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A Comparative Study of Palm Print Recognition Systems

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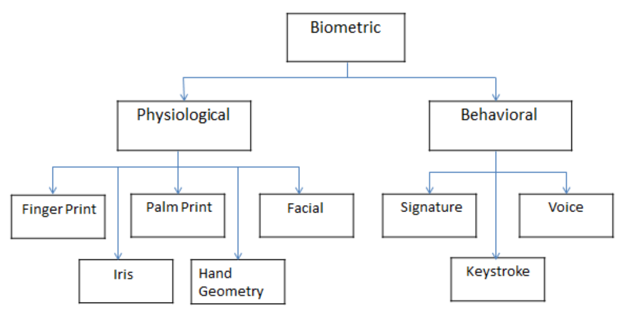
***Abstract*— In the biometric family, palm print based recognition system has become one of the active research topics. In this, the identification process consists of image acquisition, preprocessing, feature extraction and matching with the database. Palm print recognition being one of the extensively used biometric recognition system there are many methods and algorithms available to implement it. A comparative analysis listing the benefits and deficits in the established methods would give a clear and concise idea of the method to be approached for building a system that is more efficient and overcomes major faults present in the systems. This paper gives the general view of the concept of five different approaches used to implement a palm print recognition system and the comparative conclusion of the methods on the basis of specific parameters such as False Acceptance rate(FAR),false Rejection Rate(FRR), Equal Error Rate(ERR),etc.**

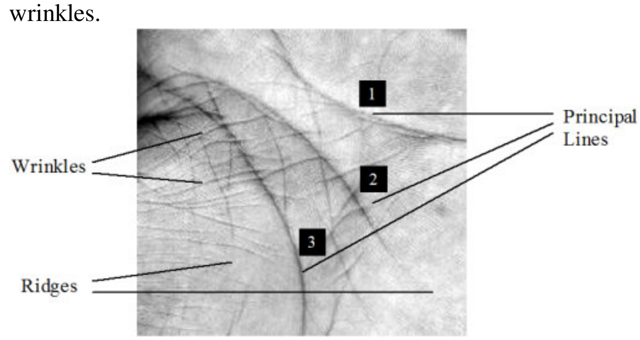
***Index Terms*—biometrics, palm print, recognition, image processing**

I. INTRODUCTION

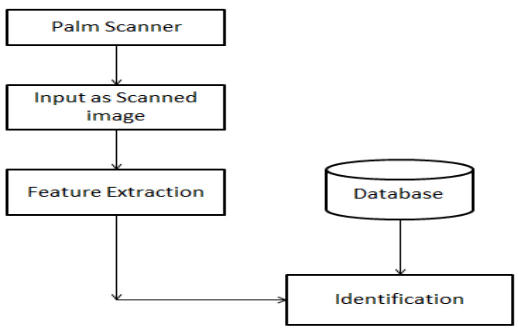
Biometric is one of the most secure and convenient authentication tool. Biometric based recognition systems are becoming popular in the field of personal identification/verification over the past decade. Based on the traits used for identification, biometrics is broadly classified into two categories such as behavioural and physiological as shown below. In biometric system, physiological characteristics/traits are considered to be more reliable compared to the behavioural characteristics.



Palm print here comes under the physiological category, it refers to an image acquired of the palm region of the hand.Palmprint focuses on the inner surface of a hand, the shape of the surface and the pattern they form.Palmprint contains more amounts of detail in terms of principal lines, wrinkles, creases and epidermal ridges. The inner surface of the palm print mainly contains three flexion creases, secondary creases and ridges. The flexion creases are also called as principal lines and the secondary creases are called wrinkles.



The Palm print recognition system follow these steps:
Palm Scanning, which is the first step, where the user scans his palm.This is followed by Preprocessing, where several filter operations are performed which intensify or reduce certain image details which enables an easier or faster evaluation. After Preprocessing, Feature extraction is done, where the region of interest is extracted from the palm print using several approaches.Then Identification is done using the Palmprint Database, where matching is performed for authentication.



II. Different Palm Print Algorithms

1. Scale Invariant Transform Feature Extraction (SIFT)

Many times when a images goes under certain transformation like, deletion of pegs or other auxiliary schemas on image acquisition devices can unavoidably introduce variations of palm print images due to hand unsteadiness. In such cases, this method is used to solve the problem, this method proposes a palm print image alignment method based on SIFT features.

SIFT (Scale Invariant feature transform) features are based on local information, which are invariant to image shift, scale, and rotation variations, and partially invariant to illumination and projective changes. Thus, it is more stable than principle lines for image alignment and can also align images with affine and projective variations.
In SIFT based algorithm, image is first preprocessed using Gabor filter. After preprocessing the image is then for SIFT feature extraction where Scale space construction is performed followed by Key point localization. Orientation assignment is done which is then followed by Descriptor computing. After feature extraction proper alignment is to be done using the Homographic matrix. Given any point in one image, in the homogeneous coordinate system [x, y, 1]^T, the corresponding point in the second image is given by

[x' ,y' ,c] = H [x, y, 1]^T

If the number of correspondences is less than 4the homograph cannot be solved. After image alignment, the query image and the gallery are better aligned, and traditional feature extraction and 4 matching methods can make most of their advantages.[3]
The competitive code algorithm applies a bank of modified Gabor filters with different orientations to palm print images, and encode the orientation into 3 bit-planes

$$G(x,y,\sigma,\delta,\theta) = \frac{\omega}{\sqrt{2\pi}\kappa}\exp\left(-\frac{\omega^2}{8\kappa^2}(4x'^2+y'^2)\right)\left(\cos(\omega x') - \exp -\frac{\kappa^2}{2}\right)$$

with

$$x' = (x-x_0)\cos\theta + (y-y_0)\sin\theta$$
$$y' = -(x-x_0)\sin\theta + (y-y_0)\cos\theta$$

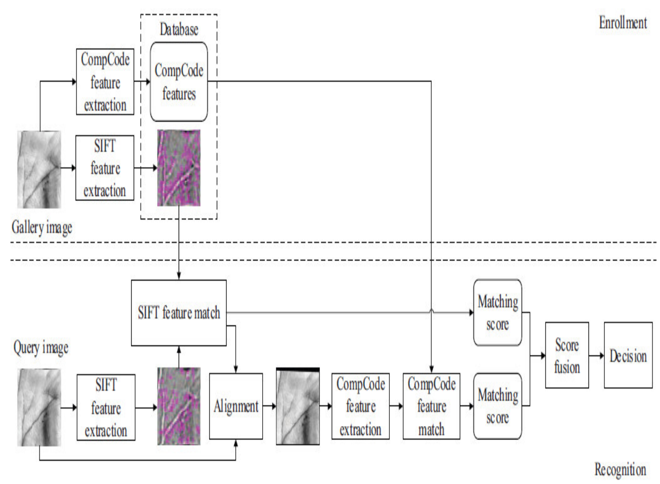
Six orientations angles are selected for competition. The winning index is encoded into binary code (competitive code) so that the difference between two competitive codes can be measured by the count of different bits in their encodings, and hence the difference can be efficiently computed using Hamming distance.[3]

$$d(P,Q) = \frac{1}{3MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\sum_{i=1}^{3} P_b^i(x,y)\otimes Q_b^i(x,y)$$

And then finally score fusion is performed using this formula.

$$d = w d_{\mathrm{SIFT}} + (1-w) d_{\mathrm{CompCode}}$$

This is how SIFT based algorithm works.



2. Implementation of Multimodal Biometrics Recognition System Combined Palm Print and Palm Geometry Features.

In this approach, image-processing technique is used to make a system that receive palm image of a person and determine identity of those person. We combine palm-print feature and palm geometry feature to create a multimodal biometric recognition system. Palm geometry feature is compute base on 16-point marker that already determine. While palm print compute using line detection in ROI of palm.

In Palm feature acquisition, we observe that the geometric structure of the hands of every person is different. From hands we can extract feature such as finger length, palm width, thickness of a finger, etc. Palm-print feature can be found extracting line print in Region of Interest in palm image, usually on centre of palm we use line detection and image enhancement technique to make this line more visible. Image pre-processing however is used to make the image more appropriate for extraction process. It consists of 4 processes :(a) Luminance Extraction,(b)Binary image conversion, (c)ROI measurement, (d)image normalization The luminance value of an image is calculated as follows:

$$I(x, y) = 0{,}299 \cdot R + 0{,}587$$

After luminance extraction, it is converted into binary image which changes the palm colour to white and background to black[1]. For ROI we use pixel with size 160x160 pixel. Intensity normalization based on mean and variance of histogram image analysis using equitation

$$I'(x,y) = \begin{cases} \phi_d + \lambda & \text{if } I(x,y) > \phi \\ \phi_d - \lambda & \text{otherwise} \end{cases}$$

with

$$\lambda = \sqrt{\frac{\rho_d \{I(x,y) - \phi\}^2}{\rho}}$$

Where ϕ, ρ_d is mean and variance of desired image that defined base on experiment. In our research we use ϕ=180 and ρ_d=180. λ is normalization step that computed base-on mean and variance

During Feature Extraction, from binary image of palm we can compute palm geometry feature like palm width, finger width and finger length. The features are then modified to compute 16 measurement of palm geometry in order to create feature vector of every person. Palm-print feature computed using line-detection in 4 directions (0o, 45o, 90o, 135o) using mask filter size 9*9 after line-detection process the result is divided into block area with size 20x20 and the standard deviation of magnitude of each block computed to make a feature vector. With ROI area size 160x160 pixels and block area 20*20 we have 64 palm-print feature vectors.[1]

Matching for verification and recognition is done by Normalize Euclidean-Distance.

$$\bar{d}(u,v) = \sqrt{\sum_i (\bar{u}_i - \bar{v}_i)^2}$$

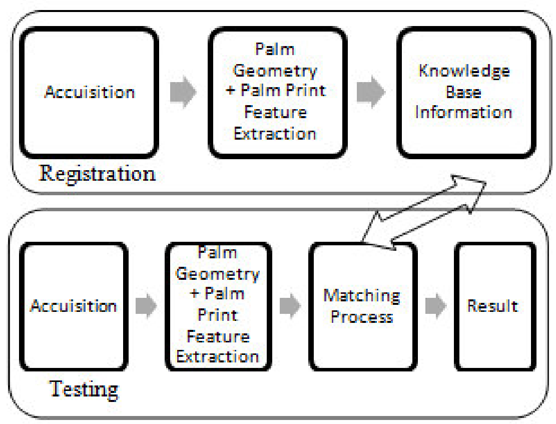
$$\bar{u}_i = \frac{u_i}{\|u\|}, \qquad \bar{v}_i = \frac{v_i}{\|v\|}$$

$$\|v\| = \left[\sum_i v_i^2\right]^{1/2}$$

Where u is feature vector from test data and v is feature vector in knowledge base which compared and has its unit vectors.

In feature fusion, the score value is calculated using

$$Score = \alpha * d_{hand}(u1, v1) + \beta * d_{palm} d(u2, v2)$$



3. A DCT-based Feature Extraction Algorithm for Palm-print Recognition

DCT stands for Discrete Cosine Transform. In comparison to person recognition based on face or voice biometrics, palm-print based recognition becomes very difficult even for a human being. For any type of biometric recognition, feature extraction is an important task, which directly dictates the recognition accuracy. Among the various palm print recognition methods this method is used widely. Extracting a unique feature form a palm image is a bit difficult. Hence objective of this method is to extract the dominant features based on ridges, wrinkles, and singular points. .[2] Fourier transform based frequency domain palm-print recognition algorithms involve complex computations. In contrast, DCT of real data avoids complex arithmetic and offers ease of implementation in practical applications

After taking the image of the palm it performs the segmentation on the image to segment the image in to narrow width bands to obtain high within-class compactness as well as high between-class reparability. After that DCT is applied to every narrow width band to obtain set of dominant features.

$$F(u,v) = \alpha_u \alpha_v \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) cos\frac{(2x+1)u\pi}{2M} cos\frac{(2y+1)v\pi}{2N}, \quad (1)$$

where

$$\alpha_u = \begin{cases} \sqrt{\frac{1}{M}} & ; \text{if } u = 0 \\ \sqrt{\frac{2}{M}} & ; \text{if } 1 \le u \le N-1 \end{cases} \quad (2)$$

$$\alpha_v = \begin{cases} \sqrt{\frac{1}{N}} & ; \text{if } v = 0 \\ \sqrt{\frac{2}{N}} & ; \text{if } 1 \le v \le N-1 \end{cases} \quad (3)$$

It is to be noted that within a particular palm-print image, the change in information over the entire image may not be properly captured if the DCT operation is performed upon the image as a whole because of the difference in patterns and positions of principal lines, ridges and wrinkles.[2]Even if it is performed, it may offer spectral features with very low between-class separation. In order to obtain high within-class compactness as well as high between-class separate ability, we propose to segment the palm-print image into some narrow width bands, which are capable of extracting variations in image. From all narrow bands different features are extracted. From all the features whichever feature is most significant is taken as dominant feature. In this method, for the purpose of recognition using the extracted dominant features, a distance-based similarity measure is utilized.[2]The recognition task is carried out based on the distances of the feature vectors of the training palm-images from the feature vector of the test palm-image.

$\gamma_{jk}(m)\}$ and a f -th test sample image with a feature vector $\{v_f(1), v_f(2), ..., v_f(m)\}$, a similarity measure between the test image f of the unknown person and the sample images of the j-th person is defined as

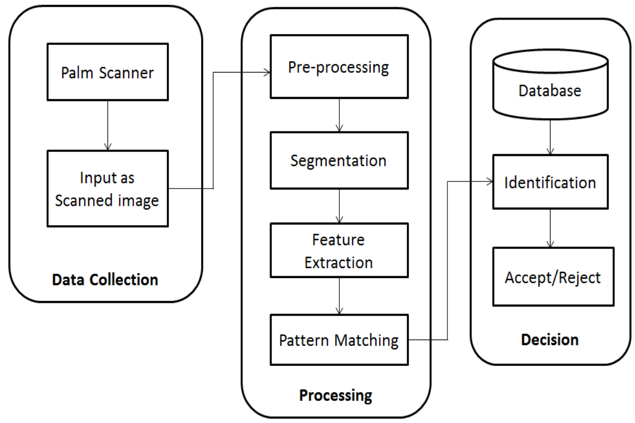
$$D_j^f = \sum_{k=1}^{q} \sum_{i=1}^{m} |\gamma_{jk}(i) - v_f(i)|^2, \quad (4)$$

where a particular class represents a person with q number of sample palm-print images. Therefore, according to (4), given the f -th test sample image, the unknown person is classified as the person j among the p number of classes when

$$D_j^f \le D_g^f, \ \forall j \ne g \text{ and } \forall g \epsilon \{1, 2, ..., p\} \quad (5)$$

With the help of distance vectors dominant features are matched in the database. This method of feature extraction offers two-fold advantages.

First, it can precisely capture local variations that exist in the palm-print images, which plays an important role in discriminating different persons. Second, it utilizes a very low dimensional feature space for the recognition task, which ensures lower computational burden.



III. COMPARISON

Comparing the above algorithms along with the experimental data we draw the following inferences:

Parameters	DCT-based Feature Extraction Algorithm for Palm-print Recognition	SIFT-based Image Alignment	Implementation of Multimodal Biometrics Recognition System Combined Palm Print And Palm Geometry Features
Type	Contact	Contactless	Contact
FAR	-	0.5	0.71
FRR	-	0.5	2.67
ERR	0.3%	0.54%	2.6%

IV. CONCLUSION

Palm lines are one of the most important features of palm Prints. In this paper, we have proposed to compare a variety of approaches to palm line extraction and matching for personal authentication. A set of methods has been extensively studied for palm line recognition for security purposes. To preserve the details of each method a brief working model has been explained along with some factual data, the comparative results on a general database demonstrate the efficiency of each method with the given context. In palm print verification, our proposed approach is more powerful to act against the forgery events occurring now.

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