Offline Handwritten Signature Recognition using Artificial Neural Network Techniques

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ABSTRACT
Every person has its own signature, different from others. People make their signature in different manner which depending upon the type of pen available, space available or accomplish it with different angle.Exactly the same signature is not possible consistently.However, in some applications, itis very important to recognize the accurate signature where, the evaluation depends on theaccuracy and time.This paper presents a design of offline Signature recognition system using neural networks.A database is created by applying global and morphological operations on the signature using different ranges. Database of total 1344 signatures of 7 persons are used for experimentation.Daubechies wavelet transform employed to extract a set of features which areutilizes as input to neural network. A Feed forward back Propagation neural network and a Radial Basis Function (RBF) network are used for the examination.An accuracy of 97.61 % with Feedforward back Propagation is observed in identifying the test signatures under different dilated and erodedimages of the signature.

Keywords
Offline signature, Feature extraction, Daubechies wavelet, Morphology,Radial Basis network, Feedforward back Propagation network.

1. INTRODUCTION
Human signature is a biometric measure of person's identification. In many sectors like banks, official documents, receipts etc. handwritten signature are verified to secure and identify the concerned person. Each individual has his own signature different with others but people unable do exactly the same signature every time. The signature verification problem aims to minimize the intrapersonal differences. Signature recognition can be categorized into following two parts: online and offline.Online handwritten signature recognition deals with automatic conversion of characters which are written on a special digitizer, tablet PC or PDA, Wherein a sensor picks up the pen-tip movements as well as pen-up/pen-down switching. However, in offline technique just scanned images of signatures are available.

Several methods were developed for the signature recognition in which neural networks (NN) performance is observed to be reasonable. An Artificial neural networks (ANN) is typically defined by three types of parameters: the interconnection pattern between different layers of neurons, the learning process for updating the weights of the interconnections, the activation function that converts a neuron's weighted input to its output activation. In the problems like handwritten recognition,a neural network is defined by a set of input neurons, activated by the pixels of an input image. After being weighted and transformed by a function, the activations of these neurons are then passed on to other neurons. This process is repeated until an output neuron is activated till the determination of character. Offline handwritten signature recognition is performed with four steps enlisted as follows-

a) Collection of database

b) Image preprocessing

c) Extracting a set of intelligent features

d) Neural network Training

Mostly signatures contain alphabet, letters and special characters.Hence it is quite difficult to identify, so treating the signature as an image. Afteracquiring theimage,different levels of processing is necessitate performing thefeature extraction.Image pre-processing represents a wide range of techniques that exist for the manipulation and modification of the images. Different wavelets transform are performed to extract the set of intelligent features which fed to different neural networks as input.

This paper demonstrated the systematic approach of handwritten signature recognition. The morphological operations are performed on the image so as to extract more features. It helps increating the database by applying global features of different range on the same signature.

2. REVIEW OF LITERATURE
Signature recognition is a complex classification problem which deals with the variation among intrapersonal signatures and interpersonal signatures.

O.C Abikoye, M.A Mabayoje,R. Ajibade [1] using back-propogation network solve this problem by applying Mask, extractingglobal and grid features to trained the Neural Network.The developed system is exhibits 100% success rate by identifying correctly all the signatures. Emre Özgünduz, Tülin Şenturk and M. Elif Karslıgil [2] proposed handwritten signature verification system based on one-against-all support vector machine. This system is tested for 1320 signatures with classification ratio of 0.95. A Moment invariant method proposed by Suhail M. Odeh, Manal Khalil [3] for signature recognition and verification purpose utilized four main features like eccentricity, skewness, kurtosis and orientation. Multi Layer Perceptron neural network structure employed for examination. The system tested on more than 200 samples and obtained 78.8% accuracy rate.H.B. Kekre, V A Bharadi, S Gupta, A A Ambardekar, V B Kulkarni [4] introduced Morphological Pixel Variance Analysis technique for the same problem. In which morphology dilation is applied on signature templates with different structuring elements. Thesystem designedby means of EX-OR template matching

based fuzzy classifier and system reported about 94.94% accuracy.

Vaibhav Shah, Umang Sanghavi, Udit Shah [5] used curve fitting algorithm for recognition. A set of shape based geometric features and the distance based parameters of signature by analyzing the polynomial equation. Niblack algorithm applied to remove the noise from the image.System founded robust for semi-skilled signatures but the performance deteriorates in case of skilled forgeries.Robust method developed by Maya V. Karki, K. Indira, Dr. S. Sethu Selvi [6] extracts 10 global features, grid features and texture feature. These features are used for Neural Network training which verify and recognize the signature image.This system was tested with 400 test signature samples and found FRR less than 0.1, FAR less than 0.2. Another robust method introduced by Dr. S. Adebayo Daramola, Prof. T. Samuel Ibiyemi [7] , a combination of Discrete Cosine Transform (DCT) and Hidden Markov Model (HMM). Success rate 99.2% obtained bymeans of this approach. Baltzakis [8] developed a neural network-based system for the detection of random forgeries. Each signature representedusing global features, grid features, and texture features. For each one of these feature sets, a special two-stage perceptron one-class-one-network (OCON) classification structure utilizes. In the first stage, the classifier combines the decision results of the neural networks and the Euclidean distance obtained by three feature sets. The results of the first stage classifier feed a second-stage radial basis function (RBF) neural network structure, which makes the final decision.

3. EXPERIMENTATION

A database is produced using seven sample signatures.Applyingthe global and morphological operations on the signature, number of evaluation parameter increases for precision. Hence thedatabase of total 1344 signatures is utilized for experimentation. Daubechies wavelet transformation extracts a set of features forneural network input. A Feed forward back Propagation neural network and a Radial Basis Function (RBF) network are used for the examination.

3.1 Compilation of Database

The signature samples were acquired from sevenindividuals. The height/width ratio of the signature is changed by reducing the height of signature. By calculating the number of rows,it is scaled down by 15% and 30%. Area of signature reduces to 10%, 20% 30% of the original signature. Signature area is counted by number of pixels (i.e number of black pixels)which belong to the signature. To reduce the size, black pixels of signature are calculatedby subtracting thewhite portion of the signature from total signature area. Then scale it to a desired percentage.Thesesample signatures thenprocessedby means of image processing tool wherein morphologicaloperations like dilation, erosion and some global operation carried out at different ranges.Single operation of Dilationand twice operation of erosion is utilized on the signature sample.Dilation operator adds the pixelson the boundary of signature whereasin the erosion the boundary pixels are deleted. The results of the application of morphological operations and rotation are shown in shown in fig 1.

amber_0_0_dilate_1_0

amber_0_0_dilate_2_45

amber_0_0_erode_3_0

amber_30_0_dilate_1_0

amber_30_20_erode_3_0

amber_15_20_dilate_2_45

Fig 1: sample Signature images

In the above signature figures: First parameter indicates height/weight ratio; Second Parameter indicates Area; Third parameter indicates Dilation/Erode factor; Fourth parameter indicates angle of rotation. In this way, from single signature 192 signature samples are obtainedby combining all parameters considering the different ranges.A database of total 1344number of signatures samples is created. The samples are further employedfor training (1050 samples) and (294 samples)testing purpose.

3.2 Preprocessing

Image preprocessing represents a wide range of techniques that exist for the manipulation and modification of images pixels.Preprocessing step is applied on both training and testing phase. First the Signaturesare converted into grayscale and then converted into binary format. In this paper, resizing and cropping of signature are performed. To remove the unwanted area cropping must performed and then resize the signature in particular format. The purpose in this phase is to make signatures standard and ready for feature extraction.

3.3 Wavelet Transform

Wavelets are functions that satisfy certain mathematical requirements and are used to train the networks. Wavelet decomposition provides local information in both space and frequency domain. Despite of equal sub-band sizes, different sub-bands carry different amounts of information.The letter ‘L’ stands for low frequency and the letter ‘H’ stands for high frequency. The low frequency band contains the overall information about the whole image therefore low frequency band is considered for further processing In the proposed system, one dimension decomposition is performed. Here eight level Daubechies wavelet transform is performed for extracting a set of intelligent features which is used as input for different neural networks.Wavelet Transform is recursively applied to all the images in the training data set until the lowest frequency sub-band is of size 34×34 pixels is reached which fed to Neural Network.

4. NEURAL NETWORK

Interconnecting artificial neurons i.e. neural networks are a very precise and efficient technique for pattern recognition purpose. From the literature review, two best suitable techniques are adopted for the signature recognition problem.Feed forward back propagation and Radial basis neural network are employed foranalysis. Finally, confirm the results of both the methods.

4.1 Feed forward back propagation

The generalizedthree layersstructure of Feed Forward back Propagation network is shown in Fig.2.

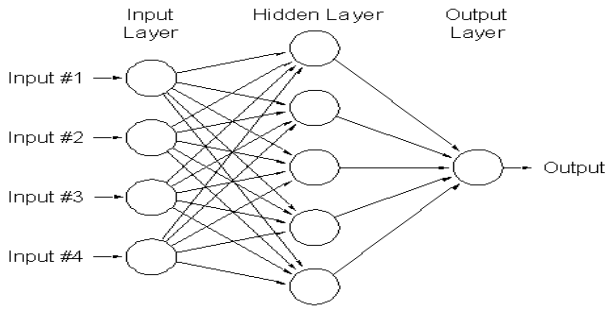

Fig-2: Feed-forward Back Propagation Neural Network

The function of Input layer is to holds the input for the network, second is hidden layer which serve as a propagation point for sending data from the previous layer to the next layer, whereas output layer holds the output data, usually an identifier for the input. In this network, inputs are propagated forward direction and compute the outputs for each output node. Then, each of these outputs is subtracted from its desired output, causing an error. In the second phase, each of these output errors is passed backward and the weights are fixed. These two segments are continued until the sum of square of output errors reaches an acceptable value. The created database divides in two parts, to perform the training and testing of the network. Three layered feed forward back propagation (FFBP) network is created whichhas two hidden layers along with input/output layer. The network structureis shown in Fig-3.

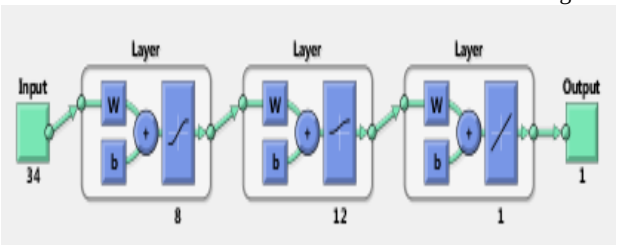

Fig-3: Neural Network Diagram

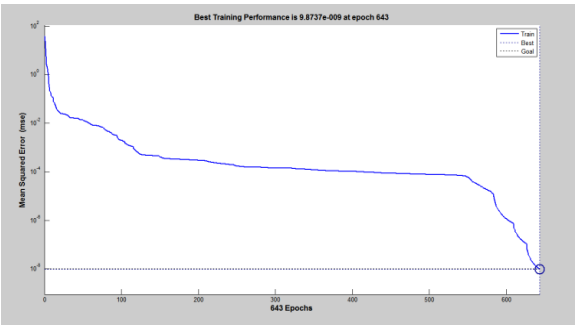

Fig-4: Network performance

The above Figure shows experimental result for feed forward back propagation neural network. The network performance test with the mean of squared errors (MSE) which has clearly shows the significant changes during training,error decreases gradually as shown in Fig-4.The minimum error observed after 643 epochs. Several architectures of Neural Networks with different learning rates are tested for comparisons. Back propagation with conjugate gradient learning seemed to be the best choice for signature recognition.

4.2 Radial basis Function

Neural network with Radial basis function is trained with the same set of extracted features database. Three layered RBF network which includes input layer, hidden layer and output layer are utilized.The networkperformancein terms ofminimum mean of squared errors (MSE) observedat 960 epochs and same is shown inFig-5.

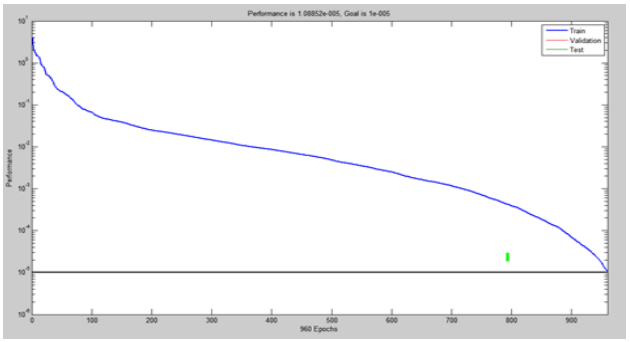

Fig-5: Network performance

Table 1: Assessment of Networks

Neural Network	Neurons required	Epochs	Time requisite for training	Accuracy
Feedforward back propagation	21	643	Less	97.61 %
Radial Basis Function	970	960	More	65.98

5. CONCLUSION

A database with changing the parameters of signature such as area, height/width ratio, and angle of signature found useful inoffline Signature recognition system. However,extraction of more features by morphological operations andwavelet transformadded preciseness of the system. From the experimental results,it is observed that feedforward back propagation method necessitated less number of neuron, superior accuracy and less computation time.Therefore, this method is found functional for signature recognition problem.

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