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Fingerprint Recognition Using Different Classifiers (ANN And K-NN)

KEYWORDS: Fingerprint recognition, Stump identification, k-NN and ANN classifiers.

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ABSTRACT *It is possible to identify any person from his/her fingerprint, since they cannot be shared or directed toward the wrong person. In this work a fingerprint recognizer is presented using two types of classifiers (k-NN and ANN). The used features are extracted using Haar mother wavelet. The aim of this work is to make a comparison between the k-NN and the ANN classifiers. In this work Levenberg-Marquardt error back propagation algorithm is used for the ANN classifier since it appears to be the fastest method for training moderate-sized feed forward neural networks . The result of using the k-NN classifier was 48%, while when using the ANN classifier the result is improved by 39%.The algorithm is evaluated using the fingerprints of 31 peoples (four versions per person) using mat lab program.*

1. Introduction

Fingerprint recognition is one of the used techniques for human identification with low implementation cost when comparing with the other biometric features . It is believed that each fingerprint is unique. Each person has his own fingerprints with the permanent uniqueness and it does not change from birth to death. Even twines fingerprints are not the same, so fingerprints can be used for identification and forensic investigation. Fingerprint authentication is used in systems at which training is available to users and where the device is operated in an indoor environment [1].

Different classifiers and techniques have been used for finger print recognition, feature extraction and classification. In this paper the important features are extracted from the wavelet transform of the fingerprint. Two classifiers are compared which are the k-nearest neighbor (k-NN) and the artificial neural network (ANN)classifiers. The ANN algorithm provides accepted performance other than the k-NN algorithm. The motivation behind this work is growing need to identify a person for security.

Previous researchers used different techniques for fingerprint recognition. G. Sambasiva Rao et al., [2] proposed finger print recognition technique using a gray level waster shed method to find out the ridges of a fingerprint image by directly scanned fingerprints or off line inked method.

Manish, et al.[3] and Chandana, et al. [4], studies the use of Minutiae-based matching technique which is the best method to extract useful information about Minutiae that can be used for the recognition process later. Jinwei Gu, et al., [5] proposed a method for fingerprint verification which includes using both minutiae and model based orientation field. It gives robust information other than minutiae points and can be used as robust features. The classification part is done by combining the decisions of the matchers based on all extracted features. Faek et al [6] used the k-NN classifier. Other researchers like Sunderjit Singh [7] compared Back Propagation Neural Network method with the support vector machine algorithm (SVM) for the classification part.

3. The database

In order to recognize fingerprint images using ANN classifier many versions of the same fingerprint are needed for training and recognition. In this work the database consists of four versions for each fingerprint. The used database consists of four different fingerprint versions of 31 peoples which has been collected by the researchers. Three samples of the used fingerprint images are shown in figure (1).

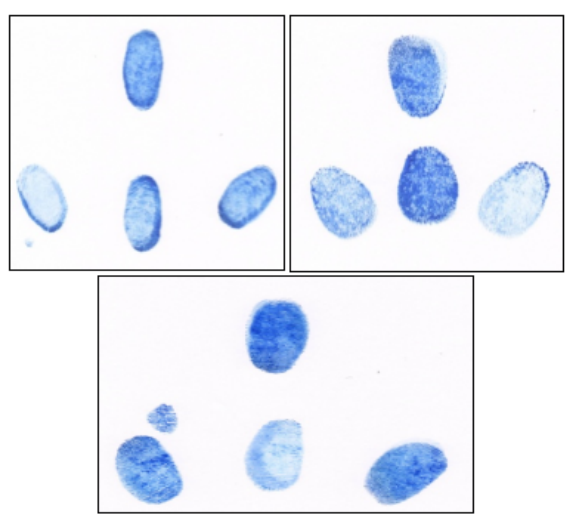

Figure (1): Three fingerprint samples (four different fingerprint versions for each person).

4. The proposed algorithm

The proposed algorithm used in thiswork includes the following steps:

1-Preprocessing (binarization, thinning, and inverting).

2-feature extraction from wavelet domain representation of the fingerprint image.

3-Classification using ANN and k-NN classifiers.

4.1 Preprocessing

Standard preprocessing techniques like (binarization, thinning, an inverting) are necessary before starting any finger-

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print recognition work.

Binarization is the process of converting the gray scale image in to binary image by fixing a threshold value. The pixel values above and below the threshold are set to 1, and 0 respectively. The binarized image is thinned using block filter to reduce the thickness of all ridge lines to a single pixel width, and it is then inverted. [8]

4.2 Feature extraction

This work follows an algorithm to extract important features from the wavelet domain representation of the finger print [9]. The algorithm starts by taking the two dimensional discrete wavelet transform (DWT) of the thinned fingerprint (two levels) using Haar mother wavelet, converting the output of the LPF to a one dimensional sequence, and then decomposing the resultant signal into different levels of DWT (10 levels). The decomposition process is continued until obtaining three lines which are obtained at level 10 decompositio . When using other wavelet types like db3, and db5, the discrete form can't be obtained at this level as shown in fig (2).

At level ten decomposition three straight lines are obtained. In this work the slops of these lines are calculated from equation (1), and then used as features with the k-NN and the ANN classifiers.

$$S = \frac{\Delta y}{\Delta x} \quad .....(1)\,,$$

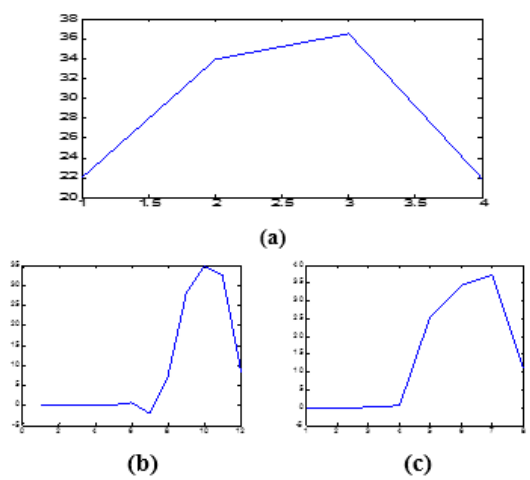

Figure (2): Level 10 decomposition using (a) Haar wavelet, (b) db3 wavelet, and (c) db5 wavelet. Y-axis represent the discrete time (samples), while X-axis represent the amplitude.

4.3 Classification using the k-NN classifier

The k-NN is the simplest method for classification. The major drawback of k-NN is its low efficiency being a lazy learning method in many applications. In this work the k-NN is used as classifier, since it is a simple arbitrary classifier. This classifier is highly applicable in some classification cases. Simply this classifier classifies each set of the data in sample into one of the groups in training [6].

4.4 Classification using the ANN classifier

In recent years, the application of ANN to many pattern recognition problems is seen, including fingerprint recognition [7] Because the convergence characters depend on the complexity of the structure including the number of the layers and the output nodes, in this work a simple structure of ANN is chosen [with a 3-node input layer, a single hidden layer with 18 nodes and only a 5- node output layer instead of a 31-node output layer] to recognize 31 peoples. Inputs to this network are the feature vectors extracted from the wavelet domain representation of the fingerprints as explained in the previous section . At the end of the training process, the net performs a binary classification on each given input pattern [10].

The value of each neuron in the output layer are distinguished as ''1'' & ''0'', which forms the output vector from 00001 to 11111.

Among the many neural networks learning algorithms, the error back propagation (BP) algorithm is considered the most useful learning algorithm. However, in training and learning phase of the ANN, a network using standard BP learning algorithm may slow the [10] .

5. Results and discussion

5.1 Results when using k-NN classifier

When using the slops of the three lines that have been obtained after level ten wavelet decomposition as features and feeding them to the k-NN classifier, the recognition rate was 48%. Only 15 peoples are recognized correctly among the 31 peoples. The slops of the three lines of four samples are shown in table (1) .

Table (1):The extracted features (three slopes) of four persons

	The first person			The second person		
The first version	10	1	-13	18	3	-16
The second version	11	1	-11	16	3	-16
The third version	11.3	1.2	-12.6	17.4	3.2	-16.2
The fourth version	10	1.1	-13.2	17	3	-15.9
	The third person			The fourth person		
The first version	12	2.9	-14	13	-1	-10
The second version	13.5	3	-14.2	11	-1	-10
The third version	13	3	-13.6	11.4	-1.3	-10.5
The fourth version	12.7	3.1	-14	11.6	-1	-11

5.2 Results when using ANN classifier.

In order to improve the recognition rate the ANN classifier is used. The recognition rate using this classifier has been improved by 39%. The speeding characteristics is of prime importance, and in order to improve this characteristic the algorithm of Levenberg-Marquardt (LM) error back propagation is employed in this work. At the end of its training, the net performs a binary classification on each given input pattern . The value of each neuron in the output layer are designated as '1' and '0', which forms the output vector from '00001' to '11111' to express 31 peoples based on their fingerprints. 27 people are recognized correctly among the 31 peoples, so the recognition rate of this part was 87%.

6. Conclusions

Robust features for fingerprint recognition can be extracted from the wavelet domain representation of fingerprint image since wavelet is localized in time and frequency. Using the slops of the line obtained at level 10 wavelet decomposition in this work are useful features to be fed later

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to the k-NN or the ANN classifier.

Haar mother wavelet is the best for extracting the features since the required discrete form is obtained with this wavelet that can't be obtained using other wavelet types like db3, db5,.. etc . Also Haar wavelet is the simplest and the easiest used mother wavelet.

However, there are misclassifications and confusion in the classification process even when using the ANN classifier which might be reduced By using larger training sets for pattern recognition or by combining extra features or may be by using fuzzy logic for the decision part since fuzzy logic allows for values between 0&1, i.e. true or false. Fuzzy logic used to describe degrees of truth which may improve the performance of the classification process.

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