VOL 1 (2017) NO 4 - 2

e-ISSN : 2549-9904
ISSN : 2549-9610

INTERNATIONAL JOURNAL ON INFORMATICS VISUALIZATION

A Review of Iris Recogntion Algorithms

Abdulrahman Aminu Ghali[#], Sapiee Jamel[#], Kamaruddin Malik Mohamad[#],
Nasir Abubakar Yakub[#], Mustafa Mat Deris[#]

[#] *Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia, Malaysia*
E-mail:aminuabdulrahman81@yahoo.com, sapiee@uthm.edu.my, malik@uthm.edu.my, aynasir@gmail.com, mmustafa@uthm.edu.my

Abstract— **With the prominent needs for security and reliable mode of identification in biometric system. Iris recognition has become reliable method for personal identification nowadays. The system has been used for years in many commercial and government applications that allow access control in places such as office, laboratory, armoury, automated teller machines (ATMs), and border control in airport. The aim of the paper is to review iris recognition algorithms. Iris recognition system consists of four main stages which are segmentation, normalization, feature extraction and matching. Based on the findings, the Hough transform, rubber sheet model, wavelet, Gabor filter, and hamming distance are the most common used algorithms in iris recognition stages. This shows that, the algorithms have the potential and capability to enhanced iris recognition system.**

Keywords— **Iris recognition, Segmentation, Normalization, Feature extraction, Matching.**

I. INTRODUCTION

Identification in iris recognition system is becoming more increasingly embedded in security applications. These security applications are used for access control, banking, border control, and forensics. Nowadays a special consideration is given to iris recognition system due to its high performance and reliability for identification [1]. The system relies on the iris pattern (texture) which if modified will affect the recognition performance [2]. In iris recognition system degraded images poses a big issue. These circumstances happen when an iris image captured in a less constrained environment produces non-ideal images with bad image quality such as speculation reflection, lighting variation poor illumination and low contrast etc [3]. Essentially, these artefacts could be falsely accepted or rejected user, which compromises the performance of the iris recognition. Therefore, this artefact in the image needs to be compensated and enhanced using various recognition techniques [4]. The Human frontal eye consists of iris, pupil and sclera. Figure 1 further illustrates the human frontal eye. Human irises have an exceptional structure that provides interlacing minute characteristics, such as freckles, coronas and stripes, these visible characteristics of iris are generally called iris texture which makes it unique and suitable for biometric measurement [3] [1] [6][7]. The uniqueness of the iris pattern makes it more stable and reliable for identification compared with other biometrics technologies, such as face, palm print, hand geometry and voice [7][8]. A human frontal eye is illustrated in Figure 1.

The iris recognition comprises of four stages, segmentation, normalization, feature extraction and matching stage. Essentially, the recognition starts with image acquisition and ends with the decision to accept or reject [4].

The following section of the paper is organised as follows: Section II discusses iris recognition stages. Section III provides paper discussion. Section IV will cover the conclusion of the paper.

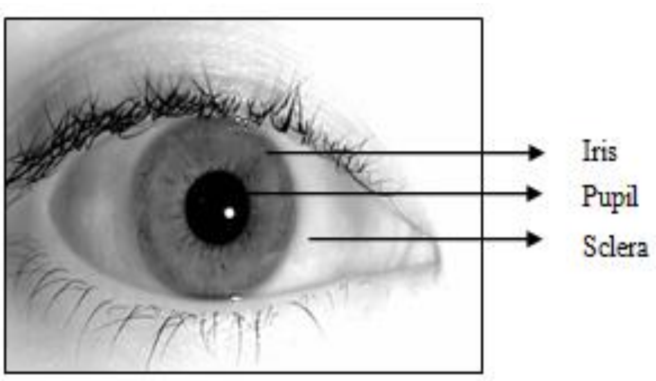

Fig.1 Human frontal eye

From Figure 1, the black represents the pupil, and the white indicates sclera the border between the pupil and sclera is called iris. Hence the anatomy of human eye is shown in Figure 2.

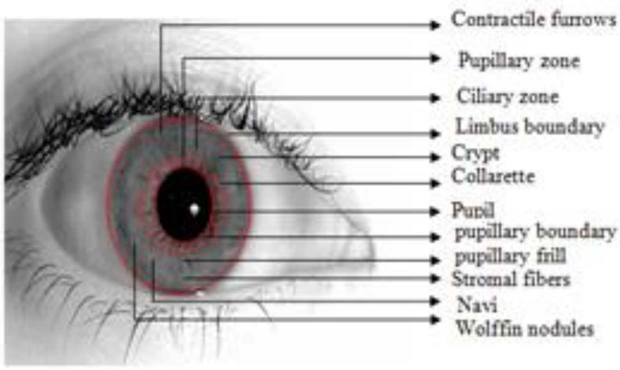

Fig. 2 Anatomy of human eye

II. IRIS RECOGNITION STAGES

Based on previous discussion in section I, iris recognition stages is of four stages which are segmentation, normalization, feature extraction and matching. Figure 3 visually described the stages of iris recognition.

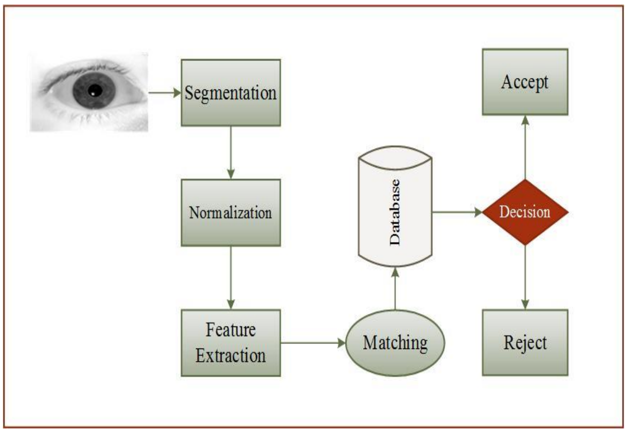

Fig.3 Iris recognition stages

A. Segmentation

At segmentation stage, the image is required to be carefully localized so that inner and outer boundaries of an iris can be modelled as a circle [9]. Based on the findings of the literature, there are various segmentation algorithms available. These are Integro-differential operator, Hough transform, Discrete Circular Active Contour, Bisection method and Black Hole Search Method [10]. Hough transform is the most used algorithms in this stage.

Hough transform is a technique used to actualize the parameters of simple geometric objects, such as lines and circles in an iris image. The parameters are the centre coordinates x_c and y_c and the radius r to define the circle, as described in Equation 1 as posited in the study [11].

$$x^2{}_c + y^2{}_c - r^2 = 0 \qquad (1)$$

In addition, Koon et al. took advantage of parabolic Hough transform to detect the upper and lower eyelids using parabolic arcs, as depicted in [12]. Moreover, many research work have used Hough transform algorithm as platform for segmenting the iris image to round circle as posited in [11], [9] [13], [14] [1] [13] [15].

B. Normalization

Once the iris region has been successfully segmented, next step is to transform the segmented iris region to rectangular block (fixed dimension). Normalization process normalizes iris regions to a fixed dimension in other to allow comparison [9]. Any inconsistency between the iris images (size) is captured due to poor illumination and low contrast image, the condition affects the accuracy of iris recognition. To achieve higher accuracy, a model (Algorithm) called "Homogenous Rubber Sheet Model", devised by Daugman [15], compensates the iris size's inconsistency [7]. There are various normalization Algorithms available these are Homogenous Rubber Sheet Model, Image Registration introduce by wildes [16] and Virtual Circle of boles [17]. In this stage Homogenous Rubber Sheet Model is the most popular algorithms used in the stage.

The Homogeneous Rubber Sheet Model assigns each point in the iris region as pair polar coordinates (r,θ) where r is the interval $[0,1]$ while θ represents the angle $[0,2\pi]$ [8]. The model is illustrated in Figure 4.

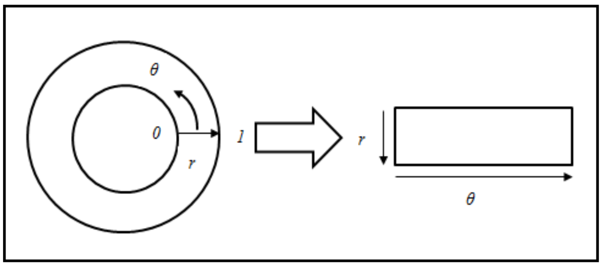

Fig. 4 Rubber sheet model

Remapping the iris region from (x,y) Cartesian coordinates to normalize non- concentric polar representation is defined as:

$$I(x(r,\theta), y(r,\theta)) \rightarrow I(r,\theta) \qquad (2)$$

with

$$x(r,\theta) = (I-r)x_p(\theta) + rx_I(\theta)$$
$$y(r,\theta) = (I-r)y_p(\theta) + ry_I(\theta)$$

where $I(x,y)$ is represented as the iris region, (x,y) is the original Cartesian coordinates, (r,θ) being the corresponding normalized polar coordinates; x_p, y_p and x_I, y_I are the coordinates of the pupil and iris boundaries along θ direction [11]. The research of [1][11][18] [4][9][19][15] also used rubber sheet model algorithms as a yardstick in other to allow comparison.

C. Feature extraction

Once the iris region has been successfully normalized, next stage is to extract significant information from iris pattern that has been extracted from normalized iris image. The extracted features are encoded to generate iris template [10]. Various iris recognitions take the advantage of using band pass decomposition of iris image to generate biometric template [11]. There are various feature extraction Algorithms, amongst them are Wavelets Transform, Gabor Filter, Laplacian of Gaussian filter, Key Local Variations Hilbert Transform and Discrete Cosine Transform. The most common used algorithm in this stage is wavelet transform and Gabor filter [10]. The wavelet transform divides the iris region into components with different resolutions. Essentially, the most common used wavelets are Daubechies, Biorthogonal, Haar and Mexican Hat wavelet.

Among the advantages of wavelet transform over Fourier transform, the wavelet has both space and frequency resolution for extracting significant features. Therefore the final output from wavelet filter is encoded and generated a biometric template [10].

The Gabor filters is also used to extract features from iris using 2D. The filters are define by harmonic function and multiplied using Gaussians function which provides best localization in both spatial and frequency domains. However, each pattern is separated to extract information using quadrature 2D Gabor wavelets. The quadrants are subdivided into four in the complex plane. Therefore each quadrant would replace with two bits of information, and then each pixel from normalized image (normalization stage) is extracted into two bits code in the template [11]. Figure 5 further illustrates phase quantization. The work of [9][20][13][15][21] also used wavelets and Gabor filter for extracting significant information from the iris pattern.

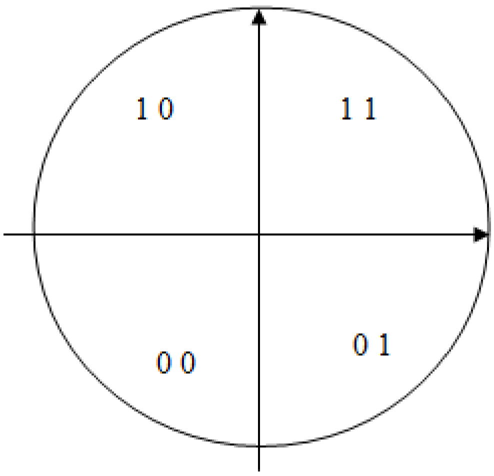

Figure 5 phase quantization

D. Matching

At matching stage, the templates generated at feature extraction stage to measure the similarity between two iris templates. This stage measures the similarity and dissimilarity between the two binary codes for making decision of acceptance or rejection [22]. In general, there are three Algorithms at matching stage. These are Hamming Distance (HD), Weighted Euclidean Distance (WED) and Normalized Correlation (NC). The most commonly used Algorithm in matching stage is Hamming distance [23].

The Hamming distance measures statistical independence between two iris templates. As deduced by Daugman [18], the Algorithm calculates correlation between the two templates. Therefore the two iris templates are defined as:

$$HD = \frac{//(template_A \cap Mask_A) \oplus (template_B \cap Mask_B)//}{//Mask_A \cap Mask_B//} \quad (3)$$

where template $_A$ and template $_B$ signify the two encoded iris feature matrices, while $_A$ and mask $_B$ are the two binary masks; "0" represents location of the noise in the pixel, and the mask with binary "1". The operator $\oplus$ represents *XOR* operator which compares bit by bit, and $\cap$ the logical *AND* operator which takes common area between two matrices as a valid iris region. The Algorithm measures iris pattern differences between the two iris templates on bit-to-bit mode. The iris extracted from same individual eye, the statistical independence and Hamming distance will be zero. On the other hand, the two individual irises extracted from iris templates will have Hamming distance close to 0.5. Hence, with this reason it is necessary to set a proper threshold when using Hamming distance. This promotes more accurate in identification [14]. In addition, much research work used Hamming distance for measuring the similarity between the two iris templates as posited in [11] [15][21][24].

III. DISCUSSION

The biggest challenge in iris recognition system is when the image is of low quality produces bad images such as poor illumination, low contrast, motion blur, camera diffusion, presence of eyelashes and eyelid, reflections. These bad images in iris recognition system increases False Rejection (FRR) and False Acceptance Rate (FAR) hence, decreasing the performance of recognition system.

Most of the iris datasets are free and available in public domain for easy access and use. Among the iris recognition datasets, CASIA is considered as the largest datasets compared with six others such as UBIRIS, MMU, ICE 2005, WVU, IIT Delhi and UPOL. They are significant for validating Algorithms performance.

IV. CONCLUSION

This paper reviewed various iris recognition stages and its algorithms. The efficiency of various methods for each stage in iris recognition was discussed. Hence, there is need for effective and enhanced performance of iris recognition algorithms.

ACKNOWLEDGMENT

This research was fully sponsored by the Office for Research, Innovation, Commercialization and Consultancy (ORICC), with VOT No U614., The authors fully acknowledge Universiti Tun Hussein Onn Malaysia (UTHM) for the financial support which has made this research possible.

REFERENCES

[1] N. Othman, B. Dorizzi, and S. Garcia-Salicetti, OSIRIS: An open source iris recognition software, Pattern Recognition. Letters, vol. 82, pp. 124–131, 2016.

[2] Y. A. Betancourt and M. G. Silvente, A keypoints-based feature extraction method for iris recognition under variable image quality conditions, Knowledge-Based Syst., vol. 92, pp. 169–182, 2015.

[3] P. M. Patil, Iris Recognition in Less Constrained Environment, International Journal of Emerging Technology and Advanced Engineering vol. 3, no. 7, pp. 196–200, 2013.

[4] A. A. Ghali, S. Jamel, Z. A. Pindar, A. H. Disina, and M. M. Deris, "Reducing Error Rates for Iris Image using higher Contrast in Normalization process," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 266, 2017.

[5] J. R. A. Oluwakemi, J.S. Sadiku, A. kayode, ris Feature Extraction for Personal Identification using Fast Wavelet Transform (FWT), vol. 6, no. 9, pp. 1–6, mar, 2014.
[6] L. Flom and A. Safir, Iris recognition system, US Patent, 4,641,349, 1987.
[7] L. Ma, T. Tan, Y. Wang, and D. Zhang, Personal Identification Based on Iris Texture Analysis, vol. 25, no. 12, pp. 1519–1533, Dec , 2003.
[8] T. Mansfield,, G. Kelly, D. Chandler, and J. Kane. Biometric product testing final report. Computing, National Physical Laboratory, (2001).
[9] H. Rai, A. yada., Iris recognition using combined support vector machine and Hamming distance approach, no 2. pp 588-593 Feb, 2013.
[10] N.Y. Tay, K. M. Mok, A review of iris recognition algorithms in information technology international symposium on vol. 2, pp. 1-7 Aug, 2008.
[11] L. Masek, Recognition of Human Iris Patterns for Biometrics Identification, pp. 1-7, 2003.
[12] W. K. Kong, D. Zhang, Accurate Iris Segmentation Based on Novel Reflection and Eyelash Detection Model, Intelligent Multimedia, Video and Speech Processing, International Symposium on. IEEE pp. 3–6, 2001.
[13] P. Punyani, A. Kumar, and R. Gupta, An optimized Iris Recognition System using MOGA followed by Combined Classifiers, International Journal of Research in Advent Technology vol. 4, no. 3, pp. 221–226, 2016.
[14] K. Okokpujie, E. Noma-osaghae, and S. John, An Improved Iris Segmentation Technique Using Circular Hough Transform, International Conference on Information Theoretic Security PP. 203-211, 2017.
[15] J. G. Daugman, High confidence visual recognition of persons by a test of statistical independence. IEEE transactions on pattern analysis and machine intelligence. IEEE, vol.15 no. 11, pp. 1148-1161. 1993.
[16] R. P. Wildes. J. C. Asmuth, G. L. Green, C.H. Stephen, R. J. Kolczynski, J. R. Matey, S. E. Mcbride, A System for Automated Iris Recognition, IEE pp. 121–128, Dec 1994.
[17] W. W. Boles and B. Boashash, A Human Identification Technique Using Images of the Iris and Wavelet Transform, EEE transactions on signal processing vol. 46, no. 4, pp. 1185–1188, 1998.
[18] E. M. Arvacheh, A Study of Segmentation and Normalization for Iris Recognition Systems , 2006.
[19] T. Lefevre, B. Dorizzi, S. Garcia-salicetti, N. Lemperiere, and S. Belardi, "Effective elliptic fitting for iris normalization q," Comput. Vis. Image Underst, , vol. 117, no. 6, pp. 732–745, 2013.
[20] K. Nguyen, C. Fookes, R. Jillela, S. Sridharan, and A. Ross, Long range iris recognition , A survey, vol. 72, pp. 123–143, 2017.
[21] M. M. Khaladkar and S. R. Ganorkar, "A Novel Approach for Iris Recognition," vol. 1, no. 4, 2012.
[22] M. N. Othman, Fusion techniques for iris recognition in degraded sequences, no.1, pp. 4–5, 2016.
[23] R. Youmaran, Algorithms to process and measure biometric information content in low quality face and iris images. University of Ottawa 2011.
[24] J. Daugman and C. Downing, Epigenetic randomness , complexity and singularity of human iris patterns, Proceedings of the Royal Society of London B: Biological Sciences, no. December 2000, pp. 1737–1740, 2001.