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A Trailblazing Intrigue Applying Ordinal Analysis of Iris Pattern for Invincibility

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Abstract - *Iris recognition is a biometric that depends on the uniqueness of the iris. Iris Recognition is regarded as the most reliable and accurate biometric identification system available. Elements of a person's biometrics are typically stable over the duration of a lifetime, and thus, it is highly important to protect biometric data while supporting recognition. A recognition system based on iris has become important in the last decades due to its reliability and comfort. Images of a human iris contain rich texture information useful for identity authentication. A key and still open issue in iris recognition is how best to represent such textural information using a compact set of features (iris features). In this paper, we propose using ordinal measures for iris patterns with the objective to characterize qualitative relationship between iris regions rather than precise measurements of iris image structures. Such a representation may lose some image-specific information, but it achieves a good trade-off between distinctiveness and robustness.*

Key Words: **Biometrics, Iris Recognition, Bi-section methods, Ordinal Measures, Circular Symmetric Filter, Hamming Distance**

1. INTRODUCTION

In recent years, the security of biometric data has been widely studied. Biometric data are believed to be unique for every person and the primary data of the biometric data remains invariable over the entire lifetime of a person [1]. It employs physiological or behavioral characteristics to identify an individual. The physiological characteristics are iris, fingerprint, face and hand geometry. Voice, signature and keystroke dynamics are classified as behavioral characteristics [2]. Among this iris recognition is believed to have reliability and accuracy. Iris recognition is a new way to identify iris images and identify identities through specific algorithms. Because of its high accuracy, uniqueness, fast speed and convenient acquisition, non-invasion and so on [3]. RIS recognition, as an extremely reliable method for identity authentication, is playing a more and more important role in many mission-critical applications, such as assess control, national ID card, border crossing, welfare distribution, missing children identification, etc. The uniqueness of iris pattern comes from the richness of texture details in iris images, such as freckles, coronas, crypts, furrows, etc [4]. Most iris recognition systems consist of four stages: image acquisition, iris segmentation, iris normalization and recognition [5].

IRIS codes are acknowledged to be uncorrelated not only between unrelated persons, but also even between identical twins and between the left and right irises of the same person [1]. Matching the iris codes from the left and right eyes of the same person gives a result that is on average basically the same as matching iris codes from unrelated persons [6].

The most challenging issue in iris feature representation is to achieve sensitivity to interclass differences and at the same time to maintain robustness against intra-class variations. So, a most important question one may ask is "What are the intrinsic and robust features of iris patterns?" or in practice, "How do we computationally model iris texture effectively and efficiently?" An equally important question to ask is "Do the currently best performing iris recognition algorithms have anything in common and what makes them effective? [4].

In this paper, we introduce ordinal measures for iris image representation in an attempt to answer some of these questions. Ordinal measures encode qualitative information of visual signal rather than its quantitative values.Paper is organized as follows. Section 2 describes latest methods used in iris recognition and its applications. The work and methodologies proposed are given in Section 3. Section 4 presents experimental results showing results of images tested. Finally, Section 5 presents conclusion & future enhancement of the works planned.

2. RELATED WORK

Daugman proposed the first successful algorithm for iris recognition [7]. In this algorithm, even and odd Gabor filters are proposed to demodulate phase information in each iris region. Then, phase value is coarsely quantized to 2-bit binary codes, and a given iris image is represented with 256 Bytes iris code. At the feature-matching step, the dissimilarity between two iris codes is measured by Hamming distance. Daugman's algorithm [7], [8] has been widely used in commercial iris recognition products. Other iris representation methods include emergent frequency and instantaneous phase [9], local texture energy orientation [10], Haar wavelet frame decomposition [11], multiscale zero-crossing representation [12], normalized directional energy feature [13], Haar wavelet binary features [14], correlation filters [15], Gaussian-Hermite moments [16], local extreme points [17], discrete cosine transform [18], direction of gradient vector field [19], etc.

The study of Miyazawa et al. (2008) presented an effective algorithm for IRIS recognition using the technique of phase based image matching of image matching using components of phase in two dimensional Discrete Fourier Transform (DFT) of given images. The evaluation of experiments using the database of CASIA IRIS image and ICE 2005 (IRIS challenge evaluation) database clearly explained that the phase components use of IRIS images made it feasible to accomplish highly accurate IRIS recognition with a simple matching algorithm. In order to decrease the data size and to increase the IRIS image visibility the author introduced the notion of two dimensional Fourier Phase Code (FPC) for indicating the information of IRIS.

Zhenan Sun and Tieniu Tan (2009) propose Multilobe differential filters (MLDFs) for ordinal iris feature extraction, aiming to model the flexibility of ordinal measures.

According to the study of Verma et al. (2012) recognition of IRIS is an accurate and reliable system for biometric identification. In this study the author used Daughman's algorithm segmentation process for recognition of IRIS. The images of IRIS are chosen from the database of CASIA then the pupil and IRIS boundary are predicted from the remaining eye image, removing noises. The segmented region of IRIS was normalized to reduce the inconsistencies of dimension between IRIS areas by using Daughman's Rubber sheet model. Then the characteristics of IRIS were encoded by convolving the normalized IRIS region with a single dimensional filter of log Gabor and phase quantizing the outcomes to produce bit wise template of biometrics.

Yung-Hui Li and Marios Savvides (2013), explored possible features and found that Gabor Filter Bank (GFB) provides the most discriminative information and also applied Simulated Annealing (SA) technique to optimize the parameters of GFB in order to achieve the best recognition rate. Experimental results show that the masks generated by the proposed algorithm increase the iris recognition rate on both ICE2 and UBIRIS dataset, verifying the effectiveness and importance of our proposed method for iris occlusion estimation.

Yao et al. (2014) proposed a study on IRIS feature extraction based on Haar Wavelet transform. In order to, increase the IRIS recognition system accuracy, this study suggested an effective algorithm for feature extraction of IRIS based on two dimensional Haar wavelet transformations. Firstly the image of IRIS was decomposed by two dimensional Haar wavelet 3 times and then a 375 bit code of IRIS was acquired by quantizing entire high frequency co-efficient at 3rd lever. Lastly the authors used a function of similarity degree as the scheme of matching. The outcomes on IRIS database of CASIA revealed that their algorithm has motivating Correct Recognition Rate (CRR) which was nearly 93.18% accompanying with reduced Equal Error Rate (EER) with 0.54%.

Zexi Li(2017) proposed an algorithm uses the Hough transformation and calculus methods to obtain rough location of the inner and outer boundary of iris, then uses the Canny edge extraction and the round Hough transformation to locate the iris boundary accurately, and finally obtains the accurate iris boundary of 90.1%.

3. PROPOSED WORK

All the previous work related to the ordinal measurement of iris pattern achieved a better accuracy and speed with some minimum noise. This paper presents an iris recognition algorithm using a bank of circular symmetric filters, which is used to capture local iris characteristics to form a fixed length feature vector. This feature extraction is helpful for ordinal measurement of iris pattern accurately, which helps to improve the False Rejection Rate (FRR) and reduce the False Acceptance Rate (FAR).

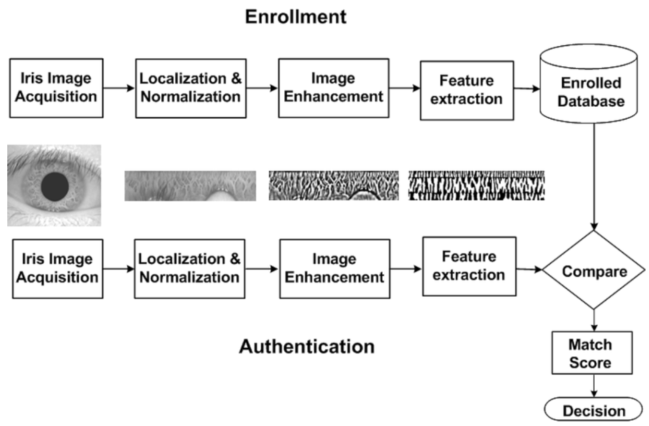

Fig -1: Block Diagram of Iris Recognition System

Iris image preprocessing is divided into three steps: iris localization, iris normalization and image enhancement.

3.1 Iris Localization

Bisection Method is used to locate the center of the pupil. The center of the pupil is used as reference to detect the inner and outer boundaries of the iris. Initially, edge detection is applied to the iris image in order to extract the edge information. For every two points on the same edge component, bisection method is applied to draw the perpendicular lines to the center point. The center point with maximum number of line intersections is selected as the center of the pupil.

A virtual circle is drawn with reference to the center of the pupil and the radius is increased within certain range. Two virtual circles with the largest number of edge points are chosen as the inner and outer boundaries of the iris. Bisection method is affected by the non-uniform illuminations and glasses reflections.

As a result, the iris inner boundary cannot be localized accurately. Similar to the discrete circular active contour method, image pre-processing algorithm is needed to remove the high intensity areas caused by illuminations and reflections.

3.2 Iris Normalization

Irises from different people may be captured in different size, and even for the iris from the same person, the size may change because of the variation of the illumination and other factors. Such elastic deformations in iris texture affect the results of iris matching. For the purpose of achieving more accurate recognition results, it is necessary to compensate for these deformations. Here, we anti-clockwise unwrap the iris ring to a rectangular block of texture of a fixed size (64x512) by piecewise linear mapping. The distortion of the iris caused by pupil dilation can thus be reduced.

3.3 Image Enhancement and Denoising

The normalized iris image has low contrast and non-uniform illumination caused by the light source position. The image needs to be enhanced to compensate for these factors. Local histogram analysis is applied to the normalized iris image to reduce the effect of non-uniform illumination and obtain well-distributed texture image. Reflections regions are characterized by high intensity values close to 255. A simple thresholding operation can be used to remove the reflection noise.

3.4 Ordinal Feature Extraction for Iris Pattern

The essential IRIS features must be encoded as that contrast between templates can be made. Most systems of IRIS recognition make use of a band pass decomposition of the IRIS image to create a biometric template. Iris offers abundant information of texture a feature vector is formed which comprises of ordered feature sequences retrieve from different representation of IRIS images.

In this paper ordinal measurement is used. The basic concept of ordinal measurement and their desirable properties in the context of iris recognition is helpful for better iris recognition.

Ordinal feature extraction of iris images is not a challenging issue due to the theoretical simplicity of ordinal measures. For example, an ordinal measure can be easily obtained by qualitatively comparing the features of two groups of image regions.

In this paper, Circular symmetric filters are proposed for ordinal iris feature extraction, aiming to model the flexibility of ordinal measures.

3.4 Circular Symmetric Filter

A circular symmetric filter (CSF) which is developed on the basis of Gabor filters. The difference between Gabor filter and circular symmetric filter lies in the modulating sinusoidal functions. The former is modulated by an oriented sinusoidal function, whereas the latter a circular symmetric sinusoidal function.
A CSF is defined as follows:

$$M(x,y,f)$$
$$G(x,y,f) = \frac{1}{2\pi\delta_x\delta_y}\exp\left[-\frac{1}{2}\left(\frac{x^2}{\delta_x^2}+\frac{y^2}{\delta_y^2}\right)\right]M(x,y,f) \quad \text{------ (1)}$$
$$M(x,y,f) = \cos\left[2\pi f\left(\sqrt{x^2+y^2}\right)\right]$$

Where is the modulating function, f is the frequency of the sinusoidal function, δ_x and δ_y are the space constants of the Gaussian envelope along the *x* and *y* axis respectively. We can obtain a band pass filter with a specific center frequency by setting the frequency parameter f .The choice of the parameters in Equation 1 is similar to that of Gabor filter.
The circular symmetric filter can capture the information of an image in specific frequency band, whereas it cannot provide orientation information because of its circular symmetry. The procedure of iris feature extraction using CSF is as follows: An CSF operator slides across the whole normalized iris image and each ordinal comparison is encoded as one bit, i.e., 1 or 0 according to the sign of the filtering result. All of the binary iris codes constitute a composite feature of the input iris image, namely, ordinal code (OC).

The dissimilarity between two iris images is determined by the Hamming distance of their features. In order to cope with the possible rotation difference between the two iris images, the input ordinal code is circularly rotated at different starting angles to match the template ordinal code. And the minimum Hamming distance of all matching results is the measure describing the dissimilarity between the two iris images.

Because iris localization and normalization have complemented the position and scale differences between two iris images, the whole procedure of iris matching is insensitive to position, scale, and rotation changes.

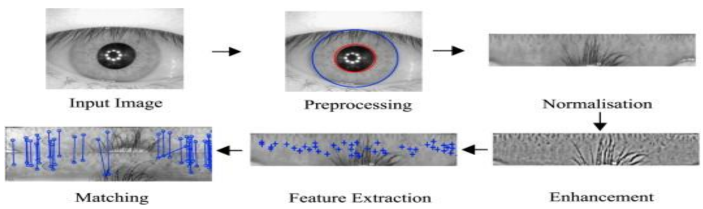

Fig -2: Step-by-Step work of proposed Iris Recognition System

4. EXPERIMENTAL RESULTS

Extensive experiments have been conducted to evaluate the performance of the proposed ordinal measures for iris recognition. CASIA database is used as the test data sets. This database represents the most challenging data set for iris recognition currently available in the public domain. Before iris image feature extraction using different encoding algorithms, the original iris image must be preprocessed. It mainly includes iris localization, normalization, enhancement & Denoising.

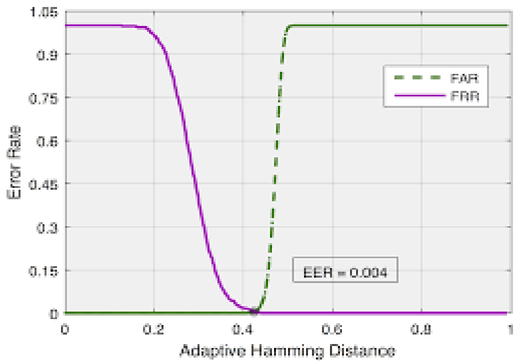

Fig -3: Performance Measure using Error Rate and Hamming Distance

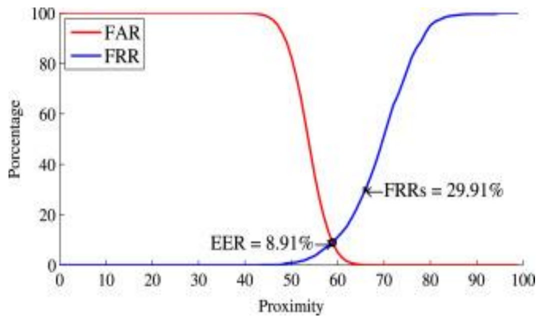

Fig -4: False Acceptance Rate versus False Rejection Rate

The proposed algorithm was tested in two modes: 1) identification and **2)** verification. For each iris class, we randomly choose three samples for training and the rest for testing. In identification tests, an average correct identification rate of **99.85%** is achieved. It is the False Acceptance Rate (FAR) and False Rejection Rate (FRR) curve which measures the accuracy of iris matching process and shows the overall performance of an algorithm. Points in this curve denote all possible system operating states in different tradeoffs.

Table -1: Comparison of FAR and FRR values

False Acceptance Rate (FAR)	False Rejection Rate (FRR)
0.001	3.56
0.01	2.17
0.1	0.83

5. CONCLUSION AND FUTURE WORK

In this paper, a new and effective algorithm for iris recognition was proposed. The proposed algorithm uses a bank of circular symmetric filters to extract local texture information of the iris. Each iris image is filtered with these filters and then a fixed length feature vector is constructed. Also, ordinal measurement of iris patterns is extracted for better recognition rate. An improved Hamming distance method is used in iris matching. Experimental results have show that the proposed algorithm achieves high performance. In future, we planned to improve the rapidity, accuracy and robustness of the system and also to implement the iris recognition system in smart environments.

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