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Recognition of Bimodal Biometric System using Transformation Techniques

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Abstracts

A wide variety of systems requires reliable personal recognition schemes to confirm or determine the identity of an individual requesting their services. In this paper, recognition of Iris and Fingerprint provides easiest way of security and faster processing. It ensures data security and protection of system from unauthorized users as well. In first part, Iris template is generated from Iris image. Iris features are generated by applying Discrete Wavelet Transformation (DWT) and Discrete Cosine Transformation (DCT) on Iris Template. Second part focus on fingerprints; the Fingerprint is preprocessed to get Region of Interest. Using DWT and Fast Fourier Transformation (FFT), features of Fingerprints are obtained. Final feature set is generated using concatenation. The final feature is compared with stored database using Euclidean distance matching to obtain exact match depending upon threshold value. We check False Acceptance Rate (FAR) and False Rejection Rate (FRR) at different threshold level.

Keywords: DWT, DCT, FFT, Euclidean distance, FAR, FRR.

Introduction

Recognition using single biometric trait is not sufficient. This system performs better for certain assumptions but fails when the biometric data available is noisy, also fails in case of unavailability of biometric template. Limitations of unimodal biometric systems can be overcome by using multimodal biometric systems which refers to the use of a combination of two or more biometric modalities in verification / identification system [6].

The most widely used method for recognition for person is fingerprint and iris [5]. The reason for chosen these two biometric are:

- (1) Iris has high degree of randomness as no two iris are alike and remains stable throughout person's life [1].
- (2) Fingerprint developed at fetal stage and remains same throughout person's life.

Multimodal biometric systems often provide promising results than any single biometric system [8]. The access to the secured area can be made by the use of ID numbers or password which amounts to knowledge based security. But such information can easily be accessed by intruders and they can breach the doors of security. This happens in case of net banking and highly secured information

zone. Thus to overcome the above mentioned issue multimodal biometric traits are used [4].

Related works

Wildes [1] proposed the algorithm which first convert image into a binary edge map and then detect
[http:// www.ijesrt.com](http://www.ijesrt.com)

circle using Hough transform. Laplacian filter at multiple scales is used to extract features. Finally, the matching between two iris images is done using normalized correlation. Arun Ross and Anil K Jain [3] introduced various scenarios that are possible in multimodal biometric systems, the levels of fusion that are plausible and the integration strategies that can be adopted to consolidate information. S. Prabhakar, A. K. Jain, and J.Wang [2] presented a unimodal fingerprint verification and classification system. The system is based on a feedback path for the feature-extraction stage, followed by a feature-refinement stage to improve the matching performance. N. K. Ratha, R. M. Bolle, V. D. Pandit, and V. Vaish [6] proposed a unimodal distortion-tolerant fingerprint authentication technique based on graph representation. Using the fin-gerprint minutiae features, a weighted graph of minutiae is constructed for both the query fingerprint and the reference fingerprint. The proposed algorithm has been tested on a large private database with the use of an optical sensor.

Model

In this section the definitions of performance parameters, methodology is discussed

A. Definitions:

(i) *False acceptance rate (FAR)*: FAR is the measure of the likelihood that the biometric security system will incorrectly accept an access attempt by an unauthorized user [8].

$$FAR = \frac{\text{No. of incorrect matches}}{\text{No. of images out of database}} \quad (1)$$

(ii) *False rejection rate (FRR)*: A false reject occurs when an individual is not matched to his/her own existing biometric template.

$$FRR = \frac{\text{No. of Falsely rejected images}}{\text{No. of images in the database}} \quad (2)$$

(iii) *Total success rate (TSR)*: It is the rate at which match occurs successfully. The number of persons recognized correctly in the database.

$$TSR = \frac{\text{Number of persons recognized correctly}}{\text{total number of persons in database}} \quad (3)$$

(iv) *Euclidean Distance*: It is the straight line distance between two pixels. If p and q are two pixels with coordinates (x_1, y_1) and (x_2, y_2) , then

$$D_E = [(x_1 - x_2)^2 + (y_1 - y_2)^2]^{1/2} \quad (4)$$

B. Methodology:

In this section block diagram of system as shown in figure 1 is discussed. The two biometric traits viz., Iris and Fingerprint are considered together to identify a person. The transform domain techniques such as DWT and DCT are used to extract the features of Iris and DWT and FFT are used to extract the features of fingerprint.

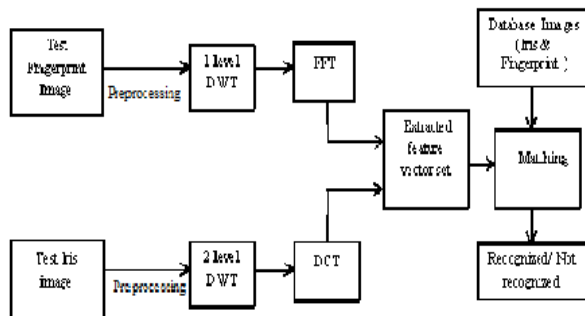


Figure 1. The block diagram of system

(i) *Iris Database* - Iris images are taken from Chinese Academy Science Institute of Automation (CASIA V1.0). The database considering 5 persons, 5 sample per person taken at different timing. Out of 25 images of 5 persons, first 3 samples are used in database. The 2 samples of each person are considered as test image to compute to FRR.

(ii) *Iris Preprocessing* - The iris image must be preprocessed before using it for the feature extraction purpose.

Pupil detection: To find the boundary between the pupil and iris, it must detect the location (centre coordinates and radius) of the pupil. The rectangular area technique is applied in order to localize pupil and detect the inner circle of iris. The pupil is a dark circular area in an eye image.

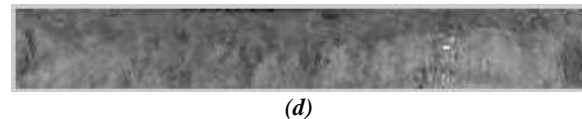
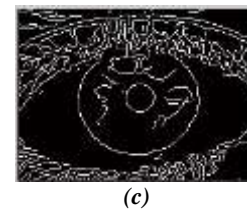
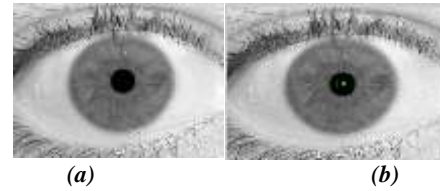


Figure 2. (a) Iris image (b) Center of pupil (c) Canny Edge Detection (d) Normalized Iris

Edge detection: Canny edge detection is used to create an edge map. The Canny method finds edges by looking for local maxima of the gradient of the iris image. The Canny edge detects strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. This method is therefore less likely than the others to be fooled by noise, and more likely to detect true weak edges.

Normalization: When the iris image is proficiently localized, then the next step is to transform it into the rectangular sized fixed image format. The Daugman's Rubber Sheet Model is utilized for the transformation process for Iris. Normalization process includes unwrapping the iris and transforming it into its polar equivalent form. It is performed utilizing Daugman's Rubber sheet model. [7]. The idea behind the dimensionless polar system is to assign an r and θ value to each coordinate in the iris that will remain invariant to the possible stretching and skewing of the image. The iris ring is mapped to a rectangular block in the anti-clockwise direction. Remapped image is called normalized image. The remapping of the iris

image $I(x, y)$ from raw Cartesian coordinate to polar coordinates $I(r, \theta)$ can be represented as,

$$I(x(r, \theta), y(r, \theta)) \rightarrow I(r, \theta) \tag{5}$$

Where, r lies in the unit interval and is the angle between $[0, 2\pi]$. Where $x(r, \theta)$ and $y(r, \theta)$ are defined as linear combinations of both the set of papillary boundary points. The following formulas perform the transformation.

$$X(r, \theta) = (1-r)X_p(\theta) + X_i(\theta) \tag{6}$$

$$Y(r, \theta) = (1-r)Y_p(\theta) + Y_i(\theta)$$

Where (X_p, Y_p) and (X_i, Y_i) are the coordinates on the pupil and limbus boundaries along the θ direction. Eye image unroll it (map it to Cartesian coordinates). Normalization produces the image of unwrapped iris region of size 50x360.

iii) *Fingerprint Database* - The fingerprint images are taken from FVC2004. The database considering 5 persons, 5 sample per person taken at different timing. Out of 25 images first 3 samples of each person are used in database and the 2 samples of each person are considered as test image to compute FRR.

(iv) *Fingerprint Preprocessing* - Fingerprint image is preprocessed to extract the ROI (Region of interest) [6].



(a) Fingerprint image (b) ROI image

Figure 2. Fingerprint preprocessing stage

(v) *Iris Features* - To generate iris features two level Discrete wavelet Transformation (DWT) is applied on normalized iris image to get approximation coefficients. The proposed system uses DWT coefficients as feature vector. The wavelet is a powerful mathematical tool for feature extraction, and has been used to extract the wavelet coefficient from normalized iris images. Wavelets are localized basis functions, which are scaled and shifted versions of some fixed mother wavelets. The main advantage of wavelets is that they provide localized frequency

information about a function of a signal. DWT can be expressed as

$$DWT x(n) = \begin{cases} d_{j,k} = \sum X(n)h(n-2^j k) \\ a_{j,k} = \sum X(n)g(n-2^j k) \end{cases} \tag{7}$$

The coefficients $d_{j,k}$ refer to the detail components in signal $x(n)$ and correspond to the wavelet function, whereas $a_{j,k}$ refer to the approximation components in the signal. The functions $h(n)$ and $g(n)$ in the equation represent the coefficients of the high-pass and low-pass filters, respectively, whilst parameters j and k refer to wavelet scale and translation factors. The main feature of DWT is multiscale representation of function. Then DCT is applied on approximation band of second level DWT [8]. The DCT Equation is given as

$$y(k) = w(k) \sum_{n=1}^N x(n) \cos \frac{\pi(2n-1)(k-1)}{2N} \tag{8}$$

$$\text{Where } w(k) = \begin{cases} \frac{1}{\sqrt{N}} & k = 1 \\ \sqrt{\frac{2}{N}} & 2 \leq k \leq N \end{cases}$$

(vi) *Fingerprint features* - Single level DWT is applied on ROI fingerprint image. The FFT is applied on approximation band to generate FFT coefficients. Then fingerprint features are generated from absolute values of FFT coefficients.

(vii) *Euclidean distance matching* - Extracted features are compared with database features by using Euclidean distance for matching.

$$d(p, q) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \dots + (q_n - p_n)^2} \\ = \sqrt{\sum_{i=1}^n (q_i - p_i)^2} \tag{9}$$

Algorithm

- Input: Iris and Fingerprint database
- Output: Recognition of person
- 1. Read test image of iris and fingerprint
- 2. Preprocessed iris image
- 3. Preprocessed fingerprint image
- 4. Two level DWT and DCT is applied on normalized iris
- 5. Preprocessed fingerprint image
- 6. DWT is applied on fingerprint

- 7. FFT is applied on approximation band
- 8. Features of iris and fingerprint are generated
- 9. Test features are compared with data base features using Euclidean distance taking appropriate threshold value

Result

For performance analysis CASIA V1.0 iris database and FVC2004 DB3_A fingerprint database are considered. The two sets of database are created by considering iris and fingerprint of 5 person. The FAR is computed by considering 5 persons which are out of database.

In recognition process we select fourth iris image which is test image as shown in figure 4 and fourth image of fingerprint image at 100 % threshold as shown in figure 5. Then we get the output as “recognized with 4” as shown in figure 6. In this recognized process we get minimum Euclidean distance between test iris image and database iris image is 93.04 and for fingerprint that distance is 2.95. In this way we test all the images with with different threshold value. Then calculate the value of FRR, TSR. Table 1 shows the value of FRR decreases from 100% to 10% and the value of TSR is increased as threshold increases.

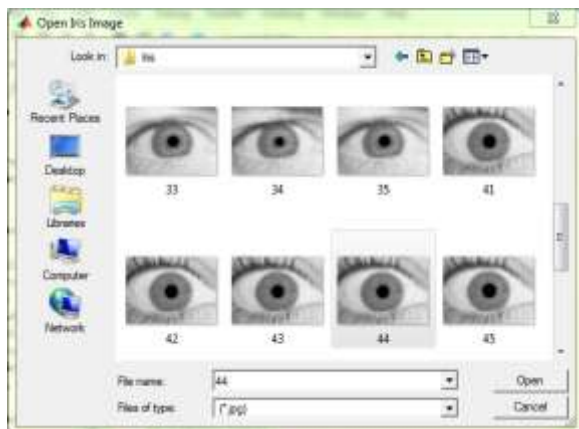


Figure 4. Test Iris Image (Fourth Person)



Figure 5. Test Fingerprint Image ((Fourth Person)

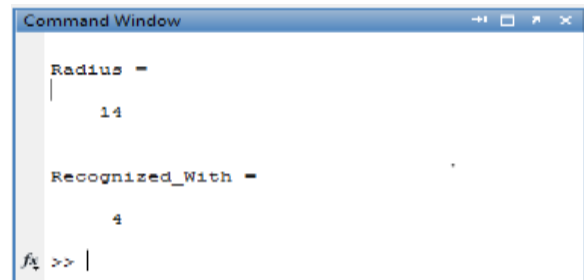


Figure 6. Correct recognition of person (Fourth Person)

Then we select Iris test image of first person as shown in figure 7 and fingerprint test image of second person as shown in figure 8. Result is not recognized as shown in figure 9.

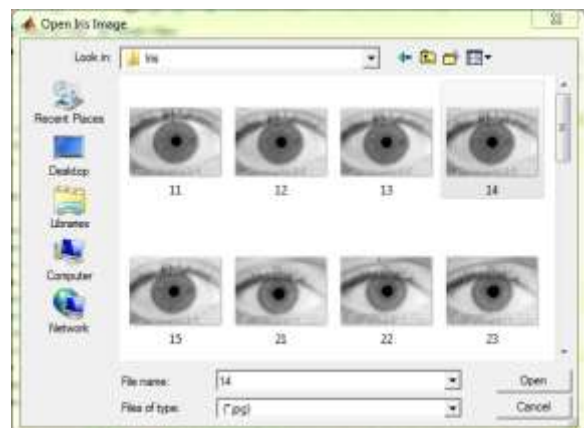


Figure 7. Test Iris Image (First Person)



Figure 8. Test Fingerprint Image (Second Person)

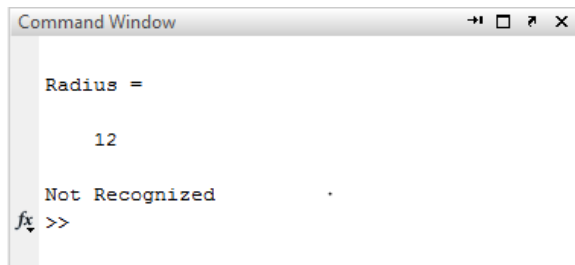


Figure 9. Not Recognized

Table 1 . FRR, FAR variation with threshold

Threshold	FRR(%)	TSR(%)	FAR(%)
10	100	0	0
20	100	0	0
30	100	0	0
40	100	0	0
50	70	0	0
6	40	30	0
70	10	50	0
80	10	90	0
90	10	90	0
100	10	90	10

Conclusion

Unimodal biometric system has some problem like noisy sensor data, lack of individuality. To overcome these disadvantages we used bimodal biometric traits Iris and Fingerprint. Iris features are generated using DWT and DCT. Fingerprint features are generated using DWT and FFT. Here we use multiple transformation to increase the robustness of system. From table 1 it is observed that value of FRR is decreased from 100% to 10% as threshold increases. Total success rate is also increased from 0% to 90%. So, efficient security system using iris and fingerprint traits has been design.

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References

- [1] R. Wildes, "Iris Recognition: An emerging biometric technology" Proceedings of the IEEE, vol.85, no.9, September 1997.
- [2] S. Prabhakar, A. K. Jain, and J. Wang, "Minutiae verification and classification" presented at the Dept. Comput. Eng. Sci., Univ. Michigan State, East LansingMI, 1998.
- [3] Arun Ross and Anil K Jain, "Multimodal Biometric: An Overview," European Processing Conference, pp. 1221-1224,September 2004.
- [4] Sulochana Sonkamble, Ravindra Thool and Balwant Sonakamble, "Survey of Biometric Recognition Systems and their Applications" Journal of Theoretical and Applied Information Technology, pp. 45-51,2005-2010.
- [5] Vincenzo Conti, Carmelo Militello, Filippo Sorbello & Salvatore Vitabile "A Frequency-based Approach for Features Fusion in Fingerprint and Iris Multimodal Biometric Identification Systems" IEEE Transaction on systems, Man & Cybernetics - Part C: Applications & Reviews, VOL. 40, No. 4, JULY 2010.
- [6] N. K. Ratha, R. M. Bolle, V. D. Pandit, and V. Vaish, "Robust finger-print authentication using local structurality," in Proc.5th IEEE Workshop ppl. Comput .Vis., Dec. 4-6, 2000, pp. 29-34. DOI 10.1109/WACV. 2000.89539
- [7] R. Wildes, "Iris recognition: An emerging biometric technology," Proceedings of the IEEE, vol. 85, no. 9, pp. 1348-1363, 1997.
- [8] Sunita V. Dhavale "DWT and DCT based Robust Iris Feature Extraction and Recognition Algorithm for Biometric personal identification" International Journal of Computer Applications (0975 - 8887) Volume 40- No.7, February 2012.