0 to 1, The resulting similarity ranges from −1 meaning exactly opposite, to 1 meaning exactly the same, with 0 usually indicating independence, and in-between values indicating intermediate similarity or dissimilarity[12]. The following similarity measures are used in our problem.

H. Cosine Similarity

This metric is frequently used when trying to determine the similarity between two images. Since there are more pixels that are in common between two images. The cosine of two vectors can be derived by using the Euclidean dot product formula. Thus, the following equation implementing.

$$Similarity = \frac{\sum_{i=1}^{n} A_i * B_i}{\sqrt{\sum_{i=1}^{n} (A_i)^2} * \sqrt{\sum_{i=1}^{n} (B_i)^2}} \quad (4)$$

Where, similarity represents the cosine similarity value between the two iris templates, A, B represents two iris templates, n represents the size of the templates.

IV. PEARSON CORRELATION COEFFICIENT

The correlation between sets of data is a measure of how well they are related. The most common measure of correlation in the states is the Pearson Correlation. The full name is the Pearson Product Moment Correlation Coefficient or PPMCC. It shows the linear relationship between two sets of data. Thus, the following equation implementing.

$$PPMCC = \frac{N(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (5)$$

Where, N represents No. of iris patterns, n represents the size of iris patterns, x, y represents two various iris patterns [16].

V. JACCARD COEFFICIENT

The Jaccard similarity coefficient isalso known as the Jaccard index,The Jaccard coefficient measures similarity between finite sample sets, and is defined as the size of the intersection divided by the size of the union of the sample sets. Thus, the following equation implementing.

$$J(x, y) = \frac{|x \cap y|}{|x \cup y|} \quad (6)$$

Where, J represents the result of Jaccard co-efficient, value between the two different iris patterns, x, y represents two various iris patterns [16].

VI. EXPERIMENTRAL RESULTS

The proposed system uses similarity measures for iris recognition. Let us assess the performance of the proposed work. The system starts working with the acquisition of human iris images in near infrared illumination to avoid reflections in the iris region. For the testing purpose, the Iris database CASIA-IrisV3, provided by Chinese Academy of Sciences–Institute of Automation (CASIA), was used. The accuracy of the system was analyzed using the 2×2-contingency table or confusion matrix. Based on the confusion matrix, performance values were calculated using the followings, where TPR= True positive rate, FPR= False positive rate, TNR= True negative rate, FNR= False negative rate [17]. The cosine similarity provides higher accuracy compared to other similarity methods.

$$\text{Precision or PPV} = \frac{TP}{TP + FP} \quad (7)$$

$$\text{Sensitivity or TPR} = \frac{TP}{TP + FN} \quad (8)$$

$$\text{Specificity or TNR} = \frac{TN}{FP + TN} \quad (9)$$

$$\text{Fall-out or FPR} = \frac{FP}{FP + TN} \quad (10)$$

$$\text{Miss rate or FNR} = \frac{FN}{FN + TP} \quad (11)$$

$$Accurarcy = \frac{TP + TN}{TP + TN + FP + FN} \times 100 \quad (12)$$

TABLE I. AVERAGE VALUES OF PRECISION, TPR, TNR, FPR AND FNR FOR VARIOUS SIMILARITY MEASURES

Similarity Measure	Avg Precision	Avg Sensitivity or TPR	Avg Specificity or TNR	Avg FPR	Avg FNR
Cosine Similarity	0.9786	0.9773	0.9314	0.0706	0.0208
Jaccard Index	0.7423	0.7643	0.7955	0.3231	0.1180
PPMCC	0.4335	0.6155	0.4005	0.4670	0.5170

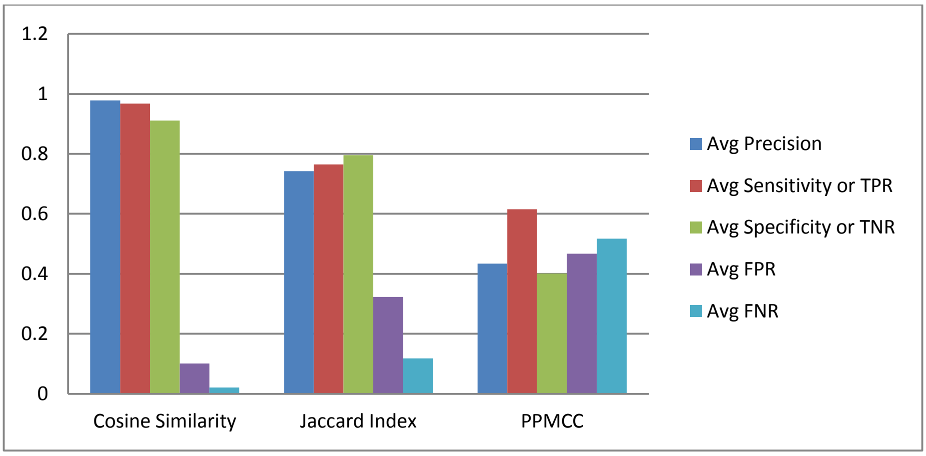

Figure 4. Average values of Precision, TPR, TNR, FPR and FNR for various Similarity Measures.

Accuracy of the proposed system is determined with five accuracy measures (such as precision, TPR, TNR, FPR, FNR). In general, when precision, sensitivity or TPR, specificity or TNR is higher, it indicates higher accuracy and when FPR, FNR rate is lower, it indicates higher accuracy [17]. In Fig. 4, X-axis represents various similarity measures, and the Y-axis represents average values of various similarity measures precision, TPR, TNR, FPR and FNR. Iris identification based on cosine similarity has higher precision and sensitivity value since it reports lower false positive rate and false negative rate compared to other methods as shown in Table I. The similarity value obtained is compared to the threshold level for matching purposes, maximum accuracy of 90% is found in threshold level in 0.94. The threshold level is moved to 0.97, where accuracy is increased to 95.43 %. Table II describes the overall accuracy of person identification based on iris using similarity measures.

TABLE II. OVERALL ACCURACY FOR PERSON IDENTIFICATION BASED ON IRIS USING SIMILARITY MEASURES

	Cosine Similarity	Jaccard Index	PPMCC
Overall Accuracy	95.43%	77.99%	50.80%

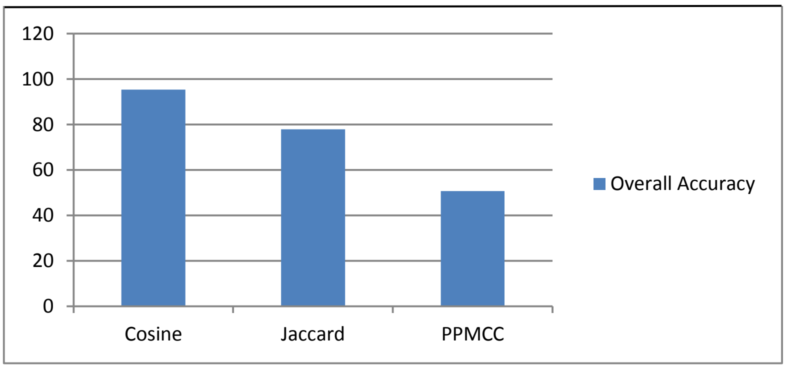

Figure 5. Overall Accuracy for Person Identification based on Iris using Similarity Measures

Fig. 5 Shows, the accuracy of all similarity methods, PPMCC recognize about 50.80% of the iris images, Jaccard index recognizes about 77.99% of the iris, but the cosine similarity provides accuracy of 95.43% using equation (12).

VII. CONCLUSION

Iris recognition as a biometric technology has great advantages such as variability, stability, and security, which promise a variety of successful applications. This paper presents a more reliable iris recognition method for biometric identification with similarity measures as the matching metric. The resultant similarity value is compared to the threshold level. If the similarity value is greater than or equal to threshold level the person is matched (authorized), otherwise the person is a mismatch (unauthorized). Finally, the cosine similarity produced better accuracy compared to others.

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