Fingerprint Identification using Multiwavelet Transform

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Abstract

identification systems have been developed to achieve automatic identification of a person based on his physiological or behavioral characteristics. Biometric systems are critical in a wide range of applications such as banking system, E-commerce, smart cards, and access control to secure system. Automatic fingerprint identification is one of the most reliable biometric system, which is used for identifying persons. This study, aim is to design a fingerprint identification system, which is capable of identifying a fingerprint with high level of accuracy. Therefore, this system can be applied to a wide range of forensic applications.

The proposed algorithm based upon multiwavelet transform (one level) as feature extraction and minimum distance classifier (Euclidean distance) to make automatic fingerprint identification . The identification accuracy of this algorithm has been found to be 72%.

التعرف على بصمة الابهام باستخدام تقنية التحويل المويجي المتعدد

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الخلاصة

تطورت أنظمة التعريف الحياتية لتحقيق التعريف الآلي للفرد معتمدا على خصائصه السلوكية والفسلجية. الأنظمة الحياتية هي ناقدة على مدى واسع في تطبيقاتها كالنظام المصرفي ،البطاقات الذكية ووصولا إلى سيطرة النظام الأمني. إن التحديد الآلي لبصمات الأصابع هو واحد من أنظمة التعريف الحياتية الأكثر ثباتا المستخدمة لتحديد هوية الأفراد . تهدف هذه الدراسة إلى تصميم نظام تحديد البصمات يكون له القدرة لتحديد بصمات الأصابع بدقة عالية وهذا ما يسهل تطبيقه وعلى مدى واسع في التطبيقات القضائية اعتمدت الخوارزمية على التحويل المويجي المتعدد (مستوى واحد) لاستخلاص الصفات(Feature Extraction) ومصنف المسافة القصيرة (المسافة الاقليدية)لتحديد بصمات الأصابع. وقد بلغت دقة هذه الخوارزمية ٧٢% .

1. *Introduction*

Biometric identification systems have been developed to achieve automatic identification of a person based on his physiological or behavioral characteristics. Biometric systems are critical in a wide range of applications such as banking system, E-commerce, smart cards, and access control to secure system[1]

Among all the biometric techniques, fingerprint-based identification is the oldest method which has been successfully used in numerous applications. Everyone is known to have unique, immutable fingerprints [2] .Biometrics is formed from the person's selected unique physical attributes which may be applied or the purpose of automated personal identification. Typically, biometrics are based on features such as fingerprints, geometry of hand and vein patterns, iris or retinal patterns, image of a face, and characteristic features of the person's voice. The inherent feature of biometric data is its great complexity. Essential in this kind of images is high spatial-frequency details. Moreover, the differences among diverse classes of patterns are small which requires high discrimination capability of the system [3] . A fingerprint has been used for identification for several centuries. Law enforcement has used fingerprints for many years as a core tool for determining identify. Because of the vast amount of data available, fingerprint technology is probably the best. Poised biometric technology for use in the data and cyber world [4] .

Fingerprint identification is based on the immutability and individuality of fingerprints. Immutability refers to the permanent and unchanging character of the pattern on each finger from birth until death. Individuality refers to the uniqueness of ridge details across individuals [5].

2. proposed System and its Implementation

2.1 *Fingerprint Identification Based on Multiwavelet Transform*

Multiwavelet is a new addition to wavelet theory. Multiwavelet needs preprocessing (prefiltering) as an essential and necessary first step.Several authors have addressed the design of profilers that are specifically suited for multiwavelet transform. Prefiltering is performed in first level decomposition only.

The proposed fingerprint identification algorithm is based on Multiwavelet Transform and minimum distance classifier. The proposed method needs two phases for

fingerprint identification. These phases are the Feature extraction and the identification phase.

2.1.1 *The Feature extraction Phase*

Feature extraction deals with the problems of how to create reference of an image. The identification system needs information about the classes of images. The images database is used to generate the Feature extraction information. Multiwavelet decomposition is done using GHM system(Geronimo, Harding and Massopust) . The gray scale image with size (256×256) pixels is decomposed into one level. The result is 16 sub-images, four sub-images with pure low frequency features and 12 sub-images with ”High” features. Figure (1.1) represents one level decomposition and the distribution of sub-images numbering.

L1L1	L2L1	H1L1	H2L1
L1L2	L2L2	H1L2	H2L2
L1H1	L2H1	H1H1	H2H1
L1H2	L2H2	H1H2	H2H2

a-one level of multiwavelet decomposition

		1	2
		3	4
5	6	9	10
7	8	11	12

b-distribution of sub-images numbering.

Figure (1.1): One level multiwavelet image decomposition

The block L1H2 contains high-pass coefficients corresponding to the second scaling function in the horizontal direction, and low-pass coefficients corresponding to the first scaling function in the vertical direction.

The implementation of Feature extraction phase is done using the following steps

1. Read an input image.
2. Decompose the image into 2-D MWT (tow damnation multiwavelet transform) with one level to get 16 sub-images.
3. Compute the normalized energy for each image except the one with "low-low" sub-image.

The result is a vector with 12 energy values **$E = (E_1, E_2, \ldots E_{12})$; i=1,…,12**

4. Save the normalized energy in the Feature extraction file.

5. If there are more images, go to step 1.

. Feature extraction information, contains 50 images in database. The 50 images are represented the fingerprint by implementing the Feature extraction steps, the result is matrix of (50×12)values which represent multiwavelet energy and the result is computed only once..

2.1.2 *The Identification Phase*

To make Identification of an unknown image, the following steps will represent the proposed Identification. figure (1.3) shows the flowchart of this algorithm.

1. Read an input image.
2. Decompose the image into 2-D MWT with one level to get 16 sub- images.
3. Compute the normalized energy for each images except the four "low-low" sub-images. The result is a vector with 12 energy values

   $E = (E_1, E_2, \ldots\ldots\ldots\ldots E_{12})$

4. Find the distance measure of multiwavelet energy vector from references data using Euclidean distance.

$$\mathbf{D=} \sum_{J=1}^{12} \left(E_j - E_{i,j}\right)^2$$

5. Determine minimum distance.
6. Assign the unknown image to a class with minimum distance.

Examples

will be takan example to demonstrate the application of the previous identification algorithm.

1-Read image (pro1\image2.bmp(figure (1.4) shows the image) .

2 -Decompose the image into 2D MWT with one level.

3-Normalized energy values of the 12 sub-images are:

E= (0.1191 0.2853 0.2501 0.1965 0.1307 0.8007 0.4968 0.0097 0.0188 0.0230 0.0509)

4- The distance (D) between tested image and reference images are:

D= (0.9617 0 1.2829 1.2999 1.2767 0.7554 0.1786 0.0072 0.0105 0.6005 0.5765
0.5098 0.0505 0.3827 0.2406 0.0061 0.6143 0.0169 0.6078 0.5335 1.3003
0.9507 0.4288 0.721 0.9195 0.8004 0.2073 0.0698 0.1063 0.6727 1.1946
0.0176 1.4903 0.1197 0.061 1.3361 0.5808 1.1884 0.0557 0.7225 0.7877
0.2291 1.5616 0.0163 0.5802 0.1564 1.4896 0.9789 0.7204 0.0273).

5-The minimum distance MD was (0).

6-Assign the unknown image to class with minimum distance (reference number 2 which is the methak talib)

7-End.

Figure 1.4 image2.bmp

3. Evaluation Test of the Proposed Algorithm

To implement and test the proposed algorithm, two sets of data are required: the feature extraction and the testing data sets. As mentioned before 50 images were taken represented fingerprint.

The multiwavelet energy is computed by implementing the 2-D MWT. The result is computed only one and saved in a file as feature extraction information. As a primary test, we implement the proposed algorithm for reference data. The result is good. As a final test, another different 25 images are taken, and compute the multiwavelet energy for each image after using 2D MWT one level decomposition. Testing these images using the proposed algorithm and the result testing is 72% accuracy.

To find the identification of any image the multiwavelet energy of this image was computed. Then we compute the Euclidean distance between the input vector and the reference images, and take the minimum distance. The final result is the class with minimum distance. Table (1.1) represents the results of testing 25 image.

Table (1.1) Results of testing fingerprint for Multiwavelet transform

0

Image	*Reference*	*Name*	*Result*
1	8	AMAR	not
2	1	MAHA	not
3	3	ALI	ok
4	4	MOHAMED	ok
5	5	ASAAD	ok
6	6	SAFAA	ok
7	12	SAILM	not
8	8	AMAR	ok
9	9	QAIS	ok
10	10	AKRAM	ok
11	11	SALI	ok
12	12	SAILM	ok
13	13	HAITHAM	ok
14	9	QAIS	not
15	15	THIKRA	ok
16	16	HANAA	ok
17	25	RADD	not
١٨	18	FADIL	ok
١٩	19	AMAAL	ok
٢٠	٦	SAFAA	not

٢١	21	NIDUA	ok
٢٢	٨	AMAR	not
٢٣	٢٣	HUSSEIN	ok
٢٤	٢٤	HAIDAR	ok
٢٥	٢٥	RAAD	ok

Success =18
Fail =7
Success rate =72%

Conclusions

Automatic fingerprint identification is one of the most reliable biometric systems, which is used for identifying persons.. There are several conclusion raised in the practical side of the project. These comments are discussed below:

١ Using multiwavelet transform as feature extraction technique gives better recognition accuracy.

٢. In this system, 12 features (needs only 48 bytes) required to perform the recognition process.

٣. The experimental results show the one level multiwavelet decomposition provides most appropriate features set for fingerprint discrimination process.

٤. The Scaling effect of fingerprint images did not be adopted, since all image measurements are considered as having the same size.

5. the procedure faild to distinguish some of fingerprints because it have unclear features.

Suggestions for future work:

If we make the suggesteds, modifications:

1. The system may be modified to make recognition depending on IRIS.
2. The system may be developed to be scaling, rotation invariant.
3. Consider larger database to insure the recognition accuracy in larger population applications.

The identification process can be speeded up by reducing the number of comparisons that are required to be performed

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