ANKARA YILDIRIM BEYAZIT UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

HUMAN IDENTIFICATION USING PALM PRINT IMAGES

M.Sc. Thesis by

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February, 2017
ANKARA

HUMAN IDENTIFICATION USING PALM PRINT IMAGES

A Thesis Submitted to

The Graduate School of Natural and Applied Sciences of

Ankara Yıldırım Beyazıt University

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Electrical and Computer Engineering, Department of Electrical and Computer Engineering

by

Mohamed R. A. ALHASSI

February, 2017

ANKARA

M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled "**Human Identification using Palm Print Images**" completed by **Mohamed R. A. ALHASSI** under supervision of **Assist. Prof. Dr. Özkan Kılıç** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ACKNOWLEDGMENTS

I would like to express my appreciation to my great supervisor, Assist. Prof. Dr. Özkan Kılıç, who gave me unlimited supporting and valuable guidance's, there is no enough words to express thanks for you. Also, I would like to thanks from my wife, She helped me a lot of times.

2017, 13 February **Mohamed R. A. ALHASSI**

HUMAN IDENTIFICATION USING PALM PRINT IMAGES

ABSTRACT

Palm recognition is one of the research areas which is considered, in recent years. In this thesis, we introduce a new method for human palmprint identification with local binary pattern and Co-occurrence matrix. First, the palm images are preprocessed with morphological technics. Then feature extraction is applied for images. We used local binary pattern (LBP) and gray level Co-occurance matrix (GLCM) for desired features. This approach is tested for 20 people and there are 1, 2, 3 and 4 images from each people. Our method is compared with PCA method. The result shows that proposed method have high accuracy and good performance (%92) for palmprint recognition.

Keywords: Identification, Palm Print, LBP, Co-Occurrence matrix.

PALM RESİM KULLANARAK İNSAN TANIMLARI

ÖZET

Palm tanıma son yıllarda kabul edilen araştırma alanlarından biridir. Bu yazıda, yerel ikili desen ve Co-olay matrisi bulunan, insan eli parmak izi tanıma sistemi için yeni bir yöntem tanıtılmaktadır. İlk olarak, palmiye görüntüleri morfolojik tekniklerle önceden işlenmiştir. Ardından, görüntüler için öznitelik çıkarımı uygulanır. İstenen özellikler için yerel ikili desen (LBP) ve gri seviye Eşzamanlılık matrisi (GLCM) kullanılmıştır. Bu yaklaşım 20 kişi için test edilmiş ve her bir insandan 1, 2, 3 ve 4 imaj bulunmaktadır. Yöntemimiz PCA yöntemi ile karşılaştırılmıştır. Sonuç, önerilen yöntemin avuç içi tanıma için verimlilik ve iyi performans (% 92) olduğunu göstermektedir.

Anahtar Kelimeler: Tanımlama, Palm Baskı, LBP, Birlikte Olma Matrisi.

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ABBREVIATION

LBP	Local Binary Pattern
PCA	Principle Component Analysis
GLCM	Gray Level Co-occurrence Matrix
IBIA	International Biometric Industry Association
DCT	Discrete Cosine Transform
DWT	Discrete Wavelet Transform
SVM	Support Vector Machine
MRTD	Machine Readable Travel Documents
COP	Consistent Orientation Pattern
CCTV	Closed Circuit Television
FMR	Fales Match Rate
DOST	Discrete Orthonormal S-Transform
ICA	Independent Component Analysis
HEBD	Horizontally Expanded Blanket Dimension
CCD	Charge Coupled Devices
JPEG	Joint Photographic Experts Group
KPCA	Krenel Principal Component Analysis
CASIA	Chinese Academy of Sciences Institute of Automation
LDP	Local Derivative Pattern

CHAPTER 1

INTRODUCTION

As an emerging biometric technology, palm print recognition has been extensively researched due to its easy collection, user friendliness, high verification accuracy and reliability. Biometrics is a unique and measurable feature for identification. Biometric systems are divided into two categories: identification and verification. The first category's aim is recognizing the identification of the individual among the others in the database. In such systems, to the question "who am I?" will answer. In the second, the person offers his identity and the aim of the system is the confirming this identification and in the systems, to the question "do what I say I am?" will answer [1].

In this thesis, the Local Binary Pattern (LBP) with Gray Level Co-occurrence Matrix (GLCM) are used for Human identification by palm print images. For classification, the minimum distance method is used. A total of 500 images are tested. In each data, there are 12 images. Some of them are used for training and some of them are used for test. The best result is get for 6 training images. In next chapters the details of the proposed method will be explained.

1.1 Verification and Identification

The most important distinction in biometrics is between verification and identification. Verification systems verify or reject users' identity. In verification systems, the user is requested to prove that he/she is the person he/she claims to be.

Therefore; the user should first claim an identity by providing a username or an ID number. After claiming the identity, the user provides a biometric data to be compared against his or her enrolled biometric data. The biometric system then returns one of two possible answers, verified or not verified. Verification is usually referred to as 1:1 (one-to-one), since the biometric data provided by the user is only compared against the enrolled biometric data of the person that the user claims to be. Identification systems, on the other hand, try to identify the person providing the biometric data. In identification systems, the user is not required to claim an identity;

which is not the case in verification systems, instead he/she is only requested to provide a biometric data. Another difference of identification from verification is that user's biometric data is compared against a number of users' biometric data. Therefore; identification is generally referred as 1: N (one-to-N or one-to-many). Then the system returns an identity such as a username or an ID number.

1.1.1 Finger-Scan

Finger-scan is a well-known biometric technology which is used to identify and verify individuals based on the discriminative features on their fingerprints. Many finger-scan technologies are based on minutiae points, which are irregularities and discontinuities characterizing fingerprint ridges and valleys. [2] Advantages of Finger-Scan Technology as follow:

- It is proven to have very high accuracy.
- It does not require complex user – system interaction; therefore, little user training is enough to ensure correct placement of fingers.
- It provides the opportunity to enroll up to 10 fingers.

Disadvantages of Finger-Scan Technology as follow:

- High resolution images are required to be acquired due to the small area of a fingerprint and this results is in more expensive acquisition devices.
- Small percentage of users; elderly populations, manual laborers and some Asian populations; are shown to be unable to enroll in some finger-scan systems per International Biometric Group's Comparative Biometric Testing. [3]
- As mentioned before, some people may tend to wear down their fingerprints in time because of their physical work.
- Individuals may have objections to collection of their fingerprints because they may have doubts about usage of their fingerprints for forensic applications.

1.1.2 Facial-Scan

Facial-scan is a biometric technology which is used to identify and verify individuals based on the discriminative features on their faces. Nonetheless, it is generally used for identification and surveillance instead of verification. Facial-scan technologies use some of many discriminative features on face such as eyes, nose, lips etc. [4]

Advantages of Facial-Scan Technology as follow:

- It is the only biometric which provides the opportunity to identify individuals at a distance avoiding user discomfort about touching a device.
- It can use images captured from various devices from standard video cameras to CCTV cameras.

Disadvantages of Facial-Scan Technology

- Changes in lighting conditions, angle of acquisition and background composition may reduce the system accuracy.
- The face is a reasonably changeable physiological characteristic. Addition or removal of eyeglasses, changes in beard, moustache, make-up and hairstyle may also reduce the system accuracy.
- To take changes in environmental conditions and user appearance into account, facial-scan technologies usually store many templates for each account, facial-scan technologies usually store many templates for each compared to many other biometrics.
- Because face of users may be acquired without their awareness, user's may have objections to facial-scan deployments.

1.1.3 Iris-Scan

Iris-scan is a biometric technology which is used to identify and verify individuals based on the distinctive features on their irises. Iris-scan technologies use the patterns that constitute the visual component of the iris to discriminate between individuals. [5]

Advantages of Iris-Scan Technology as follow:

- It is proven to have smallest FMR (false match rate) among all biometrics, therefore; iris is the most suitable biometric for applications requiring highest level of security.
- Iris does not change in time, therefore; it does not require reenrollment which other technologies require after a period of time due to changes in the biometric.

Disadvantages of Iris-Scan Technology as follow:

- It requires complex user – system interaction, particularly precise positioning of head and eye. Some systems even require that users do not move their head during acquisition.

- Very high resolution images are required to be acquired due to the small area of an iris, therefore; acquisition devices are quite expensive.
- There is a public objection to using an eye-based biometric even though many people are not aware of the fact that infrared illumination is used in iris-scan technology. Were they aware, it might be a much stronger reaction to this technology.

1.2 Literature review

Any biometric identification system is not the best solution for identification. By international biometric group, an interesting comparison is done between different systems based on four parametric, distinctiveness, and cost of identification system, time and spending effort by the user in the identification and the rate of user's comfort during identification [6].

An ideal biometric system is a system in which contains all four enumerated parameters in the farthest place per the center of the diagram [7]. In another study, has gained the highest percentage compatibility by taking six biometric techniques (face, fingerprint, hand geometry, voice, eyes and signature) with machine readable travel documents (MRTD), facial features. In this study, parameters such as registration, refreshment, hardware requirement and public acceptance is considered. Palm recognition system is a biometric system using intelligent automatic methods to identify or verify the identification of a person based on physiological characteristics. In the past two decades, the matter of identifying of palms is the extensive research field of machine's vision and pattern recognition. One of the extensive applications for recognition of palm lines is the field of security and verification. In controlling the high population areas, such as airports, railway stations, and subway and …, this method is more effective than other methods of surveillance. So, several photographs have taken from the lines in the palms of people and the device must be able to identify these people at different times, in different orientations of light and, Current methods of identifying palms uses of four types of palm's features: texture, lines, appearance and orientation. According to the extracted features they are divided into five categories:

1- Texture based methods which used the filters such as Gabor, discrete Fourier, Wavelet and Rydan filter.

2- Line based methods are like identifier of palm's directed lines, sober performance, multi-resolution filters and Rydan filter.

3- Appearance based methods are that uses from the analyzing of principal component, analysis of linear distinct appearance of local guard and analyzing of kernel principal component.

4- Orientation based methods which usually uses the Gabor filters.

5- Multi feature based method, such as the combination of features of palm's lines and filed in a same vector. Typically, combinations are done in four levels, data feature, matching, and the decision.

Combination methods in the features level are divided into four categories: series combination, parallel combination, weight combination, and core based combination [8].

In order to identify a person's palm lines, the lines must be properly extracted.
One way to define these lines are using different methods of edge detection. Sobel edge detection and Morphological operation is used in [9].

In this thesis, for the complete extraction of useful features from an appearance, a simple but powerful method, uniform local binary pattern to identification of palm, expressed because this method can pull out all the useful information of an appearance.
In [14], they proposed a new method which is based on the texture. They used two-dimensional discrete orthonormal S- transform. They used the frequency component for their work.

In [15], they used the consistent orientation pattern method to apply fast search in their paper. Their method is very stable diagonally the samples of the same subject.

In [16], an ultrasound technique for extracting 3D palmprints is experimentally evaluated. A commercial ultrasound imaging machine, provided with a high frequency (12 MHz) linear array, is employed for the experiments. The probe is moved in the elevation direction by a motorized stepper stage and at each step a B-scan is acquired and stored to form a 3D matrix representing the under skin volume. The data from the 3D matrix are elaborated to provide several renderings of the 3D ultrasonic palmprint.

In [17], horizontally expanded blanket dimension for palm print recognition. In their method, they demonstrated to be more effective than the single-scale for feature extraction.

The rest of the thesis is organized as follows: in chapter 2, local binary pattern is generally offered. Also, histogram and the co-occurrence matrix will be presented and, Appearance database will be described in this chapter. In chapter 3 the literature review will be explaining. Results of the implementation are given in chapter 4. The final chapter of the thesis is conclusion.

CHAPTER 2

METHODOLOGY

2.1 Local Binary Pattern (LBP)

One of the best ways to represent texture is LBP technique which is widely used in various applications in the recent years. Approval of good separation and important features such as invariance in monotonic changes of gray level and computational efficiency cause to made this method as one of the most useful methods for appearance analysis. Palm is composed of a combination of several small models so by this method it can be described so well.

2.1.1 Description of the Local Binary Pattern

The local binary pattern is considered as the strong approach to texture analysis. For the first time, it was proposed as square operator 3×3 by Ojala and his co-workers [10]. The operation of this method is like which 8-neighborhood on operator are comparing with the central pixel. If each of the eight neighboring pixels will be greater or equal to the amount of the central pixel will be replaced by 1 and otherwise, their amount will be zero. At last, the central pixel is replaced by summing weighted binary neighboring pixels and 3×3 window will pass to the next pixel. By getting histogram of these amounts, a descriptor for appearance texture is obtained. Figure 2.1 demonstrates the local binary pattern operator.

7	3	5
6	5	1
2	3	8

(a)

1	0	1
1		0
0	0	1

(b)

1	0	4
128	149	0
0	0	16

(c)

Figure 2.1 Demonstration of local binary pattern operator

Another extension of the LBP operator is the usage of uniform patterns

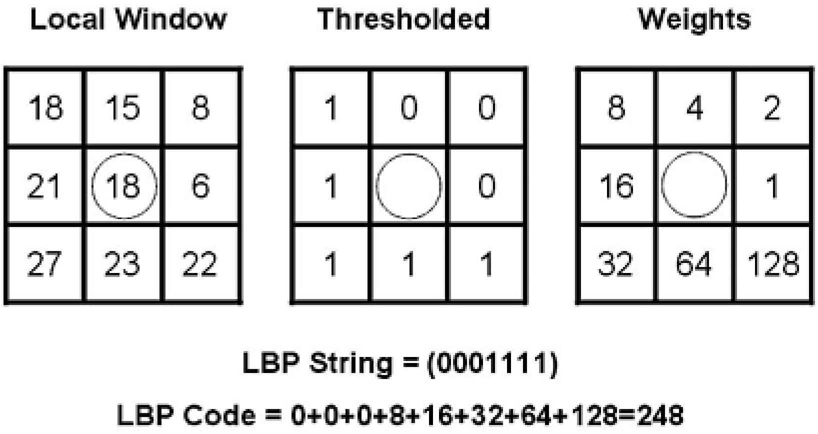

Figure 2.2 The basic LBP operator.

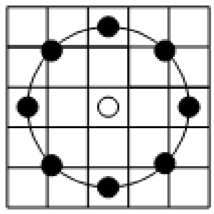

Figure 2.3 The circular (8,2) neighborhood.

The following notation is employed for the LBP operator: $LBP_{P,R}^{u^2}$, where the subscript denotes the use of the operator in a (P, R) neighborhood, and the superscript u^2 the use of uniform patterns only, categorizing all remaining patterns with a single label.

This histogram provides information regarding the distribution of localized micro-patterns, such as edges, spots and flattened areas, over the total image. Effective face representation also requires the preservation of spatial information. For this purpose, the image is divided into areas $R_0, R_1, ..., R_{m-1}$ (Ahonen et al., 2004). The length of the feature vector is thus $B = mB_r$ in which m is the number of areas and B_r is the LBP histogram size. Many small areas yield long feature vectors, resulting in high memory usage and slow classification, whereas large areas cause the loss of more spatial information. Figure 2.4 (a) displays an example of a preprocessed face mask image divided into 49 windows (Ahonen et al., 2004), a similar number to that used in the present study.

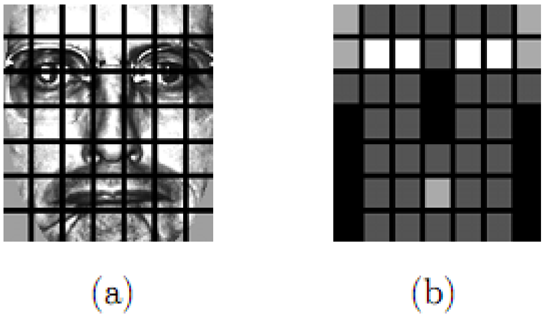

Figure 2.4 (a) Example of a Preprocessing Face Mask Image Divided into 49 Windows.

One of the best methods with which to represent texture is the LBP technique, which has been widely used in various recent applications. The method is considered one of the most useful for appearance analysis due to good separation/discrimination and other important features, such as invariance in monotonic changes in gray level, and computational efficiency. In this technique, each face is composed of a combination of several small models and thus can be described more precisely.

And the equation (2.1) shows the composing relationship of local binary pattern in each pixel:

$$LBP_{P,R(x,y)} = \sum_{P=0}^{P-1} s(g_p - g_c)2^P \qquad (2.1)$$

Which s denotes the sign 1, g_p and g_c, denotes the amount of the gray levels of neighboring and central pixels. Also, 2^P is a required factor for each neighbor because LBP method contains tissues with different ratios.

2.1.2 The Uniform Local Binary Pattern

The first improvement of the LBP was introduced as uniform pattern in 2000. If a local binary pattern consists of a maximum of 2-bit transition from 0 to 1 or vice versa is called uniform. For example, 0000000000 patterns (0 transition) and 11001001(4 transitions) are respectively the uniform and non-uniform. It has been shown that using the neighborhood (1, 8) and (16, 2) respectively are about 90% and 70% of entire pattern. The overall pattern of binary with P bits consists of P+2(P-1) of monotone model. From LBP $\binom{u2}{P,R}$ notations has been using for LBP uniform which below script express use of neighborhood (P,R) and the superscript indicates the using of uniform pattern .Uniform binary model according to equation (2) is calculated.

$$LBP_{P,R}^{U2}(x,y)=\begin{cases} I(LBP_{P,R}(x.y)) & if \begin{cases} U(LBP_{P,R}) \le 2 \\ I(z) \in [0,(P-1)P+2] \end{cases} \\ (p-1)p+2 & otherwise \end{cases} \tag{2.2}$$

That U(x) is the detonator of the number of transitions between bits, and is defined like equation (2.3):

$$U(LBP_{P,R}) = |s(g_{P-1} - g_c) - s(g_0 - g_c)| + \sum_{P=1}^{P} |s(g_{P-1} - g_c) - s(g_{P-1} - g_c)| \tag{2.3}$$

If U(x) is smaller than 2 pixels, the currently pixels labeled with an indicator function I(z), otherwise, the (P-1) P+2 will assigned to it. Indicator function index I(z) which includes the (P-1) P+2 which is applied for specific index for to each of the uniform patterns.

2.2 Appearance Histogram

In a scalar appearance, image pixels have specific amounts. The first gray level histogram represents the brightness distribution in the image. The horizontal axis of this histogram contains the pixel brightness values, and the vertical axis the number of corresponding pixels with each appearance brightness value. Suppose that the input image is a gray image with 256 levels of brightness, so each image pixel can range in value from 0 to 255. To obtain the appearance histogram, it is sufficient that in traversing all the pixels in the image we calculate the number of pixels at each brightness level.

It is clear that in a simple histogram, all pixel location information is missing and just the gray values are calculated.

2.2.1 Co-occurrence Matrix

Second-order histogram which in some references known as co-occurrence matrix, express the event rates of gray values of the two pixels which depends on the distance of image and special direction of each other.

For the first time the co-occurrence matrix have been used to extract textural features of the image in order to troubleshoot of grapefruit by Harlyk [11]. Co-occurrence matrix is the description of the frequency of P_{ij} which the two separated neighboring pixels by a fixed distance d that one of them with gray intensity i and other with gray intensity j occurs in image. So, the co-occurrence matrix from a square matrix whose size depends on the maximum pixel intensity in gray image is to be formed. Each element of P_{ij} representative of the number of occurrences pixel size I of the pixel distance from pixel size j , and usually is equal to 1 (d=1), and the angle between two pixels may represent by 0, 45, 90 and 135 degrees [12]. Figure 2.5 illustrates the desired pixel with the desired angle and 1 distance.

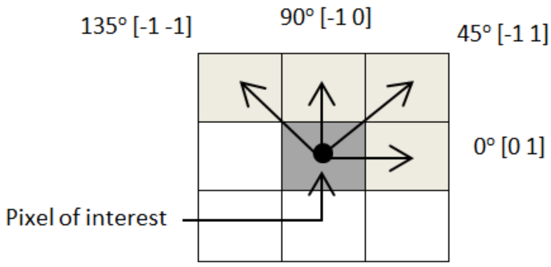

Figure 2.5 Desired pixel with desired angle and 1 distance.

The result of the co-occurrence matrix shows that how to close the pixel values of the image are to each other, the larger diameter of the core matrix of aggregate. The advantage of using this matrix on simple histogram of the image with compared to a simple histogram is in which the spatial information of pixels has destroyed and just amount of gray pixels are calculated in this matrix location of pixels. So, that the distribution of gray values is larger, there is more variance in the matrix.

In the mathematical definition of a co-occurrence matrix C_d for matrix with a distance (Δx, Δy) is defined as an equation 4:

$$C_k(i,j) = \sum_{p=1}^{n}\sum_{q=1}^{m}\begin{cases}1, \text{ if } I(p,q) = i \text{ and } I(p+\Delta x, q+\Delta y) = j \\ 0, \quad \text{otherwise}\end{cases} \tag{2.4}$$

The (i,j) elements of C_d matrix are the number of appearance of i and j which have distinct in size (Δx, Δy) with each other. In fact, co-occurrence matrix is based on the estimation of second rate which is conditional of the density function 1. Second-order statistical properties define the overall picture as well [13].

For example, figure 2.6-b, shows the co-occurrence matrix to the matrix dates' in figure 2.6 a that is calculate in direction of zero and with neighborhood of 1.

Since natural images usually have low-pass features and adjacent pixels are highly correlated, co-occurrences matrix of pixels or their diagonal coefficients are distributed. In other words, the values are large amounts of numbers on the main diagonal and gradually will reduce minor diameters. After insertion, due to the loss of correlation, the focus on the main diagonal of co-occurrence matrix be reduced and cause distribution.

0	3	1	0	0	0	0	0
0	0	0	1	1	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	1
0	0	0	0	2	0	1	0
0	0	0	0	0	0	1	0
2	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

a

1	2	4	8
1	3	5	5
5	5	7	1
6	7	1	2
8	1	2	5

b

Figure 2.6 (a) that is calculated in direction of zero and with neighborhood of 1, (b) the co-occurrence matrix to the matrix dates.

2.3 Evaluating and Choosing a Distance Function in System Performance

There are two solutions required to calculate the similarity between feature vectors. The first involves calculating the distance between two feature vectors, and the second calculating the similarity. These two measurements oppose each other. Different criteria are employed to evaluate distance and similarity. In the present paper, the similarity between a test image S and a training image T was determined via the chi-square distance (Li et al., 2007), expressed as follows:

$$D(S,T)=\sum_{n=1}^{N}\frac{(S_n-T_n)^2}{(S_n+T_n)} \tag{3-5}$$

A minimum of 1 and maximum of 4 face images of each of the selected test subjects were used in the training.

As is clear, the PCA method produces the worst results, whereas the standard LBP method is the most accurate. However, the currently proposed method has a higher accuracy than standard LBP.

Performance-based approaches appear to be strongly influenced by the number of training images employed. In a further experiment, we therefore investigated the influence of this parameter on the proposed method, using a minimum and maximum of 3 images of each test subject for training. Experiments were performed on the database, and the results presented using different algorithms.

2.4 Appearance Database

The databases of images that used in this article, is part of the image database which is collected at Hong Kong Polytechnic University. A device that is used for taking pictures is scanner which is based on CCD camera. The size of images is 384×284 pixels with 750 dpi resolution. Figure 2.7 shows the image acquisition device and the sample images which is captured by it [14].

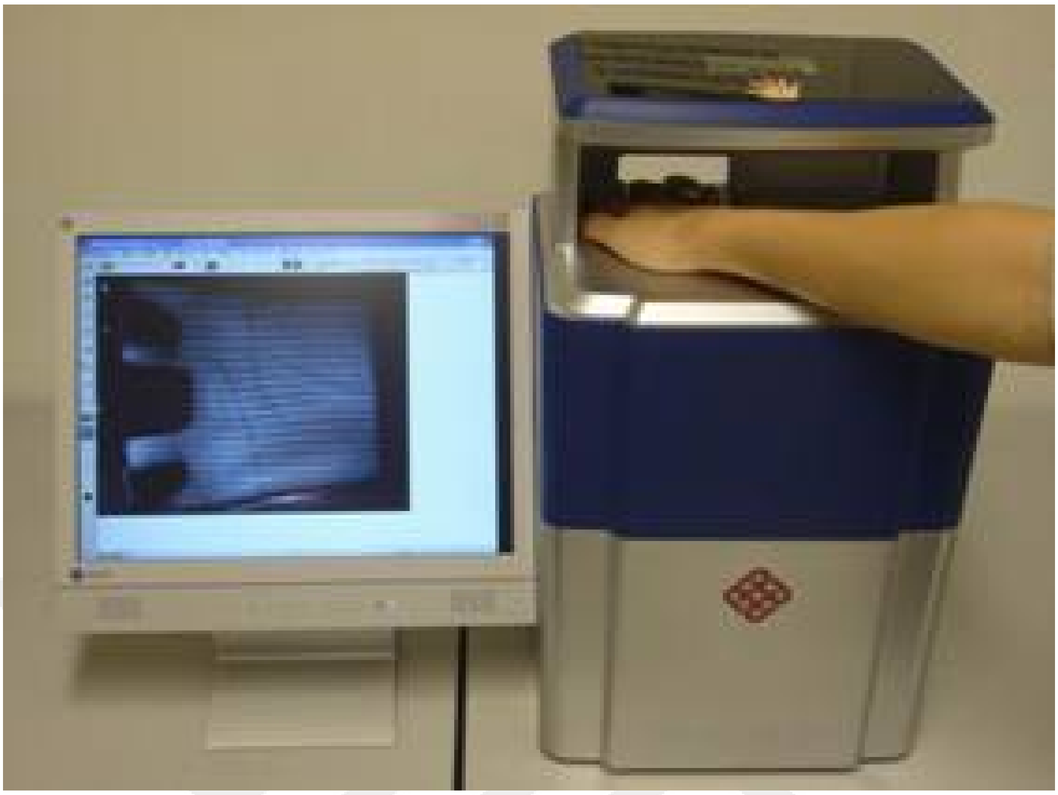

Figure 2.7 Image acquisition device and the sample images which is captured by it.

To evaluate the proposed method, many of image from this database are selected these images due to skin pigmentation and the small difference between levels of gray lines and other areas; they have different levels of brightness. The size of the original images is 384×284. After preprocessing, the central part of the image (size is 128×128), is cropped for feature extraction and matching. Fig. 2.8 shows some samples of one palm after preprocessing.

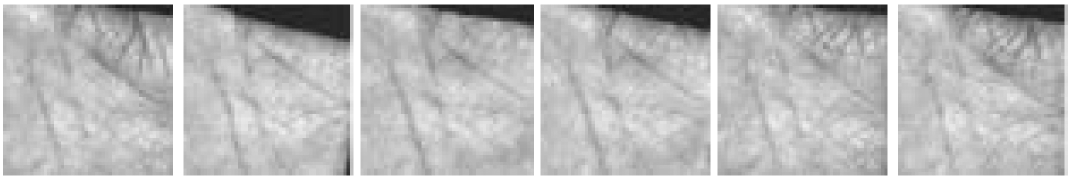

Figure 2.8 Some samples of one palm after preprocessing

As patterns of computers in recent years has made people a lot of work to be able to distinguish. Some of the characters studied patterns, symbols, pictures, sound waves are electrocardiogram. Often difficult to interpret due to the complex calculations or assessments are used in computerized recognition that human overload problems. The simplest way is matching the pattern recognition template. In this case, templates are stored in memory in the form of database, including a template set for each pattern class. Unknown class is compared with the template of each class. Classification is performed according to a predetermined matching criterion or similarity criteria. Rather than compare it with the complete pattern template to compare some of the features often gives faster and more accurate results. For this reason, the process of pattern recognition, feature extraction and classification is examined in two separate stages, including [15].

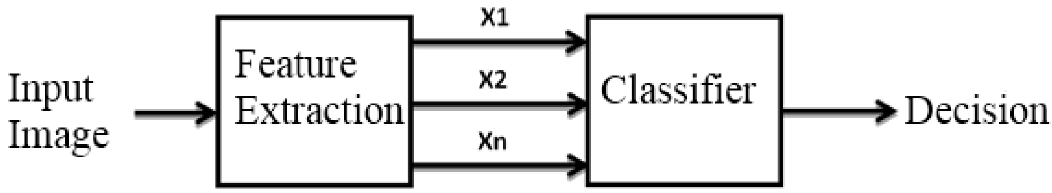

Figure 2.9 Pattern Recognition System

Figure 2.9 in feature extraction, the results of doing some measurements on the pattern makes a feature vector. This feature may vastly differ depending on the nature of the problem. In addition, severity and costs relative to each other properties can be different. Therefore, better distinguished from each other classes of properties and obtained costs must be selected to be low. Features are different for each pattern recognition problem [16].

In the classification phase of the object based on the extracted features are judged to belong to which class. Pattern recognition is concerned with the interpretation or recognition of image samples and aim to achieve the classification process by learning about the view. Two major classification technique using a template matching and feature extraction is performed. Template matching is the most common classification methods. In this method, each pixel of the image feature. Classification is done by comparing the input image of the entire class template. The comparison results occur similarity measure between the template and input information. Pixel of the input image with the template increases the degree of similarity based on equality, the corresponding differences in each pixel reduces the similarity. Maximum degree of similarity of the template class that makes after comparing all the templates are selected. Structural classification technique uses structural features and decision rules to know the classes of patterns.

2.5 Existing palmprint recognition algorithms

Researchers noticing the increase in biometric revenues in last years and realizing the advantages of palmprint scan-technology mentioned in the previous chapter started to develop algorithms to be used in palmprint recognition. Researchers' interest in palmprint recognition algorithms has significantly increased especially in last three years. Due to the fact that the palmprint recognition is a relatively new field of biometrics, there is a problem related to the utilization of a common palmprint database in order to be able to compare the performance of different algorithms. Nevertheless, The Hong Kong Polytechnic University Palmprint Database is the most commonly used palmprint database. It is here worth giving brief information about this database before explaining some of the studies on palmprint recognition. The Hong Kong Polytechnic University Palmprint Database contains 600 grayscale images corresponding to 100 different palms in Bitmap image format. Palm images have a resolution of 284x384 pixels with 256 gray levels. Six samples from each of these palms were collected in two sessions, where 3 samples were captured in the first session and the other 3 in the second session. The average interval between the first and the second collection was two months. The palmprint images in the database are labeled as "PolyU_xx_N.bmp", where the "xx" is the unique palm identifier (ranges from 00 to 99), and "N" is the index of each palm (ranges from 1 to 6), the palmprints indexed from 1 to 3 are collected in the first session and 4 to 6 in the second session. [17] Figure 2.10 shows a schematic diagram of the online palmprint capture device used to acquire these palm images. The palmprint capture device includes ring source, CCD camera, lens, frame grabber, and A/D (analogue-todigital) converter. To obtain a stable palmprint image, a case and a cover are used to form a semi-closed environment, and the ring source provides uniform lighting conditions during palmprint image capturing. Also, six pegs on the platform, which is demonstrated in Figure 2.11, serve as control points for the placement of the user's hands. The A/D converter directly transmits the images captured by the CCD camera to a computer [18].

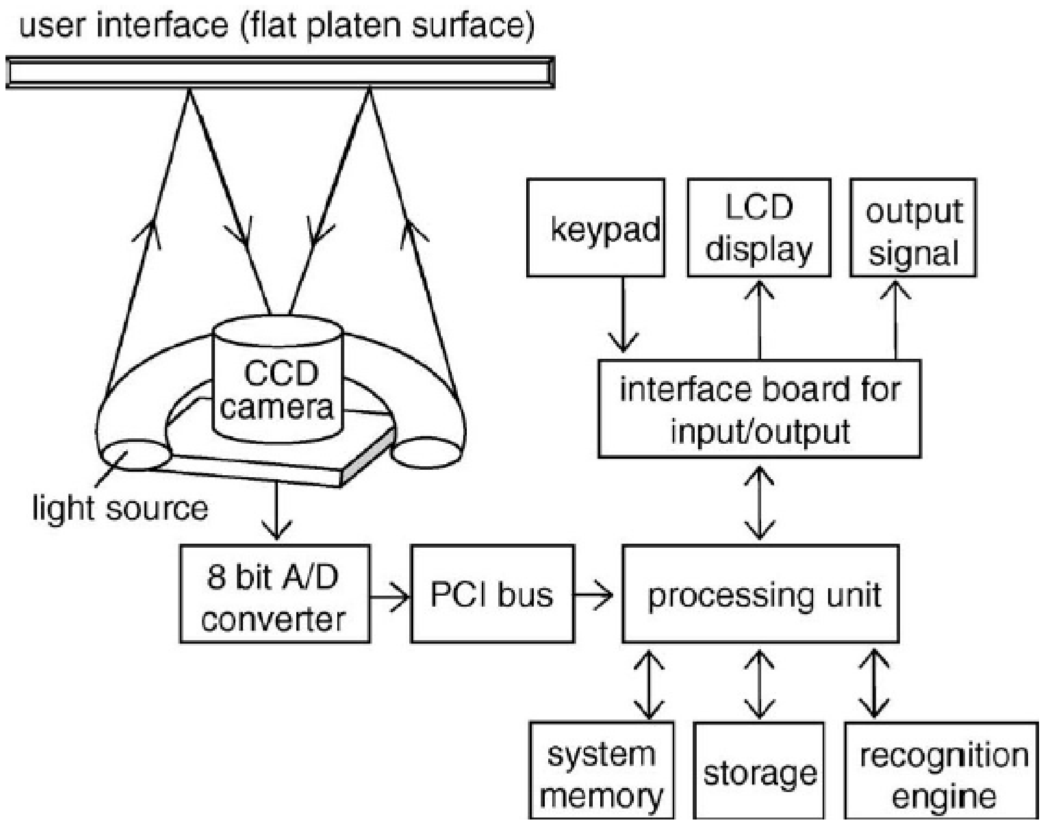

Figure 2.10 Schematic Diagram of Palmprint Acquisition System.

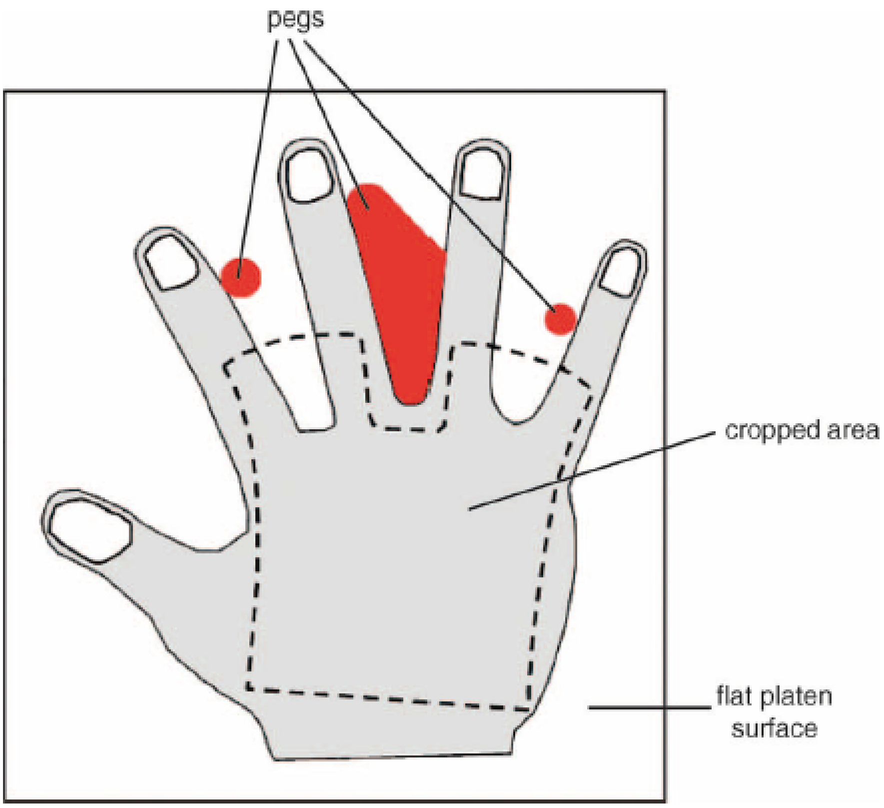

Figure 2.11 Pegs and the Cropped Area of the Palm.

Various algorithms have been developed to be used in palmprint recognition. Developed algorithms mainly include different methods for feature extraction and distance matching. From now on, some of the methods developed for palmprint recognition will be mentioned and their results will be discussed.

Fang Li et al. [19] proposed an approach utilizing Line Edge Map (LEM) of palmprint as the feature and Hausdorff distance as the distance matching algorithm. In this study, Line segment Hausdorff distance (LHD) and Curve segment Hausdorff distance (CHD) are explored to match two sets of lines and two sets of curves. They carried out an identification experiment on The Hong Kong Polytechnic University Palmprint Database. 200 palm images, i.e. 2 palm images for each person, have been randomly selected in order to test the system performance. They reserved one palm image for each individual as a template, and used remaining palm images as test images to be identified.

Fang Li et al. [20] later proposed the utilization of Modified Line segment Hausdorff distance (MLHD) as the distance matching algorithm. In this study, 2-D lowpass filter is applied to sub-image extracted from the captured hand image. The result is subtracted from the image in order to decrease the non-uniform illumination effect resulting from the projection of a 3-D object onto a 2-D image. After line detection, contour and line segment generation steps, each line on a palm is represented using several straight-line elements. Finally, MLHD is used in order to measure the similarity between two palm images. Performance of this and some other palmprint identification methods are tabulated in Table 2.1.

	Duta et al. [42]	You at all [43]	Zhang et al. [44]	LHD [40]	CHD [40]	MLHD [41]
Database Size	30	200	200	200	200	200
Feature	Feature Points	Texture and Feature Points	Lines	Lines	Curves	Lines
Matching Criteria	Euclidean Distance	Energy Difference and Hausdorff Distance	Euclidean Distance	Line Hausdorff Distance	Curve Hausdorff Distance	Modified Line Hausdorff Distance
Recognition Rates	% 95	% 91	% 92	% 96	% 92	%100

Table 2.1 Comparison of Different Palmprint Identification Methods

Algorithms employing neural networks have also been developed. Li Shang et al. [21] suggested the usage of radial basis probabilistic neural network (RBPNN). The RPBNN is trained by the orthogonal least square algorithm (OLS) and its structure is optimized by the recursive OLS algorithm (ROLSA). A fast-fixed-point algorithm is used for independent component analysis. The Hong Kong Polytechnic University Palmprint Database is used to test the developed palmprint recognition algorithm. After tests performed on this database, recognition rates between % 95 and % 98 are obtained.

There are also methods utilizing morphological operations in order to extract features in a palmprint. Xiang-Qian Wu et al. [22] presented an approach based on valley features. Bothat operation, which utilizes two morphological operations; namely opening and closing, which are defined by combining dilation and erosion; is applied to extract the valleys in different directions in low-resolution images and to form the valley feature. After the valley feature, has been obtained, a distance matching algorithm adopted to measure the similarity of the valley features has been employed. ROC curve of this approach, which has an EER of % 2, and the resulting distributions of genuine-imposter matching scores are displayed in Figure 2.12. C.

Han et al., on the other hand, utilized Sobel and morphological operations in order to enhance lines on a palm. They then divided palmprint into several sub-blocks and a feature vector has been obtained from the mean of pixel values in each sub-block.

ROC curve of this method, which has an EER of % 14, is also shown in Figure 2.12.

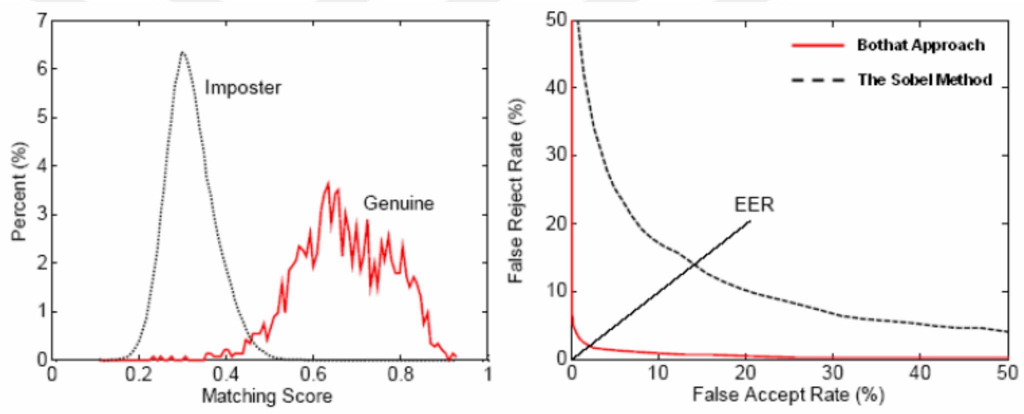

Figure 2.12 Distribution of Genuine and Imposter Matching Scores and ROC Curves

Gabor filters, being widely used in fingerprint recognition algorithms [23-24], are also used in palmprint recognition algorithms. David Zhang et al. proposed an approach utilizing 2-D Gabor filter in order to extract features. They used normalized Hamming distance to measure the similarity between palmprints. They achieved to reach an EER of % 0.6 in verification tests. ROC curve and the distributions of genuine-imposter matching scores obtained in verification tests are shown in Figure 2.13. They also performed identification tests. In this identification tests, they set up three databases consisting of 50, 100 and 200 individuals. They reserved 3 palm images of each user as templates resulting in 150, 300 and 600 templates, respectively. ROC curve obtained in identification tests for these three databases are shown in Figure 2.14. It is seen in Figure 2.14 that as the number of registered users increases, the identification accuracy of the system decreases. This is quite expected, because number of total classes in a database is equal to the number of registered users, therefore it becomes harder for the system to classify correctly.

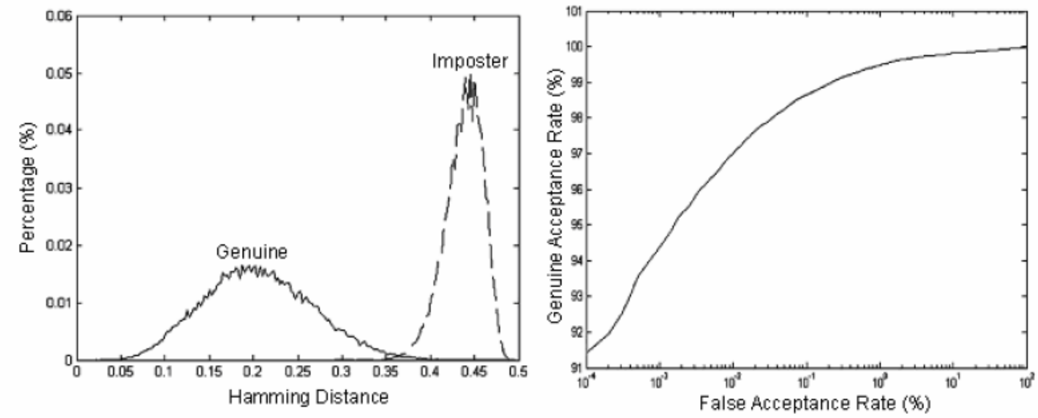

Figure 2.13 Distribution of Genuine-Imposter Matching Scores and ROC Curve – Verification

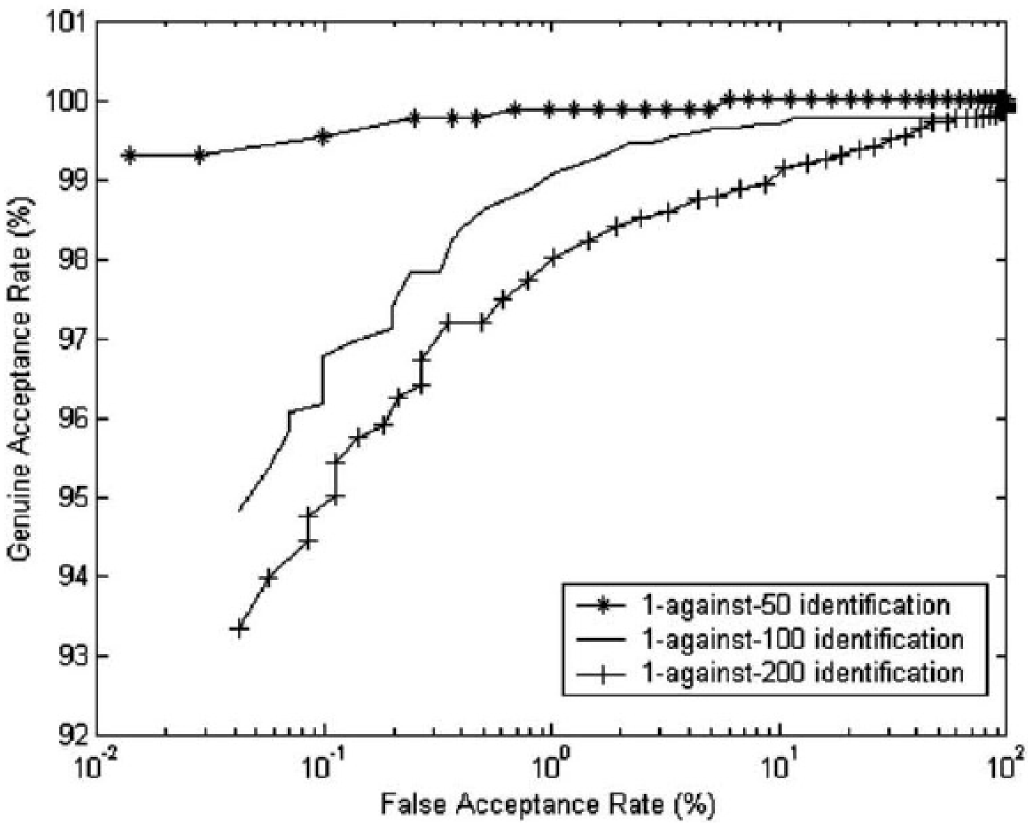

Figure 2.14 ROC Curve – Identification

Another algorithm utilizing Gabor filters is studied by Xiangqian Wu et al. [25]. This algorithm is based on the fusion of the phase information (called FusionCode) and the orientation information (called OrientationCode). In this study, 4 Gabor filters with different orientations are used to extract the FusionCode and the OrientationCode. After the FusionCode and the OrientationCode have been obtained, they are fused to obtain the feature vector, Palmprint Phase Orientation Code. Finally, modified Hamming distance is used to measure the similarity between two palm images. In verification tests, they reached an EER of 0.3 %. The distribution of genuine-imposter matching scores for this approach is shown in Figure 2.15. In order to see the effect of the fusion on verification accuracy, they also implemented Fusion Code method and the OrientationCode technique. Resulting ROC curves of these three methods are also shown in Figure 2.15.

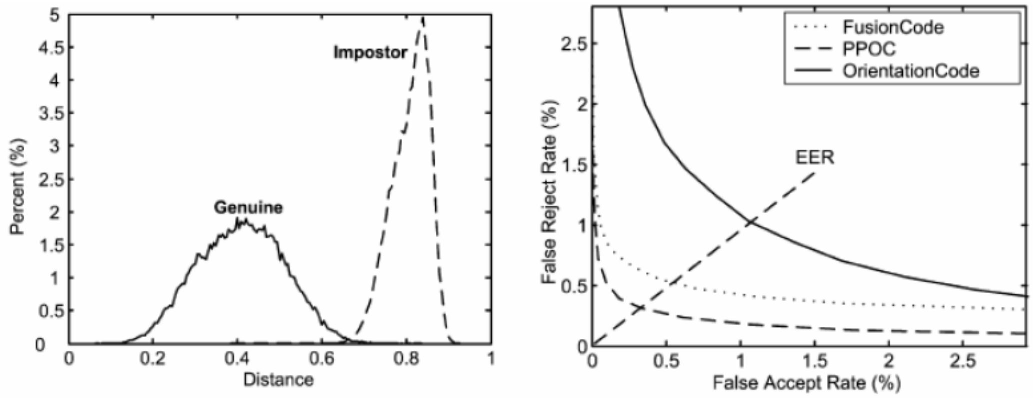

Figure 2.15 Distribution of Genuine-Imposter Matching Scores and ROC Curves

Ajay Kumar and Helen C. Shen [26] also proposed an approach in which Gabor filter is used. In this approach, 800 images have been acquired from 40 individuals, 10 from their right palms and 10 from their left palms, via HP-Scanjet ADF scanner. Acquired palm images are first normalized in order to reduce brightness and contrast variations resulting from sensor noise and variations in palm pressure. The normalization process is depicted in Figure 2.16. After normalization, each image is subjected to multi-channel filtering using a bank of Real Gabor Function (RGF) filters. These filtered images, shown in Figure 2.17, are used to extract features from each of 6 concentric circular bands. Finally, the similarity between feature vectors is measured and each palm image is classified into a class. Experimental results show that they reached an EER of 3.03 % when total number of classes is considered to be 80, that is, left and right palms of each individual are counted as two different classes. This result proves the uniqueness of palmprint texture even in two hands of an individual.

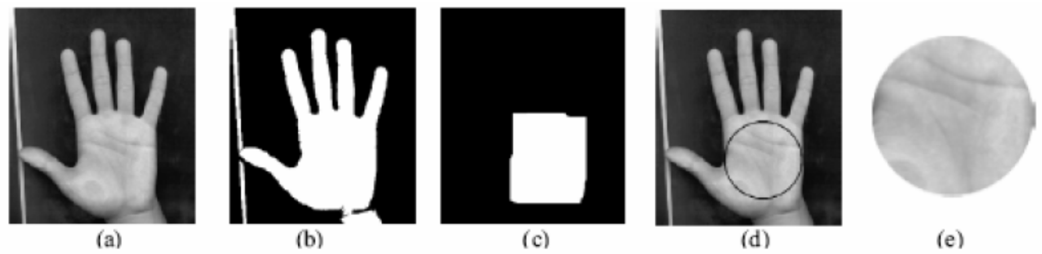

Figure 2.16 (a) Acquired Palm Image, (b) Palm Image After Thresholding, (c) After Morphological Erosion, (d) image palm section Circular Region of Interest, (e) Segmented Palmprint Image.

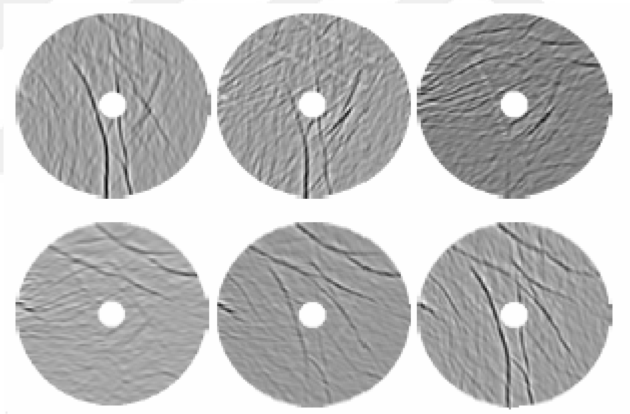

Figure 2.17 Images Filtered by Six Different Real Gabor Function Filters.

As it is seen, having proven its accuracy in many different algorithms, palmprint scan technology stems as a new reliable biometric technology.

CHAPTER 3

IMAGE PROCESSING

3.1 Image Processing Principles

In its most simple expression, blur processing, images necessary to handle a vehicle and is important two demand input-output hardware heard digitization and image display device. Due to the natural structure of this device directly to a computer analysis of the images constitute a source. Computers not with image data they are working with numerical values, Processing the image is converted to a numeric format before you start. Figure 3.1 a substantially rectangular image of the sequence number, shows how to represent. Material image, shape elements or "pixels" is divided into small regions called. The most comprehensive sub-partitioning scheme that quadrilateral sampling grid was transferred to the device in Figure 3.1.

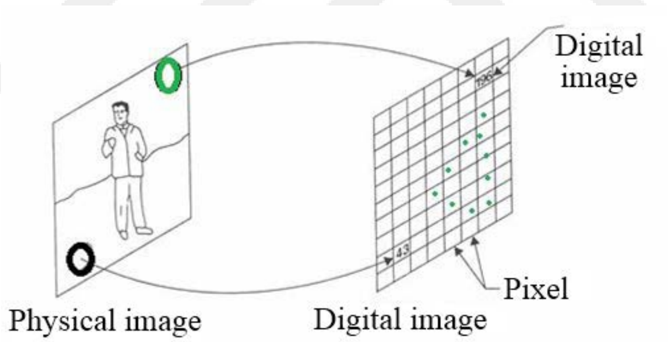

Figure 3.1 a material images and numerical shape

The conversion process is called numerical. Examples of brightness of each pixel of the image and used as numeric. This part of the process, each pixel that represents the brightness or darkness of the place. This process is shown in the picture format is applied to all pixels in a rectangular array. Each pixel location or a complete track (with line and column numbers) and has an exact value also called gray levels. This sequence numeric data is currently processed in a suitable state for the computer. Figure 3.2 shows the version of the continuous numerical image.

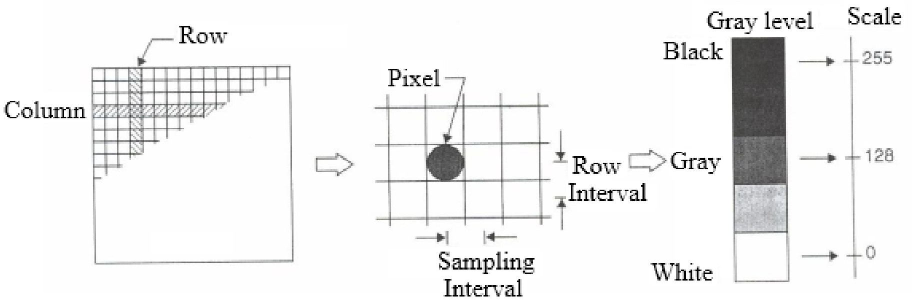

Figure 3.2 the digitization of an image

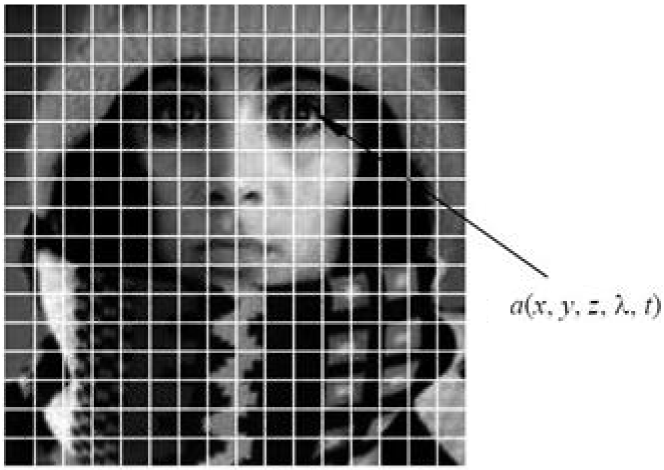

Figure 3.3 A continuous picture of digitizing shape. [m, n] where similar single point numerically, brightness, etc. shown in value.

Digital image processing can be divided into two main groups; that the input and output method of the image, the second group of images may be entered, but where are the methods of stamps issued from the images came out.

3.1.1. Image Obtained

Obtained first work to image shown in Figure 3.1, using essentially the general may be given as a numerical data, the prototyping process is referred to as preprocessing.

3.1.2. Image Enhancement

Is one of the most practical image processing section. Basically, the main idea behind the image stabilization methods, the presence of overlooked details or a form of fixed properties is shown in the foreground. The original process is to increase the contrast of the image.

Image enhancement is the process of digitally manipulating a stored image using software. The tools used for image enhancement include many kinds of software such as filters, image editors and other tools for changing various properties of an entire image or parts of an image.

Some of the most basic types of image enhancement tools simply change the contrast or brightness of an image or manipulate the grayscale or the red-green-blue color patterns of an image. Some types of basic filters also allow changing a color image to black and white, or to a sepia-tone image, or adding visual effects.

3.1.3. Image restoration

Image restoration makes a better picture. Image is a subjective process improvement, repair is a concept image objective. The renewal of the image missing mathematical and forecasting forms are used.

It is the restoration of degraded images that cannot be taken or paint again process. You can restore the original images by prior knowledge of the damage or deformity which causes the deterioration of the images, such as cracks or scratches, dust and stains. Restoration also includes modern cameras captured images which suffered deformation due to problems in the transport or the circumstances in which photos were taken, as is the case for space missions Photo scanners or medical devices. The process of removing the wrap is one example of how to restore the image.

3.1.4. Color image processing

Proliferation of the use of color digital pictures on the Internet increases the importance of this issue is the effect.

3.1.5. Compression

As is evident in the name of an image that ought to be stored is concerned with reducing the amount of certain discs. Covering technology more advanced, though quite recently, the same cannot be said for technology transfer size. This has become especially important in image content with the use of the internet. Known form of computer user's JPEG is an image compression standard certificate extensions.

3.1.6. Morphological Processing

Morphological processing depends on the image displayed in the image and shape of the unknown in useful components used in obtaining the device.

3.1.7. Segmentation

The segmentation process is one of the most challenging image processing functions. Slicing an important stage that allows the extraction of the quality of information on the image as it provides a high-level description as each region linked to neighboring areas within a network of nodes where each node area in the picture represent and carry this node card containing quality information on the region such as it is size, color and shape, and orientation , the brackets that connect the contract could be labeled with information about the relationship between neighboring regions if, for example, be a content area in the other, or be below or above the other. Complexity in network configuration varies depending on the level of technology used in the shredder.

No matter how genuine segmentation, recognition process is so true.

3.1.8. Database

Known the problem is often encoded in the database and the credit for this due to the image processing device. Database as well as to guide each processing, enable communication between the modules.

3.2. Techniques Used in Image Processing

3.2.1. Shadow Correction

Images was obtained from material objects, you can create shadows on the picture obviously still due from the sparkle, buyer or real objects. Some appeared in the pictures bright edges closer to the middle or middle aggravated opposite happens in a case of this kind of work right brightens the dark borders. Or know the easiest way to shine left or right of the image can be replicated. Shadowing, non-uniform illumination, camera-sensitive non-uniform, even the lens is dirty, not even occur. Therefore, shadowing phenomenon is undesirable. However, the image becomes objective image analysis prior to recovering from this case [27].

3.2.2. Normalization

Processes are performed before starting the processing of the image. This should be as short as pretreatment. Because normalization until the intent to be used for the algorithm is to examine the response of redundant information and action. The size of the image from the scanner are different resolutions from each other. Color images from the browser is changed to gray levels. If the size of this image was being done, and this is done with image processing and analysis stage of the learning neural network takes a long time. In fact, it increases the time to use large size and decrease in the yield of the process. Therefore, images from the scanner should reduce a certain standard [28]. As a result of these assumptions, the number of pixels of the images in our program implementation was changed to 128×128.

3.2.3. Thresholding

One of the methods used in image processing threshold base welds. The purpose of making a numerical image thresholding operation is convenience in determining the properties of the image. With a unique gray level image, i.e. to show it in black and white binary image can be altered expression in two colors. Before the thresholding process image has a threshold value. Is done by selecting a threshold value as in Figure 3.4. Is higher than the threshold gray level value of the (1) pixel value and the smallest values of the pixel value of

(0) is assigned, then the image is changed to a simpler shape in black and white. The image in Figure 3.5. prior to the thresholding process (left) and the next state (right) is seen [29].

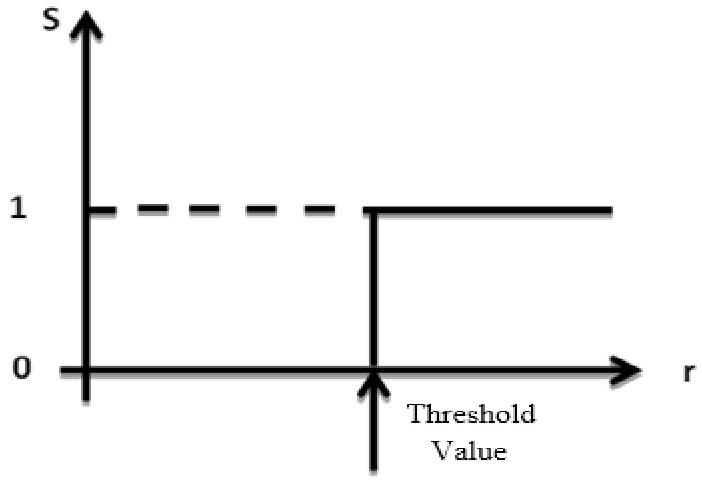

Figure 3.4 The threshold value

$$r \geq th \Rightarrow \quad s = 1 \qquad (3.1)$$

$$r < th \Rightarrow \quad s = 0 \qquad (3.2)$$

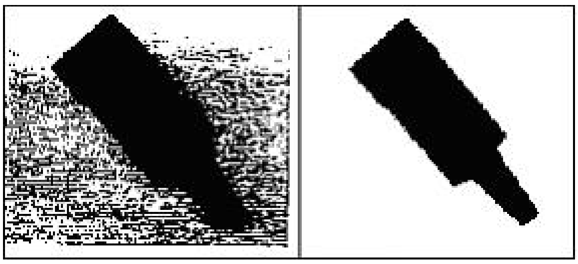

Figure 3.5. Thresholding before and after images

3.3. Human recognition based on human resources

The distinction of people based on palm prints is one of the issues that researchers have been actively involved in recent years. Different approaches based on structure and appearance [30, 31] have been proposed on this subject. Structural approaches take advantage of the different features in the image and remove those probing features. Appearance-based approaches can take the same algorithm for all problems as a whole. Appearance-based approaches that we are working on from them also work better than others. The performance of the presented method was evaluated on the PolyU-I and PolyU-II [32] palm databases. The images in the PolyU-I palmprint database were removed using a CCD camera. The database contains 600 images taken from 100 different palms. Six samples from each palm were taken in one session, the other three in another session.

The time between the second session and the first session is approximately two months. Images in the PolyU-II palmprint database were also obtained in a similar manner. There are 7752 images from 386 different palms in this database. There are 10 images in the first session and 10 images in the second session for each aviator. The time between two sessions is 69 days. All images were captured in 384 × 284 resolution at 75 dpi. Also, by changing the focus setting of the light source and the CCD camera, the images taken in the first and second sessions were given the feeling of being taken from different palm print devices. In order to obtain a stable palm image in the palmprint image capturing system, a housing and a cover are used to form a lucid closed environment, and a ring is used to ensure that the light conditions are not changed while the palmprint image is taken. Six hooks serve as control points on the platform, allowing the user to properly position their hands. The A / D converter transfers images taken with the CCD camera directly to the computer. Figure 3.6 shows a schematic diagram of the system that produces this palm print image.

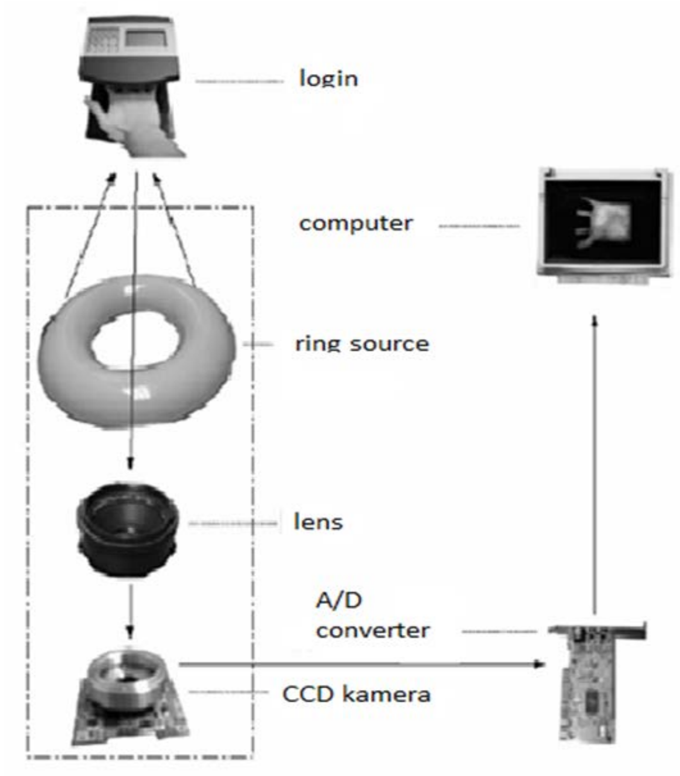

Figure 3.6 Design of palmprint capture system

In our palmprint recognition method, first, the 128 × 128 region of interest is extracted from each palm image. Then recognition process is completed with attribute parsing, attribute extraction and classification operations.

Preliminary actions.

Two kinds of methods have been applied in the selection of the region which is interested in palm images. In the selection of both regions, the palm image is first converted into a binary image with the value of the palm. The method we use for selection of the value is the minimization of blur [33]. On the binary image there are boundaries between the fingers and the nerve tracking algorithm. The next steps are slightly different.

The process of region selection method [34] is as follows:

After the original gray level image is rotated to the binary image, the gaps between the fingers are determined using the distances from the left of the view. Then the extreme values at the start point

The extreme values for the mark are marked as start point (S_{x_i}, S_{y_i}) and end point (E_{x_i}, E_{y_i}).

The center of gravity of the fingers (C_{x_i}, C_{y_i}) is calculated. There is a center of gravity and a place where the finger passes through the middle of the start and end points. Thus, three points (L_1, L_2, L_3) are obtained.

The line passing through points L_1 and L_2 is drawn and the image is rotated so that it forms the correct Y axis. A 128 x 128 image is selected with the center of the line perpendicular to the newly created Y axis and passing through L_3, centered on the region of interest.

The basic process steps of the first zone selection method are shown in Figure 3.7.

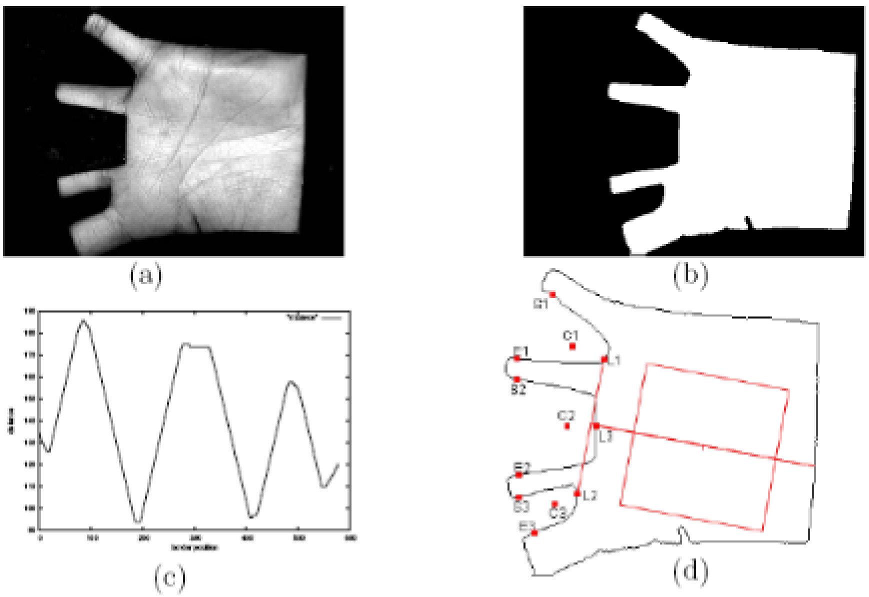

Figure 3.7. The basic steps of selecting a region are as follows: (a) Original image, (b) Binary image, (c) Image with distance from the left, (d) Fingerprint image generated as a fuzzy middle zone.

3.3.1. Feature Extraction

PCA and KPCA methods have been applied to extract features to palm print images. When applying PCA and KPCA in the first database, all training images were used and the success rates according to different attribute numbers were calculated.

Since the training sample of the second database is very large, the transformation matrix of PCA and KPCA is calculated by taking only 1 sample of each class. Thus, operations were applied at an acceptable rate. The Gaussian kernel was used for better results in KPCA. In Figure 3.8, images corresponding to the first, second and last self-capture are given.

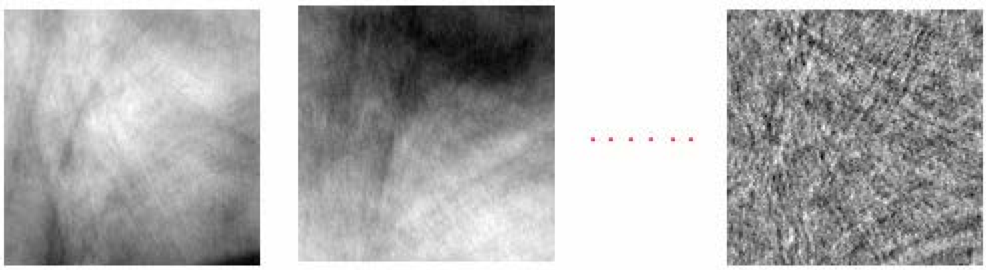

Figure 3.8. According to the first palmprint database, the first 2 and the last palm images

3.3.2. Determination of the Performance of the Palm Recognition System

Three important performance measurements are made for the performance of the palm recognition system. Correct recognition, misrecognition and rejection performance. Accurate recognition performance is correctly recognized by the system of the input image belonging to the persons in the database. A different palm image belonging to the same person is required so that the image database differs from those in the image database. False recognition performance is recognized by the system incorrectly as the input image belonging to the persons in the database. The resident database should be different from the ones in the database. The rejection performance is measured by determining whether the images submitted by the persons who are not in the database belong to a person in the image database by the recognition system. The sum of correct recognition, misrecognition and rejection is equal to 100 when the percentage of correctly recognized persons, the percentage of misidentified persons, the percentage of rejected persons, and the percentages. Therefore, the performance of the recognition system is sufficient to give the values of two of them [35]. There is a change between the percentage of false recognition of the majority of the algorithms and the percentage of rejection. For example; The rejection rate may increase if the system is mistakenly trying to make a mistake at a location like 0%. The rejection rate can be reduced, but this improves the false recognition rate. Based on the above definitions, it can be stated in the automated palm definition. When the palm images are given to the database, it can be determined as to whether the input image belongs to a person in the database and if it belongs to the image database, the system can determine the identity of the input image [36].

3.3.3. Palmprint image Databases

All experiments in this thesis study were conducted using the palm image database of the PolyU database (The Hong Kong Polytechnic University Multispectral Palmprint Database). All of the images in the PolyU palm database were obtained with the palm recognition device shown in Figure 3.9 [37]. Increasing demand for a highly accurate and robust palm authentication system in a unique high availability and reliable biometric feature of palm images has been achieved in order to obtain more detailed information and reduce palm fraud through multispectral imaging [38].

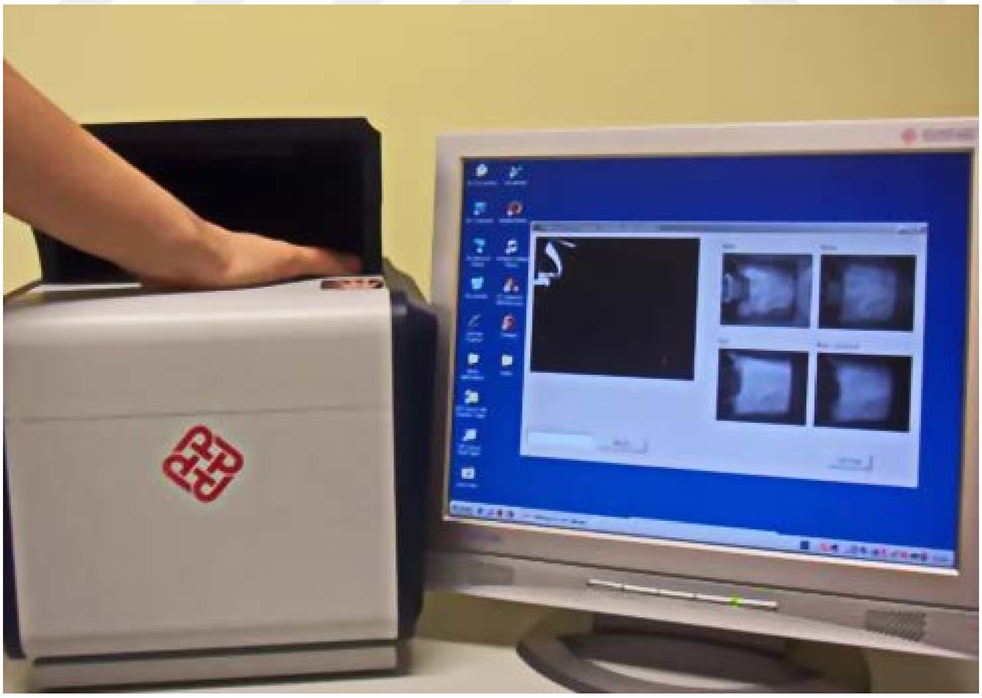

Figure 3.9. Image from PolyU Handheld Reader [37]

The Hong Kong Polytechnic University Biometric Research Center developed a real-time multispectral palm image capture device capable of capturing palm images under blue, green, red, and infrared illuminations and used it to create a large-scale multispectral palm image database. Developed in academic research, they have published a data bank that they can freely use and test in their palm verification algorithms [39]. The resolution is 96 dpi, 128 x 128 pixels and 256 gray levels with 8 bit depth. 250 volunteers, including 195 males and 55 females. The gender distribution of multi-spectral palm views was collected from people between 20 and 60 years of age. Samples were collected in two separate sessions. There were 6 palm views per session. A total of 24 palm images of one person were collected by taking 2 palm images with 4 different lighting in each session. There is a palm view of 500 different people for a lighting, which includes 6000 images in the database. The average time interval between the first and second sessions is about 9 days [40]. Each folder is named "nnnn", and "nnnn" represents the person ID between 1 and 500.

In each folder, the first 6 palm images were obtained in the first session called "1_mm", while the second 6 palm images "2_mm" were obtained in the second session. "Mm" represents the image sequence of the palm images in the session. "Blue Rar", "Green Rar", "Red Rar" and "NIR Rar" contain all the original palm views collected with blue, green, red and NIR illumination. There is also a database where only the palm ROI regions are available by subtracting the ROI of each palm image. Finger chocks were used to adjust the image while palm images were being acquired [41].

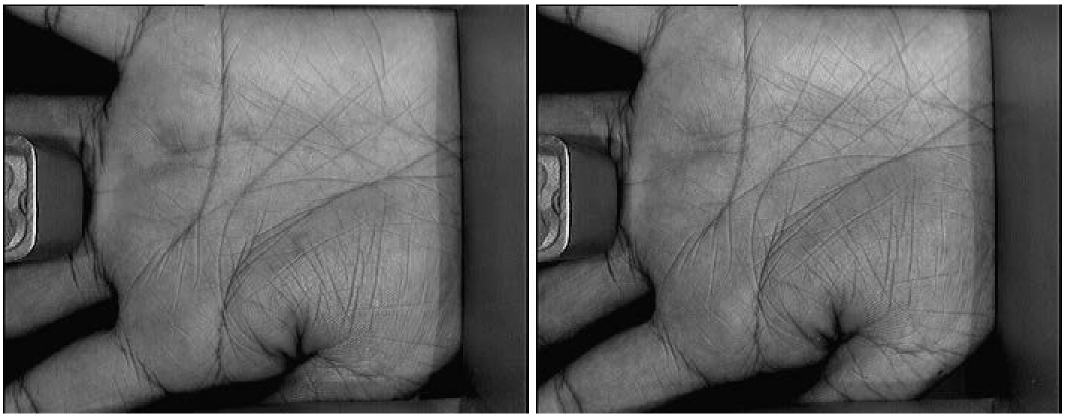

Figure 3.10. PolyU MultiSpectral Handheld Images

The images of the 15th person from the PolyU MS palmprint database in Figure 3.10. Left image 1. right image from session 2 was taken from the session.

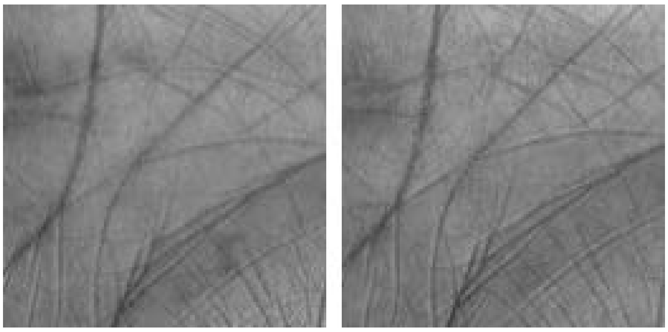

Figure 3.11. PolyU ROI Handheld Video

The PolyU Multispectral palm image in Figure 3.11 is the images obtained by extracting the region of interest from the palm image. The left image is removed from session 1 and the right image is removed from session 2.

Identity identification and verification using palm print features are still pending issues today. Researches have been developed in various ways.
Methods such as fingerprints are usually performed using Gabor filter, wavelet transform, Fourier transform, methods. Compared to the fingerprint, the palm prints have a lot of lines and high performance in recognition of the fingerprint. Even when high resolution is required for fingerprinting, this is not necessary for palm prints, and low resolution recognition is easy. People in the literature used wavelet transforms in the extraction of features and artificial neural networks in classification. In Yu 2008, he used the Modified Discrete Cosine Transform-based feature extraction method for the palm recognition approach in his work. Uses radial based artificial neural networks in classification.

Radial-based neural networks have also been used to reduce excess data to a reasonable size to facilitate training [42]. In Yang's proposed system in 2008, palm geometric features and texture properties were obtained by kernel-based component analysis (KPCA). Apply a self-organizing artificial neural network to select a small data set among the excess data to select hand geometry properties. It uses a radial-based artificial neural network in the identification phase [43].

In Lu 2008, first two-dimensional discrete wavelet transform is applied to the palm working area and then basic component analysis (PCA) is applied. It then uses the local projection protection method to reduce its size. Finally, palms are classified by a forced artificial neural network to classify images rapidly [44].

In Ekinci 2008, wavelet subband coefficients are separated by daubechies wavelets to decompose the palm image into low resolution. Then the core is applied to extract the nonlinear coefficients in the subband by principal component analysis (KPCA) method. Finally, we classify the weighted Euclidean linear distance for the similarity measure in the artificial neural network and compare it with the support vector machine (SVM) [45].

In 2007, Kong used it as an effective approach to biometrics-based authentication and identification, to extract palm-tissue features with Wavelet Transform and Zernike moment techniques. The KMeans clustering algorithm is used during the specification process. Back-propagation artificial neural networks are used in the classification phase [46]. Wong 2007 uses wavelet transform to extract palm lines to different resolution levels. At low resolution, palm thin lines are removed. At the high resolution level, palm rough lines are extracted. Ten right-handed images of 100 different individuals are used. The palm images are pre-processed to find the lock points. Looking at the key point, the images are rotated and cropped.

The palm images have been improved and resized. Two different wavelet energy levels are used. These feature vectors have been classified and tested using Euclidean distance or forward feed back propagation artificial neural network. According to the results, 99.07% accuracy dB is obtained by using type 5 wavelet and wavelet energy level 2 [47]. In his Sun 2006 study, he used an advantageous Gabor wavelet network and probabilistic artificial neural networks. First, each individual has Gabor wavelet feature vectors on the palm. They are trained with probabilistic artificial neural networks. The correct identification rate in experiments is 99.5%. In a database containing 1971 image samples, the efficiency of the algorithm is proven [48].

In Zhou 2006, she extracts feature vectors with low-band images and two-dimensional and three-band discrete wavelet transforms to palm images. He / she prefers support vector machines (SVM) in the classification phase. In experimental results, the correct recognition rate is 100% . In this work in Wen 2005, a new fingerprint enhancement algorithm is proposed to improve the clarity and continuity of the fingerprints. Fingerprint images will be assigned to detailed sub-bands, and the direction of the image will be predicted. Finally, the fingerprint image has been used Gabor filter in the wavelet environment. Experimental results show that low-quality fingerprint images are effective . Han 2003 identity recognition system; Registration and verification. During the recording phase, tutorial samples are assembled and templates are created with pre-processing, feature extraction and modeling pieces. In the validation phase, a query instance is also processed by preprocessing and property extraction modules, and then is correlated with reference templates to determine whether it is a real instance. The working area for each sample is obtained by the pre-processing module. Then, the palm properties are obtained using the Sobel method and morphological operations. Finally, a back propagation artificial neural network is used to measure similarities in the template mapping and verification phase . At Wu 2002, a new palm feature called wavelet energy features uses wavelets as a powerful tool for multiresolution analysis. Different wavelet decomposition levels in this study may reflect wave energy distribution in the main lines, wrinkles and relief lines in various directions, with palm discrimination being very high [49].

In Funada 1998, the palms consist of thick, thick lines and wrinkles. It is not possible to extract bold lines with fingerprint feature extraction algorithms. This research presents a new feature extraction method for extracting thick lines under these conditions [50].

In [52], they used multi-scale Local Binary Patterns (MSLBPs) to identify novel efficient descriptors for palm vein patterns.

In [53] they introduced a novel approach to special identification using palmprints. To tackle the key issues such as feature extraction, depiction, indexing, resemblance measurement, and fast examination for the best competition.

CHAPTER 4

The simulation results

Evaluations were done on a standard database of palms of Polytechnic University of Hong Kong Poly U Palm print. Dataset included the 600 picture of palms of 20 persons which is included in the approximately there are 12 available images from per person.

4.1. Evaluating and choosing a distance function in system performance

There are two solutions for calculating the similarity between feature vectors. Ones calculate the distance between two feature vectors, and second, calculate the similarity. These two measurements are against each other. There are different criteria to evaluate the distance and similarity, that in this thesis, the similarity between test image S and the training image T we used chi-square distance [51].
It is expressed as Eq. 4.1.

$$D(S,T)=\sum_{n=1}^{N}\frac{(S_n-T_n)^2}{(S_n+T_n)} \tag{4.1}$$

Minimum 1 and maximum 4 images in the palm of our test subjects got used to the training.

Experiments were performed on the database, Table 1 shows the obtained results.
As it is clear, the PCA method among other methods has the worst result, and LBP standard method has higher accuracy than other remaining methods. The proposed method has higher accuracy than the LBP standard.

Performance-based approaches which appear strongly have been influenced by the number of training images. So, in the third experiment, we investigated the influence of this parameter on our method. In this experiment, we used minimum and maximum of 4 images of per person to train ourselves. Experiments were performed on the database, and the results are presented on different algorithms. In table 1, the results show that the proposed method among the other training sample methods has better performance.

Table 4.1 comparing the results of proposed system with other procedures performed on the database

Number of training image	Type of identification method (R=Radius, P=Point)				
	PCA	LBPu2 (R=1,P=8)	LBPriu2 (R=2,P=16)	Our method (R=1,P=8)	Our method (R=2,P=16)
1 image	50	58	60	73	75
2 image	54	67	68	84	85
3 image	60	80	83	87	88
4 image	64	85	87	91	92

In our experiments the number of training images for one of the database has changed from 1 to 4, and the last photo is selected for testing. This experiment was performed 20 times in each stage.

The obtained average values are recorded. In Figure 4.1, the change in accuracy percentage terms of the training number images is shown.

4.2. Experimental results

Experiments were conducted to demonstrate the performance of the proposed approach. Our algorithm was validated on palmprint images. The proposed recognition method outlined for Palmprint images were implemented using the Matlab programming language and run on a PC with an Intel, Duo CPU 2.00 GHz, 2.00 GHz of RAM machine and yielded the results in the figure 4.1 ,4.2 and table 4.1. In the experiment, we selected the samples from the first session for training, and the samples from the second session for testing. Thus, the total number of training samples and test images are both 300. Table 4.1 shows the recognition accuracy of different methods. From Table 4.1, several findings could be found. First, proposed LBP method is an effective method; no less than 4% improvement could be gotten by multiscale scheme.

Second, as more information could be extracted, the proposed method could get better result than traditionally multiscale method. Finally, the proposed method could get better result than learning based methods, PCA.

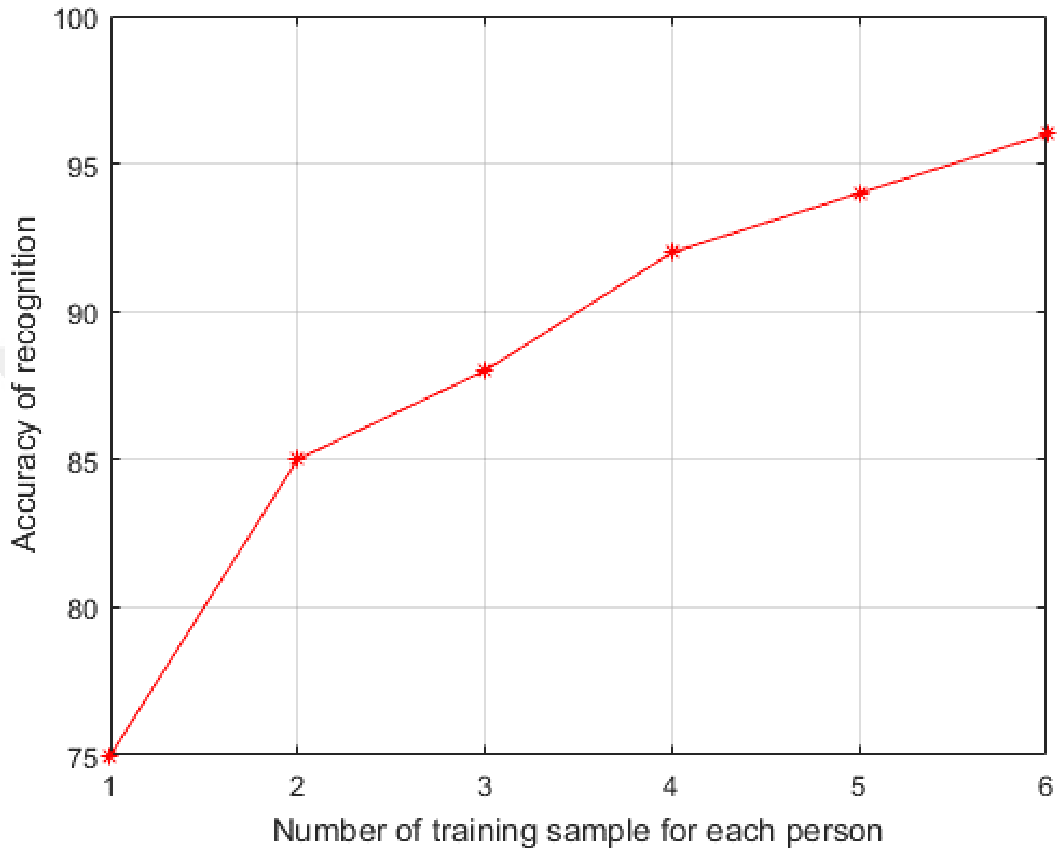

Fig. 4.1: The changes in accuracy percentage terms of the training number images each person

As can be seen, the proposed method is highly dependent on the number of training images and accuracy of about a few percent increase in the number of images increases from 1 to 4 are visible. Figure 4.2 shows the effects of training image on recognition accuracy and precision of each method.

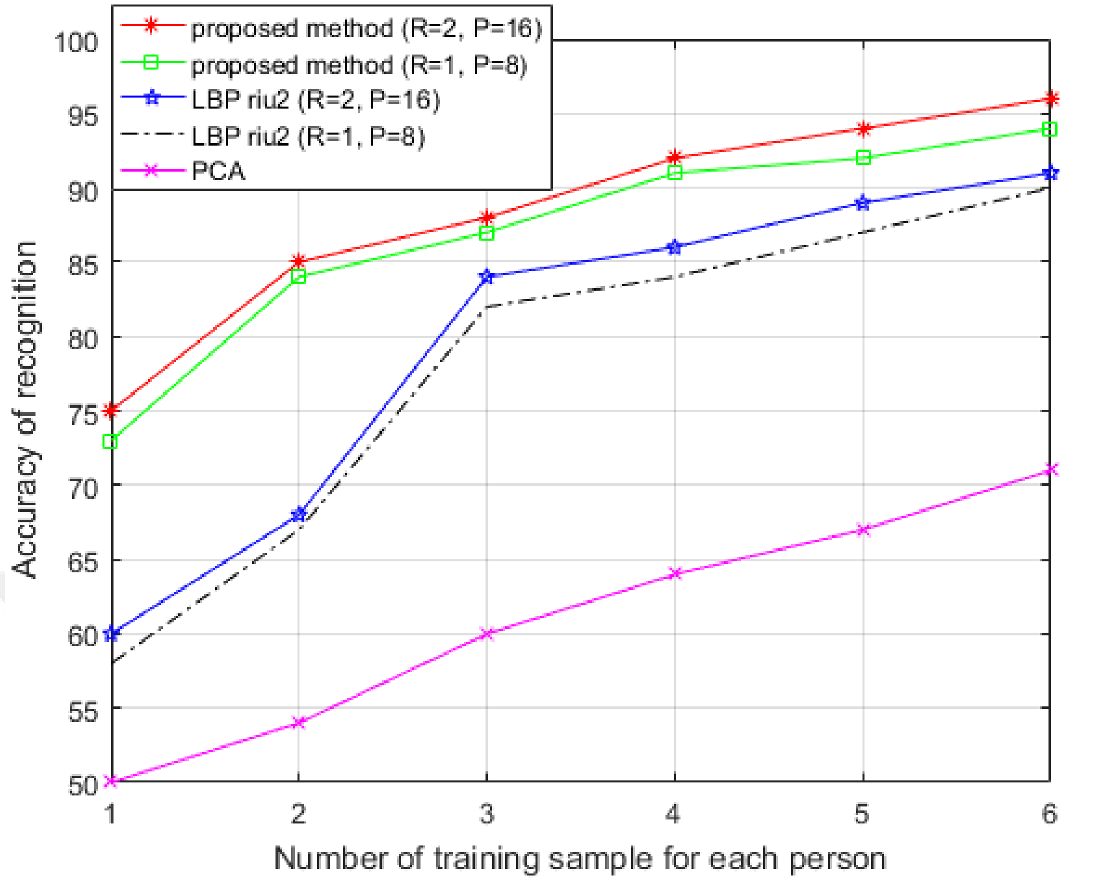

Fig. 4.2: The effects of training image on recognition accuracy and precision of each method

The comparison between proposed method and other methods are shown in table 4.2.

Table 4.2. Comparison between proposed method and other methods

Method	Accuracy
Mirmohamadsadeghi, Leila and et. al. [52]	90.6%
Youe, Jane et. al. [53]	88.23%
PCA [29]	71%
Proposed method	**97%**

Mirmohamadsadeghi, Leila and et. al. [52] Proposed a new approach based on local texture patterns. In first step, operators and histograms of multi-scale Local Binary Patterns (LBPs) are used in order to identify new efficient descriptors for palm vein patterns. Novel higher-order local pattern descriptors based on Local Derivative Pattern (LDP) histograms are used for palm vein description. In simulation, they got 90.6%.

In [53] they presented a new approach to hierarchical palmprint coding with multiple features for personal identification in large databases. To tackle the key issues such as feature extraction, representation, indexing, similarity measurement, and fast search for the best match, they proposed a hierarchical multi feature coding scheme to facilitate coarse-to-fine matching for efficient and effective palmprint verification and identification in a large database. They result which they got is 88.23%. Also in [29] they used principle component analysis and the result which they got is 71%. With comparing of their result our result is 97% and this result is got for 6 train images.

To compare proposed method with Hierarchical Palmprint, and Local Derivative Pattern (LDP)

The hierarchical approach is by four level:

- Global geometry-based key point distance.
- Global texture energy.
- Fuzzy “interest” line.
- Local directional texture energy.

The Hierarchical Palmprint has been tested on a database with 7752 palmprint images from 386 different palms.

Another method is Local Derivative Pattern (LDP), The LBP operator has been proposed for face recognition, finger vein recognition, dorsal hand vein recognition, and palmprint recognition. The LDP operator has been proposed for face recognition and finger vein recognition. However, palm vein recognition problem has not been investigated from such point of view

The Local derivative pattern (LDP) operator is a high-order texture descriptor. It was proposed as an encoding scheme for local patterns.

As in the case of fitting the LBP operator to best extract veins, the LDP operator needs to be applied with parameters best suitable for the vein extraction task.

The dataset used in this work for training and testing the algorithms is the CASIA multi-spectral Palmprint Image Database Vl.O (CASIA database) .This dataset consists of palm print images of 100 individuals (six samples per individual), captured under six different NIR illuminators.

CHAPTER 5

Conclusion

More recognizing machines from the brightness intensity of the pixels are used as input data. Brightness intensity dates from the palm were under the influence of rotation and changing of environment brightness. In our proposed method, the local binary pattern is used which was strong in state, light changes. Additionally, most of the palm recognition systems which based on binary pattern uses for identifying, just from a steady LBP form and only with a certain scale. Obtained characteristics by using LBP single-scale methods gain structure of the image at a particular resolution is not useful for diagnosis of overall image texture and by this method with many discriminate models to obtain useful properties are excluded. Multi-scale approach can provide more features under different settings. So, to achieve more discriminate features with less waste, we used from combination of uniform local binary pattern with a different radius. The proposed method is proposed to identify palms in this thesis which is based on combination of co-occurrence matrix according to local binary pattern. The results show that the proposed method has also been stated that the accuracy of all methods is higher and its speed is like the similar algorithm.

In addition to being positive that the developments are so fast in this regard, their negative aspects also affect our lives and counterfeits cause us to take advantage of the technology. For this reason, biometrics technologies have been recently introduced to replace cryptography. They use security systems such as facial recognition, iris recognition, and retina recognition in combination with fingerprints to ensure passage through a door as a sample.

Biometrics technology, in addition to the developments shown above, yet confronts the following serious problems:

• Expensive equipment required for biometrics

• The seamless connection of different systems to each other has not yet been achieved.

• Biometry systems are a whole new way to use them.

Biometric systems need to be practical as well as reliable, so it is also important to know which systems people are familiar with. Examples of such methods are:

1. Identification principle: According to this principle, the signature (information) is presented to the system and the system retrieves it from the database of all other information that belongs to the signature owner.
2. Verification principle: According to this principle, someone is entering the system identity. The system tries to make a decision by examining the records belonging to that identity to see if any of these really possesses the identity.

Future work

In future, we can use the other feature extraction methods like the Gabor wavelet and combine with local binary pattern. Also, we can use the texture feature for reach the high accuracy. This work can use in practice as applications.

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