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Design of Iris Recognition Biometric System

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***Abstract*: Now a days to access any secured system passwords are used. These passwords can be forgotten. In order to avoid these issues biometric security systems are implemented. Biometric security system makes use of human characteristics for their reliable identification. Iris recognition system uses iris of the human for identification. The pattern of iris of individual never changes over the time and hence it provides accurate authentication of the human. To evoke these discriminating features of iris, various methods had been used in the previous papers. In this proposed work design of iris recognition system consist of Segmentation, Normalization, Feature extraction using Gabor Filter and Feature matching using hamming distance algorithm applied on image of 320x280 dimensions obtained from CASIA database. For edge detection Canny edge detection algorithm is implemented. Experimental analysis shows that Gabor filter has shown better accuracy of iris segmentation and this design of iris biometric system has better performance.**

***Keywords*: Canny Edge Detection(CED), Circular Hough transform (CHT), Feature Extraction, Gabor Filter, Hamming distance, Iris Recognition.**

1. Introduction

The passwords which are used for identification purposes to access any secured system can be forgotten or guessed. Technologies that exploit biometric systems have potential for identification and verification of individuals for controlling access of any secured system. Iris biometric systems are more secure and user friendly. Mostly used biometric system proofs like fingerprint can be forged, face of human changes over time period. But iris recognition system is more effective, since iris have unique pattern which is particular for any two individuals. Due to effectiveness of iris biometric system the popularity of Iris biometric system has grown considerably in last few decades. As an illustration, over 50% of the papers cited in a recent survey [1] were published since 2005.There are many reasons for authors area of interest on this topic 1) it is a naturally protected internal organ that is visible from the exterior; 2) it has near circular and planar shape that more easily turns its segmentation and parameterization; and 3) its texture has a predominantly randotypic chaotic appearance that is stable over a lifetime. The eye imaging in nearby infrared(NIR) band show up extravagantly composed, iris pattern, while eye image taken in VW band show poor clarity. For this reason acquisition of eye image has done in NIR wavelength band i.e in range of 700-900nm. Due to different conditions of imaging that uses NIR spectrum, features of patterns in range of iris are finely visible and there is good contrast among sclera, iris, pupil portions. Fig. 1 shows structure of eye and fig. 2 shows eye image in NIR band.

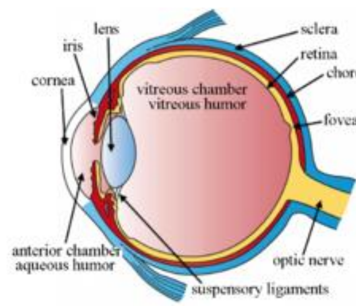

Fig. 1. Structure of iris

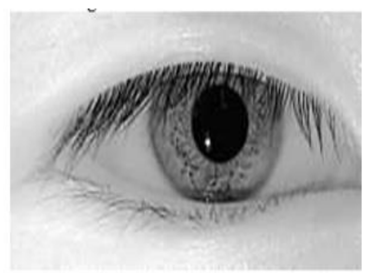

Fig. 2. Eye image in NIR band

The algorithms used for Iris recognition biometric system are very time consuming and sequential processes executing on central processing units (CPUs). Therefore, multiprocessor stage like FPGA can be used.

2. Proposed iris recognition system

Iris recognition system can be implemented by using five steps. The proposed methodology for iris recognition is shown in fig. 3.

- Image acquisition.
- Segmentation.
- Normalization.
- Feature extraction.
- Feature matching.

A. Image acquisition

The first step in iris recognition is acquiring images. The image choosed for iris recognition should be free from noise i.e., it should be good and clear image so as to eliminate process of noise removal and also helps in avoiding errors in calculation .In this proposed work CASIA IV database is used for captured images. These databases have been captured specially for iris recognition research as shown in fig 4.

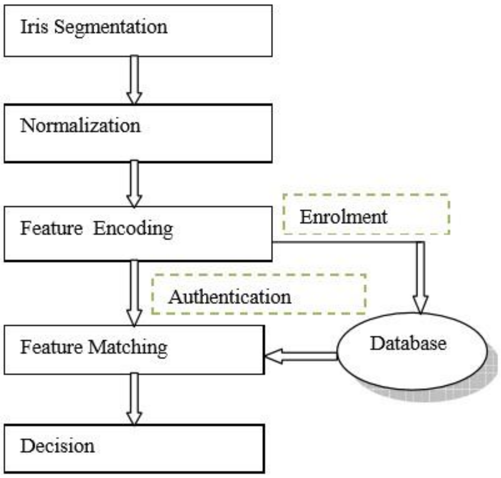

Fig. 3. Iris recognition steps

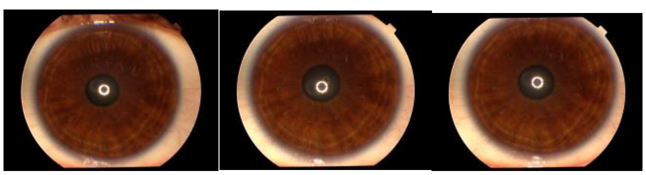

Fig. 4. Database of captured images

B. *Image segmentation*

Segmentation is the process used to isolate the Iris from the captured image. For Iris localization, Richard Wildes [2] method have been used and it consists of two main algorithms namely CED algorithm and CHT algorithm. The iris region is lies between the outer boundary of both iris and pupil. Segmentation process is most critical factor in the Iris recognition, the most accurate of detection the pupil and Iris boundary the most the accurate the identification will be [3]. After approximately locating the iris region as shown in figure 4. It's time to isolate eyelashes and eyelids which are excluded and isolated that appear on the upper and lower parts of the iris region. Success of segmentation process depends on the quality of captured image. More good quality image more accurate segmented image will be. The operation of the segmentation depend on two steps to locate the iris and pupil boundary, the first steps apply edge detector, which is an technique to located edges. There are many methods to detect the edge. In this paper canny edge detector algorithm is used for segmentation purpose. It is most efficient method to locate edges. It depends on the strength and intensity value of the pixel detect the edge from the image[4].

Canny edge detection consists of main five stages they are Smoothing, Computing gradient, Non maximum suppression, Thresholding, Tracking of edges by hysteresis.

- Smoothing is used to remove noise by using Gaussian filter.
- Computing gradients depends on the magnitude and direction of gradient of an image. Magnitude is computed by convolution of two 3x3 masks. To find out the gradient values at each pixel, sobel operator is used. Edges should be detected where the intensity of the pixel is high. Magnitude and direction of gradient of pixels are obtained as a result of sobel operation.
- *Non maximum suppression:* The small values pixels (i.e., close to zero) will be suppressed and replaced by zero except the points at local maxima.
- *Thresholding*: In Thersholiding strong edges are determined from the image. To make this thresholding more accurate double thresholding method is used.
- *Hysteresis:* Lastly the edges are obtained by suppressing the edges which are not connected with the strong edge line. Figures 5 and 6 show preprocessed gray image of eye, and edge detected eye image.

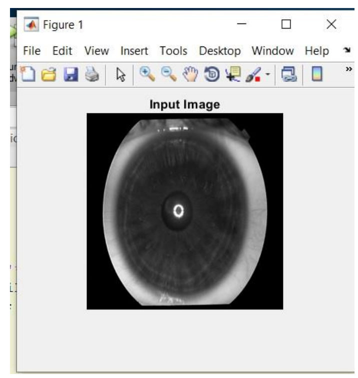

Fig. 5. Input image for canny edge detection

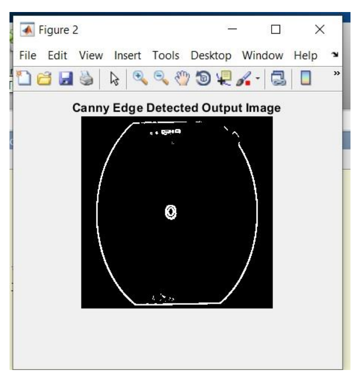

Fig. 6. Output image of canny edge detection

After completion of egde detection step next step is to detect iris and pupil circle, for this process Circle Hough transform (CHT) is used. The CHT is a fundamental procedure utilized as an important part in DIP, for recognizing objects with shape of circle in digital picture. The reason for this method is to find out circles in improper picture inputs. The circle edge points are created by "voting" in Hough parameter space and after that selecting the nearby maximum edge values in the matrix of accumulators.

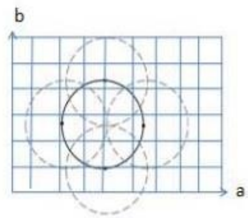

Fig. 7. Circle detection using CHT

$(x-a)2+(y-b)2=r$ (1)
$A=x-r\cos\theta$ (2)
$B=y-r\cos\theta$ (3)

where x, y are coordinates, and a, b are centers of the circle and these can be written as given in equations (2) and (3), where r is radius of the circle.

C. *Image normalization*

The iris normalization part includes two steps iris unwrapping and conversion of it to its polar equivalent. This can be done by using rubber sheet model also called RS model introduced by Daugman [5]. In this model every points in the iris image is converted from its cartesian co-ordinate (x,y) to its equivalent polar coordinate(r,θ). Where θ is the angle of range [0,2π] and r is radius of the interval of range [0,1]. Fig. 8 shows the iris image before remapping.

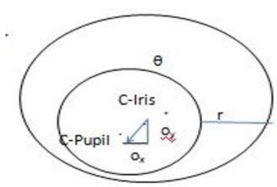

Fig. 8. Iris image before remapping

Due to the fact that the center of the pupil and the center of the iris are not at the same point remapping has to be done to rescale the points before unwrapping and it depends on angles surrounding the circular boundaries of pupil and iris. Remapping can be given by the equations,

$r'=(\alpha\beta)2\pm(\alpha\beta2-\alpha-ri2)$ (4)
Where
$\alpha=ox2+oy2$ (5)
$\beta=\cos[\pi-\arctan[oooo\ oooo]-\theta\theta]$ (6)

After unwrapping an iris image, the angular resolution is converted into a horizontal dimension and the radial resolution is converted into a vertical dimension of an unwrapped image. Fig. 9 illustrates Daugman's RS model.

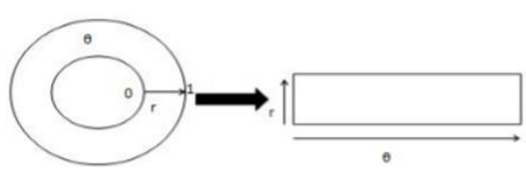

Fig. 9. Daugman's RS model

D. *Feature extraction using gabor filter*

As we know large number of feature extraction methods have been deployed. In [6] author have used the zigzag collarette area of the iris for extracting its features. In [7], researcher have used method of non-subsampled contourlet based features for iris recognition. While Multiscale morphological features have been used in [8]. Because of the low contrast of iris images, some researchers ([9], [10]) have also worked on contrast enhancement methods before the actual application of feature extraction process.

E. *Feature matching using hamming distance*

Feature matching is done by using the Hamming distance algorithm. In this algorithm, number of different symbols present at same position while comparing two strings of equal length. In other words we can say that numbers of error bits are found when one string is compared with the other of the same lenght. The more the HD is closed to zero more the image will be similar to its template image. The HD between two feature extracted iris templates is measured using equation. These two iris templates to be compared are of binary sequences and of equivalent length and corresponding bits are compared and hamming separation is measured. The equation for the hamming distance is given by

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

In above equation Template A and Template B represents feature extracted template of captured image and feature extracted template of stored images. ⊗ is a symbol indicating binary Exclusive-Or operation to detect different binary symbols in two iris templates. ∩ is a symbol indicating binary AND operation. ‖●‖ symbol shows summation. Mask A and mask B represent the masks of binary values that are associated with template A and B respectively.

3. Experimental results and analysis

Input image from CASIA database is segmented and normalized image is obtained using MATLAB as shown in Fig 10.

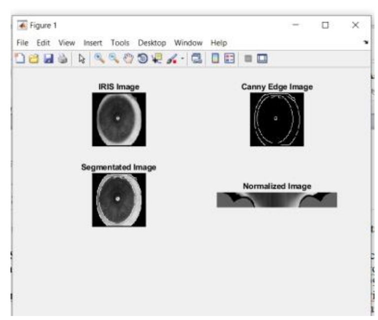

Fig. 10. Output of normalized image

This reading of this normalized image using text files in order to import image to Verilog environment and perform Gabor

Filter calculations. Lastly the output consists of binary values 0 or 1, the simulation result of Gabor Filter is obtained as shown in Fig. 11.

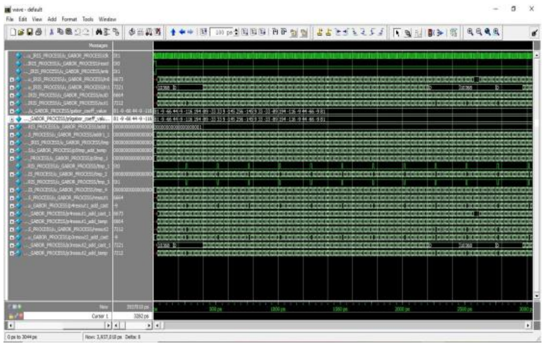

Fig. 11. Simulation waveform of Gabor Filter Algorithm

In this Iris image processing image pixel value is compared pixel by pixel to find out number of different pixels between the two images of iris. These two iris templates to be compared are of binary sequences and of equivalent length, corresponding bits are compared and hamming separation is measured. As observed in simulation results of hamming distance and experimental values obtained, for exact same two eye images HD is 0. The simulation result of hamming distance and experimental values obtained for same two iris images is 0. Output of simulation of hamming distance is shown in Fig. 12.

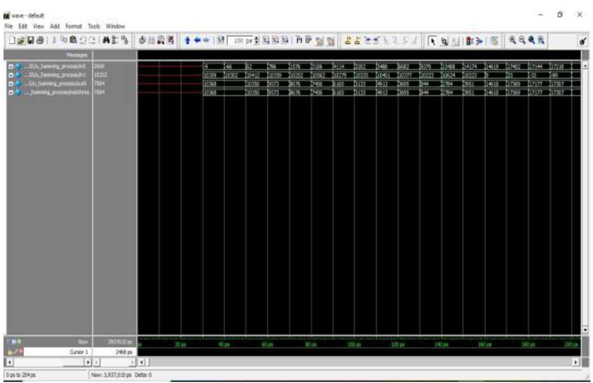

Fig. 12. Simulation result of hamming distance

Hence our analysis output shown that input image matches with database image.

Output result in Matlab is shown in Fig. 13.

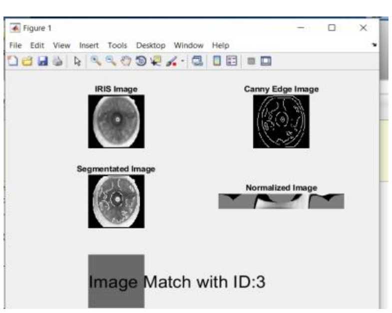

Fig. 13. Output of MATLAB

4. Conclusion

Iris recognition is one of the most exact biometric system now a days used widely. Unique features of iris of human cannot be changed over the time. It's unique pattern make it more secure biometric system then other biometric system. For pre-processing of image, segmentation process and normalization process MATLAB software is used. Canny Edge algorithm is applied to detect the edges of image. Gabor Filter is used for feature extraction and hamming distance algorithm is used for calculating template distance. Here we can conclude that accuracy of this system using Gabor filter is better. As combination of the MATLAB and Verilog is done simulation is done in less time. Hence, we can conclude performance of this system is good.

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