ICSE
2009

PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON SCIENCE AND ENGINEERING

Volume - 1

Electronics
Electrical Power
Information Technology
Engineering Physics

Sedona Hotel, Yangon, Myanmar
December 4-5, 2009

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Organized by
Ministry of Science and Technology

DECEMBER 4-5, 2009
SEDONA HOTEL, YANGON, MYANMAR

ELECTRONIC ENGINEERING

Software Implementation of Iris Recognition System Using Wavelet Transformation

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Abstract—**This paper describes the software implementation of Iris Recognition System using Wavelet Transformation. This system intends to apply for high security required areas. The demand on security is increasing greatly in these years and biometric recognition gradually becomes a hot field of research. Iris recognition is a new branch of biometric recognition, which is regarded as the most stable, safe and accurate biometric recognition method. In this paper, the image data base is created by inputting the digital photos via Matlab program. Image processing tool box and Wavelet transformation tool box are mainly applied to implement the system. Edge detection, Image localization, Haar Wavelet transformation and Hamming Distance are mainly applied. Finally the accuracy of iris recognition system is tested and evaluated with different iris images.**

Keywords— **Biometric Recognition, Iris localization, Wavelet transformation. Hamming Distance, Automatic Segmentation.**

I. Introduction

Biometric authentication has proven to be a reliable way to verify a human's identity. The technology has certain advantages over more traditional password-, pin-, or hardware token-based human identification systems. First, biometric traits cannot easily be stolen, forged, or guessed. Second, there is no need to remember one's biometric traits. Third, biometrics is difficult to repudiate. Due to these benefits, biometric authentication systems are being deployed in many real-world applications. Current systems employ many different biometric traits, including fingerprints, iris images, face images, retinal scans, palm prints, and gait patterns. We implemented 'Iris Recognition' using Matlab for its ease in image manipulation and wavelet applications. The first step of our project consists of images acquisition. Then, the pictures' size and type are manipulated in order to be able subsequently to process them. Once the preprocessing step is achieved, it is necessary to localize the iris and unwrap it. At this stage, Haar Wavelets is used to extract the texture of the iris. Finally, the recognized results are evaluated and compared the coded image with the already coded iris in order to find a match or detect an imposter.

II. Implementation Process

Implementation process can be divided into 5 parts.

1. Image acquisition
2. Preprocessing
3. Localization
4. Feature encoding
5. Matching

Figure 1 shows the block diagram of Iris Recognition Process.

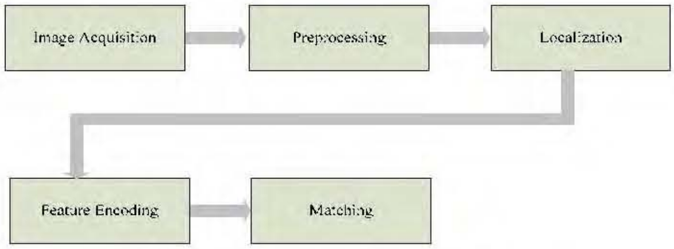

Fig. 1 Block Diagram of Iris Recognition Process

A. Image acquisition

Image acquisition is considered the most critical step in this project since all subsequent stages depend highly on the image quality. In this step, digital camera is used for high quality resolution images. The resolution is set to 1280x960, the type of the image to jpeg format. Furthermore, the eye pictures are taken while trying to maintain appropriate settings such as lighting and distance to camera.

B .Image preprocessing

In the preprocessing stage, the images are transformed from RGB to gray level and from unsigned integer eight-bit to double precision thus facilitating the manipulation of the images in subsequent steps.

C. Localization

The Hough transform is a standard computer vision 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 employed to deduce the radius and centre coordinates of the pupil and iris regions. An automatic segmentation algorithm based on the circular Hough transform is employed. Firstly, an edge map is generated by calculating the first derivatives of intensity values in an eye image and then thresholding the result. From the edge map, votes are cast in Hough space for the parameters of circles passing through each edge point. These parameters are the centre coordinates x_c and y_c, and the radius r, which are able to define any circle according to the equation. The center and radius of the iris in the original image are determined by rescaling the obtained results. After having located the outer edge, it is needed to find the inner one which is difficult because it is not quite discernable by the canny operator especially for dark eyed people.

Therefore, after detecting the outer boundary, the intensity of the pixels within the iris is tested. Depending on this intensity, the threshold of the Canny is chosen. If the iris is dark, a low threshold is used to enable the Canny operator to mark out the inner circle separating the iris from the pupil. If the iris is light colored, such as blue or green, then a higher threshold is utilized. The pupil center is shifted by up to 15% from the center of the iris and its radius is not greater than 0.8 neither lower than 0.1 of the radius of the iris. This means that processing time, dedicated to the search of the center of the pupil of this part is relatively small. Hence, instead of searching a down sample version of the iris, we searched the original one to gain maximum accuracy. Thus the boundaries of the iris are determined as shown in Fig. 2 and then manipulation is done this zone to characterize each eye.

Fig. 2 Detected Boundaries of Iris with Light Color Eye

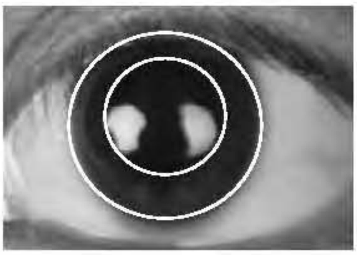

Fig. 3 Detected Boundaries of Iris with Dark Color Eye

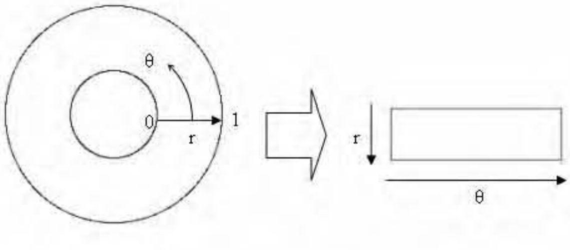

Fig. 4 Block Diagram of Localization of Iris

D. Mapping

After determining the limits of the iris in the previous phase, the iris should be isolated and stored in a separate image. For this purpose, the coordinate system is changed by unwrapping the lower part of the iris (lower 180 degrees) and mapping all the points within the boundary of the iris into their polar equivalent (Fig. 2 & 4). The size of the mapped image is fixed (100x400 pixels) which means that an equal amount of points at every angle are taken. Therefore, if the pupil dilates the same points will be picked up and mapped again which makes the mapping process stretch invariant.

Fig. 5 Original Image of Iris with Light Color Eye

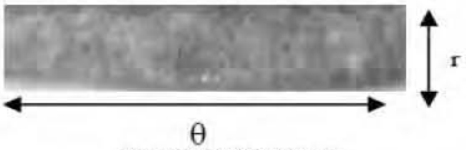

Fig. 6 Iris Isolated Image

E. Feature encoding

In order to provide accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted. Only the significant features of the iris must be encoded so that comparisons between templates can be made. Most iris recognition systems make use of a band pass decomposition of the iris image to create a biometric template.

The template that is generated in the feature encoding process will also need a corresponding matching metric, which gives a measure of similarity between two iris templates. In this research, the Haar wavelet transformation is chosen to get the significant features from the iris localization data.

Haar wavelet is the one type of wavelet family which can be executed by using waveinfo('haar'). A survey of the main properties of this wavelet can be obtained. And it operation can be described as following equations:

$\psi(x) = 1$ if $x \in [0, 0.5]$
$\psi(x) = -1$ if $x \in [0.5, 1]$
$\psi(x) = 0$ if $x \notin [0, 1]$
$\phi(x) = 1$ if $x \in [0, 1]$
$\psi(x) = 0$ if $x \notin [0, 1]$

By getting the feature vectors in the range of [-1 0 1] can be simply applied to achieve the decision rules. So a decision can be made with high confidence as to whether two templates are from the same iris, or from two different irises. Fig. 7 illustrates the output of Haar wavelet transformation.

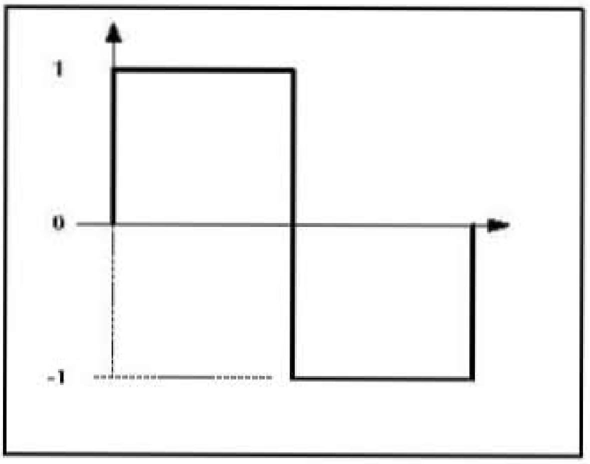

Fig. 7 Haar Wavelet Transformation

The 5-level of wavelet transformation results the detail and approximation coefficients of one mapped image obtained from the mapping part. These coefficients are used to code the binary forms at the next stage.

F. Binary Coding Scheme

After the haar wavelet transformation is done, the resultant features are needed to convert into the binary form. In order to code the feature vector some of its characteristics are observed. It is found that all the vectors that have a maximum value that is greater than 0 and a minimum value that is less than 0. Moreover, the mean of all vectors varied slightly between -0.08 and -0.007 while the standard variation ranged between 0.35 and 0.5.

If "Coef" is the feature vector of an image than the following quantization scheme converts it to its equivalent code-word:

If Coef(i) >= 0 then Coef(i) = 1
If Coef(i) < 0 then Coef(i) = 0

The next step is to compare two code-words to find out if they represent the same person or not.

G. Matching Scheme

For matching, the Hamming distance was chosen as a metric for recognition, since bit-wise comparisons were necessary. The Hamming distance algorithm employed also incorporates noise masking, so that only significant bits are used in calculating the Hamming distance between two iris templates. Now when taking the Hamming distance, only those bits in the iris pattern that corresponds to '0' bits in noise masks of both iris patterns will be used in the calculation. The Hamming distance will be calculated using only the bits generated from the true iris region, and this Hamming distance formula is given as

$$HD = \frac{1}{N}\sum_{j=1}^{N} C_A(j) \oplus C_B$$

where, C_A and C_B are the coefficients of two iris images and N is the size of the feature vector. The symbol $\oplus$ is the known Boolean operator that gives a binary 1 if the bits at position j in C_A and C_B are different and 0 if they are similar.

Due to the analysis of Hamming distance from the feature vector, the maximum Hamming distance that exists between two irises belonging to the same person is 0.32. Thus, when comparing two iris images, their corresponding binary feature vectors are passed to a function responsible of calculating the Hamming distance between the two. The decision of whether these two images belong to the same person depends upon the following result:

- If HD <= 0.32 decide that it is same person
- If HD > 0.32 decide that it is different person

In matching scheme, the binary bits from each of iris feature vector are compared first. And then the bits are shifted two bits left or right direction and the comparison result are used to get the right decision. The number of bits moved during each shift is given by two times the number of filters used, since each filter will generate two bits of information from one pixel of the normalised region. The actual number of shifts required to normalise rotational inconsistencies will be determined by the maximum angle difference between two images of the same eye, and one shift is defined as one shift to the left, followed by one shift to the right. The shifting process for one shift is illustrated in Fig. 8. One shift is defined as one shift left, and one shift right of a reference template. In this example one filter is used to encode the templates, so only two bits are moved during a shift. The lowest Hamming distance, in this case zero, is then used since this corresponds to the best match between the two templates.

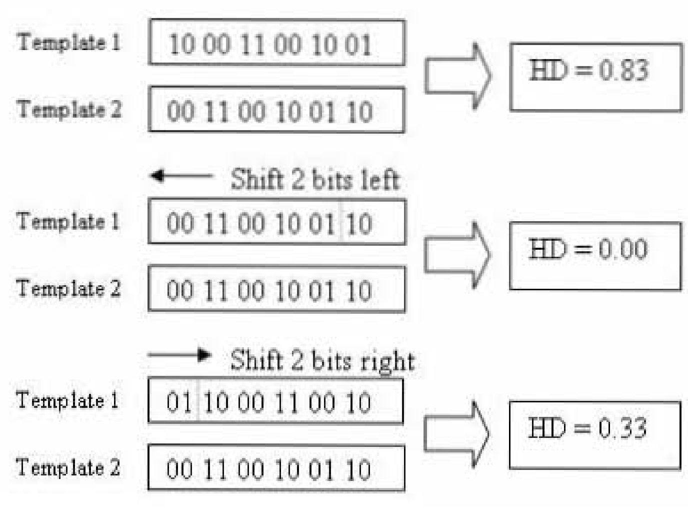

Fig. 8 An illustration of the shifting process.

III. Results and Performance

In this project, the performance of the iris recognition system as a whole is examined. Tests were carried out to find the best separation, so that the false match and false accept rate is minimized, and to confirm that iris recognition can perform accurately as a biometric for recognition of individuals. As well as confirming that the system provides accurate recognition, experiments were also conducted in order to confirm the uniqueness of human iris patterns by deducing the number of degrees of freedom present in the iris template representation.

There are a number of parameters in the iris recognition system, and optimum values for these parameters were required in order to provide the best recognition rate. These parameters include; the radial and angular resolution, r and θ respectively, which give the number of data points for encoding each template, and the filter parameters for feature encoding.

IV. Conclusions

Analysis of the developed iris recognition system has revealed a number of interesting conclusions. It can be stated that localization is the critical stage of iris recognition, since areas that are wrongly identified as iris regions will corrupt biometric templates resulting in very poor recognition. The results have also shown that localization can be the most difficult stage of iris recognition because its success is dependent on the imaging quality of eye images.

Another interesting finding was that the encoding process only required one Haar wavelet transformation to provide accurate recognition. Also the optimum centre wavelength was found to be dependent on imaging conditions, since different lighting conditions will produce features of different frequencies.

An improvement could also be made in the speed of the system. The most computation intensive stages include performing the Hough transform, and calculating Hamming distance values between templates to search for a match. Since the system is implemented in MATLAB®, which is an interpreted language, speed benefits could be made by implementing computationally intensive parts in C or C++. Speed was not one of the objectives for developing this system, but this would have to be considered if using the system for real-time recognition.

Acknowledgment

The author would like to thank to Dr. Myo Myint, Lecturer and Head, Department of Electronic Engineering, Mandalay Technological University for his kindness, graceful attitude and permission to do this paper. The author would be pleased with her expression of gratitude of her teacher, Dr Hla Myo Htun, Lecturer, Department of Electronic Engineering, Mandalay Technological University, for his valuable advices, helpful suggestions for this paper.

References

[1] Daugman, J. "*How Iris Recognition Works*", available at http://www.ncits.org/tc_home/ m1htm/docs/ m1020044.pdf.

[2] Lim, S., Lee, K., Byeon, O., Kim, T, "*Efficient Iris Recognition through Improvement of Feature Vector and Classifier*", ETRI Journal, Volume 23, Number 2, June 2001

[3] Jain, A., Duin, R. and Mao, J. 2000. "*Statistical Pattern Recognition: A Review*" IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 22, pp. 436-437.

[4] Pavlidis, T. 1977. "*Structural Pattern Recognition*". Springer-Verlag, New York.

[5] Wildes, R.P, "*Iris Recognition: An Emerging Biometric Technology*", Proceedings of the IEEE, VOL. 85, NO. 9, September 1997.

[6] Howard Demuth, Mark Beale, Martin Hagan 1998. "*Image Processing Toolbox™ 6*, User's guide", the Math Works Inc.