

Fingerprint Recognition Using Artificial Neural Network: Review

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Abstract: *The use of fingerprint in biometric identification has been the most widely used authentication system. The uniqueness of the fingerprint for every human provides us with all we need for faultless identification. However, during the fingerprint scanning process, the image generated by the scanner may be slightly different during each scan. This paper puts the implementation of Artificial Neural Networks to provide an efficient matching algorithm for fingerprint authentication. Using the Back-Propagation technique, the algorithm works to match twelve fingerprint parameters and relate them to a unique number provided for each authorized user. Upon matching, the algorithm returns the best match for the given fingerprint parameters.*

Keywords: *Back propagation, Bio-metric, Neural network, Authentication*

I. Introduction

This paper deals with the implementation of a pattern matching algorithm to match and authenticate fingerprints. The algorithm uses Neural Network concepts to perform effective pattern matching to identify fingerprints. The concept relies on image processing techniques to locate 12 fingerprint features using fingerprint analysis by moment. Fingerprint processing must return the match of each of these features. Though any pair of corresponding feature values may be same for two individuals, the combination of all 12 values may never be the same. Hence: an effective and unique identification parameter is found for each individual.

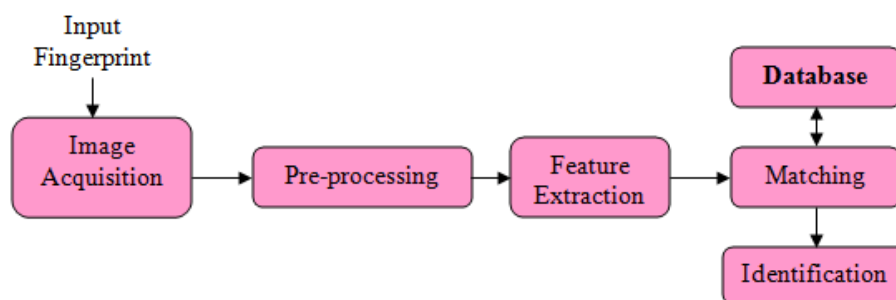
A fingerprint is a graphical pattern of ridges and valleys on the surface of a human finger. Due to the uniqueness and permanence of fingerprints, they are among the most reliable human characteristics that can be used for personal identification. The performance of an automatic fingerprint identification system relies heavily on the fingerprint image quality which can be affected by several factors such as the presence of scars, variations of the pressure between the finger and acquisition sensor, worn artifacts, and the environmental conditions during the acquisition process. For constructing an effective fingerprint identification system, an effective enhancement algorithm is necessary.

Directional behaviour is an obvious characteristic in a fingerprint image caused by the continuous flow of fingerprint ridges whose orientations are slowly changing in the fingerprint pattern. Ridges and valleys in a local neighbourhood form a sinusoidal-shaped wave, which has a well-defined frequency and orientation. The ridge orientations as well as the ridge period are maintained almost constant inside a small local area. The basic idea for enhancing a fingerprint is to first detect the orientations of the ridges, and then a smoothing operation is performed along the ridge directions to remove the noise.

Ridge orientations can be estimated directly from a gray-scale image using gradient methods and others require a binary fingerprint image. With the orientation information available, the smoothing operation is usually done by adaptive filters attuned to the corresponding orientation and ridge period in local regions. Hong et al use Gabor filters as Sobel filters to remove the noise and retain true ridge and valley structures, and high pass filter that is used to enhance the image. The classical stages of enhancement and ridge detection are binarization, enhancement, feature extraction, training and matching. The basic fundamental steps of these systems are image acquisition, pre-processing segmentation, enhancement and feature extraction, matching along with classification through databases. Authentication or verification systems authenticate the person's identity by comparing the own biometric template(s) stored in database (One-to-One comparison). An identification system is recognized by an individual by searching the entire templates in database for match (One-to-Many Comparison).

II. Methodology

All process of recognition of fingerprint with artificial neural network given below



Fundamental Steps of Fingerprint Recognition System

Fingerprint Image:

A fingerprint is the feature pattern of one finger. Each person has his own fingerprints with the permanent uniqueness. Due to the uniqueness and permanence of fingerprints, they are among the most reliable human characteristics that can be used for personal identification.

Image Acquisition:

A number of methods are used to acquire fingerprints. Among them, the inked impression method remains the most popular one. Inkless fingerprint scanners are also present eliminating the intermediate digitization process. Fingerprint quality is very important since it affects directly the minutiae extraction algorithm. The size of the scanned fingerprints that are used in this research is 188x240 pixels. The images are taken in this size in order to ease the computational burden.

Fingerprint Image Processing:

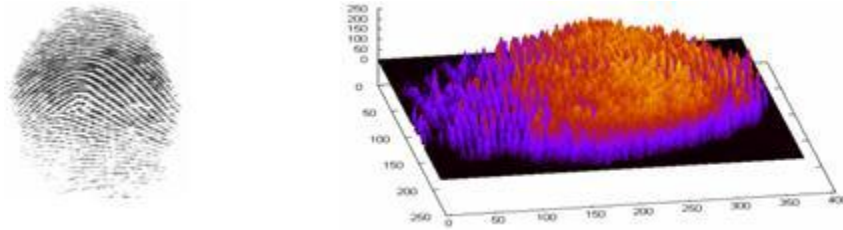
Processing of fingerprint image is necessary to: (i) improve the clarity of ridge structures of fingerprint images (ii) maintain their integrity, (iii) avoid introduction of spurious structures or artifacts, and (iv) retain the connectivity of the ridges while maintaining separation between ridges. Fingerprint image processing operations are image enhancement, image normalization and image binarization.

Fingerprint Image Enhancement:

The local ridge orientation is an intrinsic property of the fingerprint images. By viewing a fingerprint image as an oriented texture, a number of methods have been proposed to estimate the orientation field of fingerprint images. The previous enhancement algorithm is either local orientation field filter-based or Gabor filter-based. The orientation field filtering techniques usually assume the local ridge orientation could be reliably estimated and be taken advantage to enhance the fingerprint image. The ridge structures in poor-quality fingerprint images are not always well-defined and, hence, the orientation information could not be correctly detected, which greatly restricts the applicability of these techniques. The Gabor filter based technique could obtain a reliable orientation estimate even for corrupted images. It is unsuitable for an on-line fingerprint recognition system such as AFIS because the algorithm is computationally expensive.

Fingerprint Profile Normalization Algorithm:

An ideally sensed or scanned fingerprint image has clear and distinct ridges and valleys. For example, an ideal fingerprint image could be a rolled ink impression on a fingerprint card. The finger skin profile made of the ridges is evenly pressed on the flat paper card, which leaves the ink impression of ridges as continuous flow of foreground passes, and in between the ridges are the valleys as background with white colour. But in reality the fingerprint scanning devices are far from this ideal set up. Even the National Institute of Standards and Technology (NIST) fingerprint images scanned from the inked fingerprint cards are not perfect. Although the noise introduced in the fingerprint images during the scanning is a problem in fingerprint minutiae extraction, the uneven distribution of the pixel levels in the fingerprint images is another common problem for detection of ridge orientation. Figure shows an example image of uneven ridge profile.



Example fingerprint image of uneven ridge profile

There are algorithms for image normalization. To decrease the dynamic range of the gray scale between ridges and valleys of a fingerprint image, proposed the following algorithm. Let $I(i, j)$ denote the gray-level value at pixel (i, j) , M and VAR denote the estimated mean and variance of I , respectively, and $G(i, j)$ denote the normalized gray-level value at pixel (i, j) . The normalized image is defined as follows.

Fingerprint Binarazation:

Binarazation is the process of converting the gray-scale image into a binary image is called binarazation. Zeros and ones forms binary image. Global threshold algorithm is used for performing binarazation process. Looking at each pixel on the fingerprint image and deciding whether it should be converted to black (0) or white (255) i.e., to 0 or 1 from gray level to black and white image each pixel value is compared with threshold level then pixel value is set to Zero; otherwise it is set to 255. Figure shows a binary image from the binarization algorithm and the selected ridge pixels, and the rest of the pixels are filled in white.



The image on left is from the locally adaptive binarization algorithm, and the image on right shows the selected ridges

Fingerprint Feature Extraction with Moments:

Moment invariants are important shape descriptors in computer vision. There are two types of shape descriptors: contour-based shape descriptors and region-based shape descriptors. Regular moment invariants are one of the most popular and widely used contour-based shape descriptors is a set of derived by Hu. A computer vision system recognizing objects in captured images is established using Geometric Moment (GM). GM was derived from the theory of algebraic invariant. GM technique is chosen to extract image features since the features generated are Rotation Scale Translation (RST)-invariant. GM was successfully applied in aircraft identification, texture classification and radar images to optical images matching.

Overview of Neural Network:

A *neural network* is a computational structure inspired by the study of biological neural processing. There are many different types of neural networks, from relatively simple to very complex, just as there are many theories on how biological neural processing works. A layered feed-forward neural network has *layers*, or subgroups of processing elements. A layer of processing elements makes independent computations on data that it receives and passes the results to another layer. The next layer may in turn make its independent computations and pass on the results to yet another layer. Finally, a subgroup of one or more processing elements determines the output from the network. Each processing element makes its computation based upon a weighted sum of its inputs. The first layer is the *input layer* and the last the *output layer*. The layers that are placed between the first and the last layers are the *hidden layers*. The processing elements are seen as units that are similar to the neurons in a human brain, and hence, they are referred to as *cells*, *neurotises*, or *artificial neurons*. A *threshold function* is sometimes used to qualify the output of a neuron in the output layer. Synapses between neurons are referred to as *connections*, which are represented by edges of a directed graph in which the nodes are the artificial neurons. Nets consist of small units called *cells*, and these are connected to each other in such a way that they can pass signals to each other.

Fingerprint Classifier:

Classification is the final stage of any image-processing system where each unknown pattern is assigned to a category. The degree of difficulty of the classification problem depends on the variability in feature values for objects in the same category, relative to the difference between feature values for objects in different categories. In this study MLP (Multilayer Perception) classifiers used as pattern classifiers.

MLP has been termed a universal approximate, and can provide an optimal solution to an arbitrary classification problem. It implements linear discriminates, but in a space where the inputs have been mapped nonlinearly. The key power provided by such networks is that they admit fairly simple algorithms where the form of the nonlinearity can be learned from the training data. The models are thus extremely powerful, have nice theoretical properties, and apply well to a vast array of real-world applications. Figure 4 shows a simple three-layer MLP neural network, consisting of an input layer, hidden layer and an output layer, interconnected by modifiable weights represented by links between layers. One of the most popular methods for training such multilayer networks is based on gradient descent in error-the back propagation algorithm a natural extension of the LMS (Least Mean Square) algorithm. Guided by an analysis of networks and their function we can make informed choices of the scaling of input values and initial weights, desired output values, and more. Network architecture or topology plays an important role for neural net classification, and the optimal topology will depend on the problem at hand.

III. Result

The algorithm is implemented using 2.1 GHz Pentium 4 machine with Windows 7 and MATLAB 8.0 as the development tool. Two set of images are required, one for the training of the neural network and another set of images upon which testing is done. Each image is of size 188×240 pixels. In this research, the testing subjects reach to 100 images taken from 100 different peoples. These 100 images are divided into 50 known images (previously trained one) and 50 images (newly untrained one) recognition phase of the 100 testing fingerprint samples. Neural Network is trained upon some set of images, and tested upon unseen images. The results are analyzed to calculate the recognition rate of the system. A recognition rate of 100% is obtained for this system. This recognition rate value is perfectly suitable for fingerprint recognition systems. In this technique neural network uses back propagation algorithm for error computation and new weights calculation for each neuron link. The network undergoes process of training, continuously in an iterative manner it calculates output from each layer, extracting the mean square error and propagating it backwards if it is not approaching targets. Due to this backward error propagation, error-signal for each neuron is calculated. Which in fact is used for neuron weight updating. If its approaching targets then training is considered done. The process of training these images in which training curve is approaching its goal through readjustment of weights and biases.

IV. Conclusion

Biometrics-based methods for personal authentication assume that the biometric characteristics used for the verification of an individual's identity are unique from person to person. However the uniqueness of fingerprints from one individual to another has been thoroughly verified. This algorithm aims to capitalize on this uniqueness and improve the efficiency, in terms of matching accuracy, of fingerprint identification and authentication. In this paper back-propagation Neural Network has been trained as a fingerprints classifier to identify fingerprints with time effective pre-processing, which greatly increases the performance of the network. The recognition rate of fingerprints depends on the quality of fingerprints and effectiveness of pre processing system.

References

- [1]. Jain and E. A.I, "**An Introduction to Biometric Recognition**", IEEE Tran. on Circuits and Systems for Video Technology, Vol.14, No.1, pp: 4-20, 2004.
- [2]. M. Mercimek, K. Gulez, and T. Mumcu, —**Real object recognition using moment invariants**!, Sadhana Vol. 30, pp: 765–775. © Printed in India, 2005.
- [3]. V. Srinivasan, and N. Murthy, "**Detection of Singularity Points in Fingerprint Images**", NUCEJ Vol.15 No.2, Pattern recognition, 20, pp.513-523., 1992.
- [4]. D. Maio and D. Maltoni, —**Direct Gray Scale Minutiae Detection in Fingerprints**!, IEEE Tran on Pattern Analysis and Machine Intelligence, Vol.19, No. 1, 1997.
- [5]. S. Al, "**Fuzzy Control for Fingerprint Feature Selection**", Proc. ACCV Vol. 3, pp: 767-771, 1995.
- [6]. X. Xia, and L. O'Gorman, **Innovations in Fingerprint Capture Devices**!, Journal of Pattern Recognition, Pergamon Press, Vol. 36, No. 2, pp. 361-370, 2002.
- [7]. J.P. Hayes, —**Computer Architecture & Organization**!, Mc,Grew-Hill compon, 1998.
- [8]. A. Chatterjee, S. Mandal, G. M. Atiqur Rahaman, and A. M. Arif, "**Fingerprint Identification and Verification System by Minutiae Extraction Using Artificial Neural Network**", ISSN 2218-5224 (ONLINE), VOLUME 01, ISSUE 01, 2010.
- [9]. A. Askarunisa, Sankaranarayanan. K, Sundaram. R and Sathick .M. Batcha, —**Finger Print Authentication Using Neural Networks**!, MASAUM Journal of Computing, Vo. 1, No. 2, 2009.
- [10]. G. Jha, —**Artificial Neural Networks**", Indian Agricultural Research Institute, PUSA, New Delhi-110 012, 2005.