A Study on the Neural Network Model for Finger Print Recognition

Vijaya Sathiaraj
Dept of Computer science and Engineering
Bharathidasan University, Trichirappalli-23

Abstract:

Finger Print Recognition [FPR] is an unique technique to avoid intruders in any part of the information system, where the data are very essential than somebody's life, like military code transaction, some secret operations at nation's higher authority level. Current finger print recognition systems are very tough to allow the intruders. This finger print recognition system is used widely, nowadays, in all part of the fields where data or information plays the key role in each and every process. But to reduce the complexity in developing these systems we need to choose between the choices of algorithms. Thus this topic induces a keenness to take as a research oriented one. There are numerous techniques are available for finger print recognition. One of them is Artificial Neural Networks(ANN) . In ANN there are many networks methodologies are available. But up to my evaluation, Backpropagation training network is the most successful one. As per the need to develop a system to recognize the exact thumb impressions from the match with the images that has already stored, the main task before is, to make the system activate through artficial neural network. There are numerous and specific types of networks such as perceptron, backpropagation network, counter propagation network, Hopfield networks, etc.., but here the backpropagation network has been selected for the study. Because of its wide range of usage in many fields, backpropagation network has been taken into account, without ignorance, because of its drawbacks.

Keywords: ANN, BPN, FP, NN

1. Introduction

In today's modern scientific developments an interesting word is often spelled out by the scientists and researchers, who feel it is very tough to describe and put into a bound and also challenging. The word is **"ARTIFICIAL NEURAL NETWORK"(ANN).** Here they are trying to model the human brain, which is a concept used as a base in the robotics. Actually ANN are biologically inspired; that is they are composed of elements that perform in a manner that is analogous to the most elementary functions of the biological neuron. These elements are then organized in a way that may be or may not be related to the anatomy of the brain[1]. Despite this superficial resemblance, ANN exhibit a surprising number of the brain's characteristics. For example, they learn from experience, generalize from previous examples to new ones, and abstract essential characteristics from inputs containing irrelevant data. In the earlier period of the research, the people who involved in the modeling of the human brain system, felt painstaking to learn about the operations done in between the billions of neurons which in turn connecting to hundreds of thousands of others. They tend to define two objectives of neural modeling and they are used as the base until today: first, to understand the physiological and psychological functioning of the human neural system; and second, to produce computational systems (ANN) that perform brainlike functions, which is the main criteria of the creation of the ANN[2]. Initially, a group of researchers developed networks consisting of a single layer of artificial neurons, called **PERCEPTRON,** which are used to problems such as weather prediction, electrocardiogram analysis, and artificial vision. But perceptrons weren't successful enough to satisfy some of the critical problems such as **Exclusive-Or** problem.

2. Methodology

To work with the finger print recognition system through artificial neural network, we have to make train the neurons involving in the network. That is, one of the interesting characteristics of ANN is the ability to learn. Their training shows so many parallel to the intellectual development of human beings that it may seem that we have achieved a fundamental understanding of this process.

3. Objectives of the Work

Here the topic that was chosen is to recognize "NEURAL NETWORK MODEL FOR FINGER PRINT RECOGNITION " of variant persons[3]. Why we need to record these finger prints and recognize whether a particular impression is of a particular person? In today's world for each and every country data hiding is an essential thing to keep its secrecy in each and every field. We need to restrict any kind of intruders to avoid information leakage. To maintain the security level for information hiding we need a strict methodologies such as facial recognition, voice recognition, finger print recognition, etc., In these finger print recognition is an unique technique to avoid intruders in any part of the information

system, where the data are very essential than somebody's life, like military code transaction, some secret operations at nation's higher authority level[4]. Why finger print recognition is an unique system than others in data security? Because the finger print (thumb impression) is unique for person to person. No one can have a same kind of thumb impression. This thing made the researchers to develop a hard security system based on the thumb impressions as their input. Current finger print recognition systems are very tough to allow the intruders. Researchers developed such a kind of hard algorithms to restrict the traitors. Thus this topic make me interest to choose and make a research work on the methodologies involved in this system. The main task is to develop an artificial neural network using backpropagation algorithm. Here the main task is to train the neural network. There are specifically two types of training methodologies. One is, supervised training and the other is unsupervised training method. Here the supervised training method has been selected to train the network. Here a training pair of images are selected and train the network to recognize them. After the training with some number of training pairs, the network is going to be tested, whether it can able to recognize the finger print images successfully or not.

4. Implementation

a) Matching the finger print images

Everyone is known to have unique, immutable fingerprints. A fingerprint is made of a series of ridges and furrows on the surface of the finger. The uniqueness of a fingerprint can be determined by the pattern of ridges and furrows as well as the minutiae points.**Minutiae** points are local ridge characteristics that occur at either a ridge bifurcation or a ridge ending. Fingerprint **matching** techniques can be placed into two categories: minutae-based and correlation based. Minutiae-based techniques first find minutiae points and then map their relative placement on the finger[5]. However, there are some difficulties when using this approach. It is difficult to extract the minutiae points accurately when the fingerprint is of low quality. Also, this method does not take into account the global pattern of ridges and furrows. The correlation-based method is able to overcome some of the difficulties of the minutiae-based approach. However, it has some of its own shortcomings. Correlation-based techniques require the precise location of a registration point and are affected by image translation and rotation.

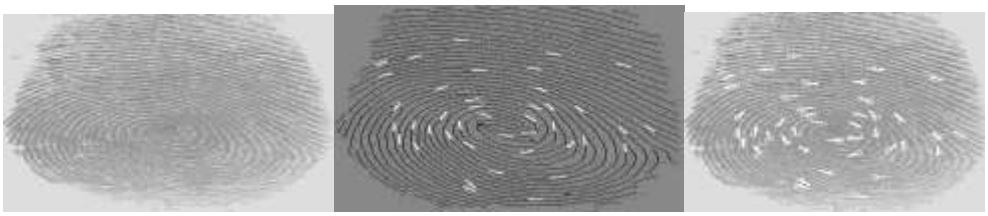

Fig. 4.1 Minutiae points in a thumb image

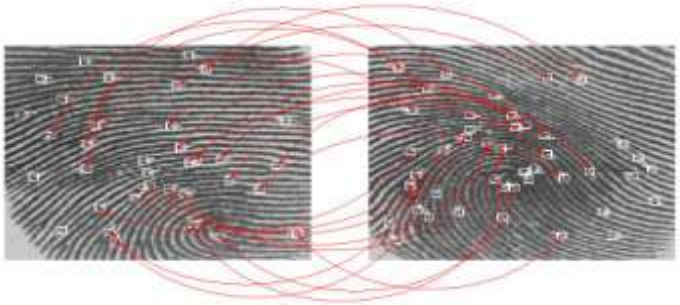

Fig. 4. 2 Matching the finger print images.

Fingerprint matching based on minutiae has problems in matching different sized (unregistered) minutiae patterns. Local ridge structures can not be completely characterized by minutiae. Here an alternate representation of fingerprints is tried, which will capture more local information and yield a fixed length code for the fingerprint. The matching will then hopefully become a relatively simple task of calculating the Euclidean distance will between the two codes. A commercial fingerprint-based authentication system requires a very low False Reject Rate (FAR) for a given False Accept Rate (FAR). This is very difficult to achieve with any one technique. Till the investigation is in process to find out the methods, to pool evidence from various matching techniques to increase the overall accuracy of the system[6]. In a real application, the sensor, the acquisition

system and the variation in performance of the system over time is very critical. A testing process has been done on the system, on a limited number of users to evaluate the system performance over a period of time.

b) Fingerprint classification

Large volumes of fingerprints are collected and stored everyday in a wide range of applications including forensics, access control, and driver license registration. An automatic recognition of people based on fingerprints requires that the input fingerprint be matched with a large number of fingerprints in a database (FBI database contains approximately 70 million fingerprints!)[7]. To reduce the search time and computational complexity, it is desirable to classify these fingerprints in an accurate and consistent manner so that the input fingerprint is required to be matched only with a subset of the fingerprints in the data

WHORL **LEFT LOOP** **RIGHT LOOP** **ARCH**

TENTED ARCH

Fig 4.3 Classifications of the fp images.

Fingerprint classification is a technique to assign a fingerprint into one of the several pre-specified types already established in the literature which can provide an indexing mechanism. Fingerprint classification can be viewed as a coarse level matching of the fingerprints. An input fingerprint is first matched at a coarse level to one of the pre-specified types and then, at a finer level, it is compared to the subset of the database containing that type of fingerprints only. The fingerprints are classified into five classes, namely, ***whorl, right loop, left loop, arch, and tented arch*.**

c) Fingerprint image enhancement

A critical step in automatic fingerprint matching is to automatically and reliably extract minutiae from the input fingerprint images. However, the performance of a minutiae extraction algorithm relies heavily on the quality of the input fingerprint images. In order to ensure that the performance of an automatic fingerprint identification/verification system will be robust with respect to the quality of the fingerprint images, it is essential to incorporate a fingerprint enhancement algorithm in the minutiae extraction module. We have developed a fast fingerprint enhancement algorithm, which can adaptively improve the clarity of ridge and furrow structures of input fingerprint images based on the estimated local ridge orientation and frequency. We have evaluated the performance of the image enhancement algorithm using the goodness index of the extracted minutiae and the accuracy of an online fingerprint verification system. Experimental results show that incorporating the enhancement algorithms improves both the goodness index and the verification accuracy.

Fig.4.4 Image enhancement

The above figure denotes that if the corresponding points of shapes in a finger print image occur in that particular pixel then it is considered as 1, otherwise it is 0. Then these values are matched with the same pixel values of the target output image.

Now the real hypothesis is based on how really the training methodology is going to take over in **BACKPROPAGATION NETWORK(BPN).** Before going to this subject first, an introduction to BPN is needed and its part to the neural network researches.

d) Structure of BP network

Training the back propagation network requires the steps that follow:

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.

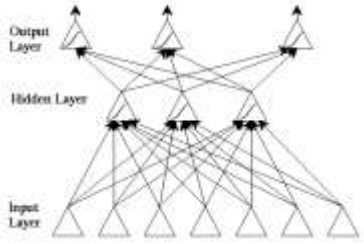

FIG. 4.5. Structure of BP network

e) Level of accuracy

The hidden layer learns to recode (or to provide a representation for) the inputs. More than one hidden layer can be used. The architecture is more powerful than single-layer networks: it can be shown that any mapping can be learned, given two hidden layers (of units). The units are a little more complex than those in the original perceptron: their input/output graph is

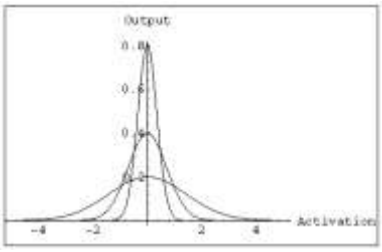

Fig.4.6 Level of accuracy

As a function:

$Y = 1 / (1+ \exp(-k.(\Sigma W_{in} * X_{in}))$

The graph shows the output for *k=0.5, 1, and 10,* as the activation varies from -10 to 10

5. Conclusion

It is evident from the work that the neural networks can be used to solve the "NEURAL NETWORK MODEL FOR FINGER PRINT RECOGNITION " problem effectively. Especially, the BACK PROPAGATION NETWORK can be very useful for solving the taken problem. Here the input is an image, the thumb impression, of a person is got from the device "thumb scanner" and they are displayed in a separate software tool. When the matching process is invoked then the neural program will first find out, to which class of thumb image, the input image s 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, and the person who belongs to the input image is considered as authorized person. Otherwise, then the system will signal as MATCH FAILED AND UNAUTHORIZED ENTRY. When the crucial problems, which are often faced by BPN, like indefinite step size and temporal instability, occur then it will be the greatest block before the training process section of a neural network. Because, in order to give training for each neuron (in each layer of the hidden layer) and if one neuron fails in its process then it will affect all the outs of other neurons also. The weight changes have to be made, i.e., adjustments, in order to achieve the result denoted in the target. The pattern recognition problem can be solved through other neural networks also. But BPN is a systematic method for training multilayer artificial neural networks. It has a strong mathematical foundation. Despite its limitations, backpropagation has dramatically expanded the range of problems to which artificial neural networks can be applied, and it has generated many successful demonstrations of its power.

References

[1]. Cottrell, G. W., Munro, P., Zipser, "***Image compression by backpropagation**."* University of California, San Diego. 1987
[2]. Wasserman. P. D.. Neural Computing: "***Theory and Practice."*** New York: Pergamon Press. 1988
[3]. Rumelhart, D. E., Hinton, G. E., and Williams, R. J. "***Learning internal representations by error propagation".*** 1986
[4]. Beale, R. and Jackson, T.. "***Neural Computing, an Introduction**."* Adam Hilger, IOP Publishing Ltd : Bristol. (1990)
[5]. Ripley, B.D. "***Pattern Recognition and Neural Networks**,"* Cambridge: Cambridge University Press. (2006)
[6]. Hertz, J., Krogh, A., and Palmer, R.. "***Introduction to the Theory of Neural Computation"***. Addison-Wesley: Redwood City, California. (1991)
[7]. Balloons. Computer Vision and Image Processing: Image Understanding, 53:211-218, March 2011.