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Multimodal Biometrics System Based on Sliding Neighborhood Operation, FAST Features, Region Properties

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Abstract:

The multimodal biometric systems becomes more popular nowadays. The multiple biometric are combined to avoid the problems such as noisy sensor data, non-universality, poor security,etc. In this paper, fingerprint, palm-print andhand-geometry are combined for person identityverification. All the three biometrics collected from the sameimage. The sliding neighborhoodoperations for feature extraction of fingerprint, FAST algorithm for palm-print and region properties for hand-geometryfeature extraction thepre-processing phase. The feature level fusion is usedfor identification. Thesystem was tested on a database of 7 subjects. The better recognition ate is achieved with this multimodal biometrics system.

Keywords —**Multimodal, 3 * 3 Sliding Neighborhood operation, FAST features, Region properties, Euclidean.**

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I. INTRODUCTION

In current era secured access control system and uniqueness are the important challenging tasks. The biometric authentication system becomes very popular because it uses behavioral and physiological characteristics to uniquely identify the individual [1].Biometrics system works in two modes i.e. verification systems and identification systems [2].

Uni-modal biometric systems uses single trait for person identification.The unimodal system also has many problems like, non-universality, noisy sensor data, etc. The problems of unimodal system overcome by using multimodal biometric systems, which uses multiple biometric traits for identification [3].

II. SYSTEM DESCRIPTION

The database images are acquised and restored in database for every subject. The samples of same subject are taken for each modality i.e. fingerprint, palmprint and handgeometry. There are different level of fusion available in biometrics. The feature levelfusion is most widely used because according to many researchers the feature level fusion produces better results. The performance of the biometrics system is given by the accuracy of the system.

This paper introduces the system model of a multimodal biometric verification system which is based on a fusion of fingerprint, hand geometry and palmprint features that are simultaneously acquired from a single hand image. The database contains images of left and right hand for every subject . Each of these palmprint images are used to extract specific features. Firstly, all the three modalities features are individually obtained from the same hand image. Secondly, the fingerprint and handgeometry features are combined as aJFV at feature lever fusion; and finally, a decision is made whether to accept or reject the person. Figure 1 shows the block-diagram of proposed multimodal biometricauthenticationbased on fusion of fingerprint, palm-print and handgeometry.

The rest of the paperorganized as follows - Section III gives background of related work in literature. Section IV gives proposed method which contains image acquisition, pre-processing, feature

extraction techniques, Section V discussed the experiments and results. Section VI summarily gives conclusion. Section VII gives acknowledgement.

III. LITERATURE SURVEY

The different purposes of multimodal biometrics system described in paper [1] Slobodan Ribaric et. al. gives a bimodal biometric verification system for physical access control based on the features of the palmprint and the face, palm matching is based on the adapted HYPER method.In paper[2] Teddy Ko gives various scenarios in multimodal biometric systems using fingerprint, face and iris recognition, the levels of fusion that are possible and the integration strategies that can be adopted to fuse information and improve overall system accuracy.

In [3] Antonia Azzini et. al. given idea about using a fuzzy control system to manage a multi-modal authentication system, checking the identity of a user. Gawande, U. et al [4] proposed a feature-level fusion framework for combining features of Iris and Fingerprint and algorithm Radial Basis Function based neural network (RBFNN) with accuracy rate 97.3%. The researchers also gives various scenarios in multimodal biometric systems using fingerprint, face and iris recognition, the levels of fusion that are possible and the integration strategies that can be adopted to fuse information and improve overall system accuracy. How the image quality of traits will affect the overall identification accuracy and the need of staffing for the secondary human validation and general working of multimodal biometrics system with Iris and Palmprint and fusion is done at the matching score level by Sum Rule technique , k-Nearest Neighbourhood (k-NN) based classifiers, adapted HYPER method, Wavelet transform, Multi-scale wavelet decomposition [5-8].

V. Conti, et al [9] have proposed multimodal biometric system using two different fingerprints. The matching module integrates fuzzy logic methods for matching score fusion. Both decision level fusion and matching score level fusion were performed.

Gawande, et al [10,11] used log Gabor filter and 2D Gabor filter can be used to extract the feature vectors from both Iris and Fingerprint and then they are concatenated. Hamming distance (HD) is used to generate a final match score. Asim Baig, et al [12] proposed a state of the art framework for multimodal biometric identification system which can be adapted for any type of biometrics to provide smaller memory footprint and faster implementation. The recognition rate is 90%. Cheng Lu, et al [13] suggested idea which utilizes two or more individual modalities, like face, ear, and fingerprint, to improve the recognition accuracy by new dimensionality reduction method called Dimension Reduce Projection (DRP). The recognition rate is 95.8%.

Mohammad Imran, et al [14,15] proposed a new hybrid approach to verification aspect of a multi-biometric system and comparative analysis with traditional approaches such as multi-algorithmic and multimodal versions of the same. As well as the system based on fusion of whole dorsal hand geometry and fingerprints that acquires right and left (Rt/Lt) near-infra-red (NIR) dorsal hand geometry (HG) shape and (Rt/Lt) index and ring fingerprints (FP). Accuracy rate is 99.71%. Feifei CUI, et al [16] proposed multimodal biometrics recognition based on score level fusion of fingerprint and finger vein. Recogntion rate is 98.74%. Nishant Singh, et al [17] presents an efficient multimodal biometric system based on 4 slap fingerprint images. The system utilizes 4 slap fingerprint scanner to simultaneously collect fingerprints of multiple fingers on a hand in one image. Decision threshold is 0.9869 and FAR is 5.08%.

IV. PROPOSED METHOD

The following block diagram shows the overall representation of proposed work :-

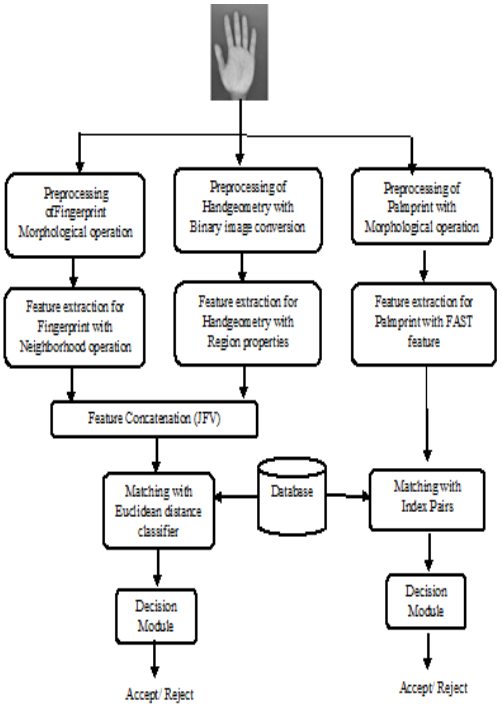

Fig. 1 Block diagram for Proposed Work

The first step is data acquisition with different types of sensors. In second step preprocessing like morphological operation like thinning, opening. Binary imageconversion, etc. Different algorithms are used for feature extraction in third step. After that Joint feature vector is created for fingerprint and handgeometry feature vectors. Feature vectors are trained as training and testing matrix. In fourth step matching module euclidean distance classifier is used for classification and testing image is matched with database image and decision is made. And palmprint features are already classified hence they are directly matched and decision is made. Accordingly image is accepted or rejected.

A. ***Image Acquisition***

In first step images are scanned on Crossmatch sensor for fingerprint in two different modes of acquisition i.e. Single Flat mode (SF) and Single Flat Flexi mode (SFF) for left and right hand of subject. The only difference between these two mode is that in SF mode subject is restricted with area to place finger on the acquisition area and SFF mode allows to put finger anywhere in acquisition area. For handgeometry the full hand images are used which is scanned with the help of HP Laserjet scanner. The center region between finger and wrist is used as palm. In this experiment thecenter region of handgeometry images of specific size are used as palm for future use. The KVKR multimodal biometrics database contains all these images. From the database, total 1120 images of fingerprint, 112 images of handgeometry and 112 images of palmprint for left and right hand of 7 subjects are used for the purpose in this research.

B. ***Pre-processing Module***

In second steppre-processing technique are applied to each trait. For fingerprint morphological thinning and median filter is used. For handgeometry the colour images are converted into grayscale images. After that morphological opening is done to eliminate background illumination. The grayscale image is converted into binary image by using thresholding and background noise is removed. All connected components in images are find out. The palmprint images are colored images they are converted into grayscale images. The specific threshold value is set for future processing.

C. ***Feature Extraction Module***

The third step is feature extraction for all three traits. The feature extraction of fingerprint images done with nlfilter 3 x 3 sliding neighborhood operation. With the help of this operation extracted minutiae as termination and bifurcation for all samples. For feature extraction of handgeometry images region properties are used. Region properties gives geometric features of the shape. In this research various features are extracted for handgeometry such as Height, Width, Area, Perimeter, Bounding Box, Majoraxislength, Minoraxislength. In case of palmprint feature extraction is done with new technique i.e. Features from Accelerated Segment Test (FAST) algorithm. This algorithms finds the corner feature points in two or more images. This corner points are common for both images in the form of Index pairs. The algorithm gives count of total number of index pairs in two images at the standard threshold value 0.031. Joint feature vector is prepared by concatenation of fingerprint and

handgeometry feature vectors. And palmprint feature vector remains isolated.

D. ***Matching Module and Decision Module***

The system is then trained with training and testing matrix. For fingerprint the mean of 6 samples out of 8 samples is calculated and considered as training matrix for both features. The remaining two samples are considered as testing samples of termination and bifurcation . Feature matrix for fingerprint of termination where SF and SFF feature matrix are taken is individually for left and right hand. After this SF and SFF termination were considered in combination. Same procedure is repeated for bifurcation for left and right hand of all subjects. For handgeometry from total 112 images of 7 subject mean of 6 samples is taken and considered as training matrix for left and right hand for each subject. Remaining two samples are considered as testing matrix.

In case of palmprint we used 112 images for 7 subject of both left and right hand. From 112 we used 98 for training and remaining 14 for testing matrix. 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.

In orderto feature fusion, these two individual feature vector of fingerprint and handgeometry are concatenated into single feature vector called as Joint feature vector at feature level fusion. Euclidean distance classifier is used for classification purpose on the Joint feature vector. The distance matrix is calculated which contains pairwise distance between two feature values. The JFV compared with JFV template in database on the basis of minimum threshold value. Finally, a decision is made whether to accept orreject the person.By comparing results of these two images we can easily recognize the particular subject. If the image sample belongs to same person then the both image contains maximum no of matching corner points in common called as index pairs. If the images doesn't belongs 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. The resultant matrix contains total number of index pairs for each pair of tested image samples. This test gives appropriate idea about the test sample belongs to which subject. Afterwards this matrix for further analysis and ease of use is reduced to the classification matrix which contains the total number of samples correctly classified in particular class for each subject. There is no need of using any specific classification technique. Then decision is made for person accepted or rejected .

V. EXPERIMENTS & RESULTS

In this research work the multimodal biometrics system is developed. For that purpose feature level fusion of fingerprint and handgeometry is done. Matching is done with the help of euclidean distance classifier. The decision is made whether the person is accepted or rejected.

Table 1. Distance matrix of JFV for fingerprint and handgeometry

Left hand

Subject	Sub1	Sub2	Sub3	Sub4	Sub5	Sub6	Sub7
Sub1-7	3267.658	284437	339516.7	274960.9	325418.5	286776.5	302118.4
Sub2-7	288755.5	1201.02	53912.51	10887.21	39822.62	2122.023	16613.62
Sub3-7	339393	51824.31	3537.448	61346.52	10883.64	49528.04	34181.51
Sub4-7	292216.9	5285.972	50498.58	14230.57	36390.72	3467.44	13104.81
Sub5-7	335806.8	48250.49	6983.839	57718.99	7350.942	45911.9	30612.53
Sub6-7	289869.4	3286.282	52829.74	11814.22	38743.99	1226.521	15560.49
Sub7-7	301828.8	14404.44	40883.64	23797.57	26783	12219.23	3472.28
Sub1-8	176406.93	26994 1.1	32502 1.3	26045.9	31092 2.4	27228 3.6	28762 0.2
Sub2-8	289192.5	1697.334	53477.74	11325.47	39389.6	2005.917	16184.88
Sub3-8	337536.4	49968.13	5290.838	59487.46	9018.347	47675.44	32328.03
Sub4-8	276108.4	11730.12	66586.6	2373.971	52499.45	13882.99	29230.9
Sub5-8	335731.8	48161.52	6969.817	57650.49	7237.094	45826.15	30532.69
Sub6-8	291367.5	4382.899	51328.78	13420.21	37256.34	1608.291	14153.01
Sub7-8	300484.5	13064.78	42219.05	22458.11	28118.69	10864.46	4816.994

Table 2. Distance matrix of JFV for fingerprint and handgeometry

Right hand

Subject	Sub1	Sub2	Sub3	Sub4	Sub5	Sub6	Sub7
Sub1-7	2836.662	289440.2	347092	304025.7	346339.4	305034.6	292637
Sub2-7	281276.9	5340.82	629900.57	200406.99	622409.37	210004.27	9011.169
Sub3-7	351934.1	653204.46	7676.452	507706.55	8486.449	497501.57	621808.41
Sub4-7	299458.5	130105.83	448407.91	2141.465	440903.08	3220.166	9754.684
Sub5-7	349194.7	625906.15	5025.543	480200.23	5689.169	470007.74	594308.59
Sub6-7	302666.6	161904.02	416401.48	1741.283	408704.25	924.0298	130202.84
Sub7-7	288562.9	3701.297	557803.85	127305.46	550108.52	139103.68	1343.769
Sub1-8	6762.943	293345.8	350997.1	307929.2	350244.2	308940.4	296538.1
Sub2-8	280999.8	5616.069	632606.96	203107.83	625203.89	212708.56	9272.132
Sub3-8	353354.1	667407.11	9106.194	521905.6	9888.079	511705.92	636005.89
Sub4-8	299459.7	130602.18	448506.63	2033.952	440903.1	3203.518	9741.977
Sub5-8	346049.4	594505.56	2031.234	448804.32	2572.835	438608.23	563004.67
Sub6-8	303027	164904	412602.4	2295.984	405003.91	1076.31	134409.15
Sub7-8	283442	4377.674	608903.52	178502.48	601303.95	189608.96	6454.755

In above table 1 and 2 the highlighted cells indicates correctly classified values and highlighted values indicates the misclassified values for left and right hand.

Table 3. Recognition Rate JFV of Fingerprint and Handgeometry

Test	Total no of sample tested	Correct classified	Miss classified	RR
Left hand	14	11	3	78.57 %
Right hand	14	11	3	

Total 28 test samples are tested for Joint Feature Vector of fingerprint and handgeometry. Out of which 22 are correctly classified and 6 are misclassified. The reason for miss-classification is the poor quality of images.

On other hand , the palmprint we used 112 images for 7 subject of both left and right hand. From 112 we used 98 for training and remaining 14 for testing matrix. 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 the both image contains maximum no of matching corner points in common called as index pair. If the images doesn't belongs 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. The resultant matrix contains total no of index pairs for each pair of tested image samples. This test gives appropriate idea about the test sample belongs to which subject. Afterwards this matrix for further analysis and ease of use is reduced to the classification matrix which contains the total no of samples correctly classified in particular class for each subject. The 'x' entry indicates that no match in corresponding class. The table 14 shows classification matrix for palmprint samples.

Table 4. Classification matrix for palmprint samples

Test Sample	Sub1	Sub2	Sub3	Sub4	Sub5	Sub6	Sub7
	Class-1	*Class-2*	Class-3	*Class-4*	*Class-5*	*Class-6*	*Class-7*
Sub1-8	8	x	x	x	x	x	x
Sub2-8	x	8	x	x	x	x	x
Sub3-8	x	x	8	x	x	x	x
Sub4-8	x	x	x	8	x	x	x
Sub5-8	x	x	x	x	8	x	x
Sub6-8	x	x	x	x	x	8	x
Sub7-8	x	x	x	x	x	x	8

For palmprint the feature are correctly classified into corresponding classes.As the success rate of palmprint is 100% , hence there is no need of fusion of palmprint with other two modalities. The following table clearly shows recognition rate of Palmprint samples.

Table 5 : Recognition Rate for Palmprint samples

Sub	Total no of sample tested	Correct Classified	Miss Classified	RR
Sub1	8	8	0	100 %
Sub2	8	8	0	
Sub3	8	8	0	
Sub4	8	8	0	
Sub5	8	8	0	
Sub6	8	8	0	
Sub7	8	8	0	

The table 6 represents the individual recognition rate for each modality.

Table.6. Individual Recognition Rate For Fingerprint, Palm and Handgeometry for both left and right hand

Test	Total no of sample tested	Correct classified	Miss classified	RR
Fingerprint	56	50	6	89.29 %
Palm	56	56	0	100 %
Hand	32	30	0	90.63 %

The Overall Recognition rate of Multimodal biometrics system with JFV of Fingerprint &Handgeometry , Palmprint is as shown in Table 7.

Table.7. Individual Recognition Rate For Fingerprint, Palm and Handgeometry for both left and right hand

Test	Total no of sample tested	Correct classified	Miss classified	RR
Fusion of Fingerprint & Handgeometry	28	22	6	78.57 %
Palm	56	56	0	100 %

5. CONCLUSION

The results clearly indicates the significance of the method used in this research work. The results of fingerprint recognition was improved because of combination of features of SF, SFF mode.The region properties are easy way to identify unique features. The Joint Feature Vector is efficient way for feature level fusion of fingerprint and handgeometry in multimodal biometrics. For palmprint recognition the new approach FAST feature algorithm reduces number of comparisons and provides easy recognition rate because it gives direct discrimination between image samples. It also helpful in reducing overhead of fusion as it gives highest recognition rate.

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