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A Review of IRIS Recognition Method

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ABSTRACT
Biometric system is used for individual authentication based on unique characteristics. Secure communications and mobile commerce are some application areas where biometrics are being used to authenticate a person. Iris based security applications uses infrared cameras and video cameras for logins and transaction authentications. Accuracy, speed and template size are attributes that are important for large-scale identity programs and national database applications. In this paper, different iris recognition methods are discussed. These methods aid an appropriate outlook for future work to build integrated classifier on latest input devices.
Keywords:- Biometric System, Iris Recognition, Authentication, Iris Recognition methods

I. INTRODUCTION

Biometrics recognition systems are originated from real life criminal and forensic applications. Some methods such as finger prints and face recognition already proved to be very efficient in human recognition [1].Biometrics is a combination of "Bio" means life and "metrics" means measure [10]. Biometrics is defined as the science and technology of measuring and analyzing biological aspects of human being. Biometric authentication is highly reliable because physical human characteristics are much more difficult to forge than security codes, passwords, and other security system. Biometrics Technologies are classified into two categories-

A. *Physiological Biometrics*

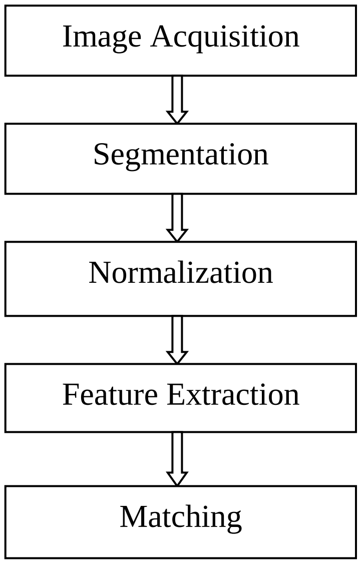
These are biometrics which are derived from a direct measurement of a part of human body. The most prominent and successful of these types of measures are finger prints, face recognition, iris scans and hand scans.

B. *Behavioral Biometrics*

Extract characteristics based on an action performed by an individual. Established measure includes key-stroke scan and speech patterns.

Biometric authentication technique based on iris pattern is suitable for high level security systems. Iris is the annular ring between the pupil and the sclera of the eye. The structure of iris is fixed from about one year in age and remains constant over time. It exhibits long-term stability and infrequent re-enrolment requirements. The variations in the gray level intensity values distinguish two individuals. The difference exists between identical twins and even between left and right eye of the same person. The iris is highly protected, noninvasive and ideal for handling applications requiring management of large user groups, like voter ID management. The iris recognition techniques potentially prevent unauthorized access to ATMs, cellular phones, desktop PCs, workstations, buildings and computer networks. The accuracy of iris recognition systems is proven to be much higher compared to other types of biometric systems like fingerprint, handprint and voiceprint.

A typical iris recognition system involves following steps:



Iris Recognition System

The first step, image acquisition deals with capturing sequence of iris images from the subject using cameras and sensors. These images should clearly show the entire eye especially iris and pupil part, and then some preprocessing operation may be applied to enhance the quality of image e.g. histogram equalization, filtering noise removal etc. The next step of iris recognition is to isolate the iris portion from the eye image, called segmentation. It is a technique required to isolate and exclude the artifacts as well as locating the circular iris region. The inner and the outer boundaries of the iris are calculated. Segmentation of iris depends on the quality of the eye images. An automatic segmentation algorithm based on the circular Hough transform is employed by Wildes et al. [1], Kong and Zhang [2], Tisse et al. [3], and Ma et al. [4]. The next step of iris recognition is to isolate the iris portion from the eye image, called segmentation. It is a technique required to isolate and exclude the artifacts as well as locating the circular iris region. The inner and the outer boundaries of the iris are calculated. Segmentation of iris depends on the quality of the eye images. In third step segmented iris is normalized. The normalization process will produce iris regions, which have the same constant dimensions, so that two images of the same iris under different conditions will have characteristic features at the same spatial location. In order to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted in the fourth step. Only the significant features of the iris must be encoded so that comparisons between templates can be made. This paper is mainly study of different feature extraction algorithms available. Once the features of iris are extracted we are required to match the iris template with the available in the database. Most of the authors have calculated Hamming distance [5, 6] between two iris template. The Hamming distance algorithm employed also incorporates noise masking, so that only significant bits are used in calculating the Hamming distance between two iris templates.

II. IRIS IMAGE DATABASE

Biometric system has been an active research topic in recent years. Iris Recognition is one of the popular biometric researches because of its high accuracy. The accuracy of the iris recognition system depends on the image quality of the iris images. Noisy and low quality images degrade the performance of the system. There is not any public iris database while there are many face and fingerprint databases. Lacking of iris database may be block to the research. To promote the research, National Laboratory of Pattern Recognition, Institute of Automation (IA), Chinese Academy of Sciences (CAS) have provide iris database freely for iris research.UBIRIS database is the publicly available database. It consists of images with noise, with and without cooperation from subjects. The UBIRIS database has two versions with images collected in two distinct sessions corresponding to enrolment and recognition stages. The second version images were captured with more realistic noise factors on non-constrained conditions such as at-a-distance, on-the-move and visible wavelength. CASIA iris image database images are captured in two sessions [29]. CASIA-IrisV3 contains a total of 22,051 iris images from more than 700 subjects. It also consists of twins' iris image dataset. ND 2004-2005 database is the superset of Iris Challenge Evaluation (ICE) dataset, uses an Iridian iris imaging system for capturing the images [7]. The system provides voice feedback to guide the user to the correct position. The images are acquired in groups of three called as shot. For each shot, the system automatically selects the best image of the three and reports values of quality metrics and segmentation results for that image. For each person, the left eye and right eye are enrolled separately. The specifications of databases are listed in Table 1.

III. Iris Recognition Methods

C. Phase Base Method

The phase based method recognize iris patterns based on phase information. Phase information is independent of imaging contrast and illumination. J.Daugman [14][15] designed and patented the first complete, commercially available phase-based iris recognition system in 1994. The eye images with resolution of 80-130 pixels iris radius were captured with image focus assessment performed in real time. the results of the iris search greatly constrain the pupil search, concentricity of these boundaries cannot be assumed. Very often the pupil center is nasal, and inferior, to the iris center. Its radius can range from 0.1 to 0.8 of the iris radius. Thus, all three parameters defining the pupillary circle must be estimated separately from those of the iris. The pupil and iris boundary was found using integro differential operator.

$$\max_{(r,x_0,y_0)} \left| G_\sigma(r) * \frac{\partial}{\partial r} \oint_{(r,x_0,y_0)} \frac{I(x,y)}{2\pi r} ds \right|$$

where I(x,y) is the image in spatial coordinates, r is the radius, (x0,y0) are center coordinates, the symbol * denotes convolution and $G\sigma(r)$ is a Gaussian smoothing function of scale σ. The center coordinates and radius are estimated for both pupil and iris by determining the maximum partial derivative of the contour integral of the image along the circular arc. The eyelid boundaries are localized by changing the path of contour integration from circular to arcuate. The iris portion of the image I(x,y) is normalized to the polar form by the mapping function $I(x(r, \theta), y(r, \theta)) \rightarrow I(r, \theta)$ where r lies on the unit interval [0,1] and θ is the angular quantity in the range $[0,2\pi]$.

D. Texture-Analysis Based Method

Wildes proposed iris recognition based on texture analysis [8], [9], [10]. High quality iris images was captured using silicon intensified target camera coupled with a standard frame grabber and resolution of 512x480 pixels. The limbus and pupil are modeled with circular contours which is extended to upper and lower eyelids with parabolic arcs. The particular contour parameter values x, y and radius r are obtained by the voting of the edge points using Hough transformation. The largest number of edge points represents the contour of the iris. The Laplacian of Gaussian (LoG) is applied to the image at multiple scales and Laplacian pyramid is constructed.

E. Zero Crossing Representation Method

The method developed by Boles [13] represents features of the iris at different resolution levels based on the wavelet transform zero-crossing. The algorithm is translation, rotation and scale invariant. The input images are processed to obtain a set of 1D signals and its zero crossing representation based on its dyadic wavelet transform. The wavelet function is the first derivative of the cubic spline. The center and diameter of the iris is calculated from the edge-detected image. The virtual circles are constructed from the center and stored as circular buffers. The information extracted from any of the virtual circles is normalized to have same number of data points and a zero crossing representation is generated. The representation is periodic and independent from the starting point on iris virtual circles. These are stored in the database as iris signatures. The dissimilarity between the irises of the same eye images was smaller compared to the eye images of different eyes. The advantage of this function is that the amount of computation is reduced since the amount of zero crossings is less than the number of data points. But the drawback is that it requires the compared representations to have the same number of zero crossings at each resolution level.

F. Approach Using Independent Component Analysis

The iris recognition system developed by Ya-Ping Huang [11] adopts Independent Component Analysis (ICA) to extract iris texture features. Image acquisition is performed at different illumination and noise levels. The iris localization is performed using integrodifferential operator and parabolic curve fitting from the inner to outer boundary of iris, fixed number of concentric circles n with m samples on each circle is obtained. This is represented as a matrix n x m for a specific iris image which is invariant to rotation and size. The independent components are uncorrelated, determined from the feature coefficients. The feature coefficients are non-Gaussian and mutually independent. The basis function used is kurtosis. The independent components are estimated and encoded. The center of each class is determined by competitive learning mechanism which is stored as the iris code for a person. The average Euclidean distance classifier is used to recognize iris patterns.

G. Iris Authentication based On Continuous Dynamic Programming

The technique proposed by Radhika [12] authenticates iris based on kinematic characteristics, acceleration. Pupil extraction begins by identifying the highest peak from the histogram which provides the threshold for lower intensity values of the eye image. All the connected components in sample eye image less than threshold intensity value are labeled. By selecting the maximum area component we arrive at pupil area of the eye. Normalized bounding rectangle is implemented using center of pupil to crop iris. Continuous dynamic programming is used with the concept of comparing shape characteristics part wise.

H. Approach Based On Intensity Variations

Iris recognition system developed by Li Ma is characterized by local intensity variations. The sharp variation [4] points of iris patterns are recorded as features. In the iris localization phase, the centre coordinates of the pupil are estimated by image projections in horizontal and vertical directions. The exact parameters of the pupil and iris circles are calculated using canny edge detection operator and Hough transform. The iris in Cartesian coordinate system is projected into a doubly dimensionless pseudo polar coordinate system. The local spatial patterns in an iris consist of frequency and orientation information. Gabor filters are constructed to acquire frequency band in the spatial domain. Gabor functions are Gaussians modulated by circularly symmetric sinusoidal functions. The feature extraction begins by generating 1D intensity signals considering the information density in the angular direction.

I. Approach Based On Active Contour

The active contour [16] is one of the methods, which has been used extensively in recent years for segmentation of images. Active contour is a two-dimensional curve in the image space whose deformation is based on energy minimization. In this method, first, a primary contour is defined close to the edge of the object in mind and then, in order to detect the edge, an energy function is specified for contour deformation. Finally, by minimizing the specified energy through various arithmetic techniques, the edge detection and segmentation process is completed.

J. Fuzzy Clustering Algorithm

A new iris segmentation approach, which has a robust performance in the attendance of heterogeneous as well as noisy images, has been developed in this. The process starts with the image-feature extraction where three discrete i.e., (x, y) which corresponds to the pixel position, and z which corresponds to its intensity values has got extracted for each and every image pixel, which is followed by the application of a clustering algorithm which is the fuzzy K-means algorithm[4]. This has been used in order to classify each and every pixel and then generate the intermediate image. This correspondent image is then used by the edge-detector algorithm. As it has additional homogeneous characteristics, this eases the tuning of the parameters which were needed by the edge-detector algorithm. The main advantage of this method is that, it provides a better segmentation for non-co-operative iris recognition. The major drawback in this method is that thorough (extensive) search is needed in order to recognize the circle parameters of both the pupil as well as the iris boundaries.

K. Approach Based On Moment

Image moments describe the properties of a distribution formed using the pixel data of the image along its axes. The moments are typically chosen to depict a certain interesting property of the image. Such moment proves beneficial in extracting and summarizing the properties of the image in order to produce useful results. Properties of an image such as centroid, area, and orientation are quantified by this process. Another dividend of image moments is that they bring together the local and global geometric details of a grayscale image[18].

Some of the methods are summarized in the table1.

TABLE1
METHODS AND SIZE OF DATABASE

Sr No	Method	Size of Database	Results
1	Phase-based method	4258 images	EER: 0.08%.
2	Texture Analysis Method	60 images	EER: 1.76%
3	Zero-Crossing representation method	Real Images	EER: 8.13%
4	Approach based on intensity variations	2245 images (CASIA)	Correct Recognition Rate: 94.33%.
5	Approach using Independent Component Analysis	Real Images	81.3% for blurred iris,93.8% for Variant illumination and 62.5%for noise interference images.
6	Iris authentication based on Continuous Dynamic Programming	(a)1205 images (UBIRIS) (b)1200 images (CASIAv2)	Acceptance Rate: 98% Rejection Rate 97%
7	Iris authentication based on moment	1000 images (CASIA)	Acceptance Rate:98.5%

Table 1

IV. PROPOSED METHODOLOGY

Various researches have been going on for iris recognition, some of few authors' contribution to iris recognition is shown in table1.In this paper moment of the iris are calculated for feature extraction and Rule based fuzzy is applied to get better result. Some rules will be framed according to computed features to get better correct classification rate. Moments are capable of providing a representation of any object. Moments are scalar quantities used for hundreds of years to characterize a function and to capture its significant features.

The two dimensional geometric moment of order (p + q) of a function f(x + y) is defined as

Mpq = a1∫a2b1 ∫b2 xp yq f(x,y) dx dy,

Where p,q=0,1,2,………..∞.

Note that the monomial product xpyq is the basis function for this moment definition.
A set of n moments consist of all Mpq's for p + q <=n, i.e the set contains 1\ 2(n+1)(n+2) elements.

V. CONCLUSION

Every individual have unique physiological characteristics. Iris patterns Iris patterns may be used for reliable visual recognition. Available feature extraction methods for iris pattern are studied in this paper. This paper is an analysis of the result of the various feature extraction methods. The survey of the techniques provides a platform for the development of the novel techniques in this area as future work.

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