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A Review: Palmprint Recognition Process and Techniques

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Abstract

The palmprint recognition system has active research works over 15 years, which are employed on different images resolution (High and Low). This paper shows the types of palmprint and problems facing the palmprint recognition system. Also, focus on the process of design palmprint biometrics system step-by-step, started from image acquisition, pre-processing, feature extraction and matching and give summary of palmprint databases with their characterizations and also we present some palmprint recognition techniques and some research works related to palmprint purposes.

Keywords: Palmprint, Acquisition, Feature extraction, Matching, Databases

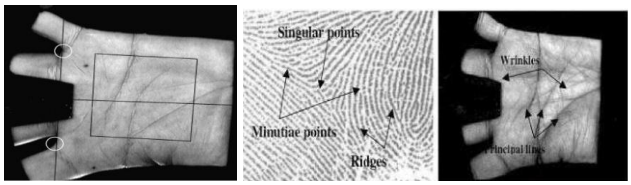
INTRODUCTION

By increasing the security of parson's authentication (identification and verification) the palmprint modality played most important trait compare with another biometrics trait(physiological or behavioral) and it is active research which made more attention for the researcher who interest in biometrics fields.

In the recent years, there are numbers of technologies were developed related to biometrics authentication system but the palmprint get less development depend on reliability and cost [1]. The palmprint approach can be classified into two categories depend on the palmprint image data type such as grayscale [2, 3], 3D [4] and multispectral. There are many of researchers working in gray scale image compare with the less researcher working in 3D and multispectral palmprint images. Recently the multispectral data are used in many areas such as face [5], iris [6] and palmprint [7].

As a definition of palmprint which defines as a small area of palm surface, which containing more information which is useful for person authentication system, in additional it has a unique feature (uniqueness means no two people has same this feature) also it called permanence it will not change in all period of time in the life. For this reason, palmprint are reliable and confident modality between the same categories of palmprint like fingerprint and face etc.

Regarding palmprint features, it has rich of features some of this feature is similar to fingerprint line minutiae feature [2], that contain ridge ending and ridge bifurcation. Also, it has many features namely Geometry feature, Delta point feature, principal lines feature and finally the wrinkles feature. All these features are extracted with different methods. Also, this feature can be captured by different resolution devices (low or high) resolution this one of advantages of palmprint which is there is side effect by devices used to capture the palm image. Another advantage is it has a small area with a lot of information to extract compare with another, also it has high acceptance. Figure 1 shows CCD palmprint image and different palmprint image namely high and low-resolution palmprint images.



(a) (b) (c)

Figure 1. Different palmprint image (a) CCD-based palm (b) High resolution (c) Low resolution [8].

The reset of this paper is organized in different parts which are started with the explanation of the palmprint types and problems. Afterward palmprint recognition process, techniques, databases are discussed in details. Finally, the conclusion is covered.

PALMPRINT TYPES

Palmprint has been classified into three groups which are discussed below:

Latent Palmprint

It is considered as unseen or sightless of palm surface .when palm impressions by accident left by friction ridge skin on a surface, whether it is seen or unseen at the proof time. There are many methods can apply to display the fractional or entire palm like electronic, physical or chemical processing. Also, the Latent palmprint can create by extraction of the eccrine

gland, blood, oil, paint and ink [9]. It may see in partly, deficient, deformed, overlapping or any conjunction type.

Patent Palmprint

They are visual and they obviously and they can form due to the transfer of strange item on the surface of palm[10].patent palmprint is seen and no need for enhancement as it is required in the first type mostly in photographed.

Plastic Palmprint

The friction ridge impression from palm skins in the article or tool which keep the texture of palm and ridges shape is called plastic palmprint. This type is seen and enhancement is not needed it can register by photograph method and improved like non-plastic impression and coated at natural secretion of a finger. This type of palm is not mostly possible since the matter type is not often attainable at the site of the crime.

PROBLEMS IN PALM

Deformation of skin

The palm contains a number of joints with a larger size which differs from the tip of the finger. Therefore deformation is not familiar between different impressions of the palm itself. It is also most critical than fingerprint deformation.

Variety of several palm regions

Various regions of palmprint possess different quality and uniqueness.

Complication of computational

Databases during palmprint operational are not as usual kept in the known coordinate system. Every probable spinning should be tried by minutiae matching algorithms. Palmprints have majority of minutiae comparing with fingerprint, therefore matching algorithms that are in general convenient from fingerprint matching algorithms are more ineffective in matching palmprints[11].

PALMPRINT RECOGNITION PROCESS

The process is performing of two phases: Training (Enrollment) and Testing (Recognition). During the training phase (Enrollment) each palm is captured by biometrics sensor or reader to generate a digital image. This image is used as training data, then pre-processing apply to training data for removing unwanted data, noise, reflection... etc. The pre-processing is used to increase the clarity of image and extract Region of Interest (ROI). The output of pre-processing is passed to the Feature extraction stage for each training data, the feature data can be extracted and stored in the database .In the case of the testing stage (Recognition) the same process as in training stage, in addition, the matching steps between the training features and testing features, the result is match or non-match or recognized or not recognized. Figure 2 show the training and testing process.

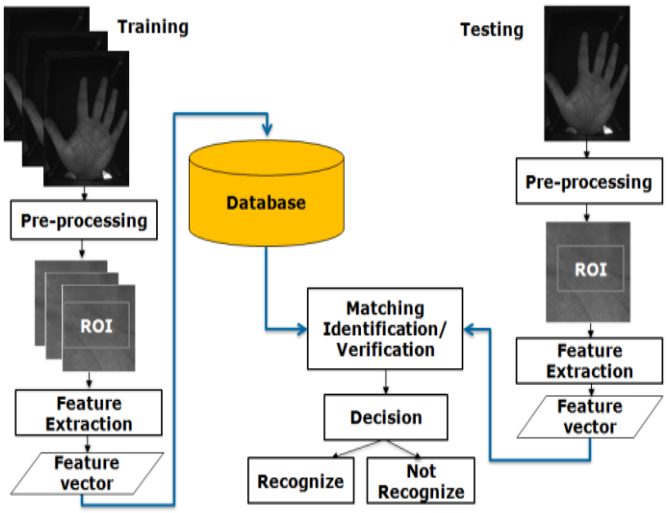


Figure 2. Palmprint recognition process

In another hand the palmprint recognition system consists of four parts as shown in figure 2.

Image Acquisition

It is the first step of any biometric system, which is the answer of many questions like how can we get the palmprint image? , which devices used to capture the palm image and what are the characterizations of these devices?. Some of the palmprint images exist in some organization which is free used also it called standard databases like PolyU database, CASIA, IIT New Delhi which are free use for the educational purpose, which we can collect by requested from the owners. There is two ways to get palmprint image traditional way “Ink” and another by using technologies such as CCD –based palmprint scanner, a digital camera which used to convert the image to digital form. Pengfei et al.[12] they are using a digital camera to capture palmprint image the camera use Power shot A75 with the colorful image. The size of image capture is 2048x1536 pixel with the resolution (110 dpi), they are captured 8600 palm (860 subject each has 10 sample).

X. Xu and Z. Guo [13] they used CCD Camera with lens and A/D convertor to capture palm image. The images are captured under the illumination from different light from a different direction. The size of image was 352x 288 pixels with a resolution lower than 100dpi.

X.Q et al.[14] they capture the palmprint image by online CCD-camera –based devices which have pegs between fingers to control the palms rotation and translation. The size of the original image which they capture is a 384x284 pixel; they have captured 3200 palms (320 subjects each have 10 samples). Zhang et al [15] were the first research team to develop online palmprint identification (CCD-based palmprint scanner) and it captured high-quality palmprint image. The

CCD-based palmprint scanner depends on the lens, camera and the light sources as shown in figure 3 which taken from [15].

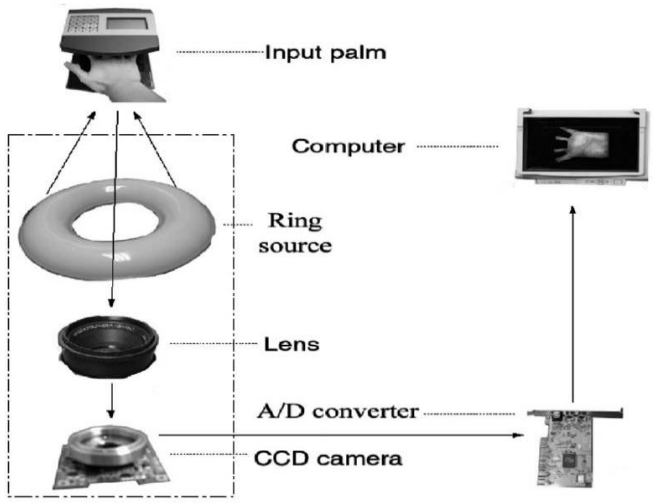


Figure 3. CCD Palmprint Captured Devices

Pre-processing

The pre-processing steps are the second and very important steps for build any biometrics system (identification or verification) which used to remove the noise and clarity the palm image. The pre-processing of palmprint system is the way to extract the very important part in palm surface which including more information it also called Region of Interest (ROI),which define as rectangle area on the palm. In the general, the main steps of palmprint pre-processing are shown in figure 4 .The steps start with converting the palm image into grayscale ,enhancement, binarization, boundary detection, detect the reference points, extreme point, valley point ,scaling finally cropping the ROI. This all the steps needed to do the pre-processing process on palmprint images. There are many of methods to extract the ROI ,such cropping direct from palmprint image without applying any algorithm[70,72].The second methods which called Competitive Hand Valley Detection methods(CHVD) another method by using Euclidean distance the difference between them by the way to get the reference point. This ROI method used to improve the palmprint matching performance.

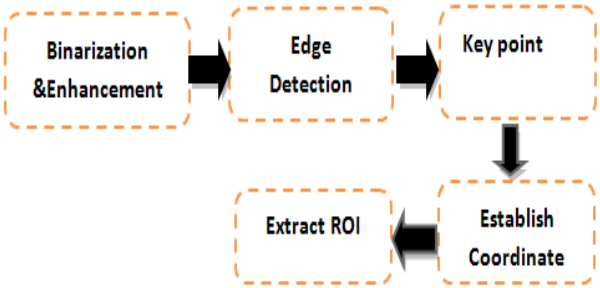


Figure 4. General steps of pre-processing

Pengfei et al[12] they are done pre-processing steps by converting palm image to binary with the help of threshold ,after that they used boundary tracing algorithm to detect the contour of hand shape then use detect the key point such as fingertip and valley point finally cropping the ROI with size 200x200 pixel.

X.Q et al[14] they are applying the noise removal on palmprint image by using Gaussian smoothing and convert the palm to the binary image then extract the boundary by using boundary tracing algorithm and the key point are detected such as Gap fingers finally the ROI cropping from palm image with size 128x128 pixel.

C. C. Han et al [16] applied to full palmprint images (scanned image) , it used the border tracing algorithm after convert the image into binary image, then located the five fingers tips and four fingers roots by used wavelet-based segmentation, and from the ring fingers points are establish the coordinate of ROI. K. Chuang et al. [17] applied the opening morphology operation for removing the noise of binary image of palm print, and then shrink the region of palm print image by segmented a rectangular region bounded by four lines: upper and lower bound should less than 200 white pixels, right and left bound should be less than 95 white pixels. It detected the boundary by using Sobel edge detection. Then, it took a double derivation of palm boundary to locate three points between the fingers. Next, it created a line by connecting the two points in the upper curve and lower curve, and this line used to align the difference palm print image. It created a point in the middle of the align line M. This point with the middle curve point used to establish the central point of the coordinate of ROI. Figure 5 show the example of extract ROI.

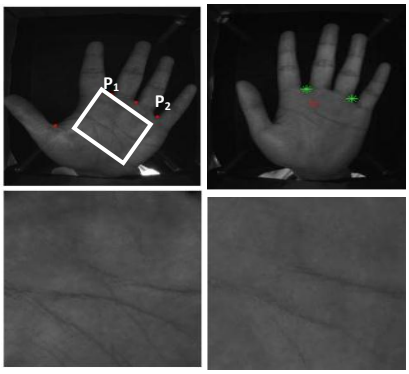


Figure 5. Example of extract ROI

Feature Extraction

The feature extraction applied on the output of pre-processing phase which is a fixed size of the image. And extract the feature of palms like principal lines, wrinkles, and minutiae, and each feature belongs to a different resolution.

Wei and Zhang [18] extracted the datum points and the line features from the palm print image. The datum points are defined as the points of palm print registration. Therefore, it detected the principle lines and their endpoints by using the directional projection algorithm. Moreover, the authors have improved template algorithm to extract the ridges and wrinkles as straight lines. D. Zhang et al. [15] since the stack

filter algorithm is able to extract the principle lines of a palm print, but the principle lines are not sufficient to prove the uniqueness of palm print. Thus, the author's proposed the 2D Gabor to represent the palm print for extracting the texture features of palm print from low-resolution.

J. Gan and D. Zhou [19] decomposed the palm print image into sub-images by using the 2-dimensional multi-scale wavelet, then four images are obtained; one of those sub-images is the approximation image for low-frequency components, and the rest of sub-images are demonstrated for the high-frequency component. After that, segment each wavelet sub-image into n^2 blocks.

C. C. Han et al [16] applied four directions of Sobel operators to extract the feature points of ROI of palm print, and then applied a complex morphology operator to extract the features of palm print image .Yao et al. [20] proposed Gabor transformation to extract the texture of palm print features which divided the palm print image into 32 regions. And it was used eight direction $(0,\pi/8,\pi/4,3\pi/8,\pi/2,5\pi/8,3\pi/4,7\pi/8)$ and four scales (2,4,8,16) 8*4=32 regions to obtain the image texture characteristics. Then it was resized the domination of Gabor image into 1/16 of the original image. After that, researchers used ICA (Independent Component Analysis) for further extracted features.

X.Q et al.[14] they extract the line feature from his database by using directional line energy feature (DLEF) which is divided ROI into 5x5 blocks of 32x32 pixel then calculate the direction line energy for each blocks then store all the feature in all blocks as feature vector ,apply the normalization to the vector by using maximum and minimum values of the component

Matching

The matching stage is to compare the acquired feature with the template in the database. In [18] proposed the Euclidean distances to match between the endpoints of two lines. And computed the three parameters (slope, intercept, and angle) of each line segmented in the two palm print images and decided whether the two lines are equal or not. But in [21] it utilized the energy difference and Hausdroff distance to match the two palms features. Gan and Zhou [19] the matching based on the Euclidean distance between feature vectors and NND (Nearest Neighbour Distance) rule.

D. Zhang et al. [15] determined the similarity measurement of two palm print by using the Humming distance. And in [16] authors proposed two verification mechanisms, one is the correlation function to measure the similarity between the two feature vectors, and the second is Back propagation neural network (BPNN) with the scaled conjugate gradient algorithm. Also, researchers in [20] identified the weight features by BBNN. X.Y Jing and D. Zhang [22] took the first five samples of each individual in the database as training samples and the reminders as test samples, and then the number of training and testing will be 950 training and 2090 testing. The first twenty low-frequency bands are selected. Thus, the principle components are 210 and it obtained 181 discrimination vectors. In this paper, the result of the recognition accuracy is 98.13%. Table 1 show some research work done on feature extraction and matching techniques. While the table 2 shows the palmprint recognition system process techniques start from pre-processing, feature extraction and matching with some results are present.

Table 1. Summary of Feature extraction and matching

Ref. No.	Feature based	Feature extraction	Matching technique	Database
[18]	Straight lines	Directional projection algorithm	Euclidian distance	Offline, 200 samples
[21]	Texture & feature points	--------	Energy different & Hausdroff distance	Offline, 200 samples
[15]	Lines & textures	Stack filter & 2D Gabor	Humming distance	Online, 193*40 samples
[23]	Textures	LPQ	--------	PolyU 189*20
[16]	Lines feature	Sobel operator & morphology	Correlation function & BPNN	--------
[19]	Features vector	Multi-scale wavelet	Euclidean distance & NND rules	Online, 100*60 samples
[20]	Texture	Gabor transformation & ICA	BPNN	50*10 samples
[24]	Orientation features	Six Gabor filter on diff direction	Humming distance	--------
[22]	Discriminant DCT features	Improve FisherPalm method	Neural network	Online 190*16 samples

Table 2. Smmary of palmprint recognition system

Ref.No.	Pre-processing	Feature extraction	Matching	Database	Accuracy
[25]	Second square-based system	SIFT to extract local feature	Hamming distance	PolyU 384X284 pixel,96 dpi, 386 subject each 20 samples	----
[13]	Gaussian smoothing, histogram equalization, key point	QPCA	Euclidean distance	database with 500 palm x12 sample	98.13%
[26]	Smoothing,binarization Boundary tracing, Reference point, key point	Morphological operator to detect the valley feature	Euclidean distance	PolyU 600 image (100 subject x6 sample)	98%
[14]	Smoothing,Binarization,Boundary tracing, Reference point ,key point	Directional line energy feature to line feature	Euclidean distance	The database,3200 (320x10) image ,384x284	97.92% 97.5%
[27]	Segmentation ,Binarization, boundary detect, 8 reference point,three canyon point	Fourier Transform	RB K-means and SVM	----	FRR=0.242 FAR=2.668
[28]	Smoothing ,binarization ,Boundary tracing, Reference point, key point	Directional Gaussian derivate filter in different direction	Hamming distance	PolyU 384X284 pixel,96dpi, 386 subject each 20 samples	EER=0.139
[29]	Palm coordinate system, binarization, Boundary tracing , Reference point, cropping	SIFT , local feature	Point-wise matching	PolyU II	EER=0.6

PALM RECOGNITION TECHNIQUES

The Region of Interest (ROI) is the very important things in palmprint image to extract .on this small area there is many features to detect. To detected this feature there are many techniques depend on which type of feature want to extract .this techniques are divided into four classes like ,line based ,statistical based ,texture based and subspace-based techniques which we discuss in this section also there are many techniques used but it is difficult to classify it, because some of them use many image processing methods as shown in [30,31,32,33,34].

Line Based Technique

This technique works on extract palmprint lines[35] which are one of the important features in palmprint , this lines namely principle lines and wrinkles line which is use as a unique feature of palmprint images that used for recognized the people in biometrics system. Also this technique essentially on orientation of palmprint lines principle lines and wrinkles line , also in edge points, where there are many edge detection methods are used in this technique like canny [36,37],sobel[38,39],prewitt..etc, while the texture feature methods which used to segmentation of palmprint lines such as Discrete wavelet transform (DWT),Gabor and fast Fourier transform ,..etc. The table shows some line based methods.

Statistical Based Technique

The statistical approach is divided into two categories first one is local statistical approach and the second is the global statistical approach, both of this approach are used to extract the statistical feature of palmprint image. Local statistical approach is working by transform image to another domain and then divided the transformed image into several block or region then calculate the local statistical feature from each region such as mean, variance and Standard deviation, etc which use as feature points in palmprint feature vector. In the case global statistical approaches which are applied on transform image and calculate the global feature like moments, centers of gravity, density. etc. Table 3 show some statistical methods used in some research paper.

Subspace Based Technique

Subspace-based approach is also called appearance based approach, which includes the analysis based on subspaces to locate the low dimensional in a high dimension of input space [40]. This approach use many of dimensional technique like PCA[41,42,43,44],LDA [45]and ICA which are subspace based methods used in palmprint recognition ,also some researcher use additional to this method like Wavelet, Gabor, and Discrete cosine ..etc. the is some Subspace-based approach show in table 3.

Texture Based Technique

This technique of feature extraction which used to extract the texture features from palmprint images. the Palmprint has many texture feature to extract which is a rich modality contain the more texture feature, This texture feature can

extract by different methods in both side local and global features, in palmprint, we can create feature vector by extracting texture information from palmprint image and store this feature as feature vector[46]. There are many texture feature algorithm are used for palmprint recognition system such Gabor ,wavelet which used by divided the palmprint to blocks another technique laws mask, cosine transform and discrete Fourier transform methods which are used to extract the texture feature from palmprint images. Table 3 show a summary of some palmprint techniques.

Table 3. Summary of Palmprint Techniques

Approach	Methods	Ref. No
Line based	Line Matching	[47]
	Line Detection	[46]
	Crease Detection	[48]
	Morphological Operators	[49]
Subspace-based approaches	Principal component analysis	[50]
	Linear discriminant analysis(LDA)	[51]
	Concurrent subspaces analysis (CSA)	[52]
	Multilinear discriminant analysis (MDA)	[53]
Statistical –based	Mean and standard deviation	[55]
	Zernike moments	[61]
	Hu Invariant Moments	[62]
	the center of gravity, density, spatial dispersivity and energy	[60]
	L1-norm energy, Variance	[63]
Texture-based	Gabor filter	[54,55]
	Laws mask	[56]
	Discrete Fourier transform	[57]
	Discrete cosine transform	[58]
	Wavelets	[59,60]
	LBP and 2DLPP	[71]

PALMPRINT DATABASES

There are many standard palmprint database available online for research purpose some of this databases are shows in table 4 with their characterization.

Table 4. Palmprint Databases

Databases	Characterization
IIT Delhi Touchless Palmprint Database [67]	It is Bitmap images and contain 3290 palms are taken from235 subjects each has 14 samples with different image size 150x150 and 800x600 pixel
KVKR-Palmprint Database[64]	It is color images, contain 900 palms taken from 150 subjects each has 6 samples, with image size 640x480 pixel
PolyU palmprint database 2.0[65]	It is grayscale images and contains 7752 palms taken from 386 subjects each has 20 samples , with image size 384x284 pixel.
PolyU palmprint database 1.0[65]	It is grayscale images and contains 600 palms taken from 100 subjects each has 6 samples, with image size 384x284 pixel
PolyU Multispectral Palmprint database [66]	It is color images and contain 6000 palms collected from 250 subjects each has 24 samples.
CASIA PalmprintImage Database[68]	It is 8-bit gray level and contain 5505 palms collected from 312 subjects with image size 640x480 pixel
CASIA Multi-Spectral Palmprint Image Database V1.0 [69]	It is 8-bit gray level and contain 7200 palms collected from 100 subjects each has 72 samples with image size 768x576 pixel.

CONCLUSION

The paper is a review on the field of palmprint recognition system. It highlighted on palmprint recognition process step-by-step, started from collect the palmprint data which coming under the acquisition stage, then the remove unwanted data and noise by enhancement technique which is done under the pre-processing stage and the result of this stage is Region of Interest (ROI) which is very important part on palmprint ,the next steps is extracted the feature from ROI of the palmprint image and the result of this feature vector which is stored in database as template for matching propose. The next stage is matching which is to compare between input palm images with a template which we store at the enrolment phase. Also the paper focus on palmprint types and the problem facing for recognition propose. The finally there are some research on palmprint recognition techniques and palmprint databases with their characterization.

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