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Biometric Identification System :A Finger Geometry And Palm Print Based Approach

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ABSTRACT: Biometrics based personal identification is emerging as a powerful means for automatically recognizing a person's identity. The biometric computing-based approach is concerned with identifying a person by his/her physiological characteristics, such as iris pattern, retina, palm print, fingerprint, and face, or using some aspect of his/her behaviour, such as voice, signature, and gesture. Fingerprint-based personal identification has drawn considerable attention over the last 25 years. Also limited work has been reported on palm print identification and verification, despite the importance of palm print features. While Single featured systems are capable of providing low to mid-range security thus for enhancing the security multi Featured systems comes into the pictures. This paper presents a new biometric approach to personal identification using palm print and finger geometry technology. In contrast to the existing methods, this identification system employs low-resolution hand images to achieve effective personal identification. The system consists of two parts: the hand image is first pre-processed and finger geometry features of index, middle, ring and little fingers are extracted. Palm print features of hand images are extracted using Harris Corner Detector. A coarse-to-fine hierarchical feature matching is employed for efficient hand recognition.

KEYWORDS: Multi Featured biometric; finger geometry; palm print; decision level fusion; hierarchical matching**;** feature extraction; Pre processing

I. INTRODUCTION

Biometric is the science of measuring human properties for the purpose of authentication and identification. Human's body part, also known as human's physiological characteristics are less vulnerable to change compared to human's behavioural characteristics such as signature, posture and gait. Some of the human's physiological characteristics are fingerprint, face appearance, hand geometry, iris pattern and palm print. Palm print is harder to imitate than fingerprint due to its size, the curvature and the complexity of the palm features. Compared to face recognition biometric system, palm print biometric system is more acceptable by the public. The cost of the hand image acquisition devices for palm print biometric system is cheaper than the iris scanning biometric system. Moreover, palm print is unique and can be captured using a conventional digital camera. Palm print does not change much across time and same goes with finger geometry features. Feature extraction is a very crucial part in a biometrics system and has great influence on the recognition result. Recently, researchers have proposed many kinds of palm print feature extraction methods, such as transform-based [1][2][3][4][5][6], line feature-based [7][8][9][10], point feature-based, statistics-based [4][9] and texture-based methods. Palm print texture features are usually obtained from the transform-based feature extraction. Some of the methods are Wavelet Transform [5][9], Discrete Cosine Transform [1] and Fourier Transform [5]. Palm lines can be extracted using Sobel operators [10], canny edge operator and others. Recently, palm print statistical features are being introduced for palm print identification purposes.

Finger geometry technology possesses a number of key advantages. First, hand geometry recognition, along with fingerprint recognition, has been around the longest, and as a result, it has certainly proved itself to be a viable technology. Second, it is deemed to be one of the easiest to use and administer of all of the biometric technologies that are available today. Third, finger geometry recognition can work in the harshest of environments, both internal and external. In terms of an internal environment, the technology can tolerate a fair amount of rough usage from end users,

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especially in large factory, warehouse, and retail settings. With respect to an external environment, the technology has proven to work in the most extreme of atmospheric climates, ranging from very hot to very cold. Fourth, hand geometry recognition is the least susceptible to privacy rights issues-primarily because of its simple enrolment and verification procedures. Fifth, the hand is a stable biometric whose physical characteristics are not susceptible to major biological changes (except for conditions of arthritis, swelling, or deep cuts), thus making hand geometry recognition a very reliable technology.
Many companies implement hand geometry systems in parallel with time clocks for time and attendance purposes. Walt Disney World has used a similar "finger" geometry technology system for several years to expedite and facilitate entrance to the park and to identify guests as season ticket holders to prevent season ticket fraud. Multi Featured biometric hand-based authentication systems use various levels of fusion: (i) Fusion at the feature level, (ii) Fusion at the sensor level, where two or more sensors are concatenated; 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 [11][12].
This paper presents a Multi Featured system based on finger geometry and palm print features of human hand, so as to improve the recognition accuracy.

Biometricfeatures
Voice,Face,Lipsmovement
Fingerprint,Face
Fingerprint,Face,Voice
Fingerprint,Face,Handgeometry
Fingerprint,Voice,Handgeometry
Voice,Handgeometry
Facialtheromogram,Face
Iris,Face
Palmprint,Handgeometry
Earform,Voice
Voice,Lipsmovement

Table 1. Biometric features suited to fusion

II. SYSTEM ARCHITECHTURE

Usual structure of all biometric systems consists of two stages: registration and recognition/verification. Prior to a recognition session, users must enrol themselves in the system. In this paper, hand images of 50 users have been captured. For every user 7 images were captured, among the 7 images, 4 images were used for training purpose and 3 images were used for testing purpose. Thus distinctive database has been established for training and testing. Images are pre-processed and their finger geometry and palm print features are extracted to get the pattern from the training database. In this project, for recognition of the user, two different modules have been used. In module 1, the image from testing database is taken and its features are extracted for authentication. The input features are matched independently with features in the database.

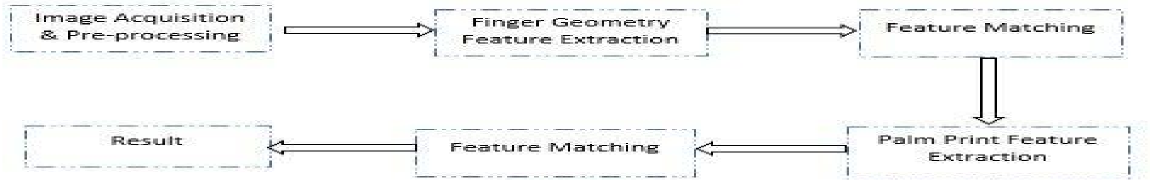

Fig.1 General Architecture of System

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III. HAND IMAGE PRE-PROCESSING

Firstly hand image is captured by digital camera. The RGB hand image is converted into gray scale image and then averaging filter is used to filter the gray scale which is further converted into a binary image. Morphological operations are performed on this binary image and then boundary of hand image is sketched. Seeing the reference point around wrist region, the Euclidean distance of every pixel on hand boundary region is calculated. The Graph of Euclidean distances obtained against hand boundary points is shown in Fig3c. From the obtained Euclidean distances, finger tips and valley points between fingers are marked and then by setting a co-ordinate system palm ROI (Region of Interest) is extracted. References on hand image pre-processing can be found in [1][2][3][4][11].

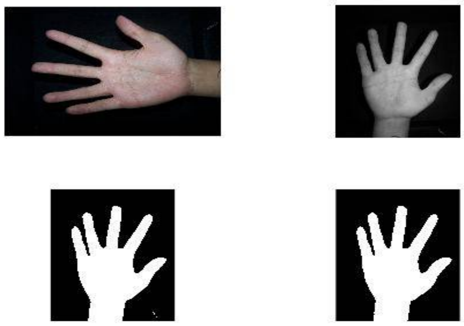

Fig.2Hand image in RGB format Fig.3preprocessing of image

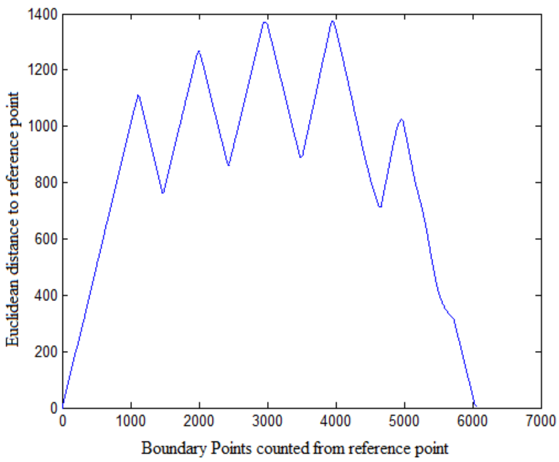

Fig.4Graph of Euclidean distance Fig.5Locating Fingertips and valleys Against boundary points

IV. MULTI-LEVEL HAND FEATURE EXTRACTION

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

A. Finger Geometry Feature Extraction:

Here all 5 fingers are considered. For every finger, length and widths at 3 different positions are computed [11]. To compute the length of finger, a line joining two valley points is drawn and centre of this line is marked.

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The line joining this centre 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 1/4th, half and 3/4th of the total length. Thus for every finger, four features are obtained. Same is repeated for other fingers to get total 20 features. The 21th feature is Palm width.

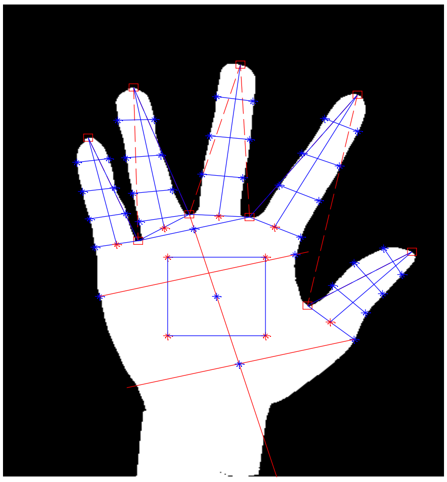

Fig.6 Finger Geometry Features

B. Palm Print Feature Extraction:

To get a palm print feature vector, Harris Corner Detector [13] 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:

1) Compute **x** and **y** derivatives of image.

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

2) Compute products of derivatives at every pixel

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

3) Compute the sums of the products of derivatives at each pixel

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

4) Define at each pixel ($\mathbf{x}, \mathbf{y}$) the matrix

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

5) 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 or 8×8 or 16×16 etc.) , 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

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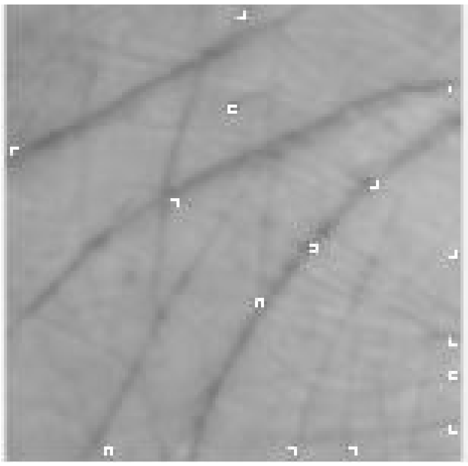
obtained. In this way, two feature vectors for every hand image are retrieved which are stored as a primary key in the database.



→

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

Fig.7 Palm Print with Corners and its binary matrix of size 4×4

V. FEATURE MATCHING

The two crucial feature vectors are extracted from every hand image. Geometrical features of fingers 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 this 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,

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

Minimum Euclidean distance gives the best match for recognition

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

+

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

→

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

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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.

VI. RESULTS

Hand images of 50 users have been captured using a digital camera and for every user 7 images are captured. Out of those captured 7 images, 4 images are used in training database while the remaining 3 images are used for testing purpose. The system which is been designed shows efficiency of results with accuracy of about 96.37% for module 1 and 97.65% with binary matrix of size 4×4 and 98.14% with binary matrix of size 8×8 and 16×16 for module 2. While for individual feature, accuracy of 96.87% for finger geometry and 97.72% with binary matrix of size 4×4 is 97.74% and for 8×8 is 98.14% with binary matrix of size 16×16 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.

Feature	Accuracy (%)
Finger Geometry	96.87
Palm Print with binary matrix of size 4 × 4	97.72
Palm Print with binary matrix of size 8 × 8	97.74
Palm Print with binary matrix of size 16 × 16	98.14

Methodology	Accuracy (%)
Module 1	96.37
Module 2 with binary matrix of size 4 × 4	97.56
Module 2 with binary matrix of size 8 × 8	98.14
Module 2 with binary matrix of size 16 × 16	98.14

Table II: Performance of the Individual Feature

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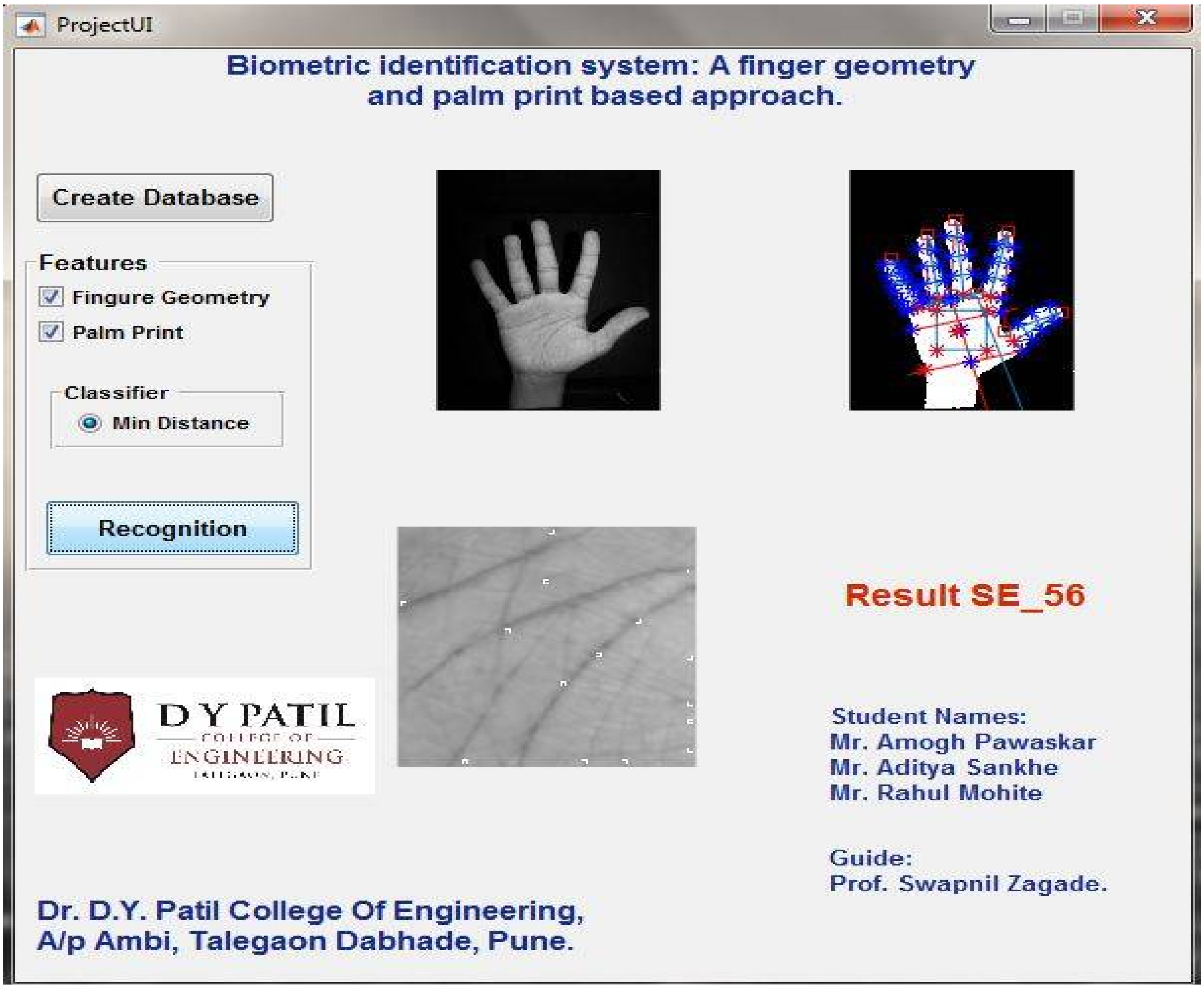

Fig.8 Project GUI

VII. CONCLUSION

In this paper, two approaches module 1 and module 2 have been successfully executed and tested to be effective as per the outcomes obtained through the various simulations. Among the two approaches, results shows, module 2 has superior accuracy and drastically reduced computational count (almost by half) than module 1. Among all several modules, module 2 with binary matrix of size 8×8 is the perfect system for personal identification and other security purposes, as it is seen to have minor change in accuracy improvement beyond binary matrix of size 8×8, which also restricts the computational count drastically. Both Modules are used for more suitable for high security applications.

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