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Comparative Performance Analysis of Feature Extraction Techniques of Iris Recognition

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Abstract: *Iris Recognition is a very accurate method for highly secure identification and personal verification system as compare to other biometric traits. It has been first introduced by J. Daugman, later many scientist have worked on the trait with different feature extraction techniques. Among the Biometric technologies, Iris recognition system is mostly used because of its uniqueness & stable characteristics. Iris recognition consist of many sections among which feature extraction is an important stage. I have worked on RED algorithm based Feature extraction of iris. The algorithm works well on CASIA 1 database, the obtained result shows high recognition rate. In this paper analysis of performance of this technique is compared with the some other methods available in literature.*

Keywords: *FAR-False acceptance rate , FRR-False rejection rate, RED-Ridge energy Detection.*

I. Introduction

A biometric system provides automatic recognition of an individual based on some sort of unique features or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, the retina and the one presented in this paper, the iris[1]. Biometric is the application of statistical analysis to biological data. Biometric verification is technique by which a person can be uniquely identified by verifying one or more distinguishing biological traits. Unique identifiers include fingerprints, hand geometry, retina and iris patterns, voice waves, DNA, and signatures. The oldest form of biometric verification is fingerprint. Iris recognition is most important trait of biometric system used today because of its accuracy. The purpose of 'Iris Recognition', is to recognize a person from his/her iris prints. In fact, iris patterns are characterized by high level of stability and distinctiveness. Each individual has a unique iris. The probability of finding two people with identical iris patterns is considered to be approximately 1 in 1052(population of the earth is of the order 1010). Not even one egged twins will have the same iris patterns. The difference even exists between identical twins and between the left and right eye of the same person it is stable over time even though the person ages. Iris recognition is the most precise and fastest of the biometric authentication methods. In biometric, Feature extraction is the process of generating features to be used in the selection and classification tasks.

II. Structure of Iris

During acquisition, image of an eye does not contain only iris but it also contains pupil and data derived from the surrounding eye region like sclera, eyelid and eyelashes as shown in Figure 1. Eye is made up of two parts sclera and cornea. Sclera consist of closely woven fibers and a small section in center is called as cornea. The cornea - transparent and a spongy tissue is known as cilliary. There is a ring of muscles called as iris, the inner part of it known as pupil. The anterior layer is divided into two parts, the central pupillary zone and surrounding cilliary zone. The border between this two is collarets[2].

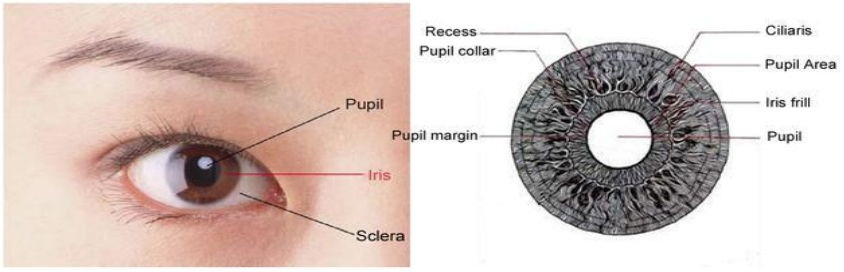

Fig 1 Eye Structure

III. IRIS recognition Methods used by researchers

In 1994, Daugman's Algorithm -

Since 1990, many researchers have worked on iris recognition system. The most important and stable work on an iris biometric recognition system was evolved from the research work published by Dr. John Daugman who described the functionality of this system in acute detail [3].

The biometric system also differ with respect to the numerous operators used in the algorithm. Similar to the work done on face recognition systems. The preliminary part of iris localization included the segmentation of boundaries. These things were defined by the definite operator - integro-differential operator, which was used to search boundaries in a given parameter space. Daugman used the rubber sheet model, a technique of mapping the polar coordinates on a circular plane to convert into a rectangular extracted iris region, irrespective of the noise factors like the eyelids and the eyelashes, which were excluded later.

2D Wavelet method was used for feature Extraction to disintegrate the given image and reassemble it by marginally reducing the size of the image, without reducing the amount of image stored. After texture analysis, the information compared using the Hamming distance, which is technique for counting similarities between the two iris codes, with the word 'iris code' being coined by Daugman himself as a representation of the iris texture in binary stamp format. He is acclaimed as the father of Iris biometric system.

In 1998, Wilde's Algorithm -

Wildes et al. was another scientist who developed an iris biometric system with a technical approach slightly different from Daugman's. In 1996 and 1998, he registered two patents related to a unique acquisition system & slightly less consistent but very effective automated iris segmentation method. The iris localization is another distinction. While Daugman used the integro-differential operator, Wildes used different way he had firstly calculated the binary edge map of the image and then used Hough transform and the relative accumulator function to calculate the intensity levels of pixels constituting a circle. This algorithm helps detect the pupillary and limbic boundary contours which are then segmented and used the segmented image is sent for feature extraction[4].

The second distinct method was the usage of a Laplacian of Gaussian filter over multiple overlapping stages in order to produce a template for feature extraction instead of using the compressional methods like Haar wavelet decomposition or 2D Gabor filters. The matching was done by computing the normalized correlation as a measure of the similarity and differences of two iris codes.

In2004, HanhoSung, J.Lim, J.park, Y.Lee -

Suggested the iris recognition method to remove unnecessary area and to increase the recognition rate.They have used canny edge detector to extract edges of inner boundary and center of pupil, diasection method to detect circular shape, applied Histogram equalization and 1-D DFT to locate the locate boundary [5]. They have used discrete wavelet transform to analyze the object and support vector machine (SVN) for recognition. They found the success rate as 99.18%.the variance is seen in illumination and glasses reflection because of camera light reduction .This method is incentive to glasses reflection and contains more information. It increase recognition rate and can be easily applied on real problem[6].

In 2006, j Kim, S.cho, D.Kim, Chung -

suggested the iris recognition system with low level of details for this they have used Laplacian operator and found superb performance in iris segmentation and recognition .Integro-differential operator to find inner & outer boundaries, DFB(directional filter Bank) to extract feature and Euclidian Distance for matching irises[7]. They have applied it on CASIA Database. Because of DFB, edges and furrows become more distinct. Even noisy components were suppressed at the same time. They found that comparable verification can be reduced with proper thresholds.

In 2011, M. Z. Rashad, M. Y. Shams, and R. M. EL-Awady -

presented the paper on iris recognition based on LBP and Combined LVQ classifier. The author explains the methods for feature extraction Local Binary Pattern (LBP) and combined LVQ classifier. Also one method by M. Z. Rashad which was based on a Local Binary Pattern and histogram properties as a statistical approaches for feature extraction , and Combined Learning Vector Quantization Classifier as Neural Network approach for classification, in order to build a hybrid model depends on both features. The localization and segmentation techniques are presented using both Canny edge detection and Hough Circular Transform in order to isolate an iris from the whole eye image and for noise detection. Feature vectors results from LBP is applied to a Combined LVQ classifier with different classes to determine the minimum acceptable performance, and the result is based on majority voting among several LVQ classifier. Different iris datasets CASIA, MMU1, MMU2, and LEI with different extensions and size are presented. Since LBP is working on a grayscale level so

colored iris images should be transformed into a grayscale level. Above methods gives a high recognition rate 99.87 % on different iris datasets compared with other methods.LBP texture analysis [8] operator is defined as a gray scale invariant texture measure derived from a general definition of texture in a local neighborhood. The average of the gray levels below the center pixel is subtracted from that of the gray levels above the center pixel. Two dimensional distributions of the LBP and local contrast measures are used as features.

Proposed system:-

The iris is an externally visible, yet protected organ whose unique epigenetic pattern remains stable throughout adult life. These characteristics make it very attractive for use as a biometric for identifying individuals. The proposed method includes various steps such as preprocessing operation to enhance the quality of an image and feature extraction process to identify the features of an image. Finally Matching is done on the basis Euclidean distance classifier on CASIA 1 database image and decision is made for identification. for Iris recognition Feature extraction is a very important step. Features are the attributes or values extracted to get the unique characteristics from the image. Features from the iris image are extracted using Ridge energy direction algorithm used for iris recognition is currently being developed at the U.S. Naval Academy by Dr. Robert Ives et.al. Feature extraction is based on the prominent direction of the ridges that appear on the image the polar coordinates are converted into rectangular co-ordinates and transformed into an energy image. We refer this feature extraction as the Ridge Energy Direction (RED) algorithm[9].

After determining the inner and outer boundaries and center of the pupil, the iris is again transformed into polar coordinates with the center of the pupil as the point of reference, into a 120 row by 180 column image. In this process, the radial extent of the iris is normalized in order to account for pupil dilation. Each row in the unwrapped iris image represents an annular region surrounding the pupil, and the columns represent radial information. Next, we consider the "energy" of the unwrapped iris image after contrast-limited adaptive histogram equalization. Here, "energy" loosely refers to the prominence (pixel values) of the ridges that appear in the histogram equalized image: higher value reflects higher energy. This "energy" image is passed into each of two different 09 x 09 directional filters (a vertical filter and a horizontal filter). These filters are used to indicate the presence of strong ridges, and the orientation of these ridges. At every pixel location in the filtered image, the filter which provides the largest value of output is recorded and encoded with one bit to represent the identity of this directional filter. The iris image is thus transformed into a one bit template that is the same size as the image in polar coordinates (120 rows by 180 columns). In some portions of the image input to the filters, the energy may be too low to reliably determine if a ridge is present. For this reason, each template is accompanied by a binary mask, with a 1 indicating presence of a ridge and a 0 indicating no ridge being detected[1].

Developed system for person identification & authentication using RED algorithm based feature extraction on CASIA 1 iris standard database recognizes the subject correctly. It uses the direction of the ridge patterns that appear in the unwrapped iris in the feature extraction process. The developed system using Ridge energy direction is performed on 25% of the total iris area and applied filter which provides the largest value of output is recorded and encoded with one bit to represent the identity of this directional filter. The iris image is thus transformed into a one bit template that is the same size as the image in polar coordinates.

IV. Performance Analysis

Biometric system performance

Due to different aspects like environmental changes, deformations and noise, it is not possible that two samples of the same biometric characteristic, acquired in different sessions, exactly same; for this reason the matching is performed by an algorithm which computes a similarity score and compares it with an acceptance threshold: in case the similarity is greater than the threshold the system claims that the two samples coincide. Differently from a password matching, sometimes the output of a biometric system may be incorrect: the main system errors are usually measured in terms of:

When an authorized user is rejected he/she must represent his/her biometric characteristic to the system. Note that a false rejection does not mean necessarily an error of the system; for example, in the case of a fingerprint-based system, an incorrect positioning of the finger on the sensor or dirtiness can produce false rejections.

Generally, FAR and FRR depend on the acceptance threshold t, which is used to set the desired security level, and are strictly related to each other. More specifically, FRR(t) is an increasing function and FAR(t) is a decreasing function, so if the threshold setting is increased to make the access harder for impostors, some authorized people may find it harder to gain access.

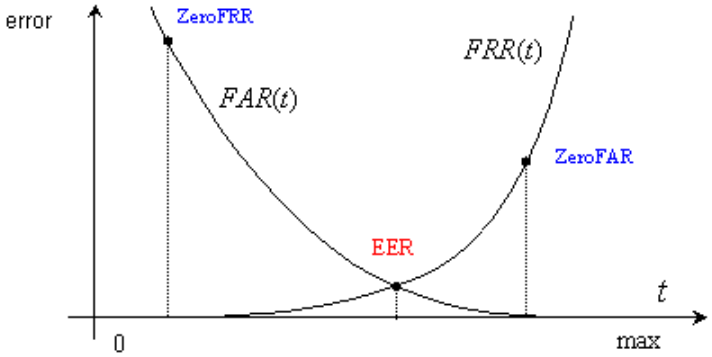

Fig.2 : False acceptance rate (FAR) and false rejection rate (FRR) as functions of the threshold t

Recognition rate of various algorithms shown in Table 1.

Table 1: List of iris feature extraction and Matching Algorithm of different researcher's.

Sr.No.	Researchers Method	Feature Extraction	Matching Process	Recognition Rate
1.	Daugman[2] 2D Gabor Hamming Distance with XOR	Daugman[2] 2D Gabor Hamming Distance with XOR	Daugman[2] 2D Gabor Hamming Distance with XOR	100%
2.	Wildes [6] Laplacian pyramid & Gaussian Filters Normalized Hamming Distance with exclusive OR operator	Wildes [6] Laplacian pyramid & Gaussian Filters Normalized Hamming Distance with exclusive OR operator	Wildes [6] Laplacian pyramid & Gaussian Filters Normalized Hamming Distance with exclusive OR operator	100
3.	Li Ma et. al	Class of 1-D Wavelets i.e., 1-D Intensity signals	Expanded binary Feature vector & Exclusive OR operations	100
4.	Poursaberi and Araabi	Wavelet Based Feature extraction	Minimum Hamming Distance(MHD) & Harmonic mean	99.31
5.	HanhoSung, J.Lim, J.park, Y.Lee	discrete wavelet transform	Support vector machin(SVM)	99.18%
6.	M. Z. Rashad, M. Y. Shams, R. M. El-Evady	Local Binary Pattern (LBP) and combined LVQ classifier	LVQ classifier	99.87%
7.	Proposed Method	RED algorithm based Feature Extraction	Euclidean distance	100

V. Comparison of Results

The performance results are based on error rates: False Acceptance Rate (FAR) and False Rejection Rate (FRR); Equal Error Rate (EER) and the overall accuracy. The percentage accuracy based on FAR and FRR of the implemented algorithms is shown in Table 1. This table shows that the Daugman's algorithm, wildes.Li Ma et al and proposed system based of Red algorithm gives the maximum accuracy with respect to FRR and FAR,0.01/0.09% and overall accuracy 100% .

VI. Conclusion

Iris recognition system is most accurate biometric methods for identification of individuals. The various methodologies and techniques of iris feature extraction had been compared with the proposed method in this paper. Different methods reviewed in this paper have their own importance depending on the techniques chosen. The summarized review of feature extraction techniques in iris recognition system can serve as a platform for development of other novel feature extraction methods. This will eventually help to increase the accuracy and reduce the complexity in iris recognition system.

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