International Journal of Pure and Applied Mathematics
Volume 118 No. 8 2018, 567-572
ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
Special Issue
ijpam.eu

Biometric Security with Iris Recognition Techniques: A Review

S.Kalaiselvi
Research Scholar
Department ofComputer Applications
Alagappa UniversityKaraikudi.
TamilNadu India.
kalaimsc1489@gmail.com[1]

R.Anandha Jothi
Research Scholar
Department ofComputer Applications
Alagappa UniversityKaraikudi.
TamilNadu India
ranandhajothi12@gmail.com[2]

Dr.V.Palanisamy
Professor &Head
Department ofComputer Applications
Alagappa UniversityKaraikudi.
TamilNadu India
vpazhanisamy@yahoo.co.in[3]

***Abstract*—This paper gives a survey on Iris Biometric recognition technique for past few years. Traditional iris segmentation methods give good results when the iris image are taken under ideal imaging conditions. However the segmentation accuracy of an iris recognition system significantly influences its performance especially in noni deal iris images. In this paper, advancements in research methodologies used by different researchers for iris localization, iris segmentation, feature extraction, and classification and encryption of the Iris images are discussed. The limitations of existing algorithms and their results are also discussed. We also discussed here, existing difficulties in iris biometric, possible solutions on them, and future scope in this field. The vast progress in this field shows that iris biometric still needs fast, real time, reliable, and robust algorithms so as to have higher recognition rate and better accuracy. We hope that this paper will surely support to this area with new research opportunities and challenges.**

Keywords— Biometric recognition; Iris recognition system; Iris database; Iris Encryption; authentication; featurematching; normalization; localization; segmentation

I. Introduction

Biometrics is the reliable, secure authentication tool for systems where controlled access to physical assets is provided by recognizing the individual either based on physiological or behavioral characteristics [1]. The physiological characteristics are Iris, fingerprint, face and hand geometry while behavioral characteristics include voice, signature, and ECG, gait and keystroke dynamics. Biometric recognition methods are based on properties which cannot be forgotten, stolen, disclosed or lost unlike traditional authentication such as passwords or PIN's. Iris is a thin, circular structure in the eye which is protected internal organ thus it is not affected by environmental condition [2]. Amongst all the biometric recognition systems Iris is the promising solution because of its uniqueness, reliability and stability over the lifetime. Even the genetically identical twins have different Iris textures [3]. The Iris recognition system has wide applications in variety of fields such as premise access control (home, office, laboratory), secure financial transactions, internet security[16,17,18],
credit card authentication, secure access to bank accounts, anti-terrorism (e.g. security screening at airports) and many more [4]. Iris recognition system acquires the image of eye; extracting the Iris region from the image to determine the unique texture for individual identification during the verification phase and matches it with the database created in enrolment process. Thusidentifying the individual's identity in a convenient, faster, precise and more reliable manner.

The various stages of processing involved in the design ofIris recognition system are:

- Localization of eye
- Boundary segmentations of Iris and pupil,
- Normalization,
- Local feature extractions and
- Matching

The organization of rest of the paper is as follows: Section II presents the detailed study of advancement in the Iris recognition system analyzing the various methods and algorithms reported in various publication and research works. Section II also presents the information of various publicly available Iris database. The optimum approach proposed for Iris recognition system is given in Section III. Section IV discusses the conclusion and future work to be carried to improve the performance of the Iris recognition systems.

II. REVIEW OF RELATED WORK

Iris image acquisition is performed either using a CCDCamera with resolution sufficient to capture the Iris detailsor during the research course the Iris images are gatheredfrom the publically available Iris database.

A. Publicly available database

This section briefs the details of publicly available database with contribution from various authors. There are many Iris databases available for research and educational purposes which will aid to verify the performance of Iris recognition systems thus encouraging the advances in this field. Several Iris image databases such as CASIA (the most widely used public datasets), MMU, Bath, UPOL, and UBIRIS are freely available for experimental purpose.

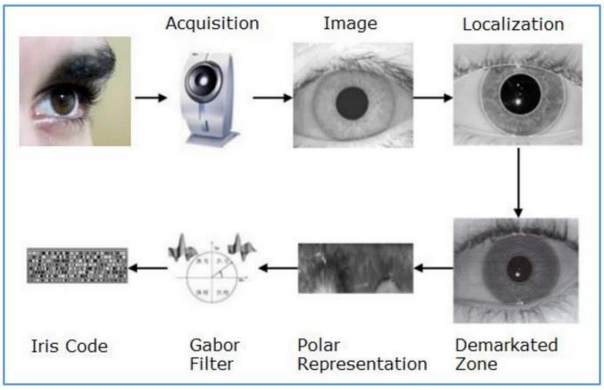

Fig.1 : Process of Iris Segmentation

Recently CASIA-IrisV4 is released on Biometrics ideal test. The first version has the advantage where the images are photographically edited to make the region of pupil to be of uniform intensity. BATH: images from this database are similar to that of MMU having similar characteristics and few noise factors with small eyelid and eyelash obstructions. UBIRIS is the database of noisy images constructed by University of Beira Interior taken from 241 subjects during acquisition.

B. Related work

The advancement in technology has led to innovations in Iris biometric recognition system. Many researchers and authors have proposed various techniques to overcome the drawbacks of traditional Iris authentication system. Most of the commercial Iris recognition system make use of patented algorithm developed by John Daugman [6]. Daugman proposed the algorithm to identify inner and outer boundaries of Iris using integro-differential operator, even the boundaries of upper and lower eyelid were detected. The operator assumes that the pupil and limbus are circular in nature and behaves as circular edge detector. The circular path is detected where there is maximum change in pixel value by varying the radius of circular contour. The upper and lower eyelids are detected by using parabolic curve as path for contour. Normalization is performed using Daughman's rubber sheet model where in the circular Iris region is unwrapped into rectangular block of fixed dimension. Phase information is encoded using quadrature 2-D Gabor and hamming distance is used for template matching. This method boasts the theoretical false match probability of 1 in 4 million.

Further an identification technique, which is invariant to tilt and scale variation has been proposed by V. Garagad et al. [5], where, the Iris region is radially traced to extract the feature. Property of discontinuity is used to crop the unwanted region in the image of an eye. To find the center coordinates of pupil, the segmented image is traced along diagonal coordinates with concentric circles of increasing radii. The coordinate that provides maximum ratio is considered as the center of pupil. Relative normalization is used where the ratio of max pupil radius of test image to max pupil radius of reference image is calculated to normalize the test image. The gray signature code of 90*180 bytes is obtained using Daugman's rubber sheet model. Then this image is code converted to binary signature code using a relative threshold. A bit by bit comparison of signature code of test image and the Iris images in the database is done to authenticate the user. The proposed work is conceptually simple as compared to differential operators with the average recognition rate of 83.14%.

Paul *et al* [7] has proposed an automatic segmentation algorithm using the circular Hough transform to identify the Iris pupil boundary and linear Hough transform for detecting the occluding eyelids. To remove the eyelashes and reflections thresholding isemployed. The segmented region is normalizedusing the Daughman's rubber sheet model. The normalizedIris image is convolved with the 1D Log-Gabor waveletsandthe resulting phase data is used to extract the feature from theIris image. And finally for the template matching Hammingdistance is employed. This recognition rate achieved a FAR of0.005% and FRR of 0.238 % for CSISA images.

Yuan *et al* [8] has proposed feature extraction method which is invariant to illumination. The pre-processing of image is performed by using Hough transform to localize Iris and Daugman rubber sheet model to normalize the Iris image. The annular region containing eyelid and eyelashes are discarded (45° to 135° and 225° to 325°) and the rest annular region is normalized and converted to 64 X 256 rectangle. Phase congruency depends on overall magnitude of signal making it invariant to illumination changes. In the process of feature extraction, the normalized image is convolved with the bank of 2D log-Gabor filters with different orientation and scales. Euclidean distance of feature vectors is calculated during matching. It is reported that the matching rate is about 98%.

Mohamed *et al.*[9] has proposed a method that differs from the existing work in the Iris segmentation and feature extraction phase. The paper also provides a comparison between two Iris localization techniques, viz., Wildes' algorithm and morphological features. In Wildes' algorithm canny edge detector is used to identify edges and then voting in circular Hough space is analyzed to estimate parameters of circle. In Morphological Feature Iris is localized using shape and geometry of Iris. Wilde's algorithm (circular Hough transform) proved to be better at localization as compared to morphological method. Daugman rubber sheet model is employed for Iris normalization. Local histogram equalization and LPF (Gaussian filter) is used to enhance the image. Gabor wavelets are used for feature extraction. The normalized image is convolved with 1D Gabor wavelet and Iris information is encoded by binary encoding scheme. Hamming distance is used for feature matching. The paper proves that Circular Hough Transform is unaffected by noise and is better than morphological methods.

A new feature extraction method based on extracting the statistical features in an Iris is presented by Sowmya B. *et al.*[10]. The pre-processing stage is similar to that proposed by Yuan *et al.*[7]. After the Iris localization concentric circle of different radii are drawn with center of pupil as the center. The mean, variance, standard deviation and mode for each circle is calculated. The image is seen as a feature vector having the above calculated values along with the number of circles drawn. Hamming distance is used for template matching.

Mabrukar*et al* [11] proposes the method to accurately localize the Iris images and the features obtained are immune to illumination. The pupil and Iris edges are identified using sobel operator and then gradient is applied to convolved images. Circular Hough transform is applied to identify the pupil center and pupil radius. The radius of Iris is obtained from first derivative of circular summation. Normalization is performed by using rubber sheet model proposed by Daugman to obtain rectangular block of 256 X 32. Features are extracted from binaries multi-scale Taylor expansion phase information which improves speed of operation and increases verification. The first and second terms of derivative gives the point where signal has greatest local asymmetry and local symmetry respectively. The first order derivative is similar to imaginary part of Gabor response and second order Taylor coefficient is similar to real part of Gabor response. The Iris eight binary features are defined by binarizing the blurred first and second order Taylor coefficients. Eight binary maps are obtained after Binarization using eight different continuous two dimensional multiscale Taylor expansion coefficients. In this paper the method used for template matching is the Elastic similarity metric for binary feature map comparison which uses similarity measure unlike Hamming distance which measures distance.

A rotation compensated Iris matching by using Fourier domain cross correlation to estimate relative rotation of two Iris images is introduced by Monro*et al* [12]. It is stated that one dimensional cross correlation is more advantageous than the 2D cross correlation as it provides improved accuracy due to elimination of eyelids and eyelash affected regions during the peak and displacement calculations with the gain in time and storage efficiency. The Iris is normalized and patch-basedzero crossing is used to generate binary feature vector. The position of sharp peak obtained by cross correlation between the candidate's iris and stored iris will indicate the degree of rotation. Sharp peak is expected for similar Iris and a flat curve will indicate a no match. Now the candidate's Iris image is shifted to align to the registered Iris thus providing improved matching. Since cross correlation peak is used for independent discrimination, peak to side lobe ratio (PSR) is used as metrics. Threshold for PSR is used to discard the local maxima of non matches. The feature vector of stored images is compared with the feature vector of selected rotated image to obtain the weighted Hamming distance which is used for verification.

Use of fast Fourier transform and moments which compares Iris image without encoding has been proposed by Jain et al. [15]. The Fourier transform converts the image from spatial domain to frequency domain and also filters noise in the image. Moment values are scale and orientation invariant of the object under study. In the methods of moments, a sequence of numbers called moments identifies the area, centroid, moment of inertia, orientation. The basic moments vary according to position with respect to origin, scale and orientation of the object. The invariant moments are normalized moments. Iris image matching is done using Euclidean distance formula, which is calculated by measuring the normal between two moment vectors. This algorithm is tested on only 10 images for matching and FAR, FRR is not mentioned.

Puhan*et al* .[16] has proposed Iris recognition based on binary maps, in contrast to methods using colour and gray scale images. The edge maps have advantages in terms of low storage space, fast processing and hardware compatibility. The Iris localization is carried out using circular Hough transform that detects the circular boundaries from the edge map of the eye image. The edge map is generated using the canny edge detection algorithm. To normalize the image, it is resized to 256*256 pixels, which allows comparison of two Iris regions of variable sizes. Thus a linear pattern is generated using the edge detection method. The Hausdorff measure between two images allows the comparison of two images without encoding. It is reported that the recognition rate is more than 98%.

III. OBSERVATION

Following observations are made by studying the above papers:

- Iris localization is performed using edge detection method like differential operator [6], cannyedge detection [9], Circular Hough transform [7,9, 11 and16] and sobel operator [11]. CircularHough transform is not suitable for real timeapplications as it is computationally intensive and requires threshold values to be chosen for edgedetection. The thresholding problem is solved indifferential method but the algorithm canfail when there is noise in eye image.

- Iris occlusion is removed using linear Hough transform [7]and extracting feature from selectiveregion [8] [14].
- Iris normalization is performed using Daughman'srubber sheet model[6, 7, 8, 9 and11] byresizing the image to a standard reference size [5][16] and using moments [15].
- Iris feature is extracted using 2D Gabor wavelets [6] [9], 1D Log-Gabor wavelets [7] and 2D LogGabor wavelets [8], binarized multi-scale Taylorexpansion [11], patch-based-zero crossing [12],drawing concentric circle on the Iris image andextracting the intensity information at variouspoints [5], and extracting the statistical features [10]. Log Gabor is advantageous over Gabor as it provides zero dc component.
- Feature matching is performed using Hammingdistance [6, 7, 9, 10, 12 and 13], Elastic similaritymetric [11] and Euclidean distance [8, 13 and 15].Hamming distance is used only with bits generatedfrom iris. Euclidean distance is used when templateconsists of integer values while elastic similarity isbased on similarity measure.
- Several algorithms are proposed that do not employ feature extraction phase and directly compare the two images. Direct comparison of images is performed using following algorithms:
  Fast Fourier transform and method of moments [15], phase based matching (BLPOC function)[14], Hausdroff distance [16].

Based on the above listed observations, an optimal approach for Iris recognition system can be designed and implemented using the techniques of Iris localization with removing the occlusion and immune to spot reflection. Use of Iris normalization techniques that are scale invariant, tilt invariant. Local feature extraction, which is invariant to intensity of the image with low storage space along with an efficient feature matching technique can be explored.

IV. PROPOSED WORK

Many existing real-world biometric applications are primarily unimodal. Traditional iris segmentation methods give good results when the iris images are taken under ideal imaging conditions. However the segmentation accuracy of an iris recognition system significantly influences its performance especially in nonideal iris images. So it is very reliable as Iris texture is unique in each individual, and its probability of two iris images to be same proved by Dr.J.Doughman. That it is one of most secure mechanism when security is concerned. This iris recognition technique consists of iris localization, normalization, encoding and comparison. In this research various iris recognition algorithms are analyzed and it is concluded that Doughman's approach given highest efficiency of overall efficiency. The proposed technique implemented into Biometric E-Voting system Applications.

V. CONCLUSION

Iris recognition has gained a greater attention due to its uniqueness, stability over the years and difficulty in forging the Iris. This paper presents the review of various existing methods proposed by different authors. Most of the solutions follow the 5 basic steps- localization of eye, image segmentation, normalization, feature extraction and matching. The Iris recognition system is one of the best secure methods of authentication. The uniqueness of the Iris and low probability of a false acceptance or false rejection all contribute to the benefits of using Iris recognition technology.SoThese kind of Algorithms possible to develop and integrate into E-voting Application.

References

[1] M. Pradhan, "Next Generation Secure Computing: Biometric in Secure E-transaction," International Journal of Advance Research in Computer Science and Management Studies, vol. 3, no. 4, pp. 473-489, 2015.J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.

[2] J. Trader, "M2SYS Blog On Biometric Technology," Delta ID, 11 June 2012. [Online]. Available: http://blog.m2sys.com/biometrichardware/iris- recognition-vs-retina-scanning-what-are-the-differences/.

[3] J. G. Daugman, "High Confidence Visual Recognition of Persons," Ieee Transactions On Pattern Analysis And Machine Intelligence, vol. 15, 1993.

[4] P. N. Belhumeur, "BIOMETRICS," 2007. [Online]. Available: http://www.cs.columbia.edu/~belhumeur/courses/biometrics/2007/Iris.pdf. [Accessed 08 August 2015]. V. G. Garagad and N. C. Iyer, "A Novel Technique of Iris Identification for," in International Conference on Advances in Computing, Communications and Informatics, 2014.

[5] J. G. Daughman, "How iris recognition works," IEEE Transactions on Circuits and Systems for Video Technology, vol. 14, no. 1, 2004.

[6] P. P. Paul and M. M. Monwar, "Human Iris Recognition for Biometric," 2001.

[7] X. Yuan and P. Shi, "Iris Feature Extraction Using 2D PhaseCongruency," in International Conference on Information Technology and Applications, 2005.

[8] M. A. Mohamed, M. A. Abou-El-Soud and M. M. Eid, "Automated Algorithm for Iris Detection and Code Generation," 2009.

[9] Sowmya.B and Sreedevi.S.L, "Iris Recognition System for Biometric Identification," in International Journal of Emerging Trends & Technology in Computer Science , 2013.

[10] S. S. Mabruka, N. S. Sonawane and J. A., "Biometric System using Iris Recognition," International Journal of Innovative Technology and Exploring Engineering, vol. 2, no. 5, 2013.

[11] D. M. Monro and Soumyadip Rakshit, "Rotation Compensated Human Iris Matching," in IEEE, 2007.

[12] W.-S. Chen, K.-H. Chih, S.-W. Shih and C.-M. Hsieh, "Personal Identification based on Human Iris Recognition with Wavelet Transform," in ICASSP, 2005.

[13] K. Miyazawa, K. Ito, T. Aoki, K. Kobayashi and H. Nakajima, "A Phase-Based Iris Recognition Algorithm," Springer-Verlag, pp. 356-365, 2005.

[14] B. Jain, Dr.M.K.Gupta and Prof.JyotiBharti, "Efficient Iris recognition algorithm using Method of Moments," in International Journal of Artificial Intelligence & Applications, 2012.

[15] N. Puhan, N. Sudha, H. Xia and X. Jiang, "Iris recognition on edge maps," in IET Computer Vision, 2007.

[16] Shankar, K., and P. Eswaran. “RGB based multiple share creation in visual cryptography with aid of elliptic curve cryptography.” China Communications 14.2 (2017): 118-130.

[17] Shankar, K., and P. Eswaran. “RGB-Based Secure Share Creation in Visual Cryptography Using Optimal Elliptic Curve Cryptography Technique.” Journal of Circuits, Systems and Computers 25.11 (2016): 1650138.

[18] Shankar, K., and P. Eswaran. “An Efficient Image Encryption Technique Based on Optimized Key Generation in ECC Using Genetic Algorithm.” Artificial Intelligence and Evolutionary Computations in Engineering Systems. Springer, New Delhi, 2016. 705-714.