RECENT DEVELOPMENTS IN IRIS BASED BIOMETRIC AUTHENTICATION SYSTEMS

Priyanka Mukherjee[1], Ankita Dutta[2], Pranab Das[3]

[1, 2, 3] *Dept of Computer Science and IT, Don Bosco College of Engineering and Technology, Assam Don Bosco University, Guwahati, India*

preah13@gmail.com, ankita.dutta17@gmail.com, pranab.das@dbuniversity.ac.in

Abstract

Authenticating the identity of an individual has become one of the most important aspects in many applications today. The iris based biometric system has therefore gained huge attention in this field. This strong interest is driven by its high level of accuracy and highly promising applications. This paper presents a comprehensive study of the various researches carried out in this field and the several techniques which forms a part of the biometric system using iris based recognition. The main emphasis is laid on the techniques or methods for segmentation, feature extraction and matching. Various methods for all this issues have been discussed in order to examine the state of art. Finally some challenges and future scopes have been discussed.

Keywords:-*Iris based recognition, segmentation, feature extraction, matching insert.*

--***--

1. INTRODUCTION

Biometric authentication system has become one of the most active research fields in authenticating the identity of an individual. A large amount of biometric systems have been employed to support this challenging field which resulted in a number of biometric systems including fingerprint, voice, hand shape, handwriting, signature. Unfortunately these systems have found to be highly invasive as they include contact of the individuals with the sensing device. An alternative to this invasive system is the automated iris recognition system which has found its way a good amount of success in the biometric field.

1.1 Iris

Iris which lies between the cornea and the lens of the human eye is a thin circular diaphragm. The iris is formed during the third year of embryonic life, the formation of complete iris pattern takes place till second year of birth and remains stable all throughout the person's life [1]. The iris consists of several layers mainly the posterior surface, stromal surface. The pattern within this layer gives iris a unique state for authentication. The various claims that iris is a unique human feature and the fact that every individual has different and a unique iris has been proven in medical experiments [2]. During examining the various irises of various individuals it has been proven in medical sciences that even the left and right iris of an individual are totally unique [3]. A front view of the human iris has been shown in the figure 1.

1.2 Outline

This paper is subdivided into four major sections. The first section gives an introduction on the automated iris recognition based biometric system. Section II explains the various techniques employed in iris recognition system. Section III represents an overview of the status of the various techniques and system and the results. Last section IV represents the observations and conclusion.

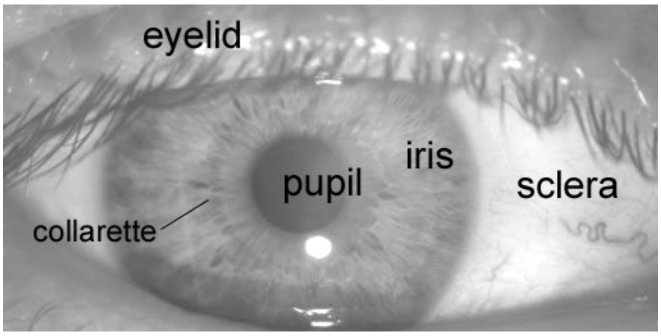

Fig: 1- A front-on View of human eye

2. TECHNIQUES USED

The various technical issues involved in the recognition of iris can be subdivided into four parts. The first set of issues includes image acquisition. The second step includes segmentation of the iris from the iris image. The third part concerns with feature extraction from the segmented iris image. Finally the fourth part concerns with the matching algorithms to match the iris pattern.

2.1 Image Acquisition

One of the most important and basic stage of iris based recognition system is to capture high quality images of iris. The fact that iris is a relatively very small region and human are very sensitive about their eyes this stage of acquisition requires careful implementation. Firstly it is required that an image of high resolution and well defined contrast is obtained and secondly the images must be well framed such that no external objects form the part of the image.

Most of the researches in this field use iris images from the following database which are freely available:

- The Chinese academy of sciences database (CASIA) [15].
- The bath database produced by the University of Bath [16].

2.2 Segmentation

The image acquisition of iris cannot yield an image consisting of only the iris. Generally image acquisition captures the image consisting of the other object such as pupil, eyelashes etc. therefore prior to feature extraction it is important to localize that portion of the image which consist of only the iris. A number of methods have been cited in the literature in this regard. However here we discuss two of most widely used methods.

2.2.1 Daugman's Algorithm

Daugman's algorithm i.e. Integro differential algorithm is one of the most popularly used in segmentation technique.

The Integro-differential operator in Daugman's helps locating the iris and pupil region. The differential operator is defined as [1].

$$\mathrm{Max}(r, x_p, y\sigma | G\sigma(r) * \frac{\partial}{\partial r} \emptyset_{(r,x0,y0)} \frac{I(\alpha,y)\, ds}{2\pi r}$$

Where $I(\alpha, y)$the eye image, r is is the radius to search for, $G\sigma(r)$ is a Gaussian smoothing function and s is the contour of the circle given by$r, x0, y0$. The operator here searches for a circular path with maximum change in pixel values, by varying the radius and center position of the circular contour.

However in determining the pupil boundary the Daugman's algorithm did not provide a acceptable result. Thus Daugman's optimized the Integro-differential [4].

2.2.2 Hough's Transform

The Hough's Transform is a standard computer vision algorithm to find the parameters of geometric objects Ashis Kumar dewagam et al [5] in their paper used the Hough's transform to determine the radius and center co- ordinate of the pupil and iris region.

Wilds et al [6], Kong and Zhang [7] used an automated segmentation algorithm based on circular Hough's transform. Here an edge map is generated from the eye image. Votes are then cast from the edge map is Hough's space for the parameters of circle passing through each point. The parameters are the center co-ordinate Xc and Yc and the radius Rc which can define any circle.

$$X_c^2 + Y_c^2 - R^2 = 0$$

A maximum point in Hough's space represents the radius and center coordinates of the circle best defined. The Hough' Transform to detect the eyelids, with parabolic arc can be represents

$$(-(X - hj)\sin\theta j + (y + k_j)\cos\theta_j)^2 = (a_j(X - h_j)\cos\theta_j + Y - kj\sin\theta j)$$

2.3. Normalization.

Once the iris is successfully segmented from the image the next step is to transform the iris image so that it has a fixed dimension. The segmented iris image from various sources may contain various dimensions in order to extract feature from the segmented image and hence perform matching the segmented iris needs to be normalized. The normalization process will thus produce iris images of same dimensions of the same iris so that two iris images of the same iris under different conditions will have the same features at similar spatial location. Li ma et al [8] al in their work used a method in which the iris ring is mapped anti-clockwise into a rectangular block of texture of fixed size (64x512).

The daugman rubber sheet model devised by daugman [5] remaps each point of the iris to a polar coordinate (r,θ) where r lies in the interval [0, 1] and θ is angle [0, 2Π] . The remapping of iris region from Cartesian region to normalized non concentric polar representation can be modeled as:

$$I(x(r, \theta), y(r, \theta)) \rightarrow I(r, \theta).$$

With

$$X(r, \theta) = (1-r)\, xp\,(\theta) + rxl\,(\theta)$$

$$Y(r, \theta) = (1-r) yp\,(\theta) + ryl\,(\theta).$$

Where I(x,y) is the iris region image, (x,y) is the original Cartesian coordinates (r, θ) is the normalized polar coordinate and xp , yp and xl, yl are the coordinates of the pupil and iris boundary. The rubber sheet model takes into consideration the size inconsistencies and pupil dilation in order to produce a normalized representation.

2.4. Feature Extraction

The individual can be accurately recognized only by discriminating them using the most unique feature of the iris. Therefore the most unique information from the iris needs to be extracted so that the comparison or matching between the templates can be made. Some of the contributions made towards feature encoding are:

2.4.1 Zero Crossing of the 1D Wavelet

Boles and Boashash [9] uses a set of one dimensional (1-D) signals and then obtain the zero-crossing representation of these signals. The wavelet is represented as the second derivative of the smoothing function θ(x).

$$\varphi(x) = \frac{d^2\theta(x)}{dx^2}$$

The zero crossing of the dyadic waves from this equation is thereafter used to encode features.

2.4.2 Discrete Cosine Transform

Ahmad M. Saharan used the discrete cosine transform to extract feature from an iris image [10]. The DCT decomposes a signal into frequency elements. When DCT is applied to an MxN matrix the 2D DCT concentrates or compresses all the information of the image in the upper-left corner of the resulting matrix. Thus this strong capability of DCT to compress the information makes it play a vital role in feature recognition/extraction.

2.4.3 Gabor Filters

A sine or cosine wave is modulated to form a Gabor filter. Daugman and Le Ma et[8] al uses the 2D Gabor filters to encode iris pattern. The output of the Gabor filter is then demodulated to compress the data. This is achieved by quantizing the information into four levels for quadrants in the complex plain. These four levels is represented by bits of data and this bits of data finally forms a template for comparison of irises.

2.4.4 Gabor Wavelet

Kshamaraj et al[11] used this method of gabor wavelet to extract feature of irises. Here firstly they generate a Gabor filter and then this Gabor filter is used to filter the images which results to give phase information. The phase information is then coded to 2048 bytes.

2.4.5 Local Feature Extraction

Lionel Martin et al [12] in their work introduced the concept of local feature extraction. Gabor filters provide the best spatial frequency resolution in 2D cases. A set of complex values can be calculated from the filtered frequencies at various positions. A phase quantization of local texture signal is performed by the quadrature image projections.

2.5 Matching

The templates generated by feature extraction needs to be matched with the iris images to check if the incoming iris image corresponds to the template so as to perform authentication. Therefore matching techniques and algorithms are needed to measure the similarity between two irises. Some of the commonly used matching techniques are discussed here.

2.5.1 Hamming Distance

The hamming distance gives a measure of how many bits are same between two bit patterns. Ashis Kumar Dewangan et al [5] used hamming distance to match codes generated by iris to measure the level of similarity.

In comparing two bit pattern hamming distance is defined as sum of non disagreeing bits over the total number of bits. The bit patterns generated from two different irises will be different and the bit patterns generated from similar irises will be highly correlated. The hamming distance of two completely independent bit patterns generated from two different irises should be 0.5. This is because the two bit patterns will be completely random. Similarly the bit patterns generated from two similar irises gives a hamming distance close to 0.0.

2.5.2 Euclidean Distance

Manesh Kokare et al[13] and C Sanchez Avela[14] in their works used the Euclidean distance as a measure of matching iris codes. Euclidean distance performs the measurement with dimensions of feature vector. For a given pair of iris signature Euclidean distance is used to compute the similarity between the signatures. A distance of zero signifies perfect match and as the distance increases the signature tends toward mismatch.

$$D_{(x,y)}^{Eucli} = \sqrt{\sum_{i=0}^{n} (x_i y_i)^2}$$

3. DISCUSSION

From the study conducted on the iris based recognition system it has been found that the iris based biometric system has occupied a vast portion of research in biometrics. A large number of techniques studied shows desirable output of the system satisfying authentication of individual. The analysis of the various iris recognition systems revealed a number of interesting states of the system. Analysis showed that segmentation is one of the critical stages of the recognition as it is the basic stage and any misinterpretation in this stage would lead to wrong authentication. A near to perfect recognition have been achieved by the various techniques used in the field.

The table below represents a comparison of the iris based recognition system with various other biometric technologies:

Table 1: Statistical comparison of various biometric techniques

Method	Coded Pattern	Misidentification rate	Security	Applications
Iris Recognition	Iris Pattern	1/1,200,000	High	High Security Facilities
Fingerprinting	Fingerprints	1/1,000	Medium	Universal
Hand Shape	Size, Length & Shape of hand	1/700	Low	Low Security facilities.
Facial Recognition	Outline, shape and distribution of eyes and nose	1/100	Low	Low Security facilities
Signature	Shape of letters, writing order, pen pressure	1/100	Low	Low Security facilities
Voice printing	Voice characteristic	1/30	Low	Telephonic services.

CONCLUSIONS

Iris based biometric system has become one of the most active research areas. It is strongly driven by many applications. Recent developments in this field shows that iris based biometric system can serve successfully towards the authentication and recognition of an individual's identity. The medical evidences suggesting that the iris of every individual is highly distinctive had made it an active topic of study and research. Bearing in mind a general framework for iris based authentication system a study has been presented of the recent and ongoing developments in the field. The state of art in each technique has been discussed.

Although a large amount of work have been done in this field many issues still remain an open challenge for implementation. At the end of the survey a discussion has been presented about the state of the system. Further if more efficient and low cost implementation can be made to the system then iris based recognition can serve as a well positioned and can be deployed widely.

REFERENCES

[1] Libor Masek, "Recognition of Human Iris Patterns for Biometric Identification", the University of Western Australia, 2003.

[2] Richard P.wildes, "Iris recognition: An emerging biometric technology", Proceedings of the IEEE , Vol. 85, NO. 9, September 1997.

[3] F.H Adler, Philosophy of the eye. St Louis, MO: Mosky, 1965.

[4] Dr. Mohamed A. Hebaishy. POSTER: Optimized Daugman's Algorithm for Iris Localization. National Authority for Remote Sensing and Space Science Gozif Titp St. Elnozha Elgididah.

[5] Ashish Kumar Dewangan, Majid Ahmad Siddhiqui. Human Identification and Verification Using Iris Recognition By Calculating Hamming Distance. International Journal of Soft Computing and Engineering (IJSCE) ISSN:2231-2307, Volume-2, Issue-2, May-2012.

[6] R. Wildes, J. Asmuth, G. Green, S. Hsu, R. Kolczynski, J. Matey, S.McBride. A system for automated iris recognition. Proceedings IEEE workshop on Applications of computer vision, Sarasota, FL, pp. 121-128, 1994.

[7] W Kong, D.Zhang. Accurate Iris Segmentation based on novel reflection and eyelash detection model. Proceedings of 2001 International Symposium on Intelligent Multimedia, Video and speech Processing, Hong Kong,2001

[8] Li Ma, Yunhong wang, Tieniu Tan. Iris Recognition Based on Multichannel Gabor Filtering. *The 5th Asian Conference on Computer Vision*, 23—25 January 20002, Melbourne Australia.

[9] W.W. Boles and B. Boashash. A Human Identification Technique Using Image of the Iris And Wavelet Transform. *IEEE Transactions on Signal Processing*, Vol. 46, No. 4, 1998.

[10] Ahmad M. Sarhan. Iris Recognition Using Discrete Cosine Transformation and Artificial Neural Networks. *J. Computer Sci*., 5(5): 369-373,2009

[11] Kshamaraj Gulmire, Sanjay Ganorkar. Iris Recognition Using Gabor Wavelet. International Journal of Engineering Research & technology ISSN:2278-0181 Vol. 1 Issue 5, July-2012.

[12] Lionel MARTIN et al. Person identification technique using human iris recognition. Proceeding of vision interface. May 2002.

[13] Ms. Lenina Vithalrao Birgale and Manesh Kokare. Iris Recognition Using Discrete Wavelent Transform. IEEE- 2009.

[14] C. Sanchez- Avila. Iris-Based Biometric Recognition Using Dyadic Wavelet Transform. IEEE AESS System Magazine. October 2002.

[15] CSBR, 2005. Center for biometrics and security resea http://www.cbsr.ia.ac.cn/english/database.aspx.

[16] University of Bath Irirs image database, 2007. http://www.bath.ac.uk/elu-eng/research/sipg/irisweb/