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Haar Wavelet Approach of Iris Texture Extraction for Personal Recognition

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Abstract— ***Iris recognition is one of the fast, accurate, reliable and secure biometric techniques for human identification. As the iris texture pattern is very unique and has no links with the genetic structure of an individual it is used as feature in iris recognition system. Poor quality images, high failure to accept rates (FTE) and high false reject rates (FRR) undermines the performance of iris recognition systems. The selection of subset of feature, its extraction and classification is a crucial step in this system. In this paper a method for iris recognition based on Haar wavelet approach of Iris texture extraction is proposed. Iris recognition system consists of iris localization, normalization, features extraction and matching modules. The feature extraction algorithm extracts haar wavelet packet energies of the normalized iris image (local features) to generate a unique code by quantizing these energies into one bit according to an adapted threshold. Hamming distance measure is used in order to find similarity between the iris images. Results are presented that demonstrate significant improvements in iris recognition accuracy when feature extracted using higher wavelet decomposition through the use of the public iris database CASIA.V4***

Index Terms—***Biometrics, Iris recognition, feature extraction, Wavelet Transform***

I. INTRODUCTION

A biometric system provides automatic recognition of an individual based on unique feature or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting. Iris Recognition has emerged as one of the most powerful and accurate identification techniques in the modern world. Iris is that portion of eye that lies in between the pupil and sclera and is unique for each and every individual. Iris has unique characteristics like stability of iris patterns throughout one's life time and is not surgically modifiable. Among all the biometrics, iris recognition has achieved highest recognition accuracy. It is also a fast, accurate and secure biometric technique that can operate in both verification and identification modes. Its probability of uniqueness among all humans has made it a reliable and efficient human recognition technique [1].

II. RELATED WORK

A variety of iris recognition approaches are proposed that can be broadly classified in three categories depending on the method used to extract features from the iris pattern. *Texture-based techniques* make use of different filters to extract Iris features from the filtered images. Daugman [2] [3] used Gabor wavelet to extract phase information of the iris to compute 256 byte binary iris code.

Hamming distance measure was used to compare two images. Wang [4] used 8 directional Gabor filter with multiple frequencies to capture local and global features of iris image. Mean and variance were used as features for matching. Laplacian pyramids constructed with four different resolution levels were used in Wildes approach [5] [6], the normalized correlation is used to compare the images. 2D, 1D haar wavelet was also used to characterize iris texture by Boles [7].

There were attempt to use *appearance based extraction techniques* such as Principal Discriminant Analysis (PCA) [8], and Independent Component Analysis (ICA) [9] which used statistical approaches to extract iris features. The PCA technique is superior in image construction. Euclidean-distance and Nearest-Neighborhood (NN) classifier are adopted in these approaches.

Local variations which are characterized by presence of important image structure are used in *Feature based extraction techniques* [10]. Bank of spatial multi resolution filters is constructed for efficient feature extraction.

In this paper personal recognition based Haar wavelet approach of Iris texture extraction is presented. The input is eye image. The iris is first localized or segmented from eye image, and then normalized. Feature extraction algorithm first decomposes the normalized iris image using Haar Wavelet in three levels. Each iris image is subset of band filtered images which contain wavelet coefficient. These coefficients characterize local iris texture. From these sub images haar wavelet energies are extracted to generate a unique code by quantizing these energies into one bit according to an adapted threshold. Hamming distance measure is used in order to compare the iris images.

This paper is organized as follows. Section 2 describes the proposed system in detail. Section 3 describes the experiment conducted to evaluate the performance of the proposed system and Section 4 summarizes the paper.

III. THE PROPOSED SYSTEM

The Algorithm of proposed Iris Recognition system is as shown in figure 1. For our approach, the input will be an eye image, and the output will be the iris template. The algorithm consists of 4 steps: Localization or Segmentation, Normalization, Feature extraction and Matching.

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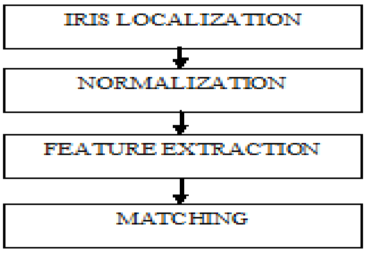

Figure 1: Iris Recognition System

A. Iris Localization

The iris is acquired as a part of a larger image that contains data derived from the surrounding eye region. So it is important to localize that portion of the image that corresponds to iris

Iris localization or segmentation segments the iris from the rest of the acquired image. The main steps in Localization are determining the boundary of iris and pupil, removal of eyelids and eyelashes. To detect the iris and pupil contour we make use of Daugman's integro-differential operator [2]. The integro- differential operator is defined as

$$max(r, xp, y0) \left| GS\sigma(r) * \frac{\partial}{\partial r} \oint_{r,x0,y0} \frac{A(x,y)}{2\Pi r} ds \right|$$

Where A (x, y) is the eye image, r is the radius of search, GSσ(r) is a Gaussian smoothing function and s is the contour of the circle given by r, x, y. The operator searches for the circular path where there is maximum change in pixel values, by varying the radius and centre x and y positions of the circular contour. The operator is applied iteratively with the amount of smoothing progressively reduced in order to attain precise localization. The output yields the centre co-ordinates and radius of iris and pupil. Linear Hough transform is then used to detect the eyelids and eyelashes.

B. Normalization

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eye images are mainly due to the stretching. The normalization process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location. For this we use the Daugman's rubber sheet model [2]. The centre of the pupil was considered as the reference point, and radial vector pass through the iris region. A number of data points are selected along each radial line and this is defined as the radial resolution(r) and it is in vertical dimension. The number of radial lines going around the iris region is defined as the angular resolution (ϴ) and it is in horizontal dimension.

If the pupil is non-concentric to the iris, a remapping formula [11] is needed to rescale points depending on the angle around the circle. This is given by

$$r' = \sqrt{(\alpha\beta)} \pm \sqrt{(\alpha\beta^2 - \alpha - a^2)}$$

Where

$$\alpha = X^2 + Y^2,$$

$$\beta = \cos(\pi - \arctan\left(\frac{Y}{X}\right) - \theta)$$

Where displacement of the centre of the pupil relative to the centre of the iris is give by X, Y and r' is the distance between the edge of the pupil and the edge of the iris at angle ϴ around the region, and a is the radius of the iris. Output of localization and normalization is shown in figure 2.

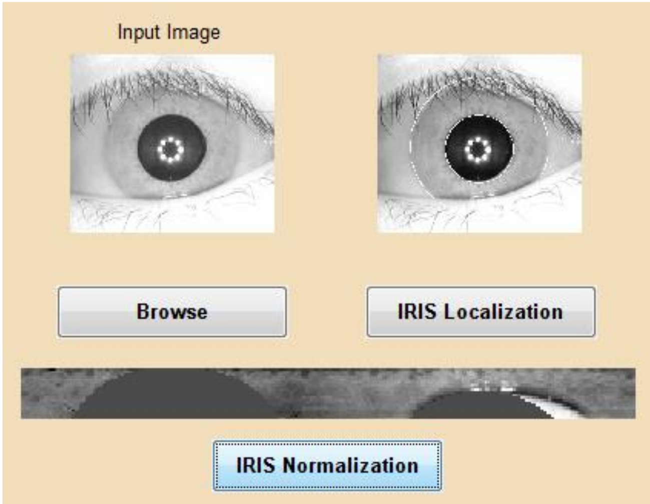

Figure 2: Localization and Normalization Output

C. Feature Extraction

Wavelets can be used to decompose the data of the iris region into components that appear at different resolutions. Wavelets have the advantage over traditional Fourier transform in that the frequency data is localized, allowing features which occur at the same position and resolution to be matched up. A number of wavelet filters, also called a bank of wavelets, is applied to the 2D iris region, one for each resolution with each wavelet a scaled version of some basis function. The output of applying the wavelets is then encoded in order to provide a compact and discriminating representation of the iris pattern. The Haar wavelet is one of the simplest wavelet transforms which can transform huge data sets to considerably smaller representations [12]. Here we use Haar wavelet transform to extract features from the iris region. De-composing images with wavelet transform yields a multi-resolution from detailed image to approximation images in each level. If images of size N x M are taken then it is decomposed up to K th level where K= 1, 2, 3 etc. The quadrants (sub-images) within the image indicated as LH, HL, and HH represent detailed images for horizontal, vertical, and diagonal orientation, respectively in the first level. The sub-image LL corresponds to an approximation image that is further decomposed, resulting in two-level wavelet decomposition.

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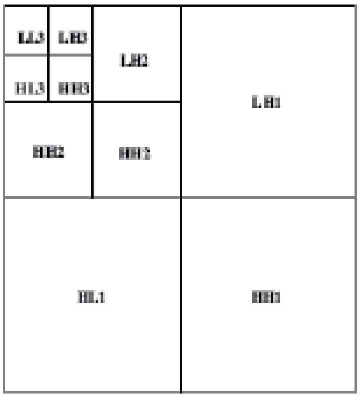

Figure 3: Three Level Wavelet transform.

The result of the third level approximation gives the large reduction in computation without much loss in the prominent features. This generates 64 sub images as shown in figure 3. Next we obtain local texture information energy measure from each of these sub images.

The energy measure is given as

$$Ei = \sum_{j,k} Si(j,k)^2$$

Ei energy measure for sub image Si, Energy measure is calculated for all 64 sub images. In our approach we use wavelet energies of each iris sub image to calculate threshold to encode the 64 sub images.

The threshold [T] is given as

$$T = K.\frac{\mu(E1, \ldots \ldots \ldots \ldots .. En)}{Max(E1, \ldots \ldots \ldots \ldots En)}$$

Where K is constant, E1… En are appropriate wavelet sub image energies of 1….n sub images and µ (E1……..En) are mean wavelet peak energy values.

After finding wavelet energies of sub images and threshold, iris code is calculated as follows

$$Code(j) = 1 \quad if\ Ej/En > T$$

$$Code(j) = 0 \quad otherwise$$

Where j=0…..63. This results in 64 bits iris code.

D. *Matching*

When a live iris is presented for comparison, the iris pattern is processed and encoded into Iris template Code. The Iris Code derived from this process is compared with previously stored Iris Code. This process is pattern matching. Pattern matching evaluates the goodness of match between the newly acquired iris pattern and the candidate's data base entry. Based on this goodness of match final decision is taken whether acquired data does or doesn't come from the same iris as does the database entry. Hamming distance is used as the distance measure which is given as

$$HD = 1/B \sum_{i=1}^{B} Xi\ [EXOR]\ Yi$$

Where Xi and Yi are query and database iris codes and B number of bits

IV. EXPERIMENTS AND RESULTS

In our implementation we have used CASIA V4 databases to analyze the performance of the proposed system and show the effectiveness of our feature extraction technique. The algorithm was implemented in MATLAB and tested for 500 images all the images shown in above figures are simulation results. The size of iris code is 64 bits which is less compared to 128, 196, 512, 1024 bits iris code used in other approaches. The performance of this system is measured comparing iris code of query image with all the images in database. Hamming distance is the measure used. A profile of hamming distances, for second image with that of database in given in Figure 4.

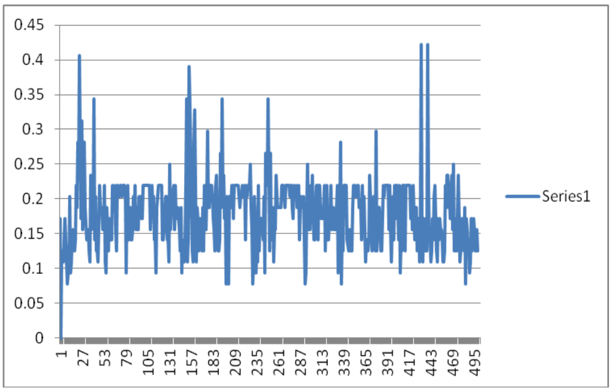

Figure 4: Hamming Distance for image 2

In this manner 2500 genuine and 60000 imposter's scores are generated. False accept rate (FAR) and false reject rate (FRR) at various thresholds are found. This error rates are brought together in receiver operating characteristics curve (ROC) that plots FAR against FRR or Genuine accept rate (GAR) at different thresholds. The ROC curves showing the performance of this algorithm for CASIA v4 database is shown below. Figure 5 shows plot of FAR and FRR and Figure 6 shows plot of FAR and GAR We have achieved an EER of 0.404754 compared to 0 .628[13].

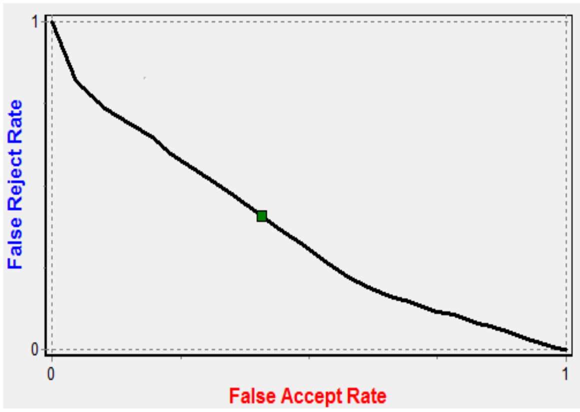

Figure 5: FAR V/s FRR

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Figure 6: FAR V/s GAR

V. CONCLUSION

Iris recognition system based haar wavelet approach of iris texture extraction is presented. The proposed system uses higher level wavelet approximation. Haar Wavelet is particularly suitable as the size of feature vector is the least compared to other wavelets. Experimental result shows that this approach is more efficient for iris code generation than classical wavelet approaches without risk of recognition errors especially for poor quality images. The proposed technique uses only the energies to encode the iris texture according to the threshold which result in small size feature vector. As the feature vector size is only 64 bits such vector size can be easily stored on smart cards and also decreases the matching time tremendously. The proposed algorithm has less computational complexity compared to other methods hence can be used for implementing high accuracy iris recognition system. This algorithm achieves better performance with EER of 0.404 compared to other approaches.

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REFERENCES

1. J. G. Daugman, Recognizing persons by their iris patterns. In A. K. Jain, R. Bolle, and S. Pankanti, editors, Biometrics: Personal Identification in a Networked Society, pages 103–121. Kluwer Academic Publishers, 1999
2. J. G. Daugman, “High confidence visual recognition of persons by a test of statistical independence”, *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 15(11), 1993, 1148–1161
3. J. G. Daugman, "How Iris Recognition Works", *In IEEE Transactions on circuits and systems for video technology*, vol. 14, no. 1,January 2004
4. L. Ma, Y. Wang, and T. Tan, “Personal identification based on iris texture analysis,” *IEEE Trans. on Pattern Analysis and Machine Intelligence*, vol. 25, no. 12, Dec 2003, pp. 1519–1533
5. R. Wildes. “Iris recognition: an emerging biometric technology.” *Proceedings of the IEEE*, Vol. 85, No. 9, 1997
6. R. Wildes, J. Asmuth, G. Green, S. Hsu, R. Kolczynski, J. Matey, & S. McBride, “A Machine vision System for Iris Recognition”, *Machine Vision and Applications*, 9(1), 1996,1-8
7. W. W. Boles, & B. Boashah, A Human Identification Technique Using Images of the Iris and Wavelet Transform, *IEEE Transaction on Signal Processing*, 46(4), 1998, 1185-1188
8. Jiali Cui, Yunhong Wang, JunZhou Huang, Tieniu Tan, Zhenan Sun, “An Iris Image Synthesis Method Based on PCA and Super-resolution,” Proceedings of the *17th International Conference on Pattern Recognition (ICPR'04).*
9. Kwanghyuk Bae, Seungin Noh, and Jaihei Kim, “Iris feature extraction using independent component analysis,” Proc. *4th Intl. Conf. on Audio and Video Based Biometric Person Authentication LNCS*, vol. 2688, 2003, pp. 838–844
10. L. Ma, T. Tan,D. Zhang, andY.Wang, “Local intensity variation analysis for iris recognition,” *Pattern Recognition*, vol. 37, no. 6, , 2005, pp. 1287–1298
11. Libor Masek, "Recognition of Human Iris Patterns for Biometric Identification", Thesis Report School of Computer Science and Software Engineering, Western Australia, 2003.
12. Rossani F., Eslava M.T., Ea T., Aml F., Amara A., “Iris Identification and robustness evaluation of wavelet packetsbased algorithm”, *IEEE International Conference on image processing*, vol.3, pp. III -257-260
13. Farid Benhammadi, nassima kihal, “Personal Authentication based on Iris Texture analysis”, *IEEE International conference on Computer systems and applications* 2008,537-543
14. CASIA Iris Image Database,

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