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Biometric Security System using finger geometry and palm print modalities

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ABSTRACT
Biometric systems are widely used for accurate personal identification for access control. Unimodal systems have been well-developed and are being used extensively in different institutions, organizations and in industries. However, these systems are only capable to provide low to middle range of security feature. Thus, for enhancing security feature, the combination of two or more unimodal biometric becomes essential. This paper presents a multimodal biometric identification system based on finger geometry and palm print features of the human hand. Here paper work is divided into two modules. In the first module, the hand image is first preprocessed and finger geometry features of index, middle, ring and little fingers are extracted. Also palm print features of hand images are extracted using Harris Corner Detector. For every modality, separate matcher is used for recognition. Decisions obtained by both the matchers are ANDed together to recognize the person. In the second module, a coarse-to-fine hierarchical feature matching is employed for efficient hand recognition. Accuracy and computation count of module 1 are compared with the results obtained by module 2.

Keywords: Multimodal biometric; finger geometry; palm print; decision level fusion; hierarchical matching.

1. INTRODUCTION

One of the primary functions of any security system is the control of people into or out of protected areas, such as infrastructural facilities and information systems. Technologies called biometrics can automate the recognition of people by one or more of their distinct physical (e.g., fingerprint, face, iris) or behavioral (e.g., speech, handwriting) characteristics. The term biometrics covers a wide range of technologies that can be used to verify person identity by measuring and analyzing human characteristics.

Hand-based biometrics has attracted lots of attention because of various advantages like: (i) Hand based biometric features are unique for an individual. (ii) They remain unchanged over the period of time. (iii) Data acquisition is less cumbersome and more user friendly. (iv) It is much less susceptible to intrinsic variations and environmental artifacts. (v) Hence it is attractive and growing alternative biometric scene.

Feature extraction is a very important part in a biometrics security system and has great influence on the recognition result. Recently, researchers have proposed many kinds of palm print feature extraction methods, such as line feature-based [11][12][13][14], point feature-based, statistics-based [6][13] and transform-based [3][4][6][7][8] method. Palm lines can be extracted using Sobel operators [14], Canny edge operator and others. Palm print texture features are usually obtained from the transform-based feature extraction. Some of the texture feature extraction methods are Wavelet Transform [5][8], Discrete Cosine Transform [3] and Fourier Transform [7]. Recently, palm print statistical features are being introduced for palm print identification purposes.

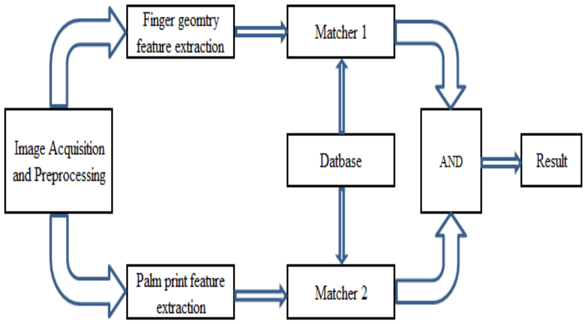
Unimodal biometric systems perform person recognition based on a single source of biometric information. Such systems are often affected by some problems such as noisy sensor data and non-universality. Thus, due to these practical problems, the error rates associated with unimodal biometric systems are quite high and consequently it makes them unacceptable for deployment in security critical applications. Combining various biometric features, commonly referred as multimodal biometric would be more robust than unimodal ones. It takes advantage of multiple biometric traits to improve the performance in many aspects including accuracy, noise resistance, universality, spoof attacks, and reduce performance degradation in huge database applications. Recently, new algorithms and applications of multimodal biometrics are emerging rapidly.

Multimodal biometric hand-based authentication systems use various levels of fusion: (i) Fusion at the sensor level, where two or more sensors are concatenated; (ii) Fusion at the feature level, where feature extracted are combined; (iii) Fusion at the rank level, where the matching scores obtained from multiple matchers are combined; (iv) Fusion at the decision level, where the accept/reject decisions of multiple systems are consolidated [1][2]. Paper presents a multimodal system based on finger geometry and palm print features of human hand, so as to improve the recognition accuracy.

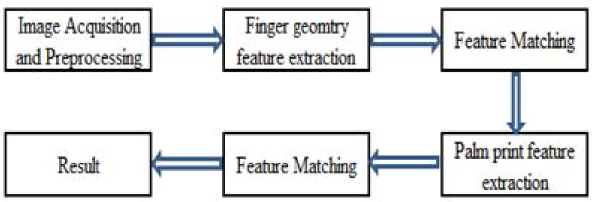
2. SYSTEM ARCHITECHTURE

Typical architecture of all biometric systems consists of two phases: enrollment and recognition/verification.

Prior to a recognition session, users must enroll in the system. In this paper, hand images of 100 users have been taken. For every user 8 images were captured, out of those 8 images, 5 images were used for training purpose and 3 images were used for testing purpose. Thus separate database has been created for training and testing. Images in the training database are preprocessed and their finger geometry and palm print features are extracted to get the template. In this work, to recognize the user, two different modules have been used. In module 1 (Fig. 1a), the image from testing database is taken and its features are extracted for verification. The input features are compared independently with features in the database. Decisions obtained by both the matchers are ANDed together to recognize the person [1]. In module 2 (Fig. 1b), palm print feature extraction is restricted only to those 5 users to which matcher 1 has shown the closest match from finger geometry features.



a) Module 1



b) Module 2

Figure 1 General Architecture of System

3. HAND IMAGE PREPROCESSING

Initially, a hand image is captured by digital camera. The captured RGB hand image is converted into gray scale image. Then filtered gray scale is converted into a binary image. Morphological operations are done on this binary image and then boundary of hand image is traced. Then with respect to a reference point (around wrist region), the Euclidean distance of every pixel on hand boundary region is calculated. Fig. 2a shows graph of Euclidean distances obtained against hand boundary points. From this Euclidean distances, finger tips and valley points between fingers are marked. Then by setting a co-ordinate system palm ROI (Region Of Interest) is extracted. An earlier work in hand image preprocessing can be found in [1][3][4][5][6][8].

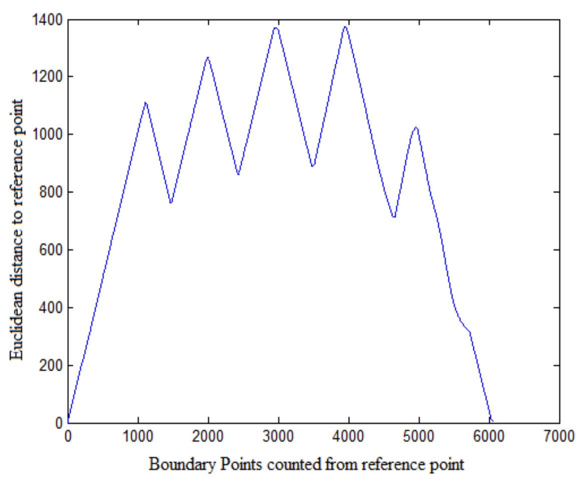


Figure 2 a) Graph of Euclidean distance against boundary points

Figure 2 b) Locating Fingertips and valleys

4. MULTI-LEVEL HAND FEATURE EXTRACTION

Feature extraction is a very important part in a biometrics security system and has great influence on the recognition result. It is very difficult to use one feature model for hand matching with high performance in terms of accuracy, efficiency, and robustness.

a. Finger Geometry Feature Extraction

Here only four fingers i.e. little, ring, middle and index finger are considered. For every finger, length and widths at 3 different positions are computed [1]. To compute the length of finger, a line joining two valley points is drawn and center of this line is marked. The line joining this center point to the finer tip gives the length of the finger. To compute the width of finger at 3 different points, finger length is divided into $1/4^{th}$, half and $3/4^{th}$ of the total length. Thus for every finger, four features are obtained. Same is repeated for other 3 fingers to get total 16 features. The 17^{th} feature is Palm width.

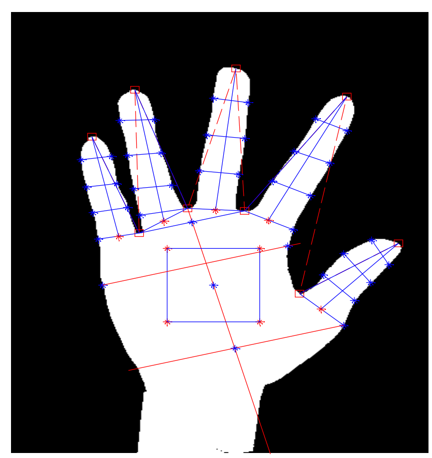


Figure 3 Finger Geometry Features

b. Palm Print Feature Extraction

To get a palm print feature vector, Harris Corner Detector has been used. Harris Corner Detector is a mathematical operator that finds features in an image. This detector is been used, as it is simple to compute, fast enough to work on computers and it is popular because it is rotation, scale and illumination variation independent.

This detector finds little patches of image that generate a large variation when moved around. Harris Corner Detector gives mathematical approach for determining corners in an image where significant change is observed in all direction. Algorithm is as follows:

i. Compute x and y derivatives of image.

$$I_x = G_\sigma^x * I,\ I_y = G_\sigma^y * I$$

ii. Compute products of derivatives at every pixel

$$I_x^2 = I_x.I_x\ ,I_y^2 = I_y.I_y\ ,I_xI_y = I_x.I_y$$

iii. Compute the sums of the products of derivetives at each pixel

$$I_{x2} = G_{\sigma'} * I_x^2\ ,I_{y2} = G_{\sigma'} * I_y^2\ ,I_{xy} = G_{\sigma'} * I_xI_y$$

iv. Define at each pixel (x, y) the matrix

$$M = \begin{bmatrix} I_{x2}(x,y) & I_{xy}(x,y) \\ I_{xy}(x,y) & I_{y2}(x,y) \end{bmatrix}$$

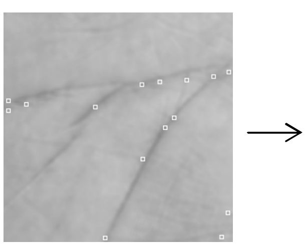
v. Compute the response of the detector at each pixel

$$R = Det(M) - k(Trace(M))^2$$

All windows that have a score R greater than a certain value are corners. They are good tracking points.

After applying Harris Corner Detector, corner points are marked on palm image. Now this image is mapped into a binary matrix of size 4×4, in such a way that if corner point is present in an image at a specific location then it is mapped as ‘1’ in a binary matrix, otherwise ‘0’. In this way, palm print feature vector is obtained.

In this way, two feature vectors for every hand image are retrieved which are stored as a primary key in the database.



0	0	0	0
1	1	1	1
0	0	1	0
0	1	0	1

Figure 4 Palm Print with Corners and its binary matrix

5. Feature Matching

As stated above, two feature vectors are extracted from every hand image. Fingers geometrical features are stored as feature vector 1 and palm print features are stored as feature vector 2. In recognition / verification mode, for new users hand image, two feature vectors are extracted and those feature vectors are compared with the feature vectors present in the database.

a. *Finger Geometry Feature Matching*

In matching process, the Euclidean distance between new users finger geometry feature vector and every stored finger geometry feature vectors in the database is computed using formula,

$$ED = \sqrt{(x - y)^2} \quad (1)$$

Minimum Euclidean distance gives the best match.

b. *Palm Print Feature Matching*

Here matching score between template of user and template stored in database is computed. Here, the aim is to find the match between index ‘0’ and index ‘1’ in binary matrix as shown below:

0	0	0	1
1	1	1	1
0	0	1	0
1	1	1	1

+

0	0	0	0
1	1	1	1
0	0	1	0
0	1	0	1

→

0	0	0	1
2	2	2	2
0	0	2	0
1	2	1	2

New matrix = Template for verification + Template from database
Index 0 = length (find (i = = 0))
Index 1 = length (find (i = = 2)) * 2
Score = Index 0 + Index 1

Maximum score gives the best match.

To recognize the user, two different modules are used. In module 1, the recognition / verification of new user is done in 1: n fashion for both the modalities i. e. finger geometry and palm print. Then decisions obtained by both the matchers are ANDed together to get the final decision. While in module 2, the recognition / verification of new user is done in 1: n fashion only for finger geometry. The palm print feature extraction is restricted only to those 5 users to which matcher 1 has shown minimum Euclidean distance for finger geometry, as it is observed that accuracy of finger geometry beyond 5 users shows a negligible change. Thus, coarse-to-fine hierarchical method is employed to match the multiple features for efficient hand recognition.

6. Results

Here, hand images of 100 users have been taken and for every user 8 images are captured. Out of those 8 images, 5 images are used for training purpose and 3 images are used for testing purpose. The system shows effectiveness of results with accuracy around 95.37% for module 1 and 98.14% for module 2. While for individual modalities, accuracy of 95.84% for finger geometry and 97.68% for palm print is observed. In terms of computational count, it is observed that for module 1, computational count is (100 × 5) + (100 × 5) = 1000; while for module 2, it is (100 × 5) + (5 × 5) = 525. Thus computational count is reduced almost by half in module 2 with enhanced accuracy than module 1.

7. CONCLUSION

This paper proposes a biometric identification system based on fusion of finger geometry and palm print modalities. In module 1, multimodal biometric features are fused on decision level with AND rule. While in module 2, multimodal biometric features are fused on decision level with hierarchical ANDing. Module 2 has shown effectiveness of results with enhanced accuracy and reduction in computational count. This system is simple to implement and feasible.

8. REFERENCES

[1] Zhu Le-qing, Zhang San-yuan; "Multimodal biometric identification system based on finger geometry, knuckle print and palm print," *Pattern Recognition Letters 31 (2010), pp. 1641-1649.*

[2] Abdallah Meraoumia, Salim Chitroub and Ahmed Bouridane ; "Fusion of Finger-Knuckle-Print and Palmprint for an Efficient Multi-biometric System of Person Recognition", *IEEE ICC 2011 proceedings.*

[3] Manisha P. Dale, Madhuri A. Joshi, Neena Gilda ; "Texture Based Palmprint Identification Using DCT Features", *IEEE-Seventh International Conference on Advances in Pattern Recognition 2009, pp.221-224.*

[4] Edward Wong Kie Yih, G. Sainarayanan, Ali Chekima, Narendra G.; "Palmprint Identification Using Sequential Modified Haar Wavelet Energy", *IEEE-International Conference on Signal processing, Communications and Networking, Chennai, India, Jan 4-6, 2008, pp. 411-416.*

[5] Kie Yih Edward Wong, G. Sainarayanan, Ali Chekima ; "Palmprint Identification Using Wavelet Energy", *IEEE-International Conference on Intelligent and Advanced Systems 2007, pp. 714-719.*

[6] Abdallah Meraoumia, Salim Chitroub and Ahmed Bouridane ; "Gaussian Modeling And Discrete Cosine Transform For Efficient And Automatic Palmprint Identification", *IEEE 2010, pp. 121-125.*

[7] W. Li, D. Zhang, and Z. Xu ; "Palmprint Identification by Fourier Transform", *IEEE-International Journal of Pattern Recognition and Artificial Intelligence, vol.16, no. 4,2002, pp. 417-432.*

[8] D. Zhang, W. Kong, J. You, and M. Wong ; "Online palmprint identification" *IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 25, no. 9, 2003, pp. 1041-1050.*

[9] Jie Wu, Xinge You, Yuan Yan Tang and Yiu-ming Cheung ; "Palmprint Identification Based on Non-separable Wavelet Filter Banks", *IEEE 2008.*

[10] Adams Kong, David Zhang, and Mohamed Kamel ; "A Survey of Palmprint Recognition", *IEEE-2008.*

[11] Xianji Wang, Haifeng Gong, Hao Zhang, Bin Li and Zhenquan Zhuang ; "Palmprint Identification using Boosting Local Binary Pattern", *IEEE-The 18th International Conference on Pattern Recognition 2006.*

[12] Feng Yue, Bin Li, Ming Yu and JiaQiang Wang ; "Fast Palmprint Identification Using Orientation Pattern Hashing", *IEEE-2011.*

[13] Shuang Wang and Yong Xu ; "A New Palmprint Identification Algorithm Based on Gabor Filter and Moment Invariant", *IEEE-2008, pp 491-496.*

[14] Kie Yih Edward Wong, Ali Chekima, Jamal Ahmad Dargham and G.Sainarayanan ; "Palmprint Identification Using Sobel Operator", *IEEE-10th Intl. Conf. on Control, Automation, Robotics and Vision Hanoi, Vietnam, 17–20 December 2008, pp 1338-1341.*