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Surveying about Different Techniques in Fingerprint Detection with Proposing New Ideas

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Abstract: People's finger prints contain rich detail that called "Minutia" we can use these details for detection and identification. The purpose of this study is providing a method for fingerprint verification and identification through extracting and comparing in detail in fingerprints. A multilayer neural network is taught by using back propagation algorithm and its specified different types of Minutia to achieve the best extraction conditions, preprocessing such as edge detection initially applied on the fingerprints. The operation is done before you apply the image to the network. All of the euclidean distances fingerprint's minutia to midpoint is calculated and are stored in the database.

Key words: Fingerprint, Minutia, pattern recognition, network, euclidean

INTRODUCTION

Unfortunately fingerprint matching is a complex pattern recognition problem. Fingerprint manual matching is notonly time consuming but also expert's educating and learning taken a lot of time. Since 1960, great efforts have done for the development fingerprint recognition systems. There are a lot of different automated systems with various algorithms for solving fingerprint recognition problem with good results. However, this doesn't mean that fingerprint identification is a completely solved problem. Designing algorithms that have great solutions to this particular problem would still be a difficult and complex problem. The purpose of this study is deeper theory-practice understanding about how to recognize fingerprint (Ashbaugh, 1999). The purposeis having a practical system that it can be able to determine whether two fingerprint's are related to one person or notaccording to numerous applications of neural systems to solve real-world problems we use these networks in the most importantpart of the systems. The method is choose for matching fingerprin's is discovered by Sir Francis Galton for the first time in 1888 he found that fingerprint's contain rich details that called Minutia. These details are in the form of discontinuities in lines that doesn't change according to his finding overtime. So, adjusting these details is a convenient way to identify two fingerprints.

The most common fingerprint is shown in Fig. 1 and 2 for possibility of details in actual fingerprints (Astrom, 2007).

Depending on skin conditions and the quality of fingerprints can be vary considerably pressure on the tip some processing on images are required of finger that we can extract acceptable Minutia. Some different fingerprints with different quality can be seen in Fig. 3. Fingerprint quality issues can be removed by using an ameliorative algorithm that is capable of separating the lines and highlight them. This type of enhancement image called binary or edge detection. A faster and more effective minutia extraction can be reached by reducing data so that

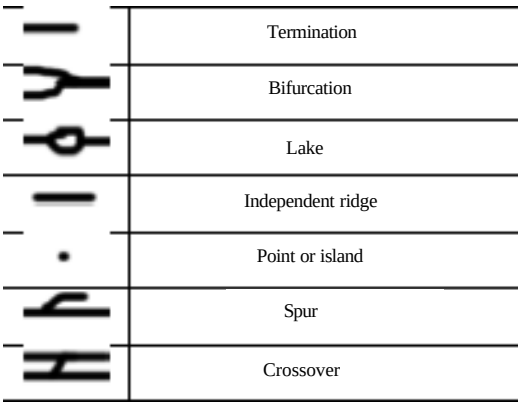

Fig. 1: The most common fingerprint

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Fig. 2: Possibility of details in actual fingerprints

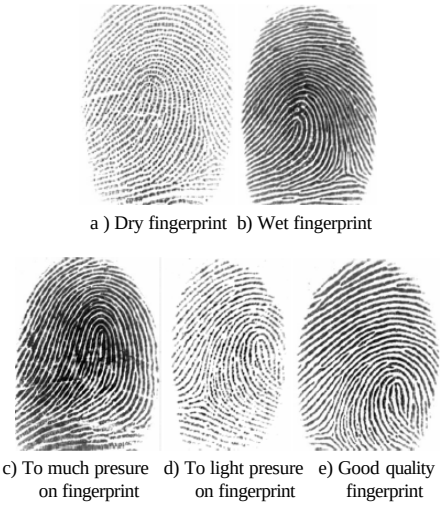

Fig. 3: Some different fingerprints with different quality

this minimum datacan show fingerprints details without any changes. Minutia only related to discontinuation in lines.

So, these details are independent of the thickness of line. After performing binary operations on edge detection or making narrow image, extraction of minutia of fingerprints can be classified as a normal issue. This issue can be solved by training a neural network that acts like a class (Paul *et al*., 1989). After network training by different samples and templates we can use this network for classifying and recognition in a processed image.

Fig. 4: Fingerprint image beforer edge detection operations

Edge detection: The purpose of edge detection in fingerprint recognition system is reducing the amount of available data in fingerprint image and saving essential information. An edge detection method is based on the convolution. Convolution is a mathematical method for mining a function with another one that lead to overlap between two functions on each other.

Two common edge detection filters are: Laplacian and Kenny; Laplacian does edge detection by taking second derivation of a gray level of image. While, Kenny uses the first derivation and it is a normaloperation to edge detection in fingerprint detection system because of noise, fracture lines and other discontinuities are rarely determined a full line. However, in this study we use fingerprint image matrix with an experimentally threshold value for fingerprint image edge detection. The final matrix is a logical matrix that contains zeroes and ones. In Fig. 4 and 5 are shown fingerprint image and the image after edge detection operations, respectively.

Narrow making: Narrow making and skeleton making is a process that can be used on binary images. This process will be continued until the width of images lines reaches to a pixel. In fact the intention of narrow making is minting the fingerprint Minute while the useless information should be removed. After narrow making width of curves in the image is Skeleton building separately imply on each pixel Pi of the fingerprint lines and according to the nearest neighbors. A set of rule have been found to test whether the pixel P_i can be deleted

Fig. 5: Fingerprint image after edge detection operations

Fig. 6: The narrow fingerprint

without being impacted on line direction and line connection or net (Ross *et al*., 2004). The skeleton building process on negative image of fingerprint is done in binary. A negative image simply achieved by placing a logical not operator on fingerprint image. Note that while narrow making algorithm mitting the bad points shouldn't:

- Cut the lines
- Lead to excessive corrosion of image you can see the narrow fingerprint in Fig. 6

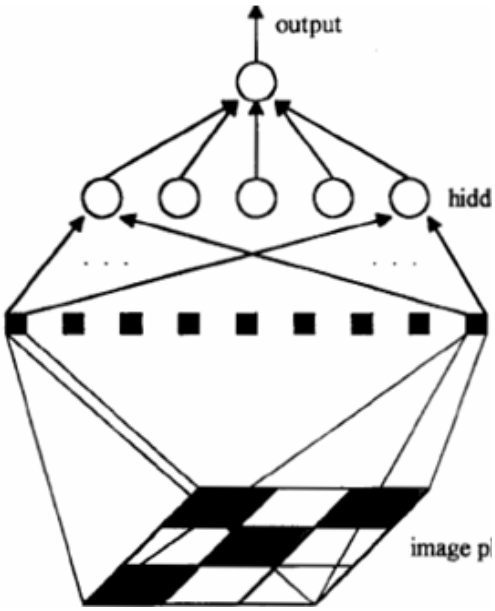

Fig. 7: Multilayer neural network that was established for extracting fingerprint's features

MARERIALS AND METHODS

Neuron model: Neuron is a processing unit that it is functional infrastructure of a neural network. Neuron has 3 elements:

- A set of communication link or synapses that each one has a special weight
- A collector to collect input signals
- An activity function to limit the output domain of a neuron (range of this function is [0, 1] or [-1, 1])

Extraction minutia: Network is made by simple process units to more effective extraction of points of the two-dimensional fingerprint pattern we use a multilayer perceptron to detect. Minutia in given fingerprint and used network was made by 3 layers. The first layer consists of q neurons, hidden layer is composed of 5 neurons and finally the last layer has i neuron. Figure 7 and 8 was shown multilayer neural network that was established for extracting fingerprint's features.

Back propagation learning rule: In mentioned network, we should determine the connection weight between 2 neurons by using propagation algorithm to minimize the error between optimal output and network output. General formula for sigmoid function in all processing units except input layer neurons is as follow:

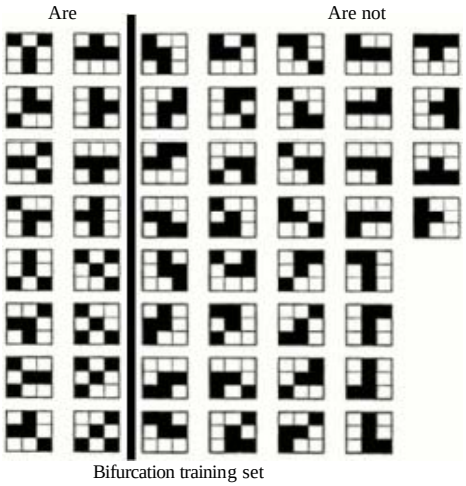

Fig. 8: Initial training patterns

$$A_k(w, y, \theta) = \frac{1}{1+e-(S_j W_{kj} y_j+\theta_k)}$$

where, connection weight W_{kj} is between unit k and unit j range from lower layer, activity Y_j of unit j and Q_K for unit k. Here, we describe the propagation algorithm. This algorithm is generally done in 3 phases:

- First phase: propagation front which calculate based on input layer
- Second phase: propagation back which calculate the errors in middle layers
- Third phase: matching weights
- Step by step propagation is as follow

Step one: Select the initial value of weight vector that they are usually determined random.

Step two: Choose one of the training patterns $\bar{x}(p)$.

Step three: Calculate output of nodes in hidden layer and the last layer:

$$y_j'(p) = g(netj'(p))$$

J ··· j = 1

$$net'_{j(p)} = \sum_{k=0}^{k} w'_{jk} X_{k(p)}$$

$$y_i^2(p) = g(net_i^2(p))$$

I ··· I = 1

$$net_i^2(p) = \sum_{j=0}^{j} W_{jk}^2 Y_j^I(p)$$

Step four: Do V_i: $y_i^2(p) = di(p)$.

- If the answer is positive then go to step 7
- If the answer is negative then go to step 5

Step five: First of all we calculat $S_i^2(p)$ the errors in hidden and the last layer. And we calculate that then we calculate that $1 \le i \le I$ note that we use upper layer weight to correct the lower layer weight. Because of that we call it propagation.

Step 6: Correction weight:

$$\Delta W_{ij}^2 = (S_i^2(p) y_j^1(p) 1 \le i \le I$$

$$\Delta W_{ijk}^2 = (S_j^1(p) x_{kj}(p)\ 1 \le k \le K$$

Step 7: A: if $p = p_t$ then $p = p+1$ and go back to step 2. B: if $p = p_t$ then {if the convergence criterion is satisfied Finish. {If the convergence criterionisn't satisfied. Then, p = 1 and go back to step 2.

Convergence criterion:

$$\frac{1}{PT}\sum_{P=1}^{PT} E^{P} W) < \Delta$$

Where:
PT = The number of training pattern
K = The number of input layer of neuron.
J = The number of hidden layer of neuron
I = The number of output layer of neuron

One of the problems of propagation learning algorithm in last step is slow convergence. In addition the failure in minimizing error function and these weaknesses lead to use some amendments to improve the weaknesses. One of these items is propagation algorithm with momentum.

Propagation algorithm with momentum: We know that propagation algorithm aims to minimize an error function is the form below:

$$E(W) = \frac{1}{2}\sum_{p=1}^{PT}\sum_{i=1}^{I}\left[d_i(p)-y_i(p)\right]^2$$

Where:
PT = The number of pattern
I = The number of neurons in last layer

Propagation error with momentum updates not only current gradientvector but also previous gradient vectors. So, if W is weight vector in MLP then $\Delta W_{(t)}$ in T is as follows:

$$\Delta W_{(t)} = -\eta\frac{dE}{dW_{(t)}} + \alpha\Delta W_{(t-i)} = \eta\sum_{s=0}^{t}\alpha^{t-s}\frac{\partial E}{\partial W_{(s)}}$$

RESULTS AND DISCUSSION

Experimental study: Three layernetwork that mentioned before is trained to detect minutia in narrow finger print with a size of 300*300. The output is 1 when the center of input window is placed on one of the features and the output is 0 when the center of the input window isn't placed on these features.

Figure 9 and 10 was shown initial training patterns that consist of 16 bifurcation samples in 8 different directions and 36 non-bifurcation samples. In this figure, we have 52 different initial training patterns. The output is 1 for 16 bifurcation samples and the output will be 0 for 36 non-bifurcation samples.

Network training is done by using back propagation algorithm with momentum and network learning rate will be 0/3 and fixed momentum will selected 0/9.

Trained network is practical in identification of minutia'splace. But there are some wrong minutia points (Fig. 3-10). This misdiagnosis will be crated in some errors of finger print that are crystalline.

Place of midpoint of fingerprint: We should find midpoint of each fingerprint to get euclidean distance between minutia and central point of fingerprint. Usually the center of fingerprint image is called core point. Krypton point is fingerprint image is called core point in fingerprint image placed in the center of defined as a highest point in where curve slope of fingerprint's lines are changed sharply. Human's fingerprints consist of a variety of patterns which are traditionally grouped based on decades ago: the left loop, arcs, spirals and bows. Loop consists of 2/3 fingerprints, spirals consists of 1/3 and bows are between 5-10%. Figure 10 is shown some fingerprint pattern with

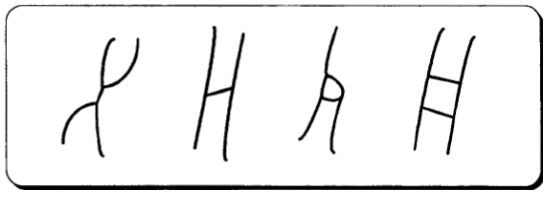

Fig. 9: This misdiagnosis will be crated in some errors of finger print that are crystalline

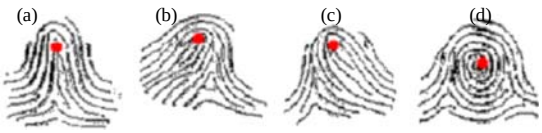

Fig. 10: Some fingerprint pattern with specified Krypton point

specified Krypton point. So far, many defection algorithms have been proposed to detect the Krypton point. That the most famous, algorithm is a Krypton index method. We will assume that midpoint is located in the center of finger prints.

Classification: After scanning the entire finger print, image, output image is binary that it's determined the Minutia point. In order to avoid such a wrong output and choose the important minutia we added two rules. To improve the ability of the algorithm.

- In clear sub-minutia points, we test these point by increasing the size to 5*5
- Id two or more minutiais close to each other, we ignore all of them. Of course we just use B

To ensure that the no changes, no rotation and no scaling we follow this operation:

- For any relived minutia is calculated to the center. Referring this distance data to the center guarantees the stability of place
- Data is arranged in ascending order fromd (0) to d (n) where n is the number of relivedminutia. This function gives us the stability of finger point
- Data is normalized by using the least distance d (0) so that d_{norm} (I) = d (0)/d (i)

This function shows the stability of scale. After extracting the location (place) of Minutia for default finger print images the calculated distances are stored in database based on each person's name and finger print. The final stage is verification phase where the given fingerprint:

- Is given to system
- Minutes are extracted
- Adjusting minutia: comparingthe extracted distances with databases
- Identify the person

CONCLUSION

Human fingertipshin consists of lines and grooves that are made distinct patterns. These patterns are fully evolved during pregnancy and remain unchanged throughout life. The impact and the role of these patterns

on environment is called finger print. Injuries such as cuts, burns and scald can harm the finger print quality in short time but these patterns will be restored. When these damages were resolved. According to studies on finger print we saw that there isn't any one will the same finger print so that each person's finger print is unique (Herschel, 1916).

According to the mentioned characteristics (features) that exist in the finger print, finger print is very practical. In a biometric scale fingerprinthas been used to solve the crime over a 100 years especially in the courts. In this study, a new method is introduced for fingerprint recognition by using a neural network. The advantage of this method compare to pervious methods is faster and more accurate those are key components in finger print recognition.

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