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Feature Extraction Methods of Iris Recognition

[1] Sarika B.Solanke, [2] Ratnadeep R. Deshmukh
[1] Assistant Professor, Department of Computer Science and Eng., DIEMS, Aurangabad (MS), India.
[2] Professor, Department of Computer Science, Dr. B. A. M. University, Aurangabad (MS), India

Abstract: ***The*** **biometric recognition system is today's essential need. Among the biometrics, iris has highly accurate and reliable characteristics. Iris recognition technique is used in many applications such as Aadhar card system, airport security, access control in factories, identification for Automatic Teller Machines and restricted access to police evidence rooms. The algorithms used in iris recognition are categorized into three stages: Image Preprocessing, Feature Extraction and Template Matching. We have studied the various Iris Recognition algorithms. This paper provides a review of major feature extraction methods of iris recognition. The Image preprocessing and Feature Extraction are the essential steps for accurate accuracy. Cumulative Sums Change Analysis Method of feature extraction is the more reliable than other methods. Hamming distance method is the most useful method for template matching. Various databases of iris are available that will be useful for researchers to implement the application for identification or verification.**

Keywords **--- Iris Recognition, Image Preprocessing, Feature Extraction, Template Matching.**

I. INTRODUCTION

Biometric identification is an emerging technology which gains more attention in recent years. It employs physiological or behavioral characteristics to identify an individual. A lot of work has been done in the field of biometric iris recognition. Daugman proposed first working methodology of iris biometrics. For biometric identification person has to be present physically. Biometric is more reliable than other techniques. Iris Recognition is one of the most reliable and proven technique as compared to other biometrics such as fingerprint, hand geometry, face, hand thermogram, retina, voice and signature etc. Iris recognition is most useful identification technique in various areas such as civilized societies and many organizations. A person's eyes iris has different iris pattern, two identical twins also has different in iris patterns and it remains same in whole of the life. We have studied existing research methods of Iris Recognition Technology. In this paper, we have discussed various types of iris recognition algorithms [1][2][3][4][5][6].
Figure 1 shows the steps of Iris Recognition Process.

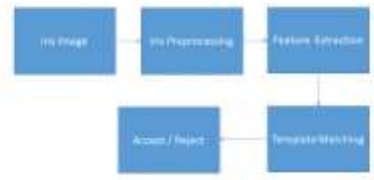

Figure 1: Iris Recognition Process

Iris recognition system is given in three steps such as Image preprocessing, Feature extraction and Template matching.

II. IMAGE PREPROCESSING

For analysis of an eye image, the original image needs to be preprocessed. Initially an image of the eye must be acquired by digital camera. It is required in digital form. It is necessary to detect the images. The acquired image always contains not only the useful parts but irrelevant parts i.e. eyelid, pupil. Iris image preprocessing is divided into three steps such as Iris localization, Iris normalization and Image enhancement. Iris localization detects the inner and outer boundaries of iris. Eyelids and eyelashes that may cover the iris region are detected and removed. Compared with the other part of the eye, the pupil is much darker. We detect the inner boundary between the pupil and the iris. The outer boundary of the iris is more difficult to detect because of the low contrast between the two sides of the boundary. It is necessary to convert iris image from cartesian to polar coordinates for normalization. The normalized iris image is a rectangle image with angular resolution and radial resolution. The iris image has low contrast and non-uniform illumination because of the position of the light source. All these factors can be compensated by the image enhancement algorithms [7][8][9].

III. FEATURE EXTRACTION

Feature plays a very important role in the field of image processing. Feature extraction methods are applied to get features that are useful in classifying and recognition of images. Feature extraction methods are helpful in various image processing applications. The various Feature Extraction methods are given as following [10][11][12][13].

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A. Gabor Filter

Gabor filter is the most useful algorithm for feature extraction. There are various kinds of Gabor filters. Gabor filters instinct response by a harmonic function. Each pattern is demodulated to extract its phase information using 2 D Gabor Wavelet. The phase information is quantized into four quadrants in the complex plane. Each pixel is demodulated into two bits code in the template. It is necessary to extract the phase information because it provides the significant information within the image. It is independent on imaging contrast and illumination. A Gabor filter is constructed by modulating a sine or cosine wave with a Gaussian. Modulation of the sine wave with Gaussian provides localization in space, though with loss of localization in frequency. Decomposition of a signal is accomplished using a quadratic pair of Gabor filters. A real part is specified by a cosine and an imaginary part is specified by a sine modulated by a Gaussian. The real filters are known as the even symmetric and imaginary filters are known as odd symmetric components.

B. Wavelet Transform

In Wavelet transform method, it decomposes the iris region into components with different resolutions. The wavelets are the small waves of varying frequency and limited duration. Wavelet transformation is better than the fourier transformation. In Fourier, the frequency remains same with the time. The commonly used methods for wavelets are Biorthogonal, Daubechies, Haar and Mexican Hat wavelet. The main advantage of wavelet transform method is that it has both space resolution and frequency resolution. The features are localized in both space and frequency domains with varying window sizes. A bank of wavelet filters is applied to the normalized iris region. Each filter is tuned for each resolution with each wavelet defined by scaling functions. The output of the filters is encoded to generate a biometric template.

C. Key Local Variations

Key local variations are used to represent the characteristics of the iris. The normalized iris image is decomposed into a set of 1D intensity signals. Dyadic wavelet transform is applied to each signal. Local extreme of the wavelet transform results correspond to sharp intensity variations of the original signal. The local maximum and minimum points are encoded into a feature vector. The feature vector is converted to a binary template with the same size as the normalized iris image [14].

D. Hilbert Transform

Hilbert transform is used to extract significant information from iris texture. Analytic image is constructed by the original image and its Hilbert transform. It can be used to analyze the iris texture. Emergent frequency and instantaneous phase is computed from the analytic image. Emergent frequency is formed by three different dominant frequencies of the analytic image. Instantaneous phase is the arctangent function of the real and imaginary parts of the analytic image. Feature vector is encoded by thresholding the emergent frequency and the instantaneous phase. The advantage of this approach is computationally effective. The filtering is performed in the fourier domain using pure real filters.

E. Discrete Cosine Transform

In this method feature are extracted by the difference of discrete cosine transform (DCT) coefficients of rectangular patches. The normalized image is divided into diagonal 8 x 12 patches. The average over width is windowed using a Hanning window to reduce the effects of noise. A similar Hanning window and DCT is applied to the patch along its length. The differences between the DCT coefficients of adjacent patches are obtained. A binary template is generated from the zero crossings of the differences between the DCT coefficients. This coding method has low complexity and good interclass separation. It is superior to other approaches in terms of both speed and accuracy [15].

F. Cumulative Sums Change Analysis Method

Normalized iris image is used for feature extraction. Overall feature extraction processing of cumulative sums change analysis method is given as: To calculate the cumulative sum the normalized image is divided into number of cell regions where each cell region contains 3 rows and 10 columns. Average of the gray values is used a representative for calculation of a basic cell region. Grouping of cell regions is done horizontally and vertically. The experimental results give better results when grouping is done by five cell region. Finally calculate the cumulative sum for every cell region group which generates the iris feature code [16][17][18].

IV. TEMPLATE MATCHING

Template matching compares the user template with templates from the database using a matching metric. The matching metric will give a measure of similarity between two iris templates. It gives a range of values when comparing templates from the same iris, and another range of values when comparing templates from different irises. Finally, a decision is made to identify whether the user is an authentic or not. The templates generated from the feature extraction stage need a corresponding matching metric. The matching metric compares the similarity between the templates. A threshold is set to differentiate between intra-class and inter-class

comparisons. The various algorithms of template matching are Hamming Distance method, Weighted Euclidean Distance, Normalized Correlation, nearest feature line and Support Vector Machine.

Hamming distance method is used to measure dissimilarity between two binary templates. The fractional hamming distance is sum of the exclusive-OR between two templates over the total number of bits. The advantage of hamming distance is fast matching speed because the templates are in binary format. The execution time for exclusive-OR comparison of two templates is approximately 10μs. hamming distance is suitable for comparisons of millions of template in large database. Weighted Euclidean Distance method is calculated using Pythagorean Theorem to calculate the distance between two points. An iris template is compared with all templates in the database. The two templates are matched if the Weighted Euclidean Distance is minimized. Normalized Correlation is defined as the normalized similarity of corresponding points in the iris region. Normalized correlation method is not computationally effective because images are used for comparisons. The nearest feature line distance is used in the classification stage. Support Vector Machine is used for pattern matching to verify a person's identity based on the iris code.

V. CONCLUSION

With the fast development of communication and Internet, the demand for accuracy and security in identification method is increasing faster. Every individual have unique physiological characteristics. We surveyed the various iris recognition techniques. Available iris recognition algorithms for feature extraction and template matching are studied in this paper. Cumulative sums change analysis method is more suitable for feature extraction and hamming distance method is mostly used because of its speed. The performance of each algorithm affects the accuracy of the system. This survey is needful to the researchers for the implementation of image processing applications.

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