International Journal of Engineering Research and Development
***e**-ISSN: 2278-067X, **p**-ISSN: 2278-800X, www.ijerd.com*
Volume 4, Issue 3 (October 2012), PP. 46-52

New Algorithm and Indexing to Improve the Accuracy and Speed in Iris Recognition

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Abstract:- Among the traits used in biometrics, iris is more reliable and unique. The four modules of iris recognition system are Localisation, Normalization, Feature extraction and Matching. Localisation is the key module in iris recognition system. It includes inner boundary localisation, outer boundary point detection, and Eyelid and Eyelash detection. Though the existing system has many algorithms for localisation, it has certain drawbacks. The efficiency of the iris recognition system is improved by detecting and removing the eyelids and eyelashes occluded. In this paper an algorithm for detecting the inner boundary of iris and removing the eyelid and eyelashes occlusion is proposed. From the results, it shows this technique is effective and it is measured in terms of False Acceptance Rate (FAR) and False Rejection Rate (FRR).

Keywords:- Biometrics, Iris localisation, traversing pixel, Sectoring, Hamming Distance, occlusion

I. INTRODUCTION

The main aim of the proposed system is for security authentication in various fields such as commercial, government, research and military. This system is already implemented in various sectors. Currently there are some issues with the existing system. Let see about the drawbacks of the current system in later part. To overcome all these drawbacks, this paper introducing the new concept with the help of Traversing algorithm and sectoring.

Some of the most commonly used traditional security systems are ID cards and passwords. These are not reliable and do not provide unique identification for an individual since ID cards can be lost and password can be forgotten. To overcome this drawback, the biometric technique came into picture. Biometric is a technique that uses the human's physical and behavioral feature. Thus it is more reliable than the traditional techniques. Of all the biometric techniques iris recognition is best because no two human's iris will be the same, even if they are twins. Also the left and the right of an individuals' iris varies which paves way for reliability.In the existing system the segmentation is done by taking the entire region of iris. There are two basic methods of localization by Daugman [2] and Wildes [6]. Moreover the two standard methods, many other iris localization algorithms are there. In this paper, the inner multi brands of iris is taken into consideration for segmentation, which increases the accuracy and saves the time.

In proposed system, the iris recognition system is divided into five parts such as image Morphological Operator, localization, Sectoring, Normalization and Iris code generation and indexing. Hence, the system is implemented to improve the accuracy and reduce the time complexity. In general, when detecting the iris part, the eyelid and eyelashes interfere and reduce the efficiency of the system, thereby affecting the FAR and FRR levels. In sectoring, the best bits of the iris region on the left and right side are alone considered so that the interference of eyelid and eyelashes are completely ignored. From the results obtained by using only the best iris bits, the efficiency of the system is improved to a larger extent yielding better FAR and FRR levels when compared to the existing systems. The rest of this paper is orderly as follows: Section II describes the basic modules in iris recognition. Section III describes proposed work in Iris recognition system. And finally, Section IV draws some results and conclusions.

II. BASIC STEPS OF IRIS RECOGNITION

Iris recognition is one of the biometric systems for gathering unique details of the individual. In most trustworthy biometrics Iris recognition is considered to be a reliable technique with low false rejection and false acceptance rates. Four modules of iris recognition involved are:

- Iris Localisation
- Normalization
- Iris Code Generation
- Matching

A. Iris Localisation

Iris localisation consists of pupil detection also called as inner boundary detection and outer iris localisation also called as outer boundary detection. Both the techniques use the integro-differential algorithm proposed by Daugman[2].

$$\max_{(r,x_p,y_o)} \left| G_\sigma(r) * \frac{\delta}{\delta r} \oint_{r,x_0,y_0} \frac{I(x,y)}{2\pi r} ds \right| \qquad (1)$$

Where,
I(x, y) -> eye image
r -> radius
S -> The circle of contour is given by y0, x0, r.
Gσ(r) -> Gaussian smoothing function

While the operator have been searching for the circular path, where there is upper limit modified in pixel values, the path must be varying the center and radius x and y location of the circular form.

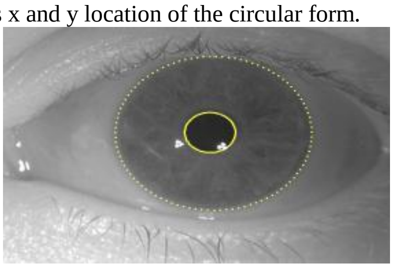


Figure 1. Localisation of Iris.

Hough transform is varaiance of the Integro-differential, Since the integro-differential too creates use of first derivatives of the image and executes a search to detect geometric parameters. Since, it works with curde derivative data, it doesn't tolerate from the thresholding issues of the Hough transform. They are using algorithm for detect the noise in the eye image but it can be fail.

B. Normalization

Iris Normalisation is the conversion from polar to rectangular co-ordinates. The conversion is done using the equation

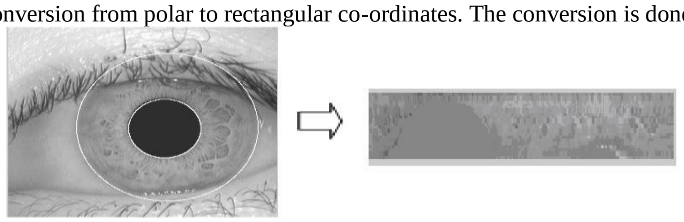


Figure 2. Daugman's rubber sheet model.

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

$$x(r,\theta) = (1-r)x_p(\theta) + rx_i(\theta) \qquad (3)$$

$$y(r,\theta) = (1-r)x_p(\theta) + ry_i(\theta) \qquad (4)$$

r_i denotes the radius of iris, r_p denotes the radius of pupil, while $(x_p(\theta), y_p(\theta)$ denotes the coordinates of the pupillary, $(x_i(\theta), y_i(\theta)$ denotes the limbic boundaries in the direction θ. The value of ρ pertain to $[0;1]$, θ pertain to $[0;2\pi]$.

C. Iris Code

Iris Code value is encoded into 256 byte. Unique code will be generated for each pixel. The uniqueness depends of the code depends on the randomness of the iris pattern and uniqueness of the iris. Iris Code image is obtained as shown in figure 3.

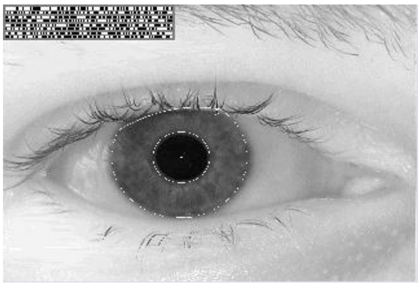


Figure 3: Iris Code

D. Hamming Distance

The hamming distance obtains the count of the bits that are same between the two bit patterns. Using the count, the decision can be made whether the patterns were generated from different patterns or same pattern.
The bit is assigned as 1 if the two bits are different and assigned as 0 if they are same. The following Hamming distance equation as shown below

$$HD = \frac{1}{N}\sum_{j=1}^{N} X_j (XOR) Y_j \qquad (5)$$

III. PROPOSED WORK

The proposal in this paper is to find the centre of mass of the pupil by the morphological operators and then followed by the traversing pixel algorithm to find the centre of the circle. Thus the inner circle is spotted and the outer circle is found using the Daugman‘s integrodifferential operator.

A. Morphological Operators

The morphological operators are used to extract the pupil region apart from the other regions of the eye. The different morphological operators used are:

1) Morphological Edge

Edges are detected by convolving the image with a simple convolution kernel devised by Sobel and Feldman.

Edge Image = ((E < threshold) * 255) (6)

Where E = sqrt (H.*H + V.*V)
H represents the horizontal edges of the original image.
V represents the vertical edges of the original image.
E represents the pixel gradients of the original image.

2) Morphological Dilate

The morphological dilate applies the dilate operation rule to expand the boundary of the image. According to rule, the value of the output pixel is the upper limit value of all the pixels in the input pixel's region. If the pixel is position to 1, then the output pixel is position to 1 in a binary image.

$$G(j, k) = F(j, k) \oplus H(j, k) \qquad (7)$$

Where $F(j, k)$ for $1 \le j, k \le N$ is a binary-valued image and $H(j, k)$ for $1 \le j, k \le L$, Where L is an odd integer, called a structuring element and it is a binary-valued array

3) Morphological Erosion

The morphological erosion contracts the boundary. It uses the erosion operation rule. The rule states the pixels outside the image border are allocated the highest value provided by the data type. The pixel values are supposed to be set to 1 for binary images. The maximum value for unit8 images is 255 for grayscale images.

G (j, k) = F (j, k) □ H (j, k) (8)

Where again H (j, k) is an odd size L x L structuring element.

4) Morphological Fill

Since non-default connectivity is specified, the morphological fill, fills hole pixels on the outer edge of an image that are not connected to the background

5) Morphological Clear Border

The pixels that are lighter than the surroundings and are connected to the image border are suppressed by using morphological clear border. It uses the morphological reconstruction. In reconstruction the input is mask image. The marker image equals the mask image along the borders and is non-zero. In all other cases it equals zero.
Below figure shows the final output image after applying all morphological operators.

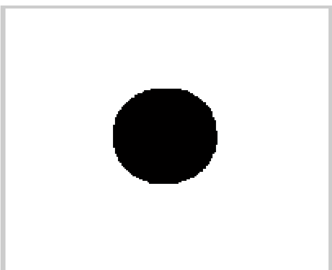


Figure 4: Iris Code

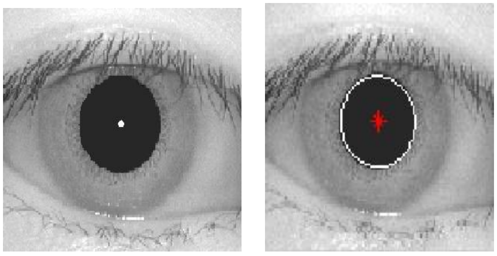
B. Centre And Inner Boundary Localization

The gray point histogram is analyzed and designed. A threshold value T is determined based on the intensity associates with the 1st important peak from the histogram. By using the below equation, the intensity value that equals T or intensity value that is fewer than the value or T are changed to zero (black). The intensity value greater than the value of T are changed to 255(white). Where, I(x, y) is greatness value of position (x, y), g(x, y) is the changed pixel value and the T represents threshold.

g (x, y) =0, if I(x, y) < T (9)
g (x, y) = 255, otherwise

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

Hence by the above process the pupil region is segmented and from the first and the last mean points of threshold the center of the pupil region is acquired. Then those are joined to form the diameter of the pupil and from which the centre point is determined. Thus the iris inner circle is obtained using the centre and the radius as in figure 5 (a) and (b) respectively.



(a) (b)
Figure 5: (a) Centre of the pupil detection (b) inner boundary localization

C. Outer Boundary Localization

Daugman‘s integro differential operator [2] is applied for detecting the iris outer boundary later than the pupil’s inner boundary is predicted. The integrodifferential operator is given as follows:

$$\max_{(r,x_p,y_o)}\left|G_\sigma(r)*\frac{\delta}{\delta r}\oint_{r,x_0,y_0}\frac{I(x,y)}{2\pi r}ds\right| \qquad (10)$$

Where,
I(x, y) -> eye image
Gσ(r) -> Gaussian smoothing function
R -> radius
S -> The circle of contour is given by y0, x0, r.

Thus, the above Equation the Daugman‘s integrodifferential operator is used to determine the iris outer boundary. The outer boundary detection of iris is shown in figure 6 along with the inner boundary and the center.

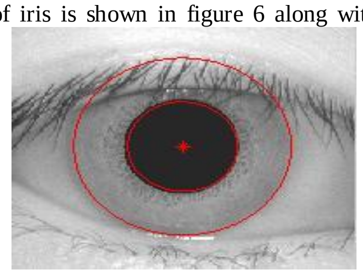


Figure 6: Outer boundary localization

D. Sectoring

After the iris boundaries are segmented using the three stages (Morphological operations, Inner boundary and Outer boundary detection), the iris regions are sectored before normalization. As per the proposal of our project, we sector the iris regions on the left and right sides at angles 20, 40 and 60, and then the normalization stage is carried out for the sectored iris regions. The white regions in the left and the right side of the figure 7 show the best bits regions of iris. The sectoring is analyzed for different angles as shown in figure 8.

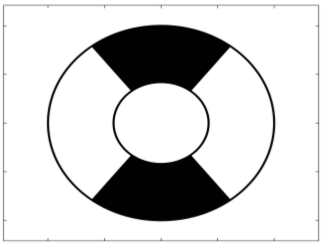
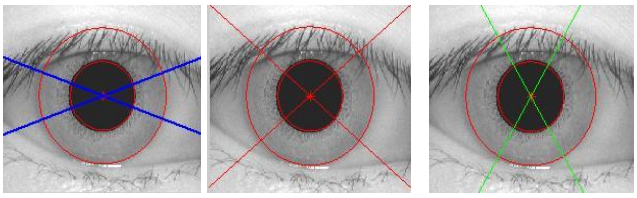


Figure 7: Sectoring



(a) 10 degree (b) 20 degree (c) 30 degree

Figure 8: Sectored images at various angles

E. Normalization

Applying the sectoring concept, the equations (2), (3), (4) are rearranged as:

$I(x(r,\varphi), y(r\ \varphi), y(r,\varphi)) \rightarrow I(r,\varphi)$ (11)

$x(r,\varphi) = (1-r)\, x_p(\varphi) + r x_i(\varphi)$ (12)

$y(r,\varphi) = (1-r)\, x_p(\varphi) + r y_i(\varphi)$ (13)

Where,
I(x, y) -> eye image
Gσ(r) -> Gaussian smoothing function
r -> radius
S -> The circle of contour is given by y0, x0, r.

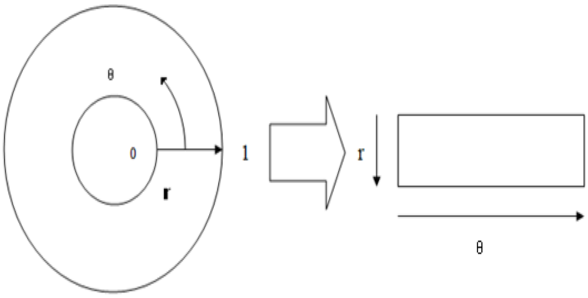


Figure 9: Daugman's rubber sheet model

Where $\varphi = (\theta/m)$, m = 3n, here n ranges from 3, 4, 5…corresponding to the value of (φ) so that eyelid and eyelashes are not considered. Here ‗r' and ‗θ' are the distance between the inner and the outer boundary of iris and the angle of variations espectively as shown in figure 8.

Applying the equations (11), (12), (13) the sectored regions from the normalized image is shown in figure 10 (a) and (b). Then while generating the iris code, the code is generated only for the sectored part of the iris.

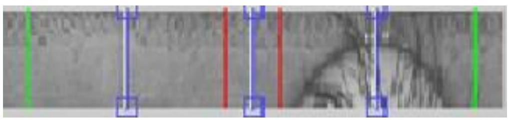
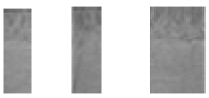


Figure 10: (a) sectored regions for n=5



(b)Sectored images

F. Iris Code Generation And Indexing

Stages for iris indexing are illustrated as follows. After segmentation and normalization as shown in Fig. 10(a) and (b), the normalized iris images is evenly cropped into blocks, and count the number of corners in each block. Then, also crop the mask off code into blocks, and if there exist masked regions in the block, a flag will record this block as 0, and other blocks are marked as 1. After that, label every block Iij with an indexing code C (i.j) obeying the rule as follows:

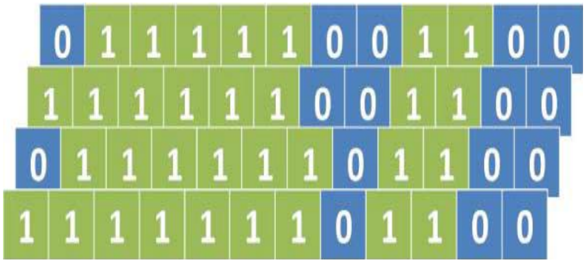
$$C_D(i,j) = \begin{cases} -1, & \text{if } F_{ij} = 0 \\ 0, & \text{if } \left(\frac{N_{ij}}{\sum N_{ij}} < Th \right) \quad \text{and} \quad (F_{ij} = 1) \\ 1, & \text{if } \left(\frac{N_{ij}}{\sum N_{ij}} \geq Th \right) \quad \text{and} \quad (F_{ij} = 1) \end{cases}$$

The remaining part of the iris region is also to be used for verification since it's also a part of the pattern so in order to remove the invalid regions in it (i.e) eyelid and eyelashes occluded regions a new method is used here in which the affected pixels are numbered as -1 in the image and the remaining pixels are allocated with the values of 1 and 0 based on the thresholds. The figure 11 shows how it will look like

Figure 11: (a) Iris Code Generation

(b) Iris Code Generation in the affected region

-1 appears in the registered indexing code, and we cannot differentiate whether this block contains dense or sparse textures, which means it can be either 1 or 0. To make sure the identity will be found the iris code should be affiliated to four iris indexing codes as follows:



Here the -1 is removed by comparing the above and the below row of the block and by converting its value to 0 or 1 based on the neighboring pixel comparison which compares the neighboring pixels of the -1 pixel zone with the other values in the blocks and the maximum appeared value in the neighboring pixels is allocated to the -1 pixel. Now during verification the pixels value patterns are compared with sample templates and then verified.

IV. CONCLUSION

Biometrics systems are widely used to overcome the traditional methods of authentication. Among the traits, iris is more reliable. The drawbacks in the existing Daugman_s algorithm have been overcome by this new methodology using traversing pixel algorithm in localisation and sectoring concept in the latter part of normalization the conversion method is used to include the verification for the affected region also, which will improve the accuracy using removal of occluded region and efficiency . using indexing.

REFERENCE

[1]. Yulin Si, Jiangyuan Mei, and Huijun Goa, Senior Member, "Novel Approaches to Improve Robustness, Accuracy and Rapidity of Iris Recognition System", IEEE Trans. On Industrial Informatics, VOL. 8, No.1, Feb 2012.

[2]. J. Daugman, ―How iris recognition works, IEEE Trans. Circuits Syst. Video Technol., vol. 14, no. 1, pp. 21–30, Jan. 2004.

[3]. Ghassan J. Mohammed, Hong Bing Rong & Ann A. Al-Kazzaz, ―A New Localisation algorithm for Iris Regonition Information Technology Journal, Research Article, vol 8, pp no. 226-230, 2009 .

[4]. Mayank Vatsa,, Richa Singh, Student Member, IEEE, ―Improving Iris Recognition Performance Using Segmentation, Quality Enhancement, Match Score Fusion, and Indexing, IEEE transactions on systems man, and cybernetics—part b: cybernetics, vol. 38, no. 4, August 2008.
[5]. X.M. Liu, K.W. Bowyer, and P.J. Flynn, ―Experiments with an Improved Iris Segmentation Algorithm, Proc Fourth IEEE Workshop Automatic Identification Advanced Technologies, 2005.
[6]. R. Wildes, ―Iris recognition: An emerging biometric technology, Proceedings of the IEEE. vol. 85, no. 9, 1999.
[7]. Yulin Si, Jiangyuan Mei, and Huijun Gao ―Nove Approaches to Improve Robustness, Accuracy and Rapidity of Iris Recognition Systems IEEE transactions on industrial informatics, vol. 8, no. 1, february 2012.
[8]. CASIA Iris Image Database, www.sinobiometrics.com
[9]. Jong-Gook Ko, Yeon-Hee Gil and Jang-Hee Yoo, "Iris Recognition using Cumulative SUM based Change Analysis", ISPACS 2006.
[10]. Daugman, J. G., "High confidence visual recognition of persons by a test of statistical independence, IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 5, no. 11, pp. 1148-1161, 1993.