IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727,
PP 04-12
www.iosrjournals.org

Multimodal Biometric System Design Using Iris, Fingerprint & Palmprint Traits for Human Identification

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Abstract: *This paper presents biometrics based iris, fingerprint and palmprint recognition and authentication system. Human iris is one of the most reliable biometric because of its uniqueness, stability and non-invasive nature. In this paper, several steps are used for iris recognition system. First, the image pre-processing is performed. Then with the use of Ridge Energy Detection Algorithm (RED), the features are extracted by filtering the normalized iris region. Finally two Iris Codes are compared and human identification is done. Fingerprint and palmprint images are enhanced using preprocessing techniques such as morphological operations. The feature extraction techniques such as neighborhood operation and Harris feature algorithm is used to independently extract fingerprint and palmprint features. Experimental results show 100% result for iris, 91.25% result for fingerprint, 100% result for palmprint. This implies that this method is more reliable over traditional methods used for authentication.*

Keywords: *RED, localization, normalization, Harris features, neighborhood operation, Euclidean, SFF*

I. Introduction

The increasing requirement for security has resulted in a rapid development of intelligent personal identification based on biometrics. Physiological or behavioral characteristics unique to an individual are called biometric measurement (such as fingerprints or voiceprints) which has the capability to reliably distinguish between an authorized person and an imposter. The automated personal identity Authentication systems based on iris recognition are reputed to be the most reliable among all biometric methods [1]. Generally, physiological and behavioral characteristics used in biometrics include the following: facial features and thermal emissions, retina, iris, gait, voiceprint, gesture, fingerprints, palm-prints, handwritten signature, hand geometry etc. These biometric measurements provide a robust approach to a wide range of applications such as identity authentication and access control [2].

Of all these patterns, Iris is the most unique feature of everyone and also left and right eye of the same person have different patterns. An example of iris is shown in figure 1 below.

Fig. 1 Example of iris

Fingerprint identification has received considerable attention over the last 25 years. More specifically, identifying the characteristics of minutiae in fingerprint is a critical task and is thus an active area of research. In general, the fingerprint of an individual is unique and is formed from an impression of the pattern of ridges on a finger. A ridge can be defined as a single curved segment, and a valley is the region between two adjacent ridges. The term minutiae refer to the local discontinuities in the ridge flow pattern and provide the features that can be used for biometric identification. The characteristics such as orientation and location of minutiae are usually taken into account when performing fingerprint matching. A typical example of fingerprint, ridges, valleys and minutia is shown in Figures 2-4 below [3].

Fig. 2 An example of fingerprint image

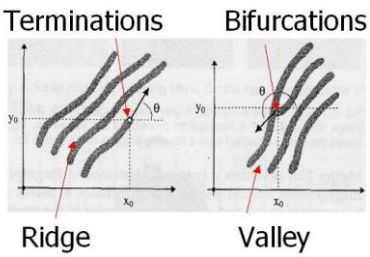

Fig. 3 An example of ridge and valley in a Fingerprint image showing Ridges ending and bifurcation

Fig. 4 Key minutiae features

The palm is the inner surface of a hand between the wrist and the fingers. The palm has unique features and provides a larger area so the more distinctive features can be generated to improve the performance of recognition system. There are different features that exist on a palm such as principle line, wrinkle line, delta point. The feature of palmprint is quite stable and specific because there is a little change in a long time. They can only be generated from a high resolution image, hard to be faked [4]. Example of palm is shown in figure 5 below:

Fig. 5 an example of Palmprint

II. Related Work

S. Palanikumar, et al [5] presented approach for enhancing International Journal of Computer Applications (0975 – 8887) Volume 95– No. 12, June 2014 27 palmprint image. The enhancement is based on curvelet which preserves the fine features without noise. The result gives high PSNR (Peak Signal-to-Noise Ratio) value for the Curvelet method. i.e. 38.1047. In 2008, V C Subbarayudu and Munaga V N K Prasad [6] proposed a Multimodal Biometric System using score level fusion of palm and iris images by using 2-D log Gabor filters for feature extraction. D. Y. Liliana, et al [7] studied about biometrics of palm for identification system using block-based line detection for palm print feature extraction process, and chain code solved the hand geometric feature extraction. We combined those two respective features and recognized it using Dynamic Time Warping (DTW) method which was able to measure the distance between two different features. The accuracy rate is 89%. V. C. Subbarayudu, et al [8] proposed general working of multimodal biometrics system with Iris and Palmprint and fusion is done at the matching score level by Sum Rule technique with recognition rate is 96.6%. Using Fingerprint, Face and Iris Recognition. Gawande, et al [9] gives use of the log Gabor filter to extract the feature vectors from both Iris and Fingerprint and then they are concatenated. Finally the phase data from 1 D log Gabor filters is extracted and quantised to four levels to encode the unique pattern of Iris and Fingerprint into bitwise biometric template. Hamming distance (HD) is used to generate a final match score. Experimental results was verified on database of 50 users accounting to FAR = 0% and FRR = 4.3%. Fan Yang et al [10] fingerprint, palm-print and hand-geometry are combined for person identity verification. Wavelet transform to extract the features from fingerprint and palm-print is used and hand-geometry feature (such as width and length) is extracted after the pre-processing phase. Feature level fusion and match score fusion together for identity. The weight values are calculated based on total minimum error. i.e. For weight1-0.75,weight2- 0.25. M. Dale, et al [11] presented palm texture using transform features and hand geometry features are represented as distances between different boundary points. The final decision is made by fusion at decision level. And accuracy rate is 99.5%. X. Wu., et al [12] proposed a palm print recognition system by extracting features using Sobel operators and using Hidden Markov Models (HMM) as classifiers. Bhawna Chouhan ,Shailja Shukla[13] presented Analysis of statistical feature extraction for Iris Recognition System using Laplacian of Gaussian filter with 97% accuracy. Ajay Kumar, et al [14] attempts to improve the performance of

palmprint-based verification system by integrating hand geometry features. These features are then examined for their individual and combined performances. The recognition rate is 98.3%. R.Gayathri, P.Ramamoorthy [15] proposed Feature Level Fusion of palmprint and Iris using KNN classifier & The experimental results demonstrated that the proposed multimodal biometric system achieves a recognition accuracy of 99.2% and with false rejection rate (FRR) of = 1.6%. K. Ito, et al [16] suggested Multi-scale wavelet decomposition of palmprint images and using mean of each wavelet sub-block has been suggested. Chinni. Jayachandra, H.Venkateswara Reddy [17] presented Iris Recognition based on Pupil using Canny edge detection and K-Means Algorithm. M. Wang, et al [18] proposed 2D PCA and 2D LDA over conventional PCA have been reported to be better for Palmprint recognition. Himanshu Srivastava [19] presented a review on Personal Identification Using Iris Recognition System. Gawande, et al [20] used log Gabor filter can be used to extract the feature vectors from both Iris and Fingerprint and then they are concatenated. The phase data from 1 D log Gabor filters is extracted and quantized to four levels to encode the unique pattern of Iris and Fingerprint into bitwise biometric template. Hamming distance (HD) is used to generate a final match score. P. Aruna kumari & g. Jaya suma, proposed a novel method of authentication using fingerprint, iris and palmprint images[21]. S.Anu H Nair, P.Aruna, K.Sakthivel proposed sparse representation of fusion of fingerprint, iris and palmprint[22]. S.R.Soruba Sree, Dr. N.Radha, propsed a Survey on Fusion Techniques for Multimodal Biometric Identification[23]. N.Parthiban1, G. Selvavinayagam proposed a method Combining two biometric systems for generating virtual identities [24]. Samarth Bharadwaj, Mayank Vatsa and Richa Singh propsed a review on Biometric quality: fingerprint, iris, and face [25]. Jayshri P. Patil, Chhaya Nayak proposed a Survey of Multispectral Palmprint Identification Techniques [26]. Dipti.S.Randive, Manasi.M.patil proposed a technique by fusion of Iris and Fingerprint how to identify a personit gives 95.45% & 97.3% of accuracy respectively [27]. S. Anu H Naira & Dr. P. Aruna proposed an Analysis of Image Fusion Techniques for fingerprint Palmprint Multimodal Biometric System[28]. Sameer P Patil, Tushar N Raka & Shreyas O Sarode proposed Multimodal Biometric Identification System by Fusion of Iris and Fingerprint images [29]. Vanaja Roselin. E.Chirchi, Dr.L.M.Waghmare & E.R.Chirchi proposed Iris Biometric Recognition for Person Identification in Security Systems [30].

III. Proposed Method

The proposed method includes various steps such as image acquisition of user from sensor, pre-processing operation to enhance the quality of image and feature extraction process to identify the features of an image. Finally, matching is done on the basis of specific features with database image and decision is made for identification.

The figure 6 shows the block diagram of biometrics identification system.

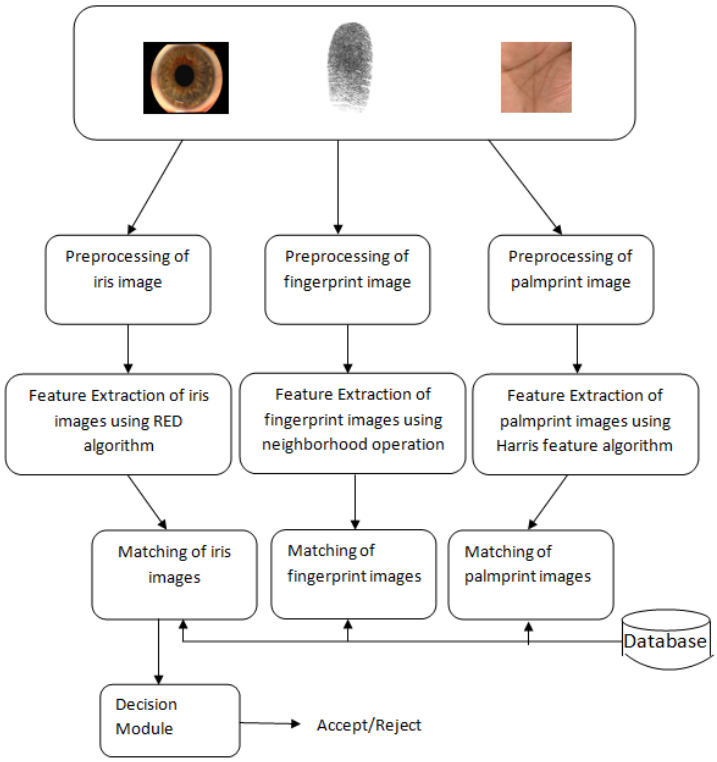

Fig. 6 Block diagram of biometric system

IV. Image Acquisition

4.1 Extraction of Iris images

For extraction of iris images CASIA iris database is used. We used total of 42 iris images of 42 different subjects from CASIA database.

4.2 Extraction of Fingerprint images

For extraction of image we used the Crossmatch sensor. This sensor provides the facility of acquisition of fingerprint in various modes. Amongst these modes we selected one mode in our research.

1) Single flat flexi finger (SFF):- In this mode there is not any restriction about acquisition area of sensor. User can put finger on any place on acquisition area. This mode acquires the images for all 10 fingers for both hands starting from left little finger to right little finger.

We used KVKR Multimodal Biometrics database. It contains data of total 1120 images for fingerprint of 8 subjects. For single flat flexi mode we used images of all 10 fingers of each person. Hence total number of images for SFF is 80.

4.3 Extraction of Palmprint images

We used KVKR Multimodal Biometrics database. For extraction of palmprint images whole handgeometry images are employed. Palmprint images are taken from the center of rectangle that can enclose the whole area of interest in palm. These center coordinates are used to extract a square palmprint region of fixed size. We used total 112 images of palmprint from database 8 images for left and right hand of subjects. Hence 16 images of every subject.

V. Preprocessing Techniques

5.1 Preprocessing of Iris Images

For iris images we first converted the colored image into a grayscale image. Then image enhancement is done.

5.2 Preprocessing of Fingerprint Images

Fingerprint images are grayscale images. They are first converted into binary images. Then we performed morphological operation such as thinning. It removes pixels so that the lines are minimally connected. And then median filter is used and general sliding-neighborhood operations to extract minutiae as feature for fingerprint.

5.3 Preprocessing of Palmprint Images

For palmprint images we used centre region of handgeometry images of specific size. These images are also colour images and we convert them firstly into grayscale images. Then image enhancement is done using some morphological operations.

VI. Feature Extraction

6.1 Feature extraction for Iris images

For iris images, after enhancement the iris is segmented into its polar coordinates. Then template generation is done by using directional filtering i.e. Horizontal & Vertical filtering techniques.

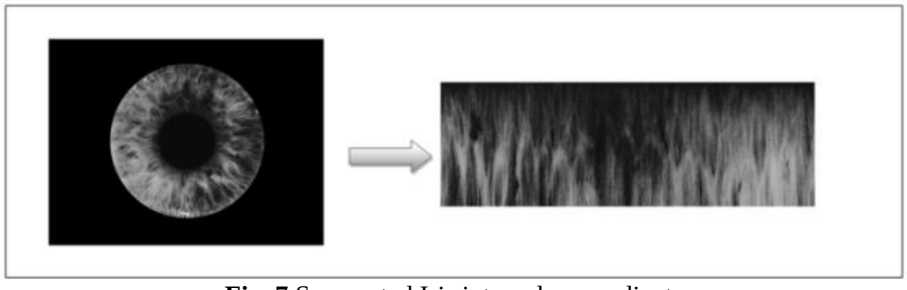

Fig. 7 Segmented Iris into polar coordinates

The directional filter gives two results, one for vertical filtering and another for horizontal filtering. Then we compare these two results and maximum directional features are considered to be the final template. This template is the compared with template of input image. If feature count is less then the image does not match, and if feature count is high the person is identified comparing with remaining samples.

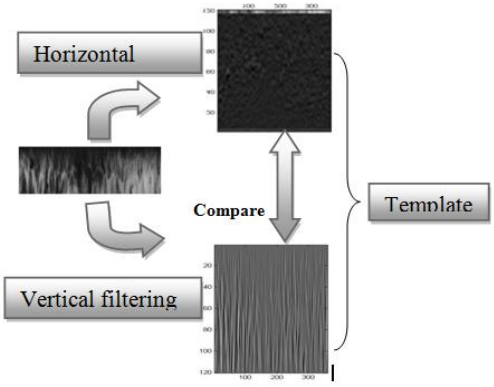

Fig. 8 Template Generation (Directional Filtering)

Following table shows results of some samples of iris images.

Table 1

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7
Subject 1	4806	15421	20239	20454	20274	20499	19888
Subject 2	13468	6427	20685	20624	19922	20535	20390
Subject 3	20661	20594	5132	12111	14131	20112	19977
Subject 4	20445	19908	17844	6873	8997	20010	19687
Subject 5	20350	19725	16005	9726	2606	19793	19552
Subject 6	20220	20305	20531	19892	20010	5335	17196
Subject 7	20151	20594	20252	19839	19549	15716	5325

6.2 Feature extraction for Fingerprint images

There are many variations in finger placement and pressure applied on the sensor, the minutia points extracted from the template and query fingerprints must be aligned, or registered before matching. We had extracted minutiae such as ridge bifurcations and endings. These features called as level 2 features which are useful to establish a fingerprint's individuality or uniqueness. We used general sliding-neighborhood operations with median filter and nlfilter 3-by-3 neighborhood. With the help of we extract minutiae as termination and bifurcation for all samples.

Figure 9: Minutiae on a fingerprint(Terminations)

Figure 10: Minutiae on a fingerprint(Bifurcations)

The score of termination and bifurcations is further used for identification. And finally the distance matrix is

Table 2

Samples of Fingerprint	Number of Terminations	Number of Bifurcation	Term+Bif
img11	1114	1313	2427
img12	549	523	1072
img13	765	864	1629
img14	739	824	1563
img15	417	481	898
img16	950	1075	2025
img17	783	887	1670
img18	831	981	1812

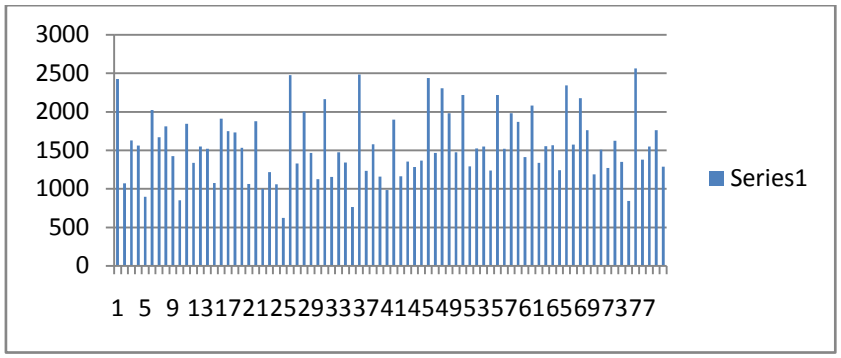

Fig. 9 Terminations + Bifurcations for Single flat flexi mode fingerprints

6.3 Feature extraction for Palmprint images

The converted grayscale image is then processed for feature extraction. We extracted the corner points of palmprint image using Harris feature extraction algorithm to find feature points.

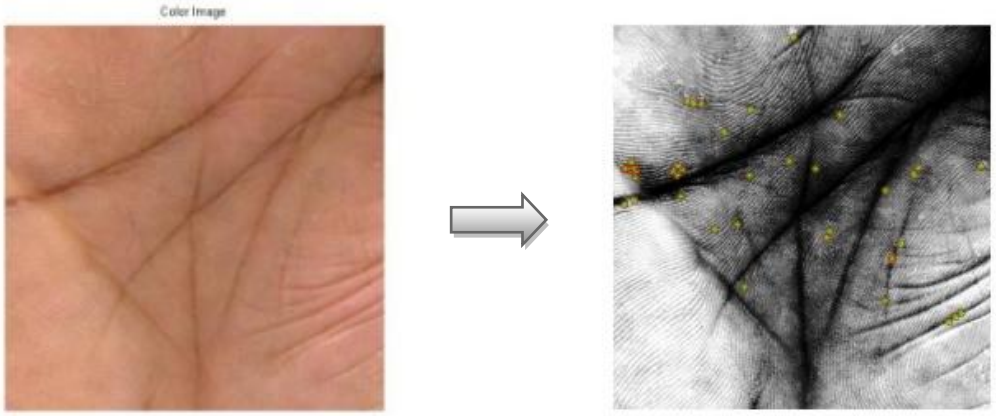

Fig. 9 Feature (Corner) points of palmprint

Corner detection is an approach used within computer vision systems to extract certain kinds of features and infer the contents of an image. A corner can be defined as the intersection of two edges. Here the corner points are considered as the features of palmprint image. Then Pair wise distance between two sets of observations is calculated using Euclidean distance method. The distance between the same samples is observed with 0 values. And if the distance value is greater then it does not match. Following table shows results of the distance matrix for some samples of palmprint images.

Table 3

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Sample 1	0	222.2521	252.8755	273.0018	256.0078	275.4088	76.53757
Sample 2	222.2521	0	345.013	56.51548	334.2933	57.56735	297.2036
Sample 3	252.8755	345.013	0	362.6679	20.24846	366.617	277.395
Sample 4	273.0018	56.51548	362.6679	0	349.4138	4	348.9928
Sample 5	256.0078	334.2933	20.24846	349.4138	0	353.3865	285.7166
Sample 6	275.4088	57.56735	366.617	4	353.3865	0	351.3004
Sample 7	76.53757	297.2036	277.395	348.9928	285.7166	351.3004	0

Following table 4 & table 5 and table 6 shows the recognition rate of iris, fingerprint and palmprint images respectively.

Table 4

Test	Total number of samples	Correct classified	Miss classified	RR
Iris images	42	42	0	100%

Single flat flexi mode gives better results and when tried with combination of different modes the result obtained is about 100%rather then testing individually.

Table 5

Test	Total number of samples	Correct classified	Miss classified	RR
Fingerprint images	80	73	07	91.25%

Table 6

Test	Total number of samples	Correct classified	Miss classified	RR
Palmprint images	112	112	0	100%

We test at least two images at a time for palm. By comparing results of these two images we can easily recognize the particular subject. If the image sample belongs to same person then both of the images contain maximum number of matching corner points in common. If the image doesn't belong to same person then they have no matching points in common or negligible matching points in common. We can compare the test image against number of images at the same time with this process. Overall recognition rate for iris, fingerprint & palmprint images is shown in following table 7.

Table 7

Test	Total number of samples	Correct classified	Miss classified	RR
Iris images	42	42	0	100%
Fingerprint images	80	73	07	91.25%
Palmprint images	112	112	0	100%

VII. Conclusions

This paper clearly indicates the idea about identification of a person based on iris, fingerprint & palmprint images. The methodology used here gives better significance and results. This is more reliable method compared with the traditional methods. For iris, RED algorithm gives the prominent features and the directional filtering made it easy for matching. The fingerprint images are used with SFF i. e. single flat flexi mode and the termination and bifurcation features are taken in consideration & the score of which is used for identification. The palmprint images are processed with the Harris feature extraction algorithm for corner points. These corner points are used further for matching. So the iris & palmprint achieved 100% results and the fingerprint is observed with 91.25% of success rate.

Acknowledgments

We would like to acknowledge and thanks to University Grants Commission (UGC), India for providing facility of UGC SAP (II) DRS Phase – I F. No. 3-42/2009 Biometrics: Multimodal System Development Laboratory.

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