

An Algorithm for Signature Recognition Based on Image Processing and Neural Networks

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Abstract— Characteristics related to people signature has been extracted in this paper. Extracted Specialty vector under neural network has been used for education. After teaching network, signatures have been evaluated by educated network to recognize real signature from unreal one. Comparing the results shows that the efficiency of this method is better than the other methods.

Index Terms— signature recognition, neural networks, image processing.

I. INTRODUCTION

Handwritten signatures are the most common criterion for recognizing and confirming identity of people. In official system, most sectors especially in commercial domain such as banks, institutes and organizations are the applicants of methods for determining identity of people. Signature is one of the biometric characteristics of people by which person can confirm and approve a document. Hence, recognizing this fact that the signature on the document belongs to which person is so important. Signature recognition method and recognizing is real or not is a popular technique among the users. The advantage of using signature recognition method is that most of new portable computers apply handwritten inputs and don't need for innovation and inventing new hardware systems to collect data. Overall, signature recognition is one of the safest methods of identity recognition and it is accepted in commercial activities [1].

Signature recognition methods have been classified into two main groups: Static and dynamic.

Static method considers signature as a two-dimensional image that doesn't have any information related to time. Therefore, static properties of signature that are not variable by time, are used to recognize signature. In dynamic method of signature recognition, pen movement while writing is

considered and a particular tool called digitalizing paper and a sensitive pen to pressure are applied. In other words, dynamic method uses the dynamic characteristics of signing process. This method involves extracting some characteristics of recorded information in the signing procedure and comparing them with the characteristics of referred and denoted signature [2, 3, 11]. How design a biometric system to recognize a person is an important matter. Based on situation, these systems can be used for recognition and confirming people. Recognition system tries to survey entered biometric data validity regarding the existed ones in database. Some of the identity recognition methods are pointed here:

Token is usually something that you carry with yourself and it can be regarded as your identity document, such as intelligent cards, magnetic cards, key, passport, ID card and so on. All these things have some faults like: being lost, not being with person, being old and being impersonate or counterfeit.

Second type of recognition systems are called knowledge that are things you remember such as password and pin code. These systems have also some faults like forgetting and being transpire.

Third class contains biometric based systems. These systems use human's physiologic and behavioral characteristics for recognition. This method doesn't have the faults of previous classes and has significantly increased safety and accuracy. Measurement and statistical analysis of biologic data is called biometric. Biometric refers to a technology for measuring and analyzing properties of body by using particular attributes (physiological or behavioral attributes) for personal identity recognition.

All the biometric systems have parameters to introduce properties and abilities of systems such as: False Acceptance Rate: This parameter determines the possibility of accepting real user from unreal one. This parameter should be as small as possible.

False Rejection Rate: This scale demonstrates how much person is not accepted by mistake (very high sensitivity). This parameter also should be small enough.

Equal Error Rate: decreasing rate of mistake acceptance increases inevitably rate of mistake unacceptance. The point in which rate of mistake acceptance equals with the rate of mistake unacceptance is the point of Equal error rate. The less amount of this parameter shows that the system has a better sensitivity and an appropriate balance.

Enrollment Incorrect: It is the possible error that may be occur while sampling to record in database to distinguish correctly [4].

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The first efforts in simulation by a logic model were done by Mackluk and Walter Pitz which are the main block of constructing most artificial neural networks. This model presents some hypothesis about neurons performance. Performance of this model is based on collecting and sum of inputs and creating output. If the sum of inputs is more than threshold, neuron will be motivated. The result of this model was doing simple functions such as OR and AND.

Not only Neurophysiologists but also psychologists and engineers have influenced the progress of neural networks. In 1958, Perceptron network was introduced by Rouzenblat. This network was similar to the previous modeled units. Perceptron has 3 layers with a middle layer known as a connecting layer. This system can learn to impose proper random output to a given input.

Obtained improvements in 1970 and 1980 were important to pay much attention to neural networks. Some other factors have roles in this case such as wide conferences and books presented to people in different fields. Today, ANN technology has faced with significant changes [5].

The followings are some static methods for signature recognition including: Two-dimensional transformations, directional information histogram, curviness consideration, creating horizontal and vertical image, following signature and finding the location of special places in signature building.

One of the pioneers in this field in 1980s is Ammar that used the idea of statistical consideration of dark points to recognize pseudo dynamic characteristics. That is, there is a positive relationship between darkness level and the amount of grayness with pressing the pen that is one individual attribute. Some Dynamic recognition methods are as follow: Possible classifiers, variation time, neural networks (ANN), and Markov hidden models, signal correlation methods, hierarchical methods, and Euclidean distances and so on[6,9,10].

In this paper we has been extracted Characteristics related to people signature. Extracted Specialty vector under neural network has been used for learning. After teaching network, signatures have been evaluated by educated network to recognize real signature from unreal one. Comparing of the results shows that the efficiency of proposed method is better than the other methods.

This paper is organized following: in the next section artificial neural networks have been considered first in section 3 proposed method has been presented. Discussions include the results of proposed algorithm was explained in section 4. Finally, Conclusion and suggestions are the next sections.

II. ARTIFICIAL NEURAL NETWORK

Artificial Neural Network is a system for processing data. It has used the idea of human brain. Data process is done by a lot of microprocessors that are connected as a network. They act parallel to each other to solve a problem.

Neural Network includes the elements of building the

layers and weights. Network behavior is dependent to the relationships between the members. Overall, there are three kinds of neurons layer in Neural Network: Input layer: receiving the raw information of network; Hidden layers: Performance of these layers is determined by the inputs and the related weight between them and hidden layers.

The weights between entrance and hidden layers determines when should activate a hidden unit. Output layer: Performance of output unit depends on the activity of hidden unit and the related weight of hidden unit and output. Figure 1 shows a section of one neuron layer in neural network.

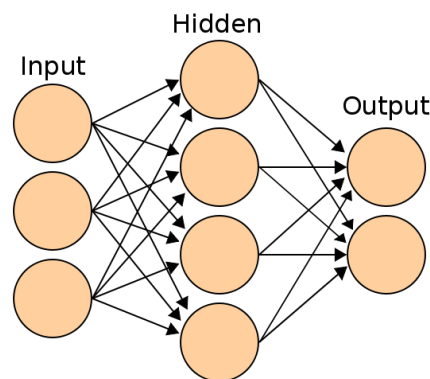


Figure 1. a section of one neuron layer in neural network

Neural networks are divided into 4 groups based on teaching method: Fixed weight: There is no learning and weights amounts are not updated.

Learning without supervisor or headman: weights are only corrected by inputs and there is not any appropriate output to correct them by comparing network output and determining error of weights.

Learning with supervisor or headman: appropriate outputs are shown to network according to the input patterns. Changing weights continues till the output differences of network are acceptable for learning patterns. Reinforcement learning: quality of the system performance is improved step by step in proportion to time [10].

III. PROPOSED METHOD

In this paper, a new signature recognition method is proposed that first by proposing preprocess methods on the images of signatures, an image without noise is created. Then by imposing other methods, we try to obtain the main characteristics of that signature. In the next step, we try to educate neural network by the use of neural network and extracted attribute curve. Finally, the efficiency of proposed method is evaluated. Flowchart of performed procedures is shown in figure 2.

A. Preprocess

As it mentioned earlier, our database is SVC 2004. First we make existed signatures (real or unreal) in this database ready for extracting attributes by preprocess. it can be explained that

preprocess is the process in lower levels. The main objectives of this step is promoting image and removing unnecessary indexes from image (removing noise).

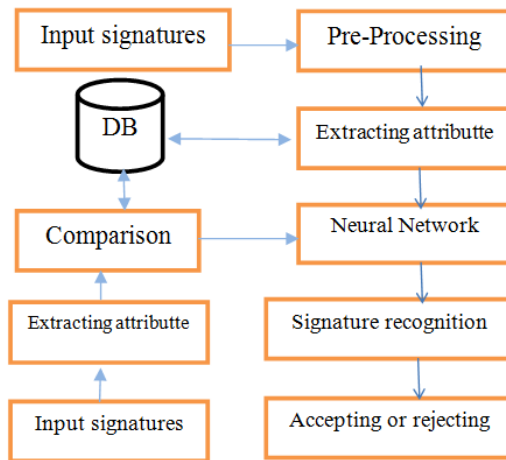


Figure2. Flowchart of Proposed Method

This step has this characteristic that both input and output is the image. The mean filter with mask 3*3 is used for this purpose. The image of mean filters is the simplest calmative filters. A mean filter $m \times n$ is a mask with a number of 1 for each elements (m, n). In other words, the amount of each pixel in output image equals with the mean of light intensity in current pixel and the vicinity pixels. For calming the image a mean filter of 3*3 is used that each element of this filter equals with 9/1. An example of $M \times N$ mask is demonstrated in figure 3.

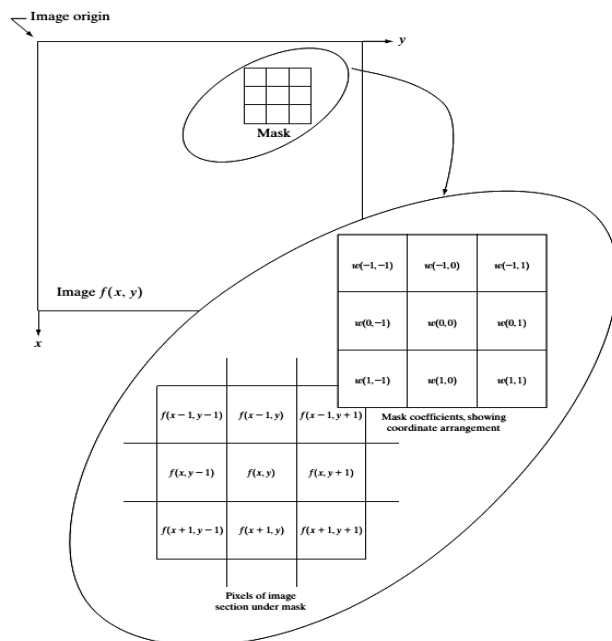


Figure 3. An example of $M \times N$ mask

B. Extracting the attributes

To determine the identity and creator of an image from its pattern, we have to extract some general or specific

characteristics out of image that is called attribution extraction. For example, in signature recognition by image processing, some attributes (like lines inclination) are extracted out of scanned image of signature to recognize the person who has signed it. The main purpose of attribute extraction is to make the raw data ready and usable for the next statistical processes. Different methods of extracting attribute may accomplish one of the following task or more according to the philosophy behind them:

Eliminating data noise, Separating independent elements of data, decreasing the dimension for producing brief representing, increasing the dimension for producing separable representation

Overall, in this extracting step, the appropriate attribute for signature recognition is extracted and pattern classes are formed if necessary.

C. Learning

In the next step that is neural network learning, as mentioned earlier, a multilayer Perceptron network with a post diffusion learning rule is used that is a comprehensive method for classifying data. It can be said that learning is a kind of learning by a supervisor. In this method it's possible that there is a relationship between the outputs and the weights or the errors are diffused from the output layer to the input one and the weights are corrected.

The main purpose is to plan a network that is initially educated by the existed learning data. Then by using the input vector to the network it can recognize its class. Such a network is widely used for pattern recognition tasks. In the next step, the difference between the signatures and the reference signatures are evaluated. If the difference is more than the predefined threshold, the signature is rejected.

IV. RESULTS

The experiment in this paper has been performed in a computer with following characteristics: Processor: Intel Core™ i5 CPU M480, Installed Memory (Ram):2.00 GB, Win 7 Home Premium, Software: Matlab R2014b.

In the proposed experiment, the database of signatures related to the first competitions of dynamic signature conforming (SVC 2004) is used. This database involves a set called Task1. The information of the signature attributes are shown in it as well as the time of its record and the pen position(pen-up and pen-down). The signatures in this database are related to 40 people and there are 40 samples for each person. From these 40 samples, 20 first samples are the major signatures and the other 20 samples are the secondary signatures signed by the professional forgers. The file is in a text format and is named UxSy.txt. x is the number of user and it is ranged from 1 to 40. Signatures 1 to 20 are real and 21 to 40 are forged.

Data of these text files started with some samples and have 4 columns of: x, y, time (t) and the pen position (pen up=0 and

pen down=1). A figure of text file is shown in the following figure.

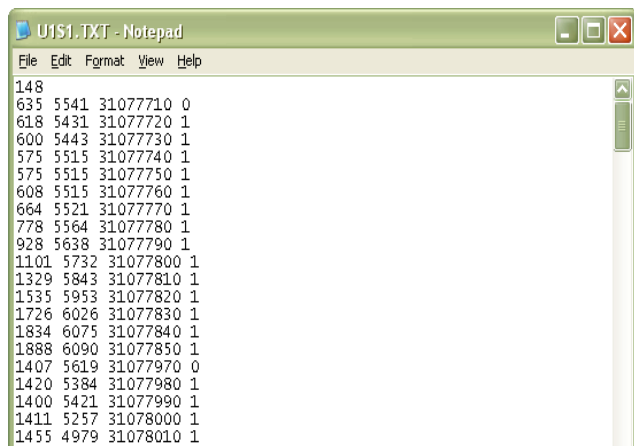


Figure 4. a section of text files U1S1.txt

For assessing the efficiency of the signature recognition methods, it is common to use a set of real signatures and forged signatures. By the use of signature database, false acceptance rate (FAR) and false rejection rate (FRR) are calculated.

False acceptance rate means that we accept someone forger as a person who has signed it and false rejection rate means that we reject someone who has signed it. For an ideal system, both false acceptance rate and false rejection rate should be a small number. False acceptance rate and false rejection rate depends on each other and decreasing one of them, increases the other. In practice, Equal error rate is used in evaluating system. Equal error rate is a point that false acceptance rate and false rejection rate equal each other. The chart of ERR calculation is shown here:

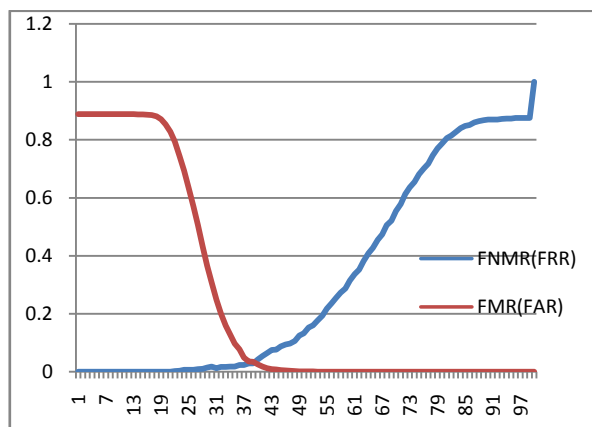


Figure 5. the chart of ERR calculation

In above chart, the range 0-100 shows the threshold amounts in horizontal axis and FAR and ARR in vertical axis. As it is clear, both positive false acceptance rate and negative false rejection rate are shown for all the samples and in two charts. The cross of these two charts shows equal error rate (ERR). This is a point in with the best amount of threshold is located on it. It should be explained that depending on the

TABLE I
COMPARISON OF THE PROPOSED METHOD WITH OTHERS METHODS

Method	FAR	FRR	Accuracy
Proposed method	13.92	15.69	86.74
Method of Livcki etal[7]	20.88	21.47	78.89
GA-SVM method[8]	15.63	17.78	83.60

identity recognition application and the safety, another point can be regarded as the threshold. The results of comparison are shown in the table1.

V. CONCLUSION AND FUTURE WORKS

In this paper, a method is proposed to recognize the handwritten signatures as the real or forged ones. Because of the increase in using the signature in financial documents and forging the signatures, Systems are developing to recognize the signatures by high accuracy and in the lowest time. This kind of systems should do a set of actions on the handwritten signatures. For example, they should do preprocess, extract attributions and form a system for accepting the real or forged signatures. 70percent of experiment was for learning and 30percent was for test. The results of proposed method showed that this model is able to recognize signature by a high accuracy and speed. It is proposed to study and research following items:

- Mail systems in companies and offices to send them without the possibility of being forged.
- Using special cameras in financial institutes for paying Cheque with determined amounts by controlling the date, price and signature.
- Signature recognition by biometric systems in offices and formal organizations such as document recording and ID recording companies.

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