International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 04 | Apr -2017 www.irjet.net p-ISSN: 2395-0072

Person Authentication using Iris Recognition

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Abstract - *Security and the authentication of individuals is essential for many different areas of our lives, with most people having to authenticate their identity on a daily basis; examples include ATMs, secure access to buildings, and international travel. Biometric identification provides a valid alternative to traditional authentication mechanisms such as ID cards and passwords, whilst overcoming many of the shortfalls of these methods; Iris recognition is most accurate than any other biometric trait. The objective of this project is to produce a working prototype program that functions as an iris recognition tool by comparing RED (Ridge Edge Direction) algorithm and HWT (Hybrid Wavelet Transform) for feature extraction in order to implement iris authentication system in MATLAB which will be more accurate and useful way that is user-friendly. Our main focus is to design application based system which accurately authenticate any person. The application based system provide security at the gate of any society or institute where we are going to fix our system which will authenticate any person and display the result if the person is authenticated then gate will open automatically. This we are going to show in graphical user interface (GUI).Our aim is to provide most accurate security system which will be used in day-to-day life.*

Key Words: **RED, HWT, Authentication, Feature extraction, MATLAB.**

1. INTRODUCTION

Key Words: ***Key Words***:

Iris recognition is one of the most accurate methods for identification between human that commonly used today [1]. Authentication system based on the iris determine user's identity in principle that some features inside the iris are unique for each person. Recent years have seen the growth of new algorithm domains.

For iris recognition in the field of automated human identification. Automated real-time iris systems have been successfully deployed in several public applications. Researchers have tried to make a system enable them to perform iris recognition to work in the real time application, so they tried to make special system for iris recognition, work with high speed and low cost.

To perform any Iris recognition system 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. The purpose of this paper is to describe all the steps of the iris recognition and implementation of two steps using FPGA and comparing the speed of the execution time with a high-performance microprocessor.

2. LITERATURE SURVEY

2.1 Pre-processing

By analyzing the structural characteristics of eyelashes, here a method for eyelash occlusion detection based on extreme point identification has been explained [2].

1) The Outer Circularity Region of Iris

2) Image Binarization

3) Image Thinning

4) Extreme point Identification

5) The Outer Circularity of Iris

2.2 Feature Extraction

Feature extraction is the process of obtaining useful information from iris which is helpful for authenticating the person [1].To create feature vectors, mathematical operations are performed on the input image and the results are used to create the feature vector when image is normalized [2]. In our methods, the top right part of the iris is used by unwrapping using Daugman's Rubber Sheet model for normalization [4]. A feature vector needs to be compared to the database in order to identify the person whom it belongs to. The proposed methods use sliding windows technique [3]. The methods used are as follows:

1) Method 1: Mean Thresholding

2) Method 2: Mean-by-Median Thresholding

2.3 Iris Matching/Authentication

1) fragile bit distance and Hamming Distance:

The proposed fusion between Hamming distance (HD) and fragile bit distance (FBD) works well than of Hamming distance alone.

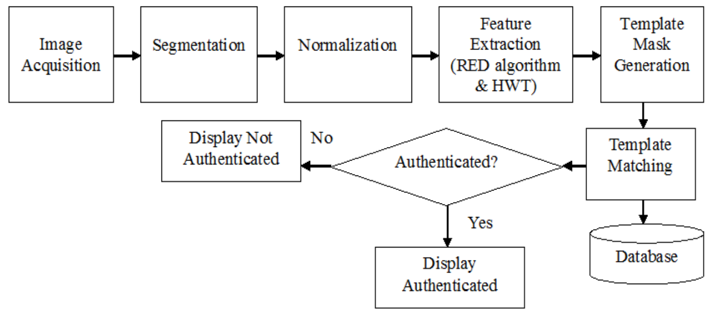
Paper 1: Eyelash occlusion detection based on extreme point identification: In this paper only inner and outer iris edge detection was explained in detail. It does not explained the overall iris recognition process.

Paper 2: Enhanced iris recognition based on image match and hamming distance: In this paper, iris segmentation is done by Hough transform, iris feature extraction is carried by Gabor filter and template matching is done by hamming distance which did not give efficient result.

Paper 3: New recognition methods for human iris patterns: In this paper, feature extraction is carried by thresholding techniques and hamming distance is used for template matching which did not give accurate result.

3. PROPOSED TECHNIQUES

The first step in iris recognition is to acquisition the image. Choose good and clear image that free of noise helps to eliminate the process of noise removal and also helps in avoiding errors in calculation. Once the image acquisition various preprocessing steps are carried out on it. It includes segmentation, normalization (polar to rectangular conversion) and then template and mask generation by applying the RED algorithm to the rectangular template [1]. This template is matched with the database using Hamming distance (which is the most foremost method that used for matching between irises) and the match identification is displayed.



Architecture depicts flow of data through system like, first input image acquisition which contains whole eye of a person. After acquisition, segmentation is done to separate the iris region from image by detecting inner and outer boundary of iris. The circular part which we get after segmentation is then normalized to form rectangular template of iris image. Then features are extracted from the rectangular template by applying RED algorithm and HWT[4]. The template which is getting from both the methods is then matched with the database template and authentication of person is done. On that basis if the person is authenticated then our application will open the gate for that person and if not authenticated then red light will blink in the application.

3.1 Segmentation

Segmentation process is used to isolate the Iris from the captured image. The iris region lies between the outer boundary of both iris and pupil. Segmentation process is most crucial factor in the Iris recognition, if the detection of the pupil and Iris boundary is accurate then identification will be most accurate. After approximately located in the iris region as shown in figure. Eyelashes and eyelids are excluded and isolated which appear on the upper and lower parts of the iris region. The operation of the segmentation depend on two steps to locate the iris and pupil boundary.

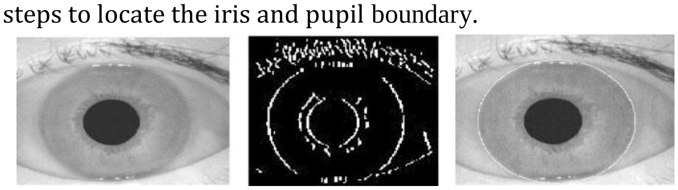


Figure 2. a) Original Image b) Image after canny edge detection using the Circular Hough transform. c) Iris detection by using Hough transformer for Iris.

The first step apply edge detector, which is a technique to locate edges. Edge detector is used to locate the edge of the iris and pupil boundary. Here Canny edge algorithm is used which is most efficient method to detect edges, it depend on the strength and intensity value of the pixel detect the edge from the image. After completing the edge step, the next step of the segmentation is to use the Circular Hough transform (CHT), which is used to detect the iris and pupil circles. The circular Hough transform can be used to detect the radius and center point of both pupil and Iris from the previous image that created by canny edge, which contains different circles with different radii and center point. The maximum value of the circle that located by CHT will consider as the outer boundary of the iris.

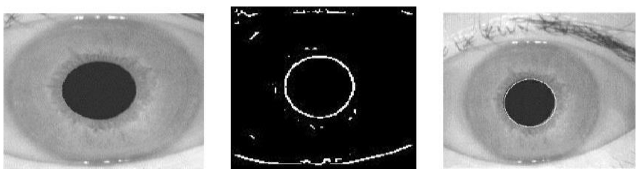


Figure 3. a) Adjustment image extracted from original image base on the Center point of the Iris b) the canny edge detector of pupil c) Pupil detect From the Hough transformer.

After detecting the iris boundary, it's the time to detect the pupil boundary but first mask the captured image and extract only the iris image as shown in figure, since the pupil is always inside the Iris. This way is used in order to decrease processing time of the Hough space since the Circular Hough transform is "brute-force" and try many pixels to locate the pupil in it. The mask will decrease the pixel that search on it for the pupil circle [6]. Using the same process in locating of circle of iris by apply canny edge detector to mask image and then apply the CHT and find the maximum circle that generated from the canny edge image as shown in figure.

3.2 Normalization

Normalization is the process of converting the iris from the polar coordinate to the rectangular coordinate. After completing segmentation. The next step is Polar to rectangular conversion. Rectangular conversion is applied to the region locating between the radius of the pupil and the radius of the iris. This process will generate the rectangular template as shown in figure 4.

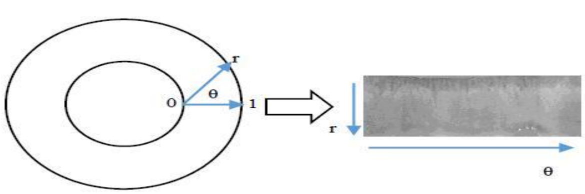


Figure 4. Polar to rectangular templates conversion

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 is called homogenous rubber sheet model which firstly used by Daugman [6]. 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 modelled 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 meshwork on iris when the pupil changes size.

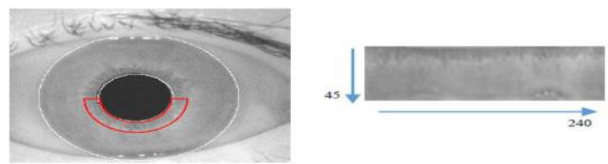


Figure 5. a) Taking only the lower ring part of the iris boundary to create a rectangular Iris that will applied to RED algorithm. b) Rectangular Iris with height 45 and width 240 of the lower part of iris.

Usually, rectangle iris is generated with radial resolution of 90 pixels and angular of 480 pixels to generate 90 *480 iris templates. The iris region that surrounded by the red line are chosen to become the rectangle iris as shown in figure (5). This rectangle iris contains only quarter part of the iris region, which have sufficient features to give authentication between users. This rectangle iris have been chosen because it doesn't contain noise which may affect the results of recognition. The size of this region in pixels is equal to 45 * 240 pixels.

4. Feature Extraction

4.1 Ridge Energy Direction (RED) algorithm

The Ridge Energy Direction (RED) algorithm is used for iris recognition. Feature extraction is based on the direction of the ridges that appear on the image [2]. 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 algorithm takes place on the rectangle iris. RED algorithm [1] is applied on rectangle irises. The RED algorithm states that filtering the rectangle Iris by two directional filter to determine the existence of ridges and their orientation. 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 repeated for each pixel in the rectangle iris, stepping right, column-by-column, and down, row-by-row until the filter is applied to all the pixels in the rectangle Iris. The filter processing is repeated two times on the rectangle iris one with vertical filter and the other with horizontal filter, as shown in figure. 9*9 RED filter have been chosen to apply to both rectangle template [5].

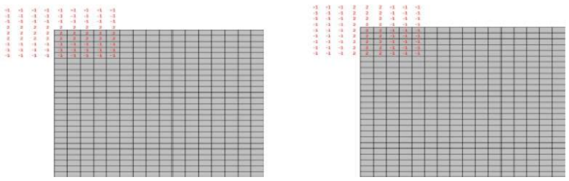


Figure 6. a) RED vertical filter size 9*9. b) RED horizontal filter size 9*9.

After the rectangle Iris template is pass through two filters the horizontal and the vertical dimension will generate two images one of them the result of the vertical filter with rectangle Iris template, and the other is created by the horizontal filter with the rectangle Iris template. The vertical and horizontal templates that generated by RED algorithm that contain quarter iris region as shown in figure. Finally, the template is generated by comparing the results of the 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 to 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 the resulting of the two different directional filter (horizontal and vertical) is above the threshold, this location will mark as not valid by putting 1 to it as shown in figure 7.

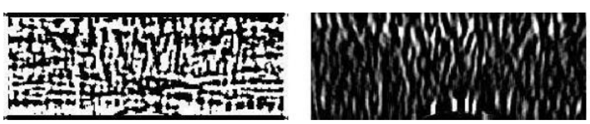


Figure 7. a) Vertical template result from vertical filter with first iris template. b) Horizontal template result from horizontal filter with first iris template.

4.2 Hybrid Wavelet Transform

In this HWT, there is combination of Discrete Cosine Transform and Harr Wavelet Transform are formed. A discrete cosine transform (DCT) expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important for lossy compression of audio, images and the numerical clarification of PDEs.

$$F(u,v) = \frac{C_u}{2}\frac{C_v}{2}\sum_{y=0}^{7}\sum_{x=0}^{7} f(x,y)\cos\left[\frac{(2x+1)u\pi}{16}\right]\cos\left[\frac{(2y+1)v\pi}{16}\right]$$

With:

$$C_u = \begin{cases} \frac{1}{\sqrt{2}} & if\ u = 0, \\ 1 & if\ u > 0 \end{cases} ; \quad C_v = \begin{cases} \frac{1}{\sqrt{2}} & if\ v = 0, \\ 1 & if\ v > 0 \end{cases}$$

For compression only cosine function is used, since it turns exposed that fewer cosine functions are desired to approximate a typical signal, whereas the cosines express a particular choice of boundary conditions for differential equations. Using DCT algorithm the performance improved for removing noise in the image and filling missing information over the regions with sensible sizes and better visual quality. The Harr wavelet transform is a type of discrete wavelet transform. The Harr wavelet is a sequence of rescaled "Square-Shaped" function which together from a wavelet family or basis. Harr wavelet has performed has performed better, for iris recognition, then other wavelets.

Harr transform uses Harr function as its basis function which varies in both scale and position. 8x8 Harr transform matrix is given below. It contains only real elements 1,-1 and 0.

5. Template Matching

The template can now be compared with the stored template using Hamming distance (HD) as the measure of closeness. The more the HD close to zero the more the accurate the identification. Highest closeness between matched eyes is 0.32 as indicated by Daugman [3].

$$HD = \frac{[(Template\ A \times Template\ B) \cap MaskA \cap MaskB]}{[MaskA \cap MaskB]}$$

Where templates A is the Iris template captured image and Template B is the iris template from 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 a calculation.

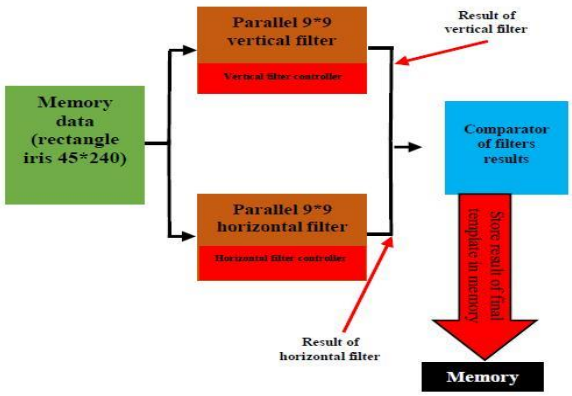


Figure 8. The process of Ridge Energy Direction algorithm

6. RESULT

The iris template have two advantage one of them is the speed since the template that have been taken is small size and it need small time to complete the RED process as shown in table the second advantage is that it's more accurate than the previous iris template, since the area that near to the pupil is most the time didn't any eyelid and eyelash that considers as noise, while the lower part of the eye may contain some of eyelid and eyelash which result as error.

Table 1. Result of Iris Template Size and Matching

Iris template	Size of iris template	Correct matching
Iris template contains feature from the lower part of the eye	90*240 pixel	98.86%
Iris template contains feature from iris that near to the pupil	30*480 pixel	100%

7. CONCLUSION

Algorithms used for iris feature extraction are fast and simple algorithm for extracting features from iris image. Quarter iris region is sufficient to identify between humans, since the matched between quarter irises in the database can be successfully recognized and we can get the result. The quarter iris enhances the RED algorithm since the time required for applying filter to full iris is lower than the time required to applying the filter to quarter iris. The algorithm giving better performance in terms of time and accuracy can be best suited for authentication.

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