PALM AND HAND GEOMETRY FEATURES HAND RECOGNITION USING

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ABSTRACT: *Biometric recognition is an emerging technology and attaining high performance from last several years. Our proposed system focuses on multiple features derived from a single template. The aim of this work is to combine palm print and hand geometry feature to achieve accuracy and high performance. The features of interest in proposed system are hand geometry, palm length, palm width and palm ratio. Hand geometry consists of hand length, hand width, fingers length and fingers width. These features are integrated to form a combined feature vector. Proposed system extracts only those features which are invariant to small variations in position of hand. A total of 20 features are obtained from each image by creating bounding box of each object, a combined feature vector of extracted 20 features are formed. An average of combined feature vector is calculated by comparing the combined feature vector with stored templates. The proposed system efficiency is calculated using true positive, true negative, false positive, false negative, accuracy and runtime. The system achieves an accuracy of 95.5%.*

Keywords: Biometric, palmprint, authentication, feature extraction, preprocessing, hand geometry.

1. INTRODUCTION

Biometrics concerned with the unique, reliable and stable personal physiological properties such as fingerprints, facial features, palm print, retina and hand geometry, or some feature of behavior, such as speech and handwriting, is emerging as the most perfect source of automated personal identification. Hand recognition has several advantages over other biometric such as a retina, iris, fingerprint etc. Hand is considered as the most easily accessible biometric and highly accepted by the users. Unlike other biometrics hand geometry features are easily accessible from low resolution images. Biometric authentication consists of two phases, in first phase users database is created where users biometric samples are stored while in second phase user matching is performed with database against the captured biometric samples.

Fig 1: Original image

Biometric application can be deployed specially in law enforcement, government offices, commercial offices, health-

care center, traveling and immigration system. The key feature of palm print and hand geometry based system is that it is user friendly. The process is fast and easy to implement. There is no technical knowledge required for the operation of system. For medium level organization hand based recognition is highly accepted due to its universality, accessibility and low cost.
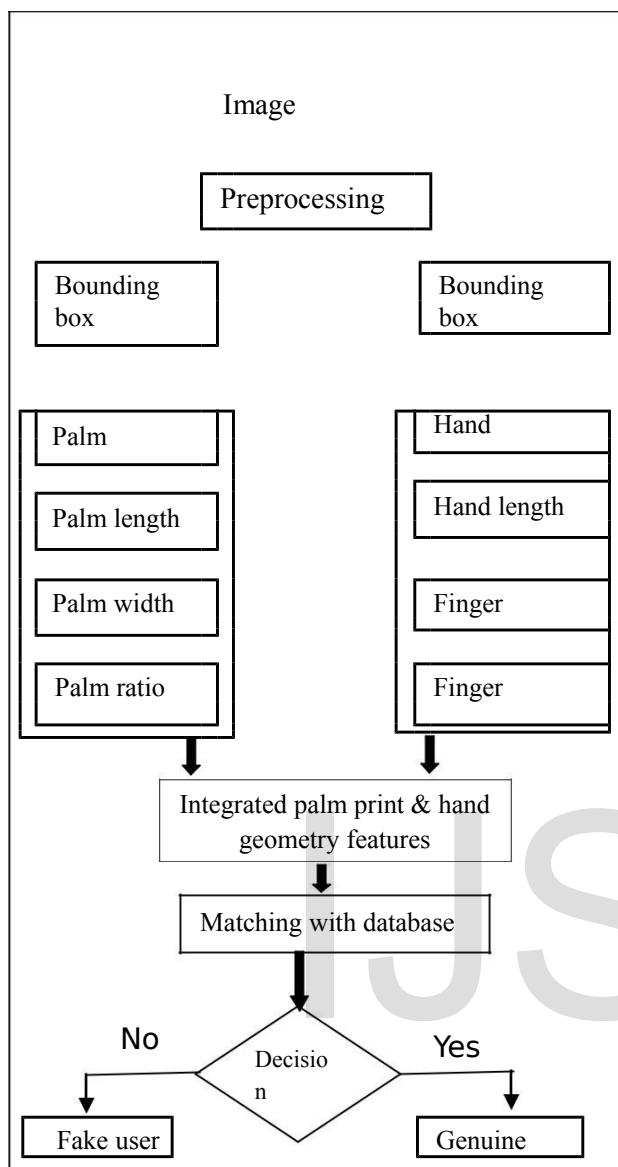
2. RELATED WORK

Multiple methods have been suggested for hand recognition. However the proposed methods differ in features and extraction of features of hand and palm.

Y. Bulatov et al.have presented a geometric classifier used in hand recognition. In this paper total of 30 features are selected for hand recognition [1]. Bounding box is found for

each of the training set. The difference of the query image to stored template is used as the measure of similarity. The system is tested on 714 hand images of 70 people. The system attains FAR of below 1% and FRR of below 3%. Bahareh Aghili et al. [2] has presented a technique to identify individual based on hand geometry. They have extracted fifteen features from user hand image like fingers width, area and circumference. These features are categorized with two different pattern recognition systems that are absolute distance and euclidean distance. The algorithm is tested on 500 images of 50 users. The system performance is shown in identification and verification stages. Ahmed Mostayed et al.have presented an authentication system from hand images [3]. This method validate with entire hand shape. Radon transform calculate peg free features and location invariant features. Features are extracted from low resolution hand images captured by document scanner. The proposed method has been tested on a total of 136 images with Euclidean distance. The proposed scheme achieves an Equal Error Rate (EER) of 5.1%.Karen H. Suaverde et al.have presented a hand geometry feature system designed to authenticate the users and prevent fake users using the system [4]. A database is used for the storage of hand images. The system extract feature from test image and compare the feature with stored images. The system achieves 95% success rate and 5% false acceptance rate. Dew Yanti et al. presented methodology for palm recognition [5]. Two methods were used for feature extraction, block-based line detection used for the extraction of palm print feature and chain code method is used to extract hand geometric features. The extracted features are combined and recognized using Dynamic Time Warping (DTW). The experiment was tested on 200 images of 50 users. In proposed work the combination of palm print and hand geometry has the highest accuracy rate of 89%. Hafiz Imtiaz et al.have proposed a novel preprocessing algorithm to detect principal lines from palms [6]. Discrete cosine transform (DCT) is used for palmprint recognition. The entire image is

Fig 2: Block diagram of proposed system

divided into several spatial modules. Feature extraction is carried out in local zones using two dimensional discrete cosine transform (2D-DCT). This algorithm achieves

images are collected, converted into binary form, noise removal and contrast enhancement is performed. Second phase is feature extraction and in third phase matching is carried out.

In proposed system IIT Delhi Touch less Palmprint Database is used. IIT Delhi is a public domain database. The images are collected from the students and staff of the IIT Delhi, india in 2007 for the purpose of experiments and research. All the images are in bitmap (.bmp) format. The resolution of the images is 800*600 pixels. The available database is from 235 users, ten images from each subject, from each of the left and right hand, are acquired in varying hand pose variations.

Preprocessing: In preprocessing the first step is the acquisition of the image. The resolution of the images are 800 x 600 pixels. The image is then converted into binary image to differentiate between object and background. After converting the image into binary, the extra area from the image is eliminated.
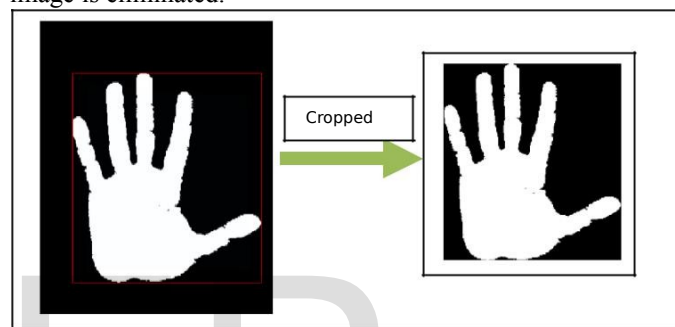

Fig 3: Binary and cropped hand image obtained from gray scale image

Morphological operations are applied to remove noises from the images.

To improve the contrast of the image, imadjust [10] is applied which smoothly map the intensity values and increase the contrast of the image. Fig 4(b) show the image after applying imadjust function.
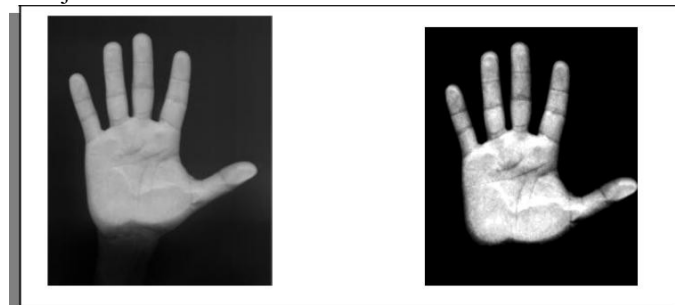

Fig 4(a): Original Image   (b): After Contrast Adjustment

recognition accuracy of 99.94%.De-Shuang Huang et al. proposed a novel verification approach based on principal lines [7]. Random transform is used to extract principal lines efficiently. For the similarity measurement between two palms, pixel to area comparison is used. The experimental results are quite strong. Jain and Duta [8] developed a verification system that aligns finger contours and measure the mean alignment error between them. They experimented with 353 images from 53 persons and report FAR of 2% and FRR of 3.5%. Oden et al. [9] presented a scheme for identification and verification by means of implicit polynomials. They achieved 95% successful results in identification and 99% success rate in verification .A, Kumar et al. [11] have presented performance of bimodal system. Discrete Cosine Transform (DCT) coefficient is used for palmprint authentication. The system has been tested on a database of 100 users.   They achieved 90% accuracy with 0.43 FAR and 0.6 FRR.

 PROPOSED METHODOLOGY

The Fig 2 describes our proposed algorithm which consists of three phases. First phase comprises of preprocessing in which

Feature Extraction: In this module different features are extracted from hand image. The proposed system extracts one measurement of length and three measurement of width for each finger. The thumb is not included in feature extraction process. The length and width of palm, hand length and palm ratio are also included in feature extraction process. A total of 16 features are extracted from 4 fingers. Including length and width of palm, palm ratio and hand length makes total of 20 features. Each finger and palm is considered as separate object. Bounding box of each object is retrieved from which length and width is measured. Finger is divided in three

different points i.e top, middle and bottom to calculate finger width. Feature set is given in table 1.

Table 1. Feature set of proposed system

S. No	Name of feature	S. No	Name of feature
F 1	Little finger length	F 11	Middle finger width top
F 2	Ring finger length	F 12	Middle finger width middle
F 3	Middle finger length	F 13	Middle finger width bottom
F 4	Index finger length	F 14	Index finger width top
F 5	Little finger width top	F 15	Index finger width middle
F 6	Little finger width middle	F 16	Index finger width bottom
F 7	Little finger width bottom	F 17	Hand length
F 8	Ring finger width top	F 18	Palm length
F 9	Ring finger width middle	F 19	Palm width
F 10	Ring finger width bottom	F 20	Palm ratio

Hand length: hand length is calculated from the cropped binary image as shown in Fig 3. The bounding box returns the starting and ending pixel of the object. So from this we can get starting pixel (x1, y1) and ending pixel (x2, y2).

Finger length: Finger length is important feature of the proposed system. As fingers are not in the position to get length and width, Hough transform is applied to detect the line of the finger. Angle is calculated from the line to rotate the fingers in straight direction [13]. Fig 5 represents different process done by the system for features extraction from fingers respectively.

Fig 5: (a). Binary image of fingers   b. Single finger

c. Hough Transform Applied   d. Rotated using returned angle from   fig 5(c)

The same process is repeated for all fingers to align in single position.

Finger width: Fingers width is calculated in three different positions that are in top, middle and bottom of the finger. For calculation of width of the finger, the initial and final pixel of finger is measured. The finger length is divided in three parts i.e top, middle and final respectively (Xi, (Xi+Xf)/2, Xf), and then width is calculated from initial pixel to final pixel. Fig 6 presents the width of finger graphically.

Fig 6. Finger divided in three points

Palm Width and Height: Palm can be extracted from the hand by applying morphological operation on the image. After applying morphological operation the fingers are removed from the image and single palm is extracted. After getting the palm from the hand image, the bounding box of the palm is measured. Fig. 7 shows bounding box of the palm.
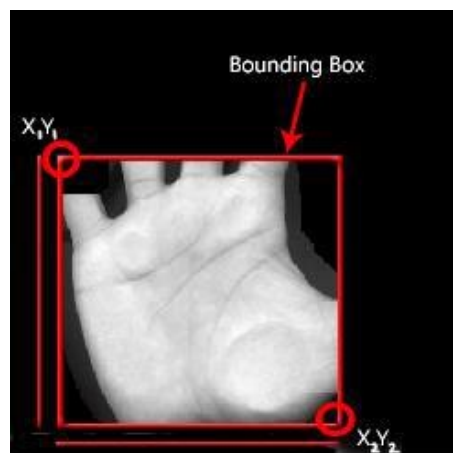

Fig. 7: Bounding box of palm

Palm ratio: Palm ratio is measured from the ROI of the palm. Palm ratio is calculated from the height and width of the respective palm. Width and height are represented by variable „m" and „n" respectively. Palm ratio can be calculated from the following formula.

$$Pr = m/n \qquad (1)$$

Where Pr represent palm ratio.

3. MATCHING MODULE

Features that are obtained from the input image are matched against template stored in the database. Matching is done by using correlation coefficient. Correlation coefficient is calculated using below given formula [12].

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{(\sum_m \sum_n (A_{mn} - \bar{A})^2)(\sum_m \sum_n (B_{mn} - \bar{B})^2)}} \qquad (2)$$

A predefined threshold is determined, on the basis of which match score is measured. In the proposed system if the similarity ratio is less than the predefined threshold, the system reject the hand as an invalid hand. Threshold value is set to 6.5, it means that if the similarity ratio is less than the specified value then the match will be rejected. Maximum similarity ratio is 7.5.

The similarity ratio of each image is calculated and stored in an array. All calculated values are combined and average is calculated.

$$C.F = \sum_{i=1}^{n} (fi)/n \qquad (3)$$

Where "C.F" is the combined feature vector and n is the natural numbers which denotes features of each user.

The advantage of this combined feature vector is that if some features are compromised in an image the overall performance of the system will not be declined. This will increase the matching probability of the images.
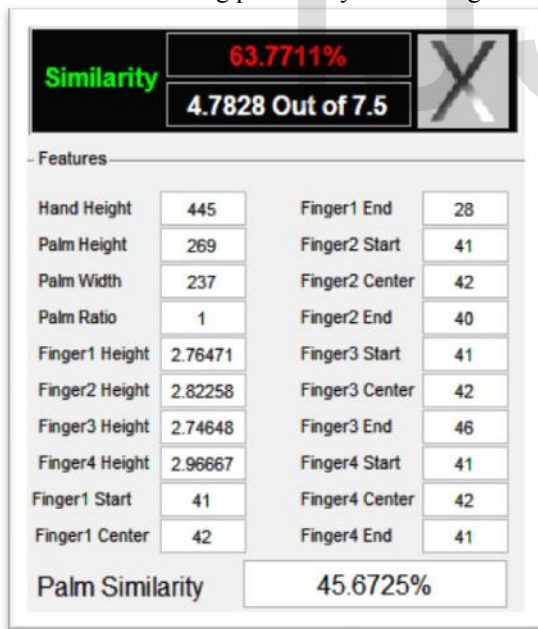

Similarity	63.7711%	X
	4.7828 Out of 7.5	

Features

Hand Height	445	Finger1 End	28
Palm Height	269	Finger2 Start	41
Palm Width	237	Finger2 Center	42
Palm Ratio	1	Finger2 End	40
Finger1 Height	2.76471	Finger3 Start	41
Finger2 Height	2.82258	Finger3 Center	42
Finger3 Height	2.74648	Finger3 End	46
Finger4 Height	2.96667	Finger4 Start	41
Finger1 Start	41	Finger4 Center	42
Finger1 Center	42	Finger4 End	41
Palm Similarity		45.6725%	

Fig 8: Features along with similarity ratio

4. DECISION

Decision module of the proposed system is used to take decision on the basis of pre calculated values and produce result in the form of user acceptance or rejection. The proposed system takes decision on the basis of template similarity. Cumulative similarity is calculated from five templates of user. Calculated cumulative similarity is used for decision purpose. The system minimum similarity ratio is 87%.

5. RESULTS AND DISCUSSION

The system has been tested on 300 images of 30 users. The system uses 70% images as a training set and 30% images as a test data set . Each image of user is stored with user name and number. Fig 9 (a,b) shows user sample templates stored in database.
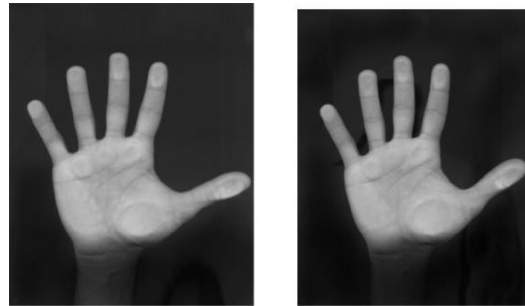

Fig 9(a). AARID1   Fig 9(b). AARID2

All the above feature extraction steps are applied on fig 9 and the results is shown in fig 10. Fig 10 depict the experimental view of the proposed system.

Fig 10: (a) input image (b) palm print (c) binary fingers (d) stored template (e) finger length and width measurement (f) palm ratio

The system is being tested for calculating the value of FAR and FRR. In 300 tests for false acceptance, a total of 18 fake images are accepted. Similarly in 300 tests for false rejections, a total of 9 genuine images are rejected by the system. In this experiment false acceptance rate and false rejection rate is calculated which are 0.06 and 0.03 respectively. The proposed system has been compared with other methods such as [5,11]. The two methods are very relevant to proposed methods, and it was desired to see how better is the proposed method in comparison to these algorithms.

In table 2 Comparison is shown among proposed system FAR and FRR with other algorithms.

Table 2. Shows FAR and FRR of proposed system

S.#	ALGORITHM	FAR	FRR
1	Proposed System	0.06	0.03
2	Dynamic Time Warping [5]	0.12	0.11
3	Bimodal System [11]	0.43	0.6

Proposed system has been incrementally tested on data set of 100, 200 and 300 images, respectively. The system produces the same result with no variation in accuracy.

The system has been tested for run time and accuracy, and compared with other algorithms. The proposed system demonstrated encouraging results. The system achieves 95.5% accuracy which is comparatively better than the mentioned methods [5,11]. The proposed system produces 95.5% accuracy on a maximum run time of 0.6s. Accuracy of system is calculated using the following formula.

ACC= (TP+TN) / (P+N)   (4)

Table 3. Comparison on the basis of accuracy

S.#	ALGORITHM	DATA SET	ACCURACY
1	Proposed System	300	95.5%
2	Dynamic Time Warping [5]	200	89%
3	Bimodal System[11]	100	90%

Table 3 evaluate comparison of proposed system with others techniques on the basis of accuracy. It is concluded that the accuracy rate of proposed system is better than other.

6. CONCLUSION

The overall performance of the proposed system shows that the proposed work can be used for verification purpose in medium level organization. The system has been tested for different security measurements which produce good results, however improvement is possible in proposed system. Proposed system is compared with other algorithms such as [5, 11]. This system mostly depends on the hand geometry of the system and palm length and width. The system can be further upgraded by minimizing the processing time, improving security level and the use of neural based classifier trained on huge database.

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