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Half Iris Matching Based on RED Algorithm

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ABSTRACT

Iris recognition is one of the most accurate identification method and it is powerful for secure of information and identification between users. The Ridge Energy Direction (RED) algorithm is the most accurate and fast approach for iris recognition. The RED algorithm reduces the effects of illumination, since only direction is used. The RED algorithm is applied after a normalization process consisting on two filter types (horizontal and vertical). This paper extends this algorithm by considering the lower portion of the iris because this portion is affected with less noise. We used different size of RED filter on Iris in order to compare the accuracy and time between them. We found that the higher filter size gives more accuracy but more processing time.

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1. INTRODUCTION

The requirements to encrypt information and protect users' identities have become extremely important nowadays. The biometric identification has accepting in our world since the feature inside the biometric is unchanged with the years and these methods are more accurate than other method for identification between people and can't be manipulated. For these reasons many government and company have invested in biometric authentication to secure its establishment. There are many types of biometric identification. This paper focuses on only one type called the Iris recognition. Iris recognition stands out as one of the most accurate biometric methods in use today. The first iris recognition algorithm was introduced by pioneer Dr. John Daugmann [1]. Iris recognition requires four main steps: 1) image capture; 2) preprocessing, which includes segmentation, and normalization; 3) feature extraction, which generates an iris template; and 4) comparison of iris templates and recognition (matching) decision.

2. IRIS RECOGNITION SYSTEM

The first and foremost step is to collect the iris images. On these images various preprocessing steps are carried out. It includes image capture, segmentation, Normalization (polar to rectangular conversion) and then template and mask generation by applying the RED algorithm to rectangular template. This template is matched with the database using hamming distance and the match identification is displayed. The flow of process is shown Figure 1. The CASAI V1 is used to capture the image.

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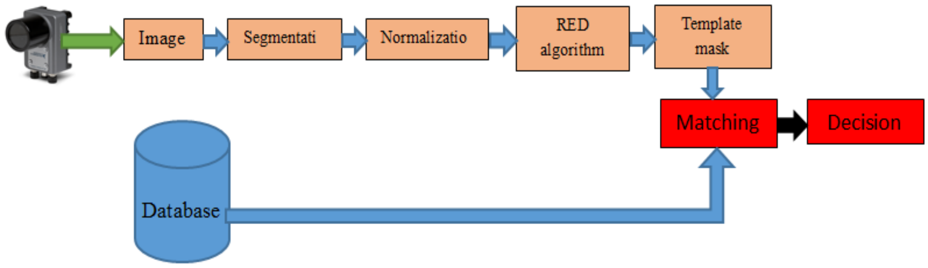


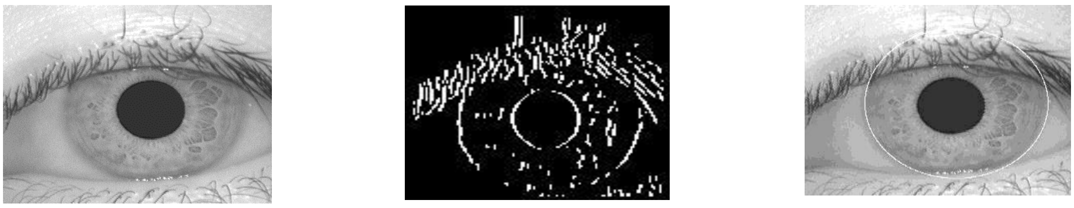
Figure 1. Iris recognition system

3. SEGMENTATION

Segmentation process is used to find the Iris from the captured image. This is the most crucial factor in the Iris recognition, the more accurate of detection the radius and the center point for both the pupil and Iris the most the accurate the identification will be. For our approach we will use the Hough transform which is an algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. The circular Hough transform can be used to detect the radius and center point of both pupil and Iris. An automatic segmentation algorithm based on the circular Hough transform is employed by Wildes et al. [2], Kong and Zhang [3]. A canny edge detector is applied to detect the iris within the captured image, as shown in figure 2. From the canny edge map of figure 2 (b), Hough space will detect the iris by the larger circle that have ones on edge detector will considered iris. Equation (1) is able to define any circle by it is parameters. These parameters are the center coordinates X and Y, and the radius r, and X0 is shift in x-axis and Y0 is shift in y-axis.

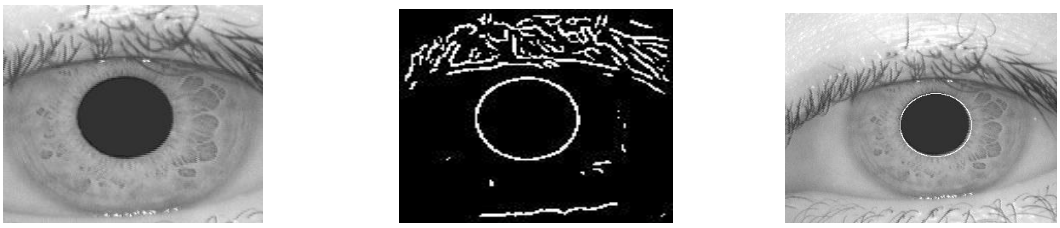
$$(y - y_0)^2 - (x - x_0)^2 = r^2 \quad (1)$$

A maximum point in the Hough space will correspond to the radius and center coordinates of the circle that have defined by the canny edge points. The result of the detection process is shown in figure 2 (c). After finding the iris from the captured image. It's the time to find the pupil using Hough transform. First stage to detect pupil is mask captured image and extract only the iris image as shown in figure 3 (a). After finding the iris from the captured image. It's the time to find the pupil using Hough transform. First stage to detect pupil is mask captured image and extract only the iris image as shown in figure 3 (a).



(a) (b) (c)

It's the time to find the pupil using Hough transform. First stage to detect pupil is mask captured image and extract only the iris image as shown in figure 3 (a). Since the pupil is always inside the Iris, this way is used in order to decrease processing time of the Hough space, since the Hough transform is "brute-force" and try many pixel in it to locate the larger circle that constructed from edge detector. This will decrease the pixel that search on it for the pupil. The same process in finding the center and radius for iris is applied for finding the center and radius for pupil as shown in figure 3. And final result from the segmentation is shown in figure 4. (The process was done on sample 3 from the 108 samples of CASIA V1 database).



(a) (b) (c)

Figure 2. a) Adjustment image extracted from original image base on the center point of the Iris b) the canny edge detector of pupil c) Pupil detect from the Hough transformer.

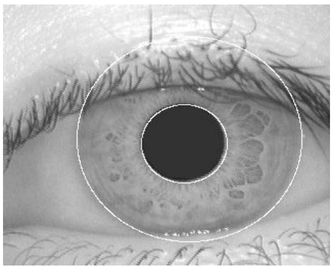


Figure 3. Result after Segmentation process.

4. NORMALIZATION

Normalization process is converting the iris from the polar coordinate to the rectangular coordinate. After completing the segmentation process and knowing the center and radius of pupil and Iris. The next step is Polar to rectangular conversion. Rectangular conversion is applied the boundary outside the pupil radius this process will generate the rectangular template as shown in figure 5.

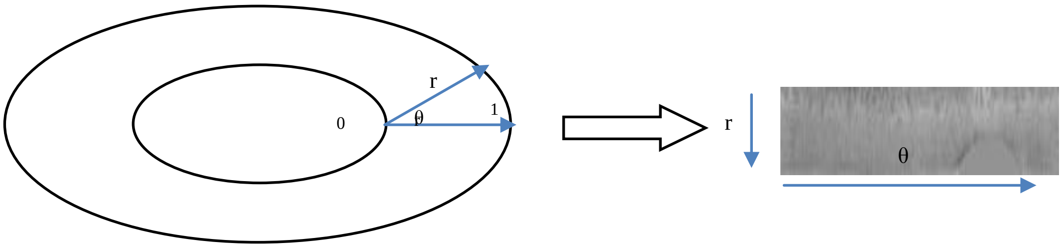


Figure 4. Polar to rectangular and template

Conversion process for iris image to rectangular template is performed using the common polar to rectangular coordinate transformation. This process is called as normalization. Re-maps each pixel within iris reign to pair polar co-ordinates (r, θ) where "r" lies in the unit interval [0, 1] and "θ" is the usual angular quantity that is cyclic over [0,2π]. This called homogenous rubber sheet model which used by Daugman [1]. The remapping of the iris image I(x, y) from raw Cartesian coordinates (x, y) to the dimensionless non-concentric polar coordinate system (r, θ) can be represented as:

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

$$x(r,\theta) = (1-r)\, x_p(\theta) + r\, x_l(\theta) \quad (3)$$

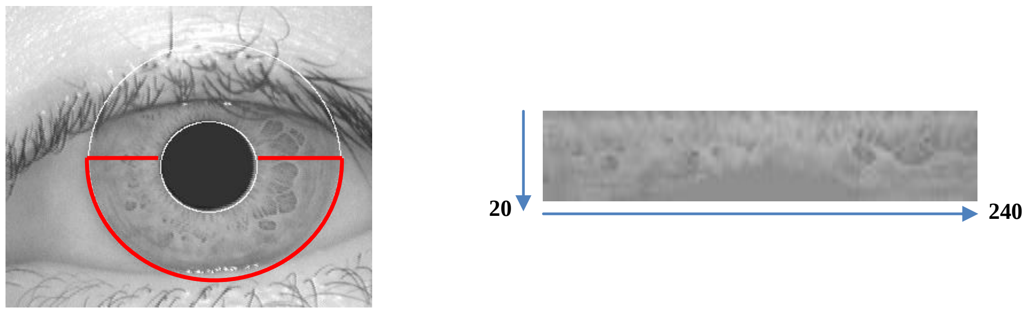
$$y(r,\theta) = (1-r)\, y_p(\theta) + r\, y_l(\theta) \quad (4)$$

Where $I(x,y)$ is the iris region image, (x,y) is the original Cartesian coordinates, (r,θ) are the corresponding normalized polar coordinates, and x_p y_p and x_l y_l are the coordinates of the pupil and iris boundaries along the θ direction. Since the radial coordinate ranges from the iris inner boundary to its outer boundary as a unit interval, it is inherently corrects for the elastic pattern deformation in the iris when the pupil changes in size.

$$r = \sqrt{x^2 + y^2} \tag{5}$$

Where $x = r\cos\theta$ and $y = r\sin\theta$ (6)

From these equations, Iris extracted from the captured image and a rectangular template is generated with radial resolution of 20 pixel and angular 240 pixel to generate 20*240 template. The template that is generated by using equation will contain only the lower portion of iris from the eye. Taking the lower part of the iris is very useful since this part of area don’t have Eyelid and eyelash as shown in figure 6 , the upper portion of the eye contain some of Eyelid and eyelash.



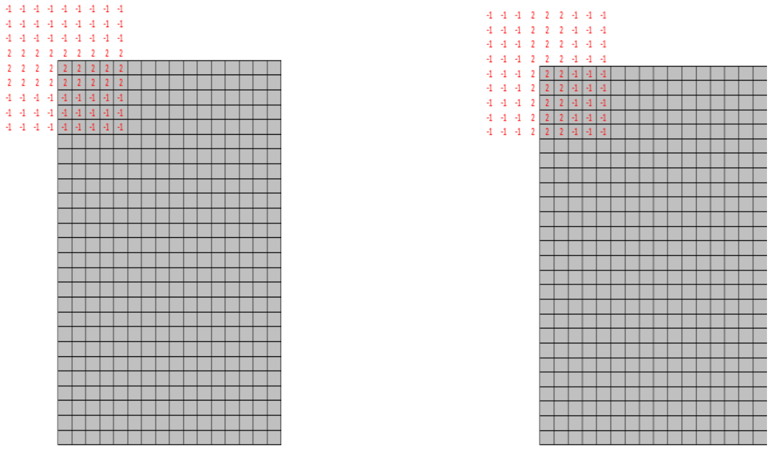
(a) (b)

Figure 5. a) Taking only the lower part of the iris boundary to create a rectangular Iris that will applied to RED. b) Rectangular Iris with height 20 and width 240 of the lower part of iris.

The rubber sheet model takes into account pupil dilation and size inconsistencies in order to produce a normalized representation with constant dimension. In this way the iris region is modeled as a flexible rubber sheet anchored at the iris boundary with the pupil center as the reference point. The dilation and constriction of the elastic mesh work on iris when the pupil changes size [2].

5. FEATURE EXTRACTION

The Ridge Energy Direction (RED) algorithm used for iris recognition. Feature extraction is based on the direction of the ridges that appear on the image [3]. Once the iris is segmented, the algorithm takes the iris and divides it into m=20 concentric radial lines and n=240 angular, which results in a 20 row x 240 column representation of the Iris. The energy of each pixel is simply the square of the value of the infrared intensity within the pixel and is used to detect features. After converting the Iris into rectangular coordinates then, the RED is applied on the lower part of the iris and transformed into an energy image. To perform filtering the rectangle Iris is further passed through a periodic array of 81 (9×9) values at a time. The RED algorithm state that filtering the rectangle Iris by two directional filter to determine the existence of ridges and their orientation [4].More specifically, the result is computed by first multiplying each filter value by the corresponding input data value. Then a summation is performed, and the result is stored in a memory location that corresponds to the centroid of the filter. This process repeats for each pixel in the input data, stepping right, column-by-column, and down, row-by-row, until the filter apply on all the pixels in the rectangle Iris. The filter processing will repeat two times on the input data one with vertical filter and the other with horizontal filter. As shown in figure 9.



(a) (b)

Figure 6. a) RED vertical filter size 9*9 applied on rectangle iris. b) RED horizontal filter size 9*9 applied on rectangle iris.

Rectangle Iris filtered in this paper with several filters of RED algorithm with different sizes. By using the hamming distance for matching between the iris templates, the more the hamming distance is close to zero the more accurate detection will be between templates. The results of filter are shown in table 1. [5] The result shown in table 1 indicates that the more the size of the filter the more the hamming distance close to zero. Also the result that the time to compute the 15*15 filter is large compared to the other filter that have lower size since it will take 225 multiplication for each value at time this multiplication will increase the time. The accuracy will increase with the size of the filter and decrease with lower the size of the filter. Although the 15*15 requires much more time to generate the template while the 7*7 filter requires lower time to generate the template with lower accuracy, so it have to balance between the accuracy and time to locate right eye in the database. This will depend on the application to choose the accuracy instead the time to locate the right eye in database or vice versa [6].

Table 1. Filter size with matching picture

Filter size	Hamming distance for match eye
7 * 7	0.133542
9 * 9	0.0829167
11 * 11	0.0422917
13 * 13	0.0302083
15 * 15	0.0225

After the rectangle Iris is pass through two filters the horizontal and the vertical dimension will generate two images one of them the result from vertical filter with rectangle Iris. And the other is created from horizontal filter with the rectangle Iris as shown in figure 8.

(b)

Figure 7. a) Vertical template result from vertical template with the input image. b) Horizontal template result from vertical template with the input image.

Finally, the template is generated by comparing the results of two different directional filters (horizontal and vertical) and writing a single bit that represents the filter with the highest output at the equivalent location. The output of each filter is compared and for each pixel, a ‘1’ is assigned for strong vertical content or a ‘0’ for strong horizontal content. These bits are concatenated to form a bit vector unique to the “iris signal” that conveys the identifiable information the mask also will generate at this process if any value of resulting of two different directional filter (horizontal and vertical) is above the threshold this location will mark as not valid by put 1 to it as shown in figure 9. This characterization of the RED algorithm filters the iris into a 20x240 = 4,800 bit template. Therefore, the algorithm requires 4,800 iterations of this process to encode a full iris image into a template.

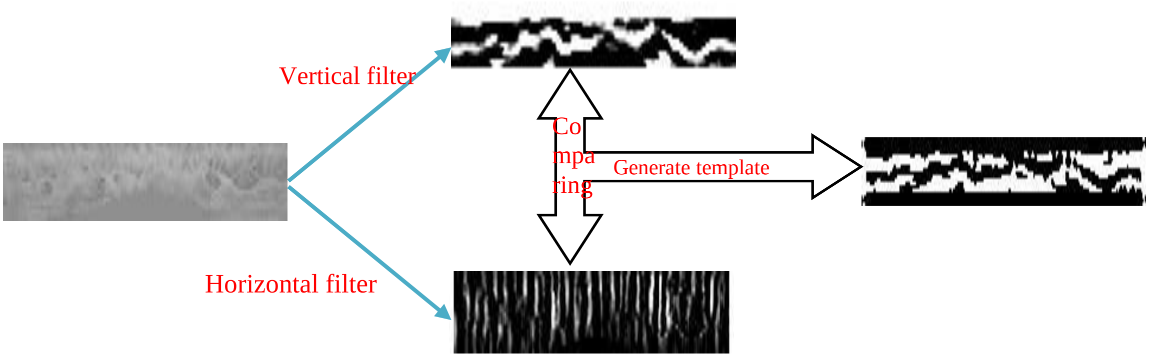


Figure 8. Ridge Energy Direction process for generating template

6. TEMPLATE MATCHING

The template can now be compared with the stored template using Hamming distance (HD) as the measure of closeness

$$HD = \frac{\|(Template\ A \otimes Template\ B) \cap Mask A \cap Mask\ B\|}{\|Mask\ A \cap Mask\ B\|} \quad (7)$$

Where templates A is the Iris template captured image and the Template B is the iris template form the database and ⊗ symbol indicates the binary exclusive-or operator to detect disagreement between the bits that represent the directions in the two templates, ∩ is the binary AND function ‖•‖ is a summation, and mask A is associated binary mask for captured image template and also mask B is associated binary mask for database. The denominator ensures that only required valid bits are included in calculation. The procedure is applied for all the samples exist in the CASIA V1 database and a result of 100% recognition is obtained by using only the lower region of the iris.

7. CONCLUSION

A new modification for RED algorithm method is applied for iris recognition by taking the lower part of the iris. This technique enhanced the RED algorithm since this part of area doesn’t contain eyelid and eyelash (noise), since this part of the iris contain less noise. The RED algorithm tested on 108 CASIA V1 database along with different filter sizes and have not reject any images that used in this paper. The result in table (1) indicates that the more the higher filter size the more the hamming distance will be close to zero with more processing time, and vice versa.

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BIOGRAPHY OF AUTHOR

Safaa S Omran was born in Baghdad, Iraq, in 1956. He received the B.Sc. Higher diploma and M.Sc. degrees in electrical engineering from Baghdad university, Iraq, in 1978, 1981 and 1984, respectively. Since 1979 he has been an assistant lecturer at the institute of technology, Baghdad, Iraq. Now he is an assistant professor in the college of engineering in electrical and electronic techniques, his position is the vice dean for postgraduate studies and scientific affairs. His interests are image processing, microprocessors based instrumentation, data compression techniques, FPGA based systems and cryptography techniques.