

Fingerprint Identification System Based On Neural Network

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Abstract : The purpose of this project is to design and develop a pattern recognition system with using Artificial Neural Network (ANN) that can recognize the type of image based on the features extracted from the choose image. Also I am comparing any two methods of neural network. This system which can fully recognizing the types of the data had been add in the data storage or called as training data. The Graphic User Interface in Neural Network toolbox is used. This is the alternative way to change the common usage of the MATLAB which are use the command insert at command window. From this kind of system, we just need to insert the features data or training data. The recognition done after we insert the test data. The system will recognize whether the output is match with the training data. Then output will produce a kind of graph that describes the feature of the data which is same as the training data.

Keywords: Fingerprint Identification System, Artificial Neural Network, Backpropogation Network, MATLAB.

I. INTRODUCTION

Biometric Identification Systems are widely used for unique identification of humans mainly for verification and identification. Biometrics is used as a form of identity access management and access control. So use of biometrics in student attendance management system is a secure approach. There are many types of biometric systems like fingerprint recognition, face recognition, voice recognition, iris recognition, palm recognition etc. In this project, I am using fingerprint recognition system using neural network.

A fingerprint is the pattern of ridges and valleys on the surface of a fingertip. The endpoints and crossing points of ridges are called minutiae. It is a widely accepted assumption that the minutiae pattern of each finger is unique and does not change during one's life. Ridge endings are the points where the ridge curve terminates, and bifurcations are where a ridge splits from a single path to two paths at a Y-junction.

When human fingerprint experts determine if two fingerprints are from the same finger, the matching degree between two minutiae pattern is one of the most important factors. Thanks to the similarity to the way of human fingerprint experts and compactness of templates, the minutiae-based matching method is the most widely studied matching method.

A neural network, also known as a parallel distributed processing network, is a computing solution that is loosely modeled after cortical structures of the brain. It consists of interconnected processing elements called nodes or neurons that work together to produce an output function. The output of a neural network relies on the cooperation of the individual neurons within the network to operate. Processing of information by neural networks is characteristically done in parallel rather than in series (or sequentially) as in earlier binary computers or Von Neumann machines. [1]

II. RELATED WORK

2.1 Proposed Algorithm

In this proposed work we introduce an algorithm of fingerprint recognition system. It is very well known that to develop a reliable fingerprint recognition system image enhancement and features extraction are needed. This proposed algorithm is divided into main three stages: Preprocessing, post processing and final minutiae matching stage. Preprocessing stage involved enhancement of image by using histogram equalization, binarization and morphological operations after applying this enhancement algorithm a binarized thinned image has been obtained. In second stage

minutiae are extracted from the enhanced fingerprint by using the optimization technique. Final stage is the recognition of the fingerprint which has been done with the help of neural network.

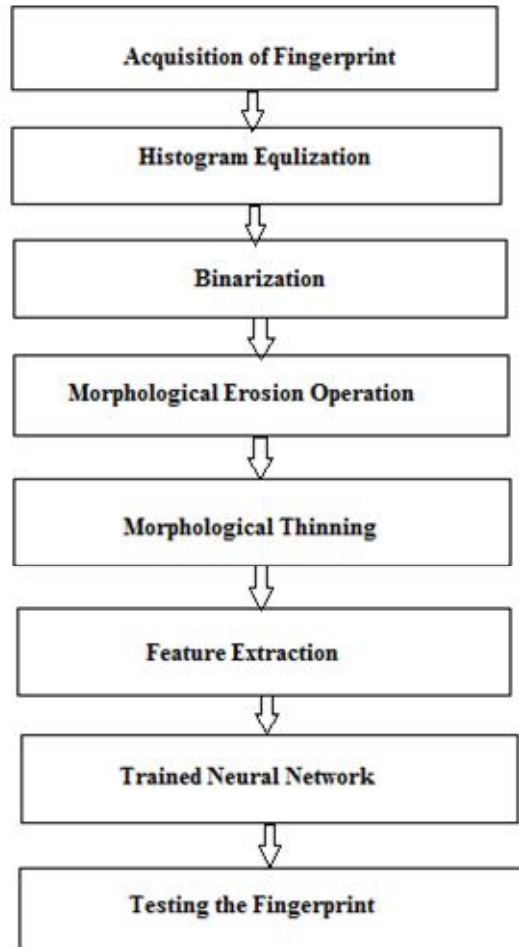


Fig. 1. Algorithm

2.2 Block Diagram

Block-diagram of the fingerprint identification system and its diverse parts can be seen in figure. The template is a pre-stored point pattern of extracted minutiae from authentic fingerprint. It is produced in the same way as the point pattern of the fingerprint in the figure. [2]

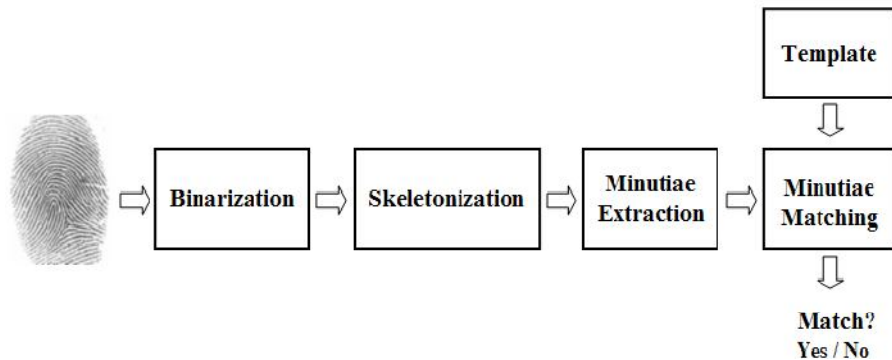


Fig. 2. Block-Diagram of the System

2.2.1 Binarization

Quality of fingerprints can significantly vary, mainly due to skin condition and pressure made by contact of fingertip on sensing device some sort of pre-processing is needed to achieve good minutiae extraction. This problem can be handled by applying an enhancing algorithm that is able to separate and highlight the ridges from background; this type of enhancing is also called linearization. Binarization is process where a greyscale image is decimated or categorized into only two levels, black and white (0 and 1). [2]

2.2.2 Skeletonization

Skeletonization is a process mostly used on binarized images by thinning a certain pattern shape until it is represented by 1-pixel wide lines, the so called skeleton of that pattern. Since minutiae are determined only by discontinuities in ridges, they are totally independent of ridges thickness. By finding the skeleton of the binarized fingerprint image through thinning of the ridges to only one pixel wide lines, the minutiae are preserved with minimum possible data. This decimation of data offers more effective minutiae extraction realization.

Skeletonization is performed on so called "negative image" of the binarized fingerprint images since above specified rules uses 1 that represents the ridges and 0 for representing the background. The binarized fingerprint images uses exact the opposite signs. A negative image is simply formed by performing a logical NOT operation on the binarized fingerprint. The examination of the pixels is done in iterations where the first two rule sets are applied in turns. The pixels that can be erased are marked and first at end of each iteration are removed from the image. This process is repeated until there are no more pixels that can be removed from the image. Then the second skeletonization process is started to remove the remaining pixels to produce the 1-pixel wide lines. This process takes only one iteration. After that the image is converted back and the skeleton of the binarized fingerprint image is found. [2]

2.2.3 Minutiae Extraction

Extracting minutiae from the skeleton of the fingerprint requires a method that is able to distinguish and categorize the different shapes and types of minutiae. This is a classification problem and can be solved by constructing and training a neural network which work as a classifier. [3]

2.2.3.1 Neural Network

Neural network is a nonlinear mapping system whose structure is loosely based on principles of the real brain. The whole network is build up with simple processing units, structures of those can be seen. The unit is a simplified model of a real neuron. Its parts are the input vector x whose containing information is manipulated by the weighted nodes by weigh vector w . The node with weight θ and input 1 is a so called bias of the neuron which gives the freedom to the neuron to be able to shift the function $f(\cdot)$. Function $f(\cdot)$ is usually a nonlinear function and is mostly called activation function. Input to this function $f(\cdot)$ is a sum of all the nodes and is denoted as u . [4]

There are many different types of the neural networks such as perceptron, backpropagation network, counter propagation network, Hopfield networks, etc... [5] I am using backpropagation neural network and cellular neural network and comparing their results.

2.2.3.1.1 Backpropagation Network (BPN)

What is making the neural networks interesting is that the determination of its weights w is done by learning. A back-propagation is one of many different learning algorithms that can be applied for neural network training and has

been used in this thesis. It belongs to a category of so called learning with the teacher. For every input vector x that is presented to the neural network there is predefined desired response of the network in a vector t (the teacher). The desired output of the neural network is then compared with the real output by computing an error e of vector t and neural network output vector y . The correction of the weights in the neural network is done by propagating the error e backward from the output layer towards the input layer, therefore the name of the algorithm. The weight change in each layer is done with steepest descent algorithm. The back-propagation algorithm is carried out in the following steps:

1. Select a training pair from the training set; apply the input vector to the network input.
2. Calculate the output of the network.
3. Calculate the error between the network output and the desired output (the target vector from the training pair)
4. Adjust the weights of the network in a way that minimizes the error.
5. Repeat the steps 1 through 4 for each vector in the training set until the error for the entire set is acceptably low. [4]

2.2.3.1.2 Cellular Neural Network (CNN)

CNN consists of an array of non-linear, locally interconnected, first order circuits. As connections are local, each cell is connected only to the cells belonging to its neighborhood, as it is shown in fig.

The state and output vary in time, whereas the input is kept constant. Templates describe the interaction of the cell with its neighborhood and regulate the evolution of the CNN state and output vectors. Template connections can be realized by voltage-driven current generators. The output characteristic f adopted is a sigmoid-type piecewise-linear function.

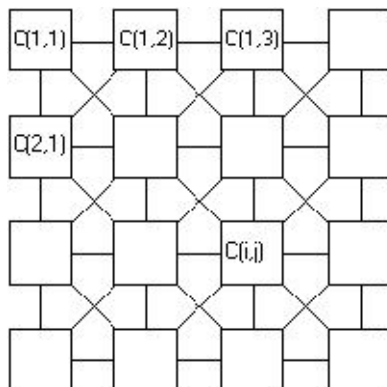


Fig. 3. Architecture of a CNN

CNNs are exploited for image processing by associating each pixel of the image to the input or initial state of a single cell. Subsequently, both the state and output of the CNN matrix evolve to reach an equilibrium state. The evolution of the CNN is governed by the choice of the template. A lot of templates have already been defined in order to perform basic image processing operations. Simple operations can be performed just by using the basic templates A , B , and the bias I , whereas more complicated processing requires the use of the nonlinear templates and the generalized nonlinear generator

The main advantage of using CNNs in image processing is related to the increasing of throughput due to the massive parallelism of the structure, joined to the similar way of signal processing, typical of CNNs. In fact they are able to perform a complete image processing analysis in time of order of 10^{-6} s (by using a CNN hardware implementation), this in form of sequences of simple tasks like array target segmentation, background intensity extraction, target detection and target intensity extraction.

2.2.3.2 Classifier Realization

Training data is divided into three different pattern classes; termination, bifurcation and no minutiae. The neural network output layer consists of three neurons, each representing one class of the training data. By training the neural network so it activates the right neuron corresponding to the pattern class, the classification of the input patterns can be achieved. Size of the training data is chosen to 5×5 windows. The 3×3 window doesn't view much information and the 7×7 window show too much information which is unnecessary. [2]

2.2.4 Minutiae Matching

Extracted minutiae from the fingerprint are together forming a point pattern in plane. Therefore matching two minutiae point patterns with each other are considered as a 2D point pattern problem. An algorithm is needed that localizes the maximum number of mutual points in the two point patterns.

The point patterns are constructed only on positions (x, y) of minutiae in the plane. The minutiae type and orientation which provides extra information are disregarded due to possible type alternation and noise in orientation. The alternation can be caused by varying pressure between fingertip and the sensor and also by binarization process. Low pressure can cause that bifurcation minutiae appear as termination minutiae in the fingerprint image. On the other hand high pressure can cause termination minutiae appear as bifurcation minutiae in the fingerprint image. Alternations of minutiae types by the binarization process has been pointed out and described in chapter 2. Bad quality of fingerprint image gives noisy orientation image and therefore false minutiae orientation. Alternation and false orientation of the minutiae gives higher risk that not all mutual points are detected. Since point patterns are based on positions of minutiae in fingerprint they form distinctive patterns. With enough points in each pattern the positions (x, y) of the minutiae are the only information that is needed for good matching results. By using only (x, y) coordinates of minutiae yields that less memory is needed for implementation of this algorithm.

The matching is performed on the two point patterns P with m number of points $\{p_1, p_2, \dots, p_m\}$ and Q with n number of points $\{q_1, q_2, \dots, q_n\}$. [2]

III. CONCLUSION

It is evident from the work that the neural networks can be used to solve the Finger Print Recognition problem effectively. Here the input is an image, the thumb impression of a person.

When the matching process is invoked then the neural program will first find out, to which class of thumb image, the input image corresponds to. This classification check is done, in order to reduce the search time between numerous images. After, the category of the input is found then the next stage of the matching process will occur. Here, the original matching is done as by taking the pixel positions of that input image and these positions are matched with all the images in that particular class. If the image's pixel positions are matched with the input image that is the indication of the signal success.

ACKNOWLEDGMENT

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