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International
Journal
Of Modern Engineering Research (IJMER)

# Palmprint Identification Based on Principle Line Using Machine Learning Techniques

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***Abstract**: In this paper, we propose principle line based Palmprint Identification method. In this method to detect principle lines of palm print is with consecutive filtering operations. Smoothing operation is used to remove image noise. Edge detector operation and closing operation are merged to extract the principle lines. Binarization yields the binary principle line. The lines detected with the developed scheme are used to extract textural information using Gray Level Co-occurrence Matrix and Statistical Property Features. Euclidean distance is used for matching to identify the genuine person and the powerful supervised classification techniques namely Support Vector classification Machine and Extreme Learning Machine with kernels like linear, radial basis function is applied to classification. The experimental results on the PolyU palmprint database demonstrate the feasibility and effectiveness of the higher accuracy and reduced execution speed shows that our proposed approach.*

***Keywords:** Biometrics, palmprint extraction, palmprint identification, Principle lines, Machine learning.*

## I. Introduction

The security of a system has three main components of authentication, authorization, and accountability. Authentication is the most important of these three elements. In the information technology domain, authentication means either the process of verifying the identities of communicating equipment, or verifying the identities of the equipment's users, which are primarily humans. Security plays a very important role in one's life. The accurate identification of the person to access secured application is static challenging due to the limitations imposed by real time applications. Samples of such applications include access to ATM, nuclear facilities, boarding a commercial flight or performing a remote financial transactions etc. The main goal of accurate identification is to prevent the imposter accessing the safe application. There are three methods in which users can be identified such as:

1. Something the user knows—Password, PIN
2. Something the user has—Key, Cards and Tokens
3. Something the user is—Unique Biological properties

Easily lost, stolen, shared or manipulated and there by undermining the intended security. The third way of identifying the person appears to be more secure, so designing a security system based on biological properties cannot be lost, manipulated or stolen. Biometric system can be defined as a pattern recognition scheme, which is capable of finding a Person based on their biological properties. These biological properties can be physical characteristics like face, finger print, hand geometry, palm print, retina, and DNA, ear, iris and hand vein .Behavioral properties like speech, gait and signature.

A biometric is a physicalor behavioural feature or attribute that can be measured. It can be used as a means of proving that you are who you claim to be, its means of proving without revealing your identity that you have a definite right.

Apalm print refers to an image acquired of the palm region of the hand. It can be either an online image (i.e. taken by a scanner, or CCD) or offline image where the image is taken with ink and paper. The palm itself consists of principal lines, wrinkles and ridges. It differs to a fingerprint in that it also contains other information such as texture, hollows and marks which can be used when comparing one palm to another.

Palm has unique distinguishing line patterns which can be used to identify people uniquely. It is a physiological biometric. A user is asked to put his/her hand in an surrounded unit having fixed illumination and a platform that restricts hand motion. It may have pegs to further fix the position of the hand. Scanners or cameras can then be used to capture the image. Palm print has high user acceptability with few hygiene based concerns characteristic of all contact based biometric. But there has been a move towards developing contactless recognition systems.

There are two types of palm print recognition research,

1. high resolution
2. low resolution

The high resolution approach employs high resolution images, and is suitable for forensic applications, such as criminal detection. In general, high resolution refers to 400 dpi [1].In high resolution images, researchers can extract ridges, singular points and minutia points as features can be detected. The low resolution approach employs low resolution images, and is more suitable for civil and commercial applications such as access control. Palm print images can be acquired with low resolution cameras and scanners and still have enough information to achieve good recognition rates. Low resolution refers to 150 dpi or less. The Low resolution images are generally use principle lines, wrinkles and texture.

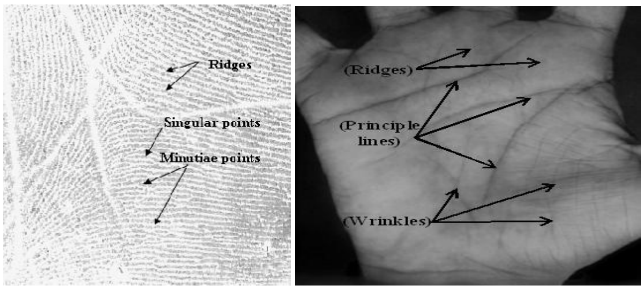


Fig.1 Palm print features in (a) a high resolution image and (b) a low resolution image.

Recognition by iris or retina brings very good results but tolerate very expensive devices of images capture in one hand and on the other hand the possibility of intrusions among the users .Recently, many researchers used verification by face or voice, unfortunately their performance is again far from being satisfactory.

Another technology is based on the geometry of the hand. It uses the geometric information to identify a person, unfortunately these informance are very limited with low accurate results. To face the problems encountered in the biometry based on the hand, David Zhang and shuproposed, in 1996, another biometric always based on the hand that is palm prints.

The palmprint, this very large and internal surface of the hand, contains several characteristic features as principle lines, wrinkles, creases and textures. Thanks to this large surface and the abundance of characteristic features, it seems that palm prints are very robust to noise and unique to every individual. Compare to other physical characteristics.

Palmprints identification has several advantages

1. Treatments of low resolution images
2. Few intrusion risks
3. The features of lines are stable
4. High level of acceptance by users.

The Physical characteristics can be fingerprint, palmprint [2,3], face, iris, signature, voice, and gait. Palmprint is an efficient characteristic because of its uniqueness and stableness. In addition, this characteristic gives a lot of biometric information, e.g., principle lines, wrinkles, ridges and datum points which are the unique features of human.

Palmprint-based biometric technology is composed of two steps: feature extraction and recognition. Image features are extracted and collected as input vector while the remaining step is to recognize or classify that vector into the suitable class to identify people.

In recent survey, Sakdanupab et al. [4] have proposed and implemented a palmprint classification method based on principle lines. The phase of principle line extraction is based on profiles of gray values within a window of size 3x3 in four directions (0, 45, 90, and 135 degrees). The principle lines consisting of heart line, head line and life line are extracted and used for recognizing people afterwards. The drawback of this method is that noise is not completely eliminated by the proposed noise reduction process. In addition, their algorithms take too much processing time. The accuracy was achieved 85.49%.

Huang et al. [5] have proposed a palmprint verification approach based on principle lines. In the process of principle line extraction, the lines are extracted by using the modified finite Radon transform. When the transformation is applied, lines in Cartesian coordinate are converted to lines in energy and direction. The energies and directions are used to detect the differences between principle lines and wrinkles. After that, those differences are finally used to verify people. The accuracy was achieved 95%.

Wong et al. [6] have described the palmprint identification based on features from lines in palmprint. In this work, Sobel mask of two sizes (3x3 and 5x5) in four directions together with an appropriate threshold are mainly used to extract feature vectors. Proceedings of the Second International Conference on Knowledge and Smart Technologies 2010 (July, 24-25, 2010)

In 2009, Zhu et al. [7] have applied an approach for major line extraction of palmprint using gradient images in 4 directions which are overlapped, and then merged with canny edge image. To obtain better results, palmprint image will be dilated and blurred with the probable template to get the major lines. The disadvantage of this method is that their algorithm is somewhat complicated to generate the principle palmprints. From our recent survey mentioned, the methods belonging to Huang and Wong are not used the principle lines as main features. The methods attempt to extract features from the whole image instead. The accuracy was achieved 87.04%.

However, the methods from Sakdanupab and Zhu focus on extracting the principle lines directly. This causes the problem because of their complexity and high processing time.In this work, the compact method to detect principle lines of palmprint is proposed with consecutive filtering operations. Smoothing operation is used to remove image noise. Edge detector operation and closing operation are merged to extract the principle lines. Binarization yields the binary principle line.Finally, the postprocessing, removing the connected components with small region, is applied to discard noise.

The Leqing Zhu and RuiXing, proposed a new hierarchical palmprint recognition method [8]. First the gradient images along the four directions are computed. Then these four gradient images are overlapped and de-noised. Edges are detected with canny detector and merged with the de-noised gradient image with and operation. The result is then dilated and blurred with a probable template to get the major line features. The bidirectional method is used for matching.

The Wei Jia, Yi-Hai Zhu, Ling-Feng Liu and De-Shuang Huang, proposed the palmprint retrieval based on principal lines for palmprint recognition [9]. In this principal lines are extracted using modified finite radon transform method. Then key points of principal lines are detected. And direction, position and energy of these are stored in the table. During matching palmprint is retrieved using the table.

The Wei Li, Lei Zhang, David Zhang and Jingqi Yan, proposed the principal line based ICP Alignment for Palmprint Verification [10]. First the modified finite Radon transform (MFRAT) is used to extract principal line. The iterative closest point (ICP) alignment algorithm is used to compute the shifting, rotation and scaling between the ROI images, and then presented an efficient way to combine the alignment result with the competitive code for palmprint recognition.

The Cong Li, Fu Liu and Yongzhongzhang, proposed a method to extract the principal lines based on their cartelistic of roof edges [11].In this at first gray adjustment and median filtering are used to enhance contrast and weaken noise. Then, palm-lines are detected based on diversity and contrast. And an improved Hilditch algorithm is used to do thinning, an edge tracking approach is applied to get rid of twigs and short lines, and then, the broken lines are connected. Finally, the single pixel principal palm-line image is obtained.

The PatprapaTunkpien, SasipaPanduwadeethorn and SuphakantPhimoltares, proposed a simple and fast method to extract the principle lines of palmprint by using consecutive filtering operations related to gradient and morphological operators [12]. A gradient masks and closing operator are used to detect the lines. The results are acceptable with 86.18 % accuracy.

The FengYue, WangmengZuo and David Zhang, proposed the iterative closest point (ICP) algorithm [13] for palmprint alignment before matching. The palm-lines are extracted using steerable filter. However, due to nonlinear deformation and inconsistency of extracted palm line feature, the ICP algorithm using only position information would fail to obtain optimal alignment parameters. To improve its accuracy orientation feature is used, which is more consistent than palm line, to make ICP registration more robust against noise.

## II. The Proposed Framework

The proposed method consists of four steps

1. Image Acquisition
2. Image Preprocessing
3. Feature Extraction
4. Matching

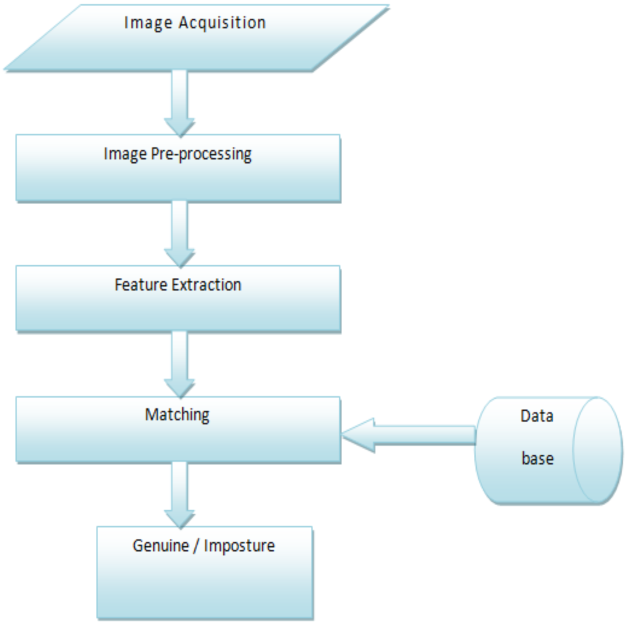


Fig.2 Proposed Architecture

**2.1 Image Acquisition**

The Poly U Palm print Database [14] is selected for experiment because it is widely used in palm print biometric area.Poly U is the most widely used low-resolution palm print database for algorithmic research considering recognition purposes. It is contained of 7752 images from 386 different persons. Persons provide either the left or the right hand, but then not both. There are 20 samples for each in bitmap file format. Visually, it is possible to identify more variability between images. The ROI of size 150x150 is cropped from each original image to be initially used for extracting the principle lines with filtering procedures based on image processing technique. Those image processing methods filtering algorithms that related to principle lines by employing gradient masks and closing operator to detect the lines and the pre-processing including smoothing, merging with binarization. It will display the principle lines and strong wrinkles.

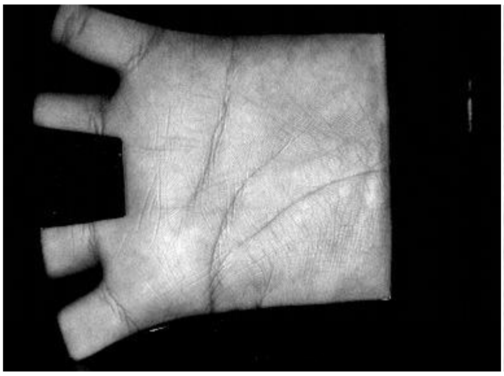


Fig.3 Original imageFig.4 RegionofInterest (ROI)of palmprint

**2.2Image Pre-Processing**

**2.2.1 Smoothing**

To blur an image, smoothing filter is applied to eliminate small object in the image for noise reduction purpose. It can also be used to get objects of interest which makes the image easy to detect. The smoothed image can be implemented by applying the mask of standard size, 3x3, with the correlation function as shown in Fig.6

| | | |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 1 | 1 |
| 1 | 1 | 1 |

Fig.5 3x3 smoothing filter mask

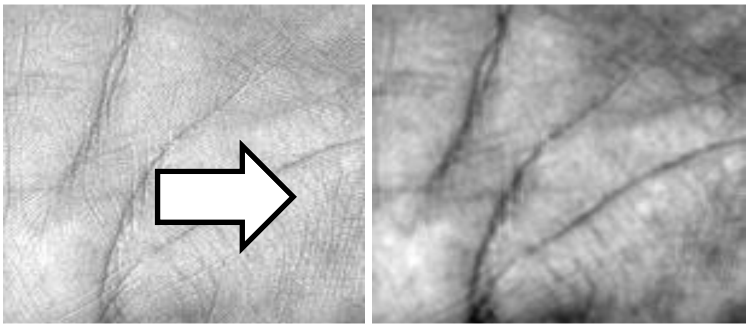

Fig.6Applying smoothing filter into an ROI

### 2.2.2 Edge detection

In our research, edge detection is implemented by gradient operator as the second filter in the whole process. Firstly, masks of size 2x2 in two directions (0º and 90º) are used as illustrated in Fig.7. With this small size, edge can be easily detected with simply computation and less processing time. Subsequently, the smoothed image is convolved with the masks in 0º and 90º respectively to enhance the edge in both directions. These results are shown as Fig.7 and Fig.8 Finally, the magnitude of gradient is obtained by taking the root sum square [15] of $G_x$and $G_y$:

$$\text{Magnitude of gradient} = \sqrt{Gx^2 + Gy^2}$$

Where$G_x$and$G_y$are image gradients in two directions.

$G_x$ =

| | |
|---|---|
| -2 | -2 |
| 2 | 2 |

$G_y$=

| | |
|---|---|
| -2 | 2 |
| -2 | 2 |

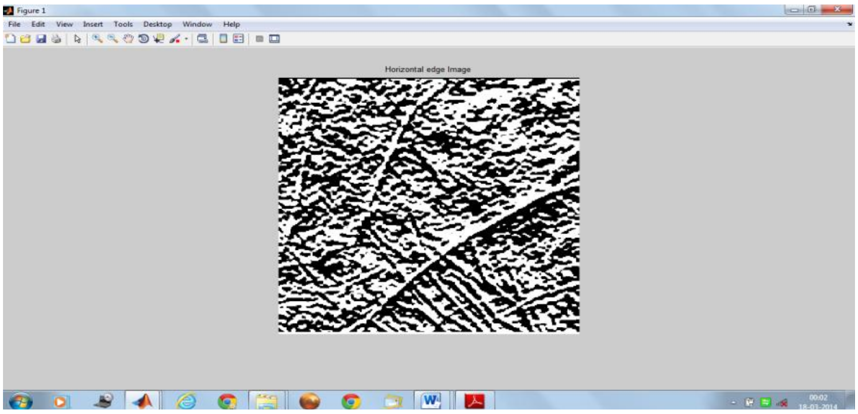


Fig.7 First derivative mask in horizontal directions

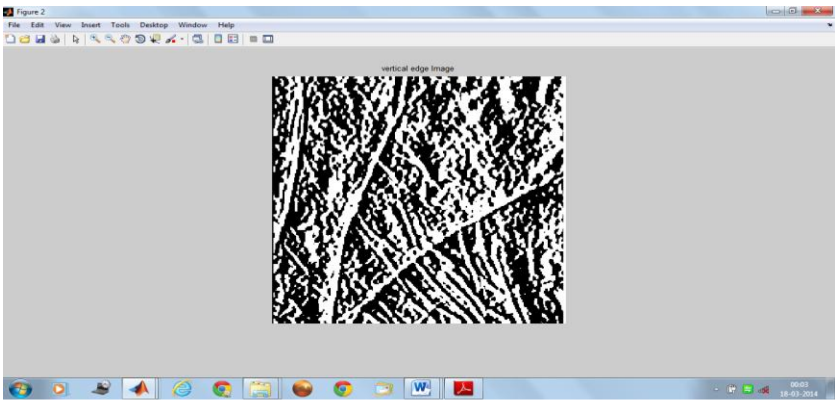


Fig.8 First derivative mask in vertical directions

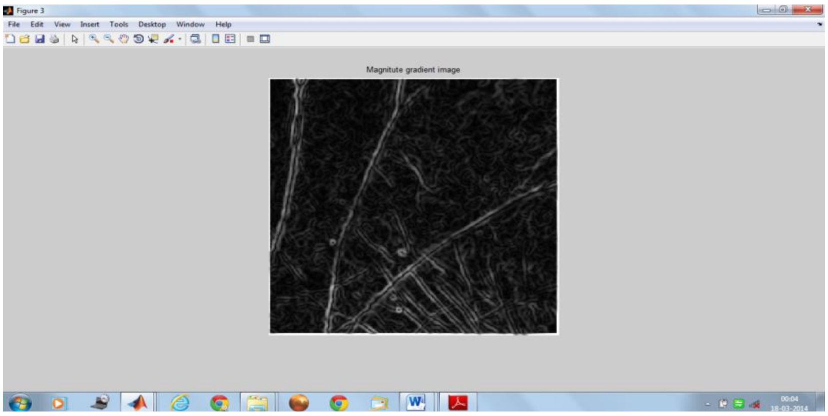


Fig.9 The magnitude gradient obtained from Fig.7 and Fig.8

**2.2.3 Closing**

Closing [16], the third operator, is the one of morphological operations which uses the basic operations of dilation followed by erosion. The closing of image *G* by structuring element *S* is denoted by *G* •*S* as follows

$$G \bullet S = (G \oplus S)\ \Theta\ S$$

Where⊕and Θare basic mathematical morphology techniques called dilation and erosion .The edge image is performed by closing operator with disk-shape structuring element as demonstrated in Fig.10

Strel =

| | | |
|---|---|---|
| 0 | 1 | 0 |
| 1 | 1 | 1 |
| 0 | 1 | 0 |

To smooth contours and fill small holes. After applying closing, the result of image is shown as Fig.11

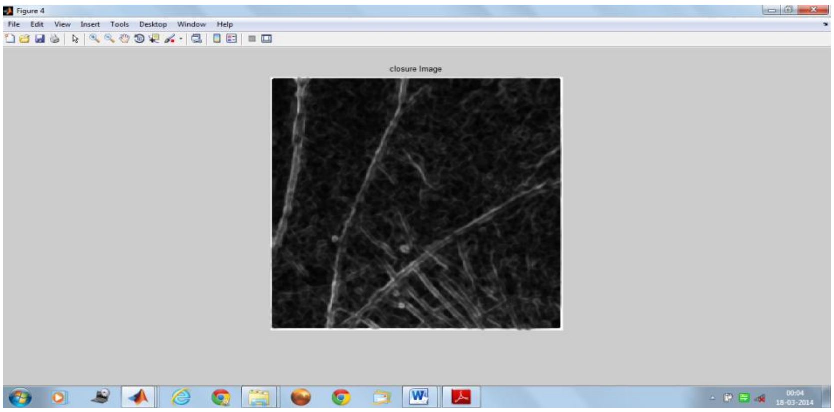


Fig.11 After closing applying result image

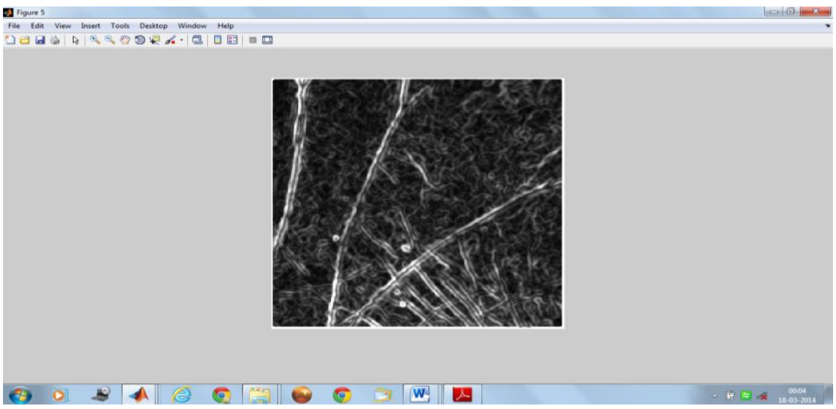

Fig.12 Gradient of an image

### 3.2.4 Merging

After the image is detected, the principle lines and closing operation is used. Gradient image and closing image are combined by merging with OR [17] operation as shown in Fig.13

This merged image obviously represents the contrast between object and background, so the binarization technique with an automatically pre-defined threshold is employed for enhancing the object from the background.

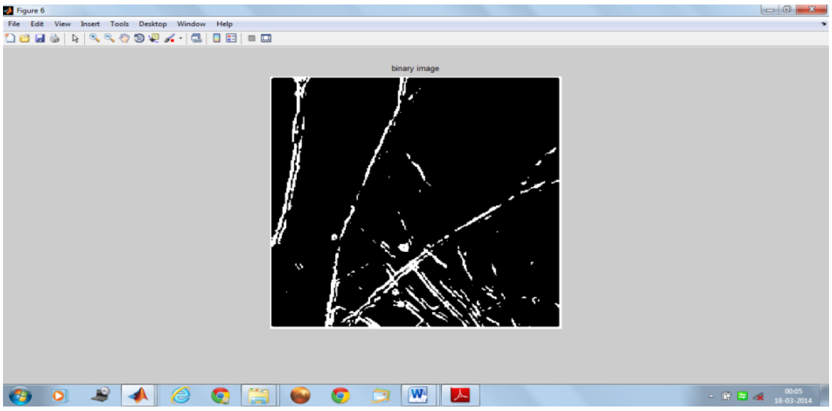


Fig.13 Binarization an image (ie) principle line and strong wrinkles will appear

### 2.3 Feature Extraction

Features play a significant role in image processing. The transformation of an image into set of features known as Feature Extraction. Features, characteristics of the objects of interest, if selected carefully are representative of the maximum relevant information that the image has to offer for a complete characterization of a region. Feature extraction methodologies analyse objects and images to extract the most prominent features that are representative of the various objects. Features are used as inputs to identify that assign them to the person that they represent. In this work Gray Level Co-Occurrence Matrix (GLCM) features and Statistical Property features are extracted from principal line extracted image.

### 2.3.1 GLCM (Gray Level Co-Occurrence Matrix) features

The GLCM features extracted in our research work are autocorrelation, contrast, correlation, dissimilarity, homogeneity, entropy, maximum probability, sum of square, sum of variance, sum of entropy, difference of entropy, and difference of variance. These features are developed by Haralick so it is also called Haralick features .Some of the features described above can be calculated using the formula given below.

**Energy**

Energy returns the sum of squared elements in the Grey Level Co-Occurrence Matrix (GLCM). Energy is also known as uniformity. The range of energy is [0 1]. Energy is 1 for a constant image. The formula for finding energy is given in below equation:

$$E = \sum_{i,j} p(i,j)^2 \qquad (1)$$

**Contrast**

Contrast returns a measure of the intensity contrast between a pixel and its neighbour over the whole image. The range of Contrast is [0 (size (GLCM, 1)-1) ^2]. Contrast is 0 for a constant image. Contrast is calculated by using the equation given below:

$$C = \sum_{i,j} |i-j|^2 p(i,j)^2 \qquad (2)$$

**Correlation**

Correlation returns a measure of how correlated a pixel is to its neighbour over the whole image. The range of correlation is [-1 1]. Correlation is 1 or -1 for a perfectly positively or negatively correlated image. Correlation is NaN (Not a Number) for a constant image. The below equation shows the calculation of Correlation:

$$CORR = \sum_{i,j} \frac{(i-\mu_i)((j-\mu_j)P(i,j)}{\sigma_i \sigma_j} \qquad (3)$$

Where $\sigma_i$, $\sigma_j$, $\mu_i$ and $\mu_j$ are the means and standard deviations of $P_i$ and $P_j$, the partial probability density functions.

**Homogeneity**

Homogeneity returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. The range of homogeneity is [0 1]. Homogeneity is 1 for a diagonal GLCM. The homogeneity is evaluated using the equation:

$$H = \sum_{i,j} \frac{P(i,j)}{1+|i-j|} \qquad (4)$$

**2.3.2 Statistical Properties of a palm image Features**

The proposed work discusses about to measure properties of image regions. There are various statistical measurements out of which part of our study and experiment are basic statistical properties of a palm image and are Area, Bounding box and centric.

The description is for the measurement of a set of properties for each connected component (object) in the binary image, BW. The image BW is a logical array; it can have any dimension

**Area:**

- The Scalar can say an actual number of pixels in the region.

**Bounding Box:**

- The smallest rectangle containing the region,
- a 1-by-Q *2 vector, where Q is the number of image dimensions: ndims(L), ndims(BW)

**Centric:**

- It is 1-by-Q vector that specifies the center of mass of the region. Note that the first element of Centric is the horizontal coordinate (or *x*-coordinate) of the center of mass, and the second element is the vertical coordinate (or *y*-coordinate). All other elements of Centric are in order of dimension.

These basic statistical properties can be used to measure the statistical property of image region. The calculated values of palm lines extracted image can be useful for palm matching technique. The matching can be done by using basic statistical properties of palm and mostly useful on extracted palm lines image [18].

**2.4 MATCHING**

**2.4.1 Euclidian Distance**

One of the most popular similarity distance functions is the Euclidian distance. It is just the sum of the squared distances of two vector values (xi,yi),

$$d_E = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \qquad (5)$$

It is variant to both adding and multiplying all elements of a vector by a constant factor. It is also variant to the dimensionality of the vectors, for example if missing values reduce the dimension of certain vectors produced output will change. Given two data sets of features corresponding to the training and testing samples, a matching algorithm ascertains the degree of similarity between them.

## III. Experimental Results

The experiments were implemented in MATLAB 2012 software with Image Processing Toolbox and on a machine with an Intel® Core™ i3-2350M CPU@2.30GHz and 2.00 GB of RAM configured with Microsoft Windows 7.The proposed model of this paper is tested on palmprint database collected by the Poly U from 1000samples for100 different person left hand palm image (10 images for each person). Among them, eight samples are used for training and remaining two samples are used for testing. For identification, each of the palmprint images was matched with all of the other palmprint images in the database.

The performance of the proposed approach is evaluated using performance metrics i.e. FAR, FRR are shown in Table I and comparative results of Accuracy and execution time using machine learning techniques are shown in Table II.

$$\textbf{FRR} = \frac{\textbf{Number of rejected verification attempts for a qualified person}}{\textbf{Number of all verification attempts for a qualified person}} \qquad (6)$$

$$\textbf{FAR} = \frac{\textbf{Number of successful independent fraud attempts against a person}}{\textbf{Number of all independent fraud attempts against a person}} \qquad (7)$$

**Table I. Comparative results of the FAR and FRR**

| Person | Support vector machine Linear | | Support vector machine RBF kernel | | Extreme Learning Machine Linear | | Extreme Learning Machine RBF kernel | |
|---|---|---|---|---|---|---|---|---|
| | FAR | FRR | FAR | FRR | FAR | FRR | FAR | FRR |
| 1 | 1 | 1.98 | 1.5 | 1.97 | 0.96 | 52 | 0.02 | 99 |
| 2 | 0.5 | 1.9 | 1 | 1.98 | 0.97 | 52 | 0.05 | 99 |

**Table II. Comparative results of the SVM and ELM classifiers**

| Classifiers | Kernels | Execution Time (seconds) | Accuracy (%) |
|---|---|---|---|
| SVM | Linear | 1.772 | 88 |
| | Radial basis function(RBF) | 1.825 | 98.1 |
| ELM | Linear | 0.0082 | 99 |
| | Radial basis function(RBF) | 0.0103 | 99 |

The comparative result shows that the predictive accuracy of Extreme Learning Machine linear is better compared to Support Vector Machine with the kernels like linear and radial basis function. The execution time taken by Extreme Learning Machine Linear is also less than the time taken by the different kernels of Support Vector Machine.

## IV. Conclusion

The proposed method to detect principle lines of palm print is with consecutive filtering operations. Smoothing operation is used to remove image noise. Edge detector operation and closing operation are merged to extract the principle lines. Binarization yields the binary principle line. The lines detected with the developed scheme are used to extract textural information using Gray Level Co-occurrence Matrix and Statistical Property Features. Euclidean distance is used for matching to identify the genuine person. The result shows that the accuracy of Extreme Learning Machine linear is better compared to Support Vector Machine with the kernels like linear and radial basis function. The execution time taken by Extreme Learning Machine Linear is also less than the time taken by the different kernels of Support Vector Machine. In future, itwill improve the accuracy; reduce the execution time for using other classification techniques.

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