International Journal of Modern Communication Technologies & Research (IJMCTR)
ISSN: 2321-0850, Volume-6, Issue-5, May 2018

Advanced IRIS Recognition System: A Review

Saumitra Vatsal, Mr. Shyam Shankar Dwivedi

Abstract— **Iris pattern recognition can be reckoned as most accurate and reliable method out of all biometrics available like fingerprint, face or speech recognition. Iris pattern recognition plays a role of paramount importance in highly secured areas where true identification is an indispensible necessity. Hence, iris pattern recognition is placed at the highest place among all available biometric technologies due to its highest efficacy and reliability. Mostly at the places like airports, seaports and to control access by screening in sensitive laboratories and factories the widely used biometric recognition has been done by matching of full fingerprint images and face detection so far but iris recognition system is more reliable and provides better results for the identification. Iris recognition works on pattern recognition. The iris is an externally visible, yet protected organ whose unique epigenetic pattern remains stable throughout adult life. These features make it more dependable and use-worthy as a biometric recognition means for an individual's identification. The iris pattern is stored as templates in the database reservoir of the system and the templates generated by screening of a new iris are compared with those available in the database in order to perform the identification. In this paper different techniques which are used for iris recognition are discussed.**

Index Terms— **Iris Detection, Bio-metric Identification, Segmentation, Normalization, Pattern Recognition and Edge Detection.**

I. INTRODUCTION

The iris pattern recognition is an exclusive dependable technique due to its highest efficacy for recognition of an individual by the use of biometric technologies available as compared to other biometrics. This iris recognition method is becoming more and more acceptable due to its highest stability and reliability which remain unchanged irrespective of passage of time. The iris scan paves a way to develop an identification system to identify the identity of an individual positively and without mistakes. The unique anatomical patterns of a human iris forms the basis to overcome the existing previous shortcomings. The colored portion seen in a human eye is the iris. It is present in front portion of the ocular sphere of the human eye as a circular membrane. It has got a central hole called the pupil which serves the purpose to regulate the quantity of light to be entered in to the eye by the dilation and constriction of pupil. The iris is comprised of many components. It is richest peculiar textures of the human. The pigment accretion can continue in the first postnatal years. The complex pattern of iris has many distinctive features such arching, zigzag collarets, ligaments, furrows, rings corona, ridges, crypts, freckles. The pattern of the iris is stored as an exclusive and unique information as an objective mathematical representation which serves the purpose of generation of biometric template and its comparison with the database templates. If after comparison the two templates one of the iris pattern generated and the other stored in the database are compatible after matching the person is accepted as identified otherwise if no matching is found the person is considered as unidentified.

In the matching process millions of templates are matched per second per CPU by matcher engines for the data sets of enlisted markings and the false match rates are infinitesimally small. Iris recognition system contains the record of many million people belonging to several countries of the world subsequent to their enrollment in the iris recognition system. The greatest advantage of iris pattern recognition is that it is an organ which is internal but visible externally in a protected anatomical framework of the human eye beside other advantages like of its high speed of matching and being highly resistant against false matching.

An iris-recognition algorithm first has to restrict the inner and outer boundaries of the iris (pupil and limbus) in an image of an eye. The pixel set of iris image is normalized by a rubber sheet model to compensate the pupillary dilation and constriction in order to carry out the process of comparison and subsequently its analysis is done to extract a bit pattern which contains coded information required for two iris images' comparison. A Gabor wavelet transform is used if Daugman's algorithm is used. It results into generation of complex numbers set which carry the information of the iris pattern as local amplitude and the phase information. When the algorithm of Daugman's is used most of the information pertaining to amplitude is discarded and the iris pattern consists of phase information of 2048 bits. By discarding the amplitude information it is ensured that due to change in illumination or camera gain like contrast makes a template stable for its long term usability in biometric analysis. By the method of one-to-many template matching for identification or one-to-one template matching for verification a template is created by imaging the iris and later it is compared against templates present in the database of the system. A positive identification is considered if the Hamming distance is below the decision threshold. It is due to the fact that if statistical improbability is considered then two different persons could agree by chance in so many bits due to templates of high entropy.

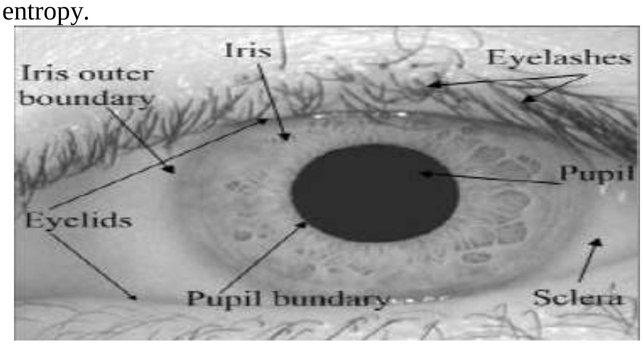

Figure 1: Anatomy of an eye

Saumitra Vatsal, M.Tech Scholar, Department of Computer Science & Engineering, Rameshwaram Institute of Technology & Management, Lucknow, India.

Mr. Shyam Shankar Dwivedi, Head-of-Department, Department of Computer Science & Engineering, Rameshwaram Institute of Technology & Management, Lucknow, India.

II. GENERAL ARCHITECTURE

The apprehension was in the form of the doubt that the algorithm involved for this purpose could be executed in real time using a general purpose microprocessor. In the process of recognition many question were resolved and a proper model was presented by Daugman [13]. The Daugman's work divides in four main parts. According to figure 2 it is depicted as a block diagram for a biometric system of iris recognition in unconstrained environment where a function of each block is discussed in short as in following figure:

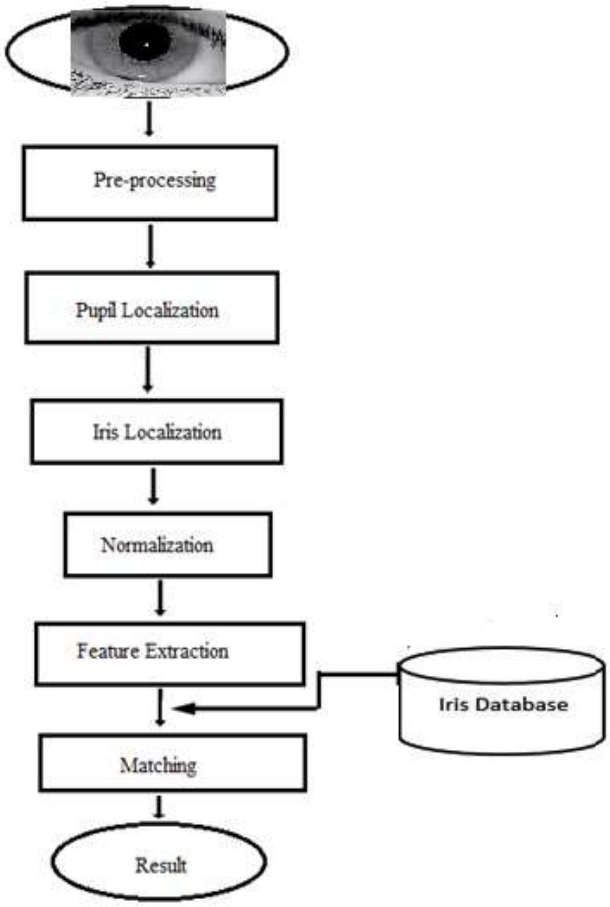

Figure 2: Iris Recognition System

Segmentation

The first step for iris pattern detection involves localization of the actual iris region from the digital image. The iris region can be divided into two circles, one circle forming the sclera boundary and the other forming the pupil boundary. Eyelids and eyelashes are also present which usually cover the upper and lower parts of the iris region. The iris pattern can be corrupted within the iris region due to specular reflections occurring inside the iris region. Therefore the technique involved must exclude these noisy regions and the circular iris region should be localized.

The degree to which the segmentation [15] applied succeeds will greatly depend on the datasets being used. Images where specular reflection occurs can hamper the process of segmentation. If the eyelids and eyelashes cover too much of the iris region then the segmentation process may not result in a success. The process of segmentation is considered as very critical for the reason that if there is incorrect localization of the data it may result into very poor detection rates. To enhance the iris segmentation there has to be an approximate localization of the iris by simply combining the Gaussian filtering, Hough transform and Canny edge detection.

Where I(x, y) represents eye image, r represents the searching radius $G_{\sigma}(r)$ is the representation of Gaussian smoothing function and S represents the the contour of circle depicted by r, x0, y0. The circular path, where the change in pixel values is maximum due to change of the values of radius and center x and y position of the central contour, is searched by the operator. By periodic application of operator the process of smoothing is progressively reduced so as to achieve a precise localize.

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

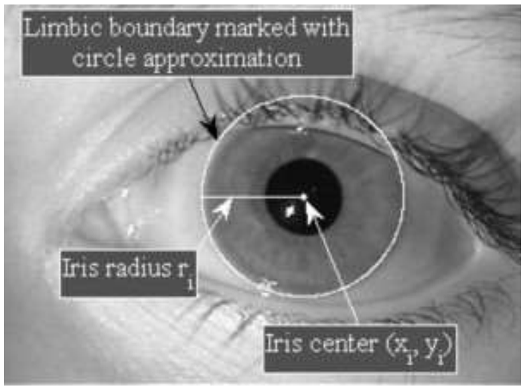

Figure 3: localized image

The following figure represents the segmentation method of human eye with the use of Gaussian Filter. It represents a flow of the process which was proposed in the order: (i) Original eye image; (ii) Gaussian filtering; (iii) Pupil detection; (iv) Limbic Boundary localization; (v) Eyelids and Eyelashes detection and (vi) Segmented iris image.

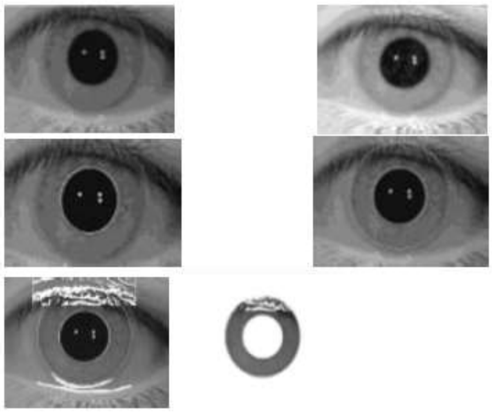

Figure 4: Flowchart of iris image segmentation

Normalization

On successfully segmented the eye image, the next step is to transform the iris region of an eye image so that it has fixed dimensions in order to allow the feature extraction process to compare two images. The cause of the dimensional inconsistencies which arise in eye image is caused by dilation of pupil mainly resulting into the stretching of the iris.

The most common cause of pupillary dilation is the change in the level of illumination falling on the eye. The inconsistency may occur due to change in imaging distance, rotation of camera, head tilt and the rotation of eye inside the eyeball socket. The process of normalization results into formation of two images of the same iris to have same characteristic features although the two images are taken in different conditions and at different time.

Daugman's rubber sheet model: According to the Daugman's rubber sheet model the normal Cartesian to polar transformation maps each pixel into a pair of polar coordiantes (r,θ) in the iris area. Here r and θ denote intervals [0,1] and [0,2π]. The formulation of unwrapping occurs as depicted as under:

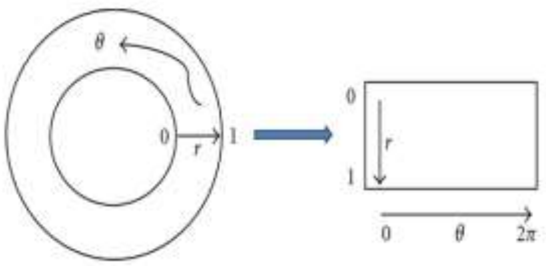

Figure 5: Daugman's Rubber Sheet Model

Histogram Equalization

The process of histogram equalization is done on each iris template for an image generation whose intensity covers the whole intensity levels range. A normalized iris image contains a very low value of contrast but it may contain non – uniform brightness at different parts of the image for the reason that because the light is applied at the acquisition time. As a result the texture of iris appears of having low contrast than what it really has. By means of histogram equalization the contrast enhancement of the image is obtained so as to fully utilize the spectrum of gray levels. The texture are highlighted as per figure below. To remove noisy components filtering operation is used.

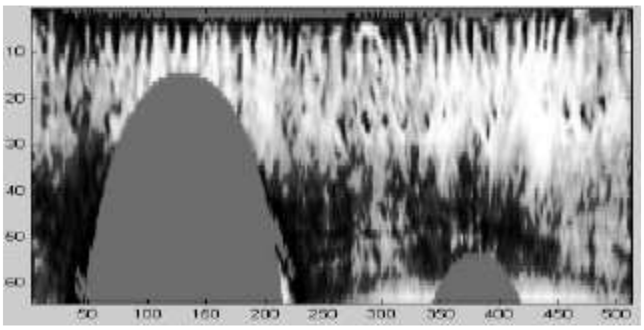

Figure 6: Enhancement of iris normalized image

III. Feature Extraction

The feature extraction is the most important step with reference to any recognition system. The characteristic information of an iris is extracted by filteration process applied to normalized iris region. This filtering is done by convolution with a Gabor's filter pair. We also extract and store information about noise position in this stage. So, the iris code is formed by some characteristic information extracted from normalized iris filtered by convolution (a pair of resulting images) and a Boolean mask representing the position of noisy pixels [11].

A modulated sine (or cosine) wave by a Gaussian constitute a Gabor filter. This filter is meant for extraction of information in space as well as in frequency domain. Two Gabor filters are designed for iris feature extraction. First filter is Gaussian modulated sine wave.

Second is the same as first but using a cosine wave. In these filters, the central frequency of the filter is specified by the sine (or cosine) wave frequency and bandwidth varies as Gaussian width does. At implementation level, each filter must be a matrix.

Iris Matching

The Hamming distance was developed by Daugman as a matching metric and the hamming distance is calculated only by number of bits which are generated by the region of the iris. In a matching algorithm all the image processing steps are incorporated at the time of enrollment of coded iris templates into the systems database.

Once the extraction of the encrypted bit pattern which correspond to binary image formed, is matched against all stored encrypted bit patterns B using simple Boolean XOR operation [2] the dissimilarity measure between two iris bit patterns is computed by the use of HD (Hamming Distance) represented as under:

$$HD=\frac{1}{N}\sum_{j=1}^{N} X_j\,(XOR)\,Y_j$$

Here N denotes the total number of bits for each iris pattern. Hamming distance is a fractional measure for dissimilarity where a 0 value represents a perfect match and a low normalized HD value denotes strong similarity of codes for the iris.

IV. ADVANTAGES AND DISADVANTAGES

The iris of the human eye is considered as an ideal part for biometric recognition of an individual for many reasons:

1. This is an internal organ which is well guarded from any outside damage since it is covered by a transparent and sensitive membrane known as cornea. This fact makes it different from fingerprints which are difficult to be recognized if the individual is involved in manual labor for a long time.
2. The iris is almost flat in structure and its dilation and constriction takes place by virtue of two muscles viz. dilator pupillae and constrictor pupillae respectively thus controlling the diameter of the pupillae. This anatomical configuration of iris makes it a more reliable biometric than face recognition.
3. However, there are so many factors that go into the formation of these textures (the iris and fingerprints) that the chance of false matches for either is extremely low. Identical twins which have identical genetic structure have different iris structures.
4. An iris scan is similar to taking a photograph and can be performed from about 10 cm to a few meters away. There is no need for the person being identified to touch any equipment that has recently been touched by a stranger, as under the norms of certain cultures it is prohibited to touch an

object which has been previously touched by a stranger as in the case of fingerprint scanner where finger has to touch a surface or for retinal scanning where the eye is almost approximated to the eyepiece as we look into a microscope.

It may be possible to make a fraud by getting a high quality image of an iris or face scanned in place of the real iris or face.

1. The iris scanners are difficult to be adjusted for people of different heights who are to be scanned in quick succession.
2. A change of lighting can affect the accuracy of scanners.
3. Iris scanners prove as more expensive biometric method as compared to other forms of biometrics, prox – card security systems or use of a password.
4. The iris scanning being a recent biometric technology makes certain countries reluctant to replace it with existing fingerprint recognition biometric because a huge investment has been made already into this fingerprint technology.
5. The iris recognition is difficult to be done if the a distance is more than a few meters and a person is not cooperating for this biometric by not keeping the head steady or looking into the camera.
6. The iris recognition biometric is susceptible to a poor image quality which is a cause of failure to enroll. Beside this an apprehension has been raised by civil right activists that iris recognition technology (like Aadhaar, national residents databases etc.) can enable Government to infringe the right of privacy of an individual without his knowledge or consent

V. CONCLUSION

This paper pertains to study of different methods for iris recognition system of an individual's identification. There are so many applications now days, which use iris recognition method for the authentication purpose like ATM machines, anti-terrorism, National border controls, computer login, etc. This system is developed using six basic modules for iris recognition. We have seen different existing techniques and methods used in each stage. From this paper we can conclude that which technique is best and we can use that for the better performance and accuracy.
The iris recognition system that was developed proved to be a highly accurate and efficient system that can be used for biometric identification. Iris recognition is one of the most reliable methods available today in biometrics field. The accuracy achieved by the system was very good and can be increased by the use of more stable equipment and conditions in which the iris image is taken. The iris recognition system has many application and it has specially been installed as a biometric method of first choice in the security zones or sensitive places where an access control is indispensible. In this review paper it has been emphasized that for sake correct identification a person need not have to remember things like passwords as he can use himself as a living password, which is called biometric recognition technology. It uses physical characteristics or habits of any person for identification. In biometrics a number of characteristics have been used in recognition technology as fingerprint, palm print, signature, face, iris recognition, thumb impression and so on but among these irises recognition is best technology for identification of a person.

REFERENCES

[1] A. K. Jain, P. Flynn, and A. Ross, Handbook of Biometrics, New York: Springer, 2008.

[2] Sunita V. Dhavale"DWT and DCT based Robust Iris Feature Extraction and Recognition Algorithm for Biometric Personal Identification",International Journal of Computer Applications (0975 – 8887), Volume 40–No.7, February 2012

[3] Libor Masek, "Recognition of Human Iris Patterns for Biometric Identification", School of Computer Science and Software Engineering, University of Western Australia, 2003.

[4] Z. Zhou, Y. Du and C. Belcher, "Transforming traditional iris recognition systems to work on non-ideal situations", IEEE Workshop on Computational Intelligence in Biometrics: Theory, Algorithms and Applications, 2009.

[5] Y. Zhu, T. Tan, and Y. Wang, ―Biometric personal identification based on iris patterns,‖ in Proc. Int. Conf. Pattern Recognition, vol. II, pp. 805–808, Nov, 2000.

[6] L. Ma, T, Yunhong Wang, and D. Zhang, "Personal identification based on iris texture analysis", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol.25, no.12, 2003

[7] W. Boles and B. Boashash, "A human identification technique using images of the iris and wavelet transform," IEEE Trans. Signal Processing, 46(4):1185–1188 (1998).

[8] Bowyer K.W., Kranenburg C., Dougherty S. "Edge Detector Evaluation using Empirical ROC Curves", IEEE Conference on Computer Vision and Pattern Recognition(CVPR), pp. 354-359,1999.

[9] X. Liu, K.W. Bowyer, and P.J. Flynn, ―Experiments with an Improved Iris Segmentation Algorithm,‖ Proc. Fourth IEEE Workshop Automatic Identification Advanced Technologies, pp. 118-123, Oct. 2005.

[10] J.Canny, "A computational approach to edge detection," IEEE Transactions on Pattern analysis and Machine Intelligence, 8: 679-698, November 1986.

[11] W. Boles and B. Boashash, "A human identification technique using images of the iris and wavelet transform," IEEE Trans. Signal Processing, 46(4):1185–1188 (1998).

[12] L. Flom and A. Safir, U.S. Patent 4 641 394, 1987, Iris Recognition System.

[13] John Daugman, Iris recognition, 2006. http://www.cl.cam.ac.uk/_jgd1000/.

[14] Adams W. K. Kong, David Zhang, Mohamed S. Kamel, "An Analysis of IrisCode", IEEE transactions on image processing, vol. 19, no. 2, pp 552,2010.

[15] S. Jayalakshmi, Dr. M. Sundaresan, "A SURVEY ON IRIS SEGMENTATION METHODS", Proceedings of the 2013 International Conference of IEEE.

Saumitra Vatsal, M.Tech Scholar, Department of Computer Science & Engineering, Rameshwaram Institute of Technology & Management, Lucknow, India.

Mr. Shyam Shankar Dwivedi, Head-of-Department, Department of Computer Science & Engineering, Rameshwaram Institute of Technology & Management, Lucknow, India.