Feature Extraction Using Discrimination Power Analysis with Palmprint in Biometric System

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Abstract

There are many methods used to distinguish persons from each other using palmprints, fingerprints, giats, hand geometry, sound waves, shape of the ear, the color of the eyes and the iris, …etc. Discrimination power analysis (DPA) is powerful to extract proper feature for palmprint, after applying (DPA) on the true color image of palmprint, some of the features and coefficients are choosing to construct vectors including these value of features. DPA is a statistical analysis, based on the image coefficients properties after sequence of process on the true color image. The discrimination power of all the coefficients is not the same and some of them are discriminant than others, the higher true of recognition rate depend on feature vectors of Discriminant Coefficient (DCs). It searches for the coefficients which have large power to discriminator different classes better than other, the performance based on (DPA) and selected (DCs) is better with less complexity.

Keywords: Palmprints, Fingerprints, DPA, DCs.

استخراج الميزة باستخدام تحليل قوة التمييز مع بصمة راحة اليد في النظام البيومتري

الخلاصة:

هناك العديد من الطرق المستخدمة للتمييز بين الأشخاص من بعضهم البعض باستخدام النخيل وبصمات الأصابع، المشيات، هندسة اليد، الموجات الصوتية، شكل الأذن، ولون العينين والقزحية، ... الخ. التمييز تحليل السلطة قوية لاستخراج سمة المناسبة للطباعة النخيل، بعد تطبيق (د ب أ) على الصورة اللون الحقيقي للطباعة النخيل، وبعض من ملامح ومعاملات يختارون لبناء ناقلات بما في ذلك هذه القيمة من الميزات. DPA هو التحليل الإحصائي، استنادا إلى خصائص الصورة معاملات بعد سلسلة من عملية على الصورة اللون الحقيقي. قوة التمييز من جميع معاملات ليست هي نفسها وبعضها تميز من غيرها، وارتفاع معدل الحقيقي للاعتراف تعتمد على ناقلات سمة من سمات تميز معامل (DCS). فإنه يبحث عن معاملات التي لها قوة كبيرة لفئات مختلفة الممي أفضل من الأخرى، وعلى أساس الأداء (DPA) واختيار (DCS) هو أفضل مع أقل التعقيد.

Introduction

Biometric is derived from the Greek words "bio" (life) and "metrics" (to measure). It is the science of establishing the identity of an individual based on the physical, chemical or behavioral attributes of the person [1].

The palms of the human hands contain pattern of ridges and valleys much like the fingerprints [10]. In general the biometrics in figure 1 is divided to:

A. Physiological techniques:

It is measure the physiological characteristics of a person example include fingerprint verification, palmprint analysis, iris analysis, facial analysis, hand geometry, vein geometry, DNA (*Deoxyribonucleic acid*) pattern analysis, ear recognition, …etc.

B. Behavioral techniques:

It is cannot be easily transferred between individuals. Further, it represents as unique an identifier as is possible at this time. Voice patterns or speech analysis, handwritten Signature, keystroke sequences analysis, gait (the body movement while walking).

The palmprint system is a hand-based biometric technology. The palmprint is concerned with the inner surface of a hand. Many features in figure (2) of a palmprint can be used to uniquely identify a person, including

a. **Geometry Features:** According to the palm's shape, such as width, length and area.

b. **Principal Line Features:** Both location and form of principal lines in a palmprint are very important physiological characteristics for identifying individuals because they vary little over time.

c. **Wrinkle Features:** there are many wrinkles which are different from the principal lines in that they are thinner and more irregular.

d. **Delta Point Features:** it is defined as the center of a delta-like region in the palmprint. Usually, there are delta points located in the finger-root region.

e. **Minutiae Features:** A palmprint is basically composed of the ridges, allowing the minutiae features to be used as another significant measurement.

Biometric system module

Palmprint recognition falls under the general category of pattern recognition problem. There are three stages in palmprint recognition problems, ***palmprint segmentation from an image, feature extraction and classification.***

Palmprint segmentation

We consider number of steps to obtain distinguish all features of palmprint.

Transform True Color to Gray image

The color space in Phase Alternating Line (PAL) TV-Standard System is represented by YUV, where Y represents the luminance and U and V represent the two color components [2]. The luminance Y can be determined from the red-green-blue (RGB) model via the following relation:

For completeness, the transform equation from expression of RGB to YUV are listed below [6]:

$$\begin{pmatrix} Y \\ U \\ V \end{pmatrix} = \begin{pmatrix} 0.299 & 0.587 & 0.114 \\ -0.147 & -0.289 & 0.436 \\ 0.615 & -0.515 & -0.100 \end{pmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix} \quad \text{.........(1)}$$

$$Y = 0.299\,R + 0.587\,G + 0.114\,B \quad \text{.......(2)}$$

It is noted that the three weights associated with the three primary colors, R, G, and B, are not the same. There different magnitudes reflect the different responses of the HVS to different primary colors.

Gray-scale images are referred to as monochrome, or one-color, images. They contain brightness information only, no color information. The number of bits used for each pixel determines the number of different brightness levels available. The typical image contains 8 bits/pixel data, which allow us to have 256 (0-255) different brightness (gray) levels [4].

Enhancement Image

It is techniques improve the quality of an image as perceived by a human. There exists a wide variety of techniques for improving image quality [3]. In image processing it is usually necessary to perform a high degree of noise reduction in an image before performing higher-level processing steps, such as edge detection. The median filter is a non-linear digital filtering technique, often used to remove ***noise*** from images or other signals, the mask of filter is represent in table 1**[5]**.

Edge Detection

Edge detection is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction.

There are three fundamental steps performed in edge detection **[6]**:

- Image smoothing for noise reduction
- Detection of edge points.
- Edge Localization

We using the sobel edge detection mask look for edges in both the horizontal and vertical directions and then combine this information into a single metric. The masks are as follows in figure 3:

These masks are each convolved with the image. At each pixel location we now have two numbers: **d1**, corresponding to the result from the row mask, and **d2**, from the column mask we use these numbers to compute two metrics, the edge magnitude and the edge direction, which are defined as follows **[7]**.

Edge magnitude

$$E=\sqrt{d1^2+d2^2} \quad \text{..........} \quad (4)$$

Edge direction

$$E1=\tan^{-1}\left[\frac{d_1}{d_2}\right] \quad \text{..........} \quad (5)$$

Binary Image

The digital image I(x,y) is represented as a two-dimensional array of data, where each pixel value corresponds to the brightness of the image at the point (x,y). Binary images are the simplest type of images and can take on two values, typically black and white, or '0' and '1'. A binary image is referred to as a 1 bit/pixel image because it takes only 1 binary digit to represent each pixel **[5]**.

The basic of intensity thresholding, composed of light object on a dark background, in such a way that object and background pixels have intensity values grouped into two dominant modes. One obvious way to extract the objects from the background is to select a threshold, ***T***, that separates these modes. Then, any point (x, y) in the image at which f(x,y)>**T** is called an object point; otherwise, the point is called a background point. In other words, the segmented image, g(x, y), is given by

$$g(x,y)=\begin{cases}1\text{..........}if & f(x,y) > T \\ 0\text{..........}if & f(x,y) \le T\end{cases} \text{..........}(6)$$

Thinning

Thinning is a morphological operation that is used to remove selected foreground pixels from binary images, somewhat like erosion or opening. It is normally only applied to binary images, and produces another binary image as output. The thinning operation is related to the hit–and–miss transform [8].

An important approach for representing the structural shape of a plane region is to reduce it to a graph. This is often accomplished by obtaining the skeleton of the region via a thinning. (also called Skeltonizing) algorithms **[6]**.

The erosion equation: $A \ominus B = \{z | (B)z \cap A^C = \emptyset$

The set of opening: $A \circ B = (A \,\theta\, B) \oplus B$

Thinning procedures play a central role in a broad range of problems in image processing. This algorithm is present for thinning binary regions. In the following discussion it is assumed that region points have value **1** and background points have value **0**. The method consists of successive passes of two basic steps applied to the contour points of the given region. Where a contour point is any pixel with value **1** and have at least one 8– neighbor valued **0 [9]**.

P_0	P_2	P_3
P_8	P_1	P_4
P_7	P_6	P_5

Figure 4. Neighborhood arrangement used by the thinning algorithm.

The first step flags a contour point P for deletion if the following conditions are satisfied:

a) $2 \le N(P_1) \le 6$,
b) $S(P_1) = 1$,
c) $P_2 \cdot P_4 \cdot P_6 = 0$, ...(7)
d) $P_4 \cdot P_6 \cdot P_8 = 0$,

Where $N(P_1)$ is the number of nonzero neighbors of P_1 :that is:–

$$N(P_1) = P_2 + P_3 + \ldots + P_8 + P_9 \quad \ldots\ldots (8)$$

And S (P_1) is the number of 0–1 transitions in the ordered sequence of P_2, P_3, ….., P_8,P_9.

In the second step, conditions a and b remain the same, but conditions c and d are changed to

c') $P_2 \cdot P_4 \cdot P_8 = 0$, …….(9)

d') $P_2 \cdot P_6 \cdot P_8 = 0$.

Feature extraction

The stage of feature extraction is very important as it ultimately determines the performance of a recognition system.

After first stage, we obtain matrix in form two dimensional of data has been obtained, it is represent active data in palmprint image. We applied Discrimination Power Analysis (DPA) algorithm has been applied on the image to find feature extraction.

Discrimination power analysis (DPA)

The coefficient of DP depends on two properties:

1. Large variation between the classes.
2. Small variation within the classes.

The coefficient matrix for the image size of i×j

$$I = \begin{bmatrix} I_{11}\ I_{12} \dots \dots . I_{1j} \\ I_{21}\ I_{22} \dots \dots \dots I_{2j} \\ \dots \dots \dots \dots \dots \dots \dots . . \\ \dots \dots \dots \dots \dots \dots \dots \dots \\ I_{M1}\ I_{M2} \dots \dots \dots\ I_{ij} \end{bmatrix} \dots .10$$

To find discrimination power having C classes and S training images for each class, totally C × S training images are present. DP of each coefficient (I_{ij})

i=1, 2, 3,….M , j=1, 2, 3 ,…N

can be estimated as follows:

1. Construct the train set matrix A_{ij}.

$$A_{ij} = \begin{bmatrix} I_{ij}(1,1)\ I_{ij}(1,2) \dots \dots I_{ij}(1,C) \\ I_{ij}(2,1)\ I_{ij}(2,2) \dots \dots I_{ij}(2,C) \\ \dots \dots \dots \dots \dots \dots \dots \dots \\ I_{ij}(S,1)\ I_{ij}(S,2) \dots \dots I_{ij}(S,C) \end{bmatrix}_{S\times C} \dots \dots \dots . . .11$$

C: No of Class.

S: No of Samples

2. Calculate the mean value of each class:

$$M_{ij}^{c} = \frac{1}{S}\sum_{d=1}^{S} A_{ij}(d,C), \quad c = 1,2, \dots . C \qquad \dots \dots .12$$

3. Calculate variance of each class:

$$V_{ij}^{c} = \sum_{d=1}^{S} (A_{ij}(d,C) - M_{ij}^{c})^2, \ c = 1,2, \dots \dots . C \quad \dots 13$$

4. Average the variance of all the classes:

$$V_{ij}^{w} = \frac{1}{C}\sum_{e=1}^{C} V_{ij}^{e} \quad \dots \dots 14$$

5. Calculate the mean value of the all training samples:

$$M_{ij} = \frac{1}{S*C}\sum_{d=1}^{C}\sum_{e=1}^{S} A_{ij}(d,e) \dots \dots \dots \dots 15$$

6. Calculate the variance of all the training samples:

$$V_{ij}^{B} = \sum_{d=1}^{C}\sum_{e=1}^{S}\left(A_{ij}(e,d) - M_{ij}\right)^2 \dots \dots \dots 16$$

7. Estimate the DP for location (I, j):

$$D(i,j) = \frac{V_{ij}^{B}}{V_{ij}^{W}}, \quad 1 \le i \le M, \ 1 \le j \le N \ \dots \dots 17$$

8. The maximum recognition rate by using the coefficient that has the maximum discrimination power and take 32 of maximum values of

discriminator power in figure (9), to save and compression in DB.

System Model (block diagram)

Classification

For classification the extracted features of the palmprint image has been compared with the ones stored in a palmprint database. After doing this comparison, palmprint image is classified as either known or unknown.

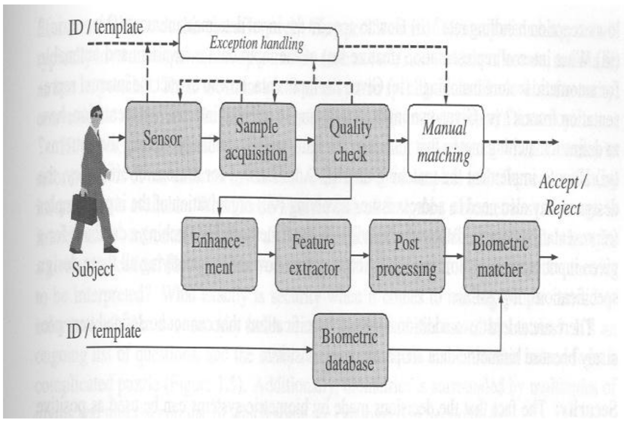


Figure 1. A generalized diagram of a biometric system [1].

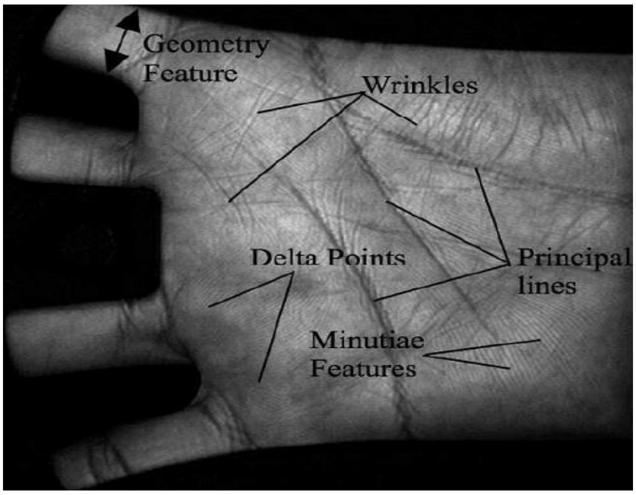


Figure 2. Illustrates some major features that can be observed on a palm [11].

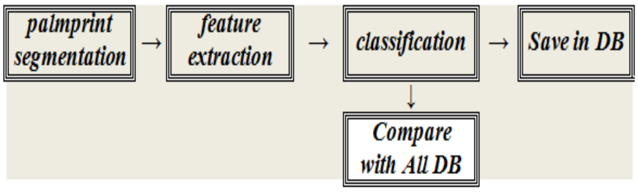


Figure 4. Block diagram of biometric system module.

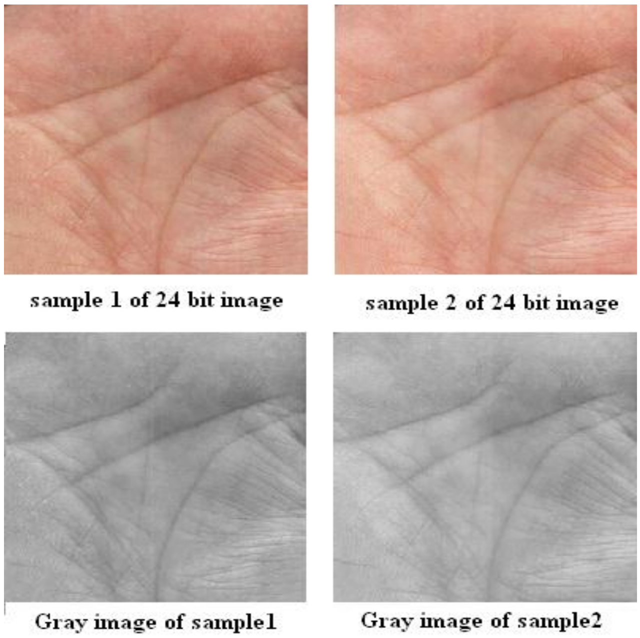


Figure 5. Transform true color to gray image

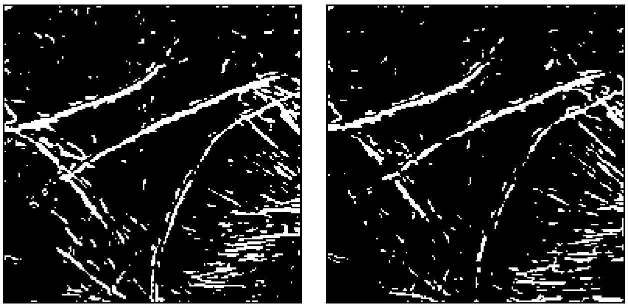
Table 1. It is mask of median filter.

1	1	1
1	8	1
1	1	1

Row mask Column mask

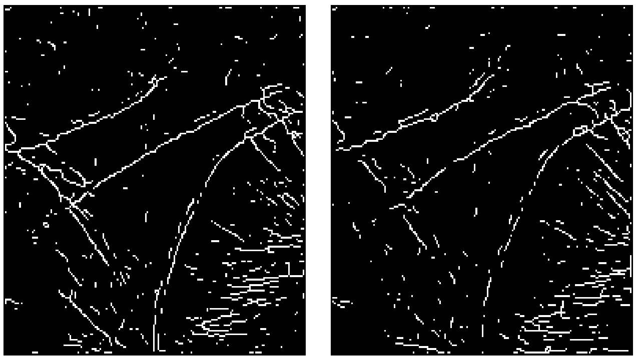
$$\begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} \quad \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \quad \ldots\ldots\ldots\ldots\ldots(3)$$

Figure 6. Edge detection mask.



Edge detection of sample 1 Edge detection of sample 2

Figure 7: Edge detection and binarization of two samples.



Thinning of sample 1 Thinning of sample 2

Figure 8. Thinning of two samples.

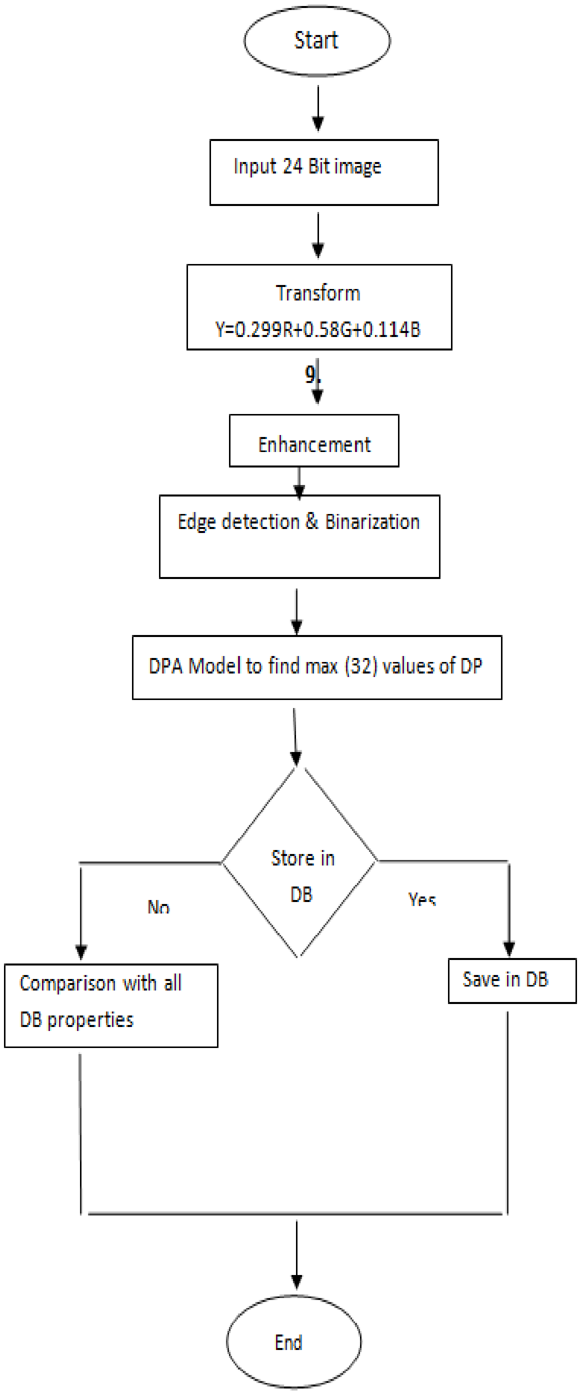


Figure 3. Flowchart of Process.

.91	.2	.08	.66	.87	.78	.65	.22	.74	.12	.34	.89	.1	.74	.23	.02
.12	.8	.65	.87	.7	.77	.32	.34	.55	.77	.74	.88	.34	.55	.65	.35
.74	.88	.98	.33	.65	.66	.44	.21	.84	.32	.55	.44	.36	.84	.65	.75
.55	.24	.44	.78	.23	.44	.32	.17	.23	.65	.84	.23	.35	.89	.76	.32
.84	.04	.23	.89	.34	.45	.08	.43	.12	.32	.22	.23	.54	.46	.22	.43
.77	.76	.23	.44	.9	.24	.32	.17	.23	.45	.23	.55	.66	.98	.21	.9
.93	.56	.33	.43	.19	.12	.87	.66	.56	.23	.54	.12	.76	.78	.32	.04
.98	.46	.22	.87	.54	.23	.7	.89	.66	.87	.67	.08	.33	.44	.45	.04
.56	.98	.21	.7	.65	.92	.65	.44	.87	.7	.77	.44	.22	.23	.66	.76
.87	.34	.67	.65	.32	.76	.66	.78	.3	.65	.88	.32	.17	.23	.33	.55
.45	.42	.08	.44	.94	.01	.44	.75	.55	.12	.65	.21	.74	.76	.43	.44
.12	.67	.90	.65	.02	.33	.32	.17	.23	.92	.55	.34	.95	.66	.65	.32
.78	.21	.12	.32	.32	.44	.12	.6	.45	.34	.46	.22	.84	.54	.32	.54
.98	.32	.55	.67	.89	.44	.34	.22	.83	.11	.98	.21	.32	.22	.12	.78

Figure 9. (32) Max value of discrimination power.

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