



Handwritten Character Recognition Using Artificial Neural Network (ANN)

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ABSTRACT Artificial Neural Network has the ability to solve complex problem in this modern computing world. Image Processing with Artificial Neural Network (ANN) has found its application in identification and analysis of medical images, fingerprints, human images, speech recognition and in handwritten character recognition. In this paper Image processing with artificial neural network is used to recognition the offline handwritten characters. In offline character recognition, processing of various steps in series are carried out, such as pre-processing, feature extraction & finally classification using artificial neural network. In preprocessing we reduce the noise and increase the quality of the image and next we go for feature extraction. In extracting the feature we use novel method, bi-orthogonal wavelet function. The feature estimated using bi-orthogonal wavelet is saved for the each image in the training set. Features saved are given as input to the Back Propagation Artificial Neural Network during training phase. It produces the output accurately based on the trained images during testing phase. The method is used to recognize all the 24 English characters effectively.

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1. Introduction

Handwritten character recognition is of two types, online and offline. Online Handwritten character recognition, which are written on a tablet PC, digitizer, PDA and in smart phones in which a sensor picks up the strokes of pen tip movement and recognition rate has reached 100%. Offline Handwritten character recognition is done with the handwritten scanned document. It is one of the active research area in which accuracy has not been reached [1-7]. The main objective of offline handwritten character recognition algorithm is to increase the recognition rate and to convert the handwritten characters to machine editable characters.

Artificial Neural Network can perform as human mind and explore ideas based on the trained data set. Handwritten characters differ in shape, style and in size from person to person and the scanned image may be noisy. Artificial neural network is able to deal with the noisy image and match the characters based on saved features.

Handwritten character recognition is not a single process, the first step is Preprocessing, second is feature extraction and finally classification using neural network.

Loci Feature extraction method calculates in four directions such as in horizontal, vertical and in 45/135 degree which uses principle component analysis(PCA) that transforms number of possible correlated values[5].

Star layered Histogram, direction and diagonal based features recognize only some characters like o, d etc., and had bad result for characters like r, q etc.,[6-8].Feature extraction using Discrete Fourier Transform has the function of continuous variables corresponding to frequency samples spaced equally and Discrete Wavelet function has more advantages over Fourier transform functions [1,9].

Classification is done using back propagation algorithm has designed with ability to recognize the characters in high rate and can reach the goal with increased performance and error rate is decreased [10-13].

2. Design of Proposed System

System consists of three modules as in Figure 1 such as preprocessing, feature extraction using bi-orthogonal wavelet and character recognition using back propagation neural network algorithm.

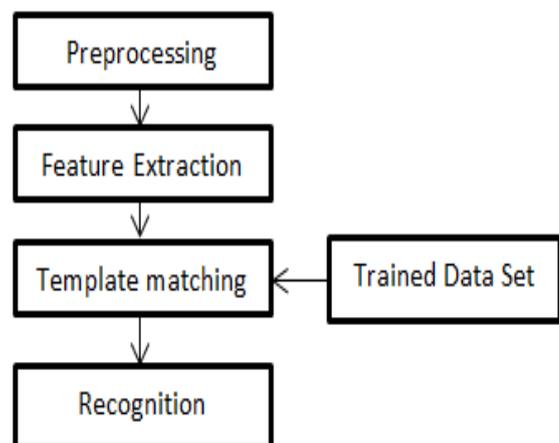


Fig. 1 Handwritten Character Recognition Block Diagram

2.1 Image Acquisition and Pre-Processing

Scanned image is given as input should have specific format like jpeg, bmp, etc. The image is obtained from digital camera, scanner or other digital device.

In pre-processing it has series of functions such as

- i. Image resized to 100 by 100 pixel.
- ii. RGB to gray conversion of resized image.
- iii. Based on the threshold the gray image is binarization.
- iv. Finally binarized image undergo thinning, edge detection and dilation based on morphological operations.

2.2 Feature Extraction

Most critical part in recognition of characters is feature extraction. Proposed feature extraction method is done using bi-orthogonal wavelet function. Bi-orthogonal wavelet is associated with wavelet transform. Designing bi-orthogonal wavelets allows more degrees of freedom compare to orthogonal wavelets and there are two scaling functions which may generate different multi-resolution analyses, and accordingly generate two different wavelet functions.

At each level, the image is decomposed into high and low frequency image, and thus the decomposition halves the resolution. Since half the number of samples are retained to characterize the entire signal. The algorithm retains even indexed rows respectively columns. Two dimensional discrete wavelet transform leads to a decomposition of approximation coefficients in four components: the approximation at first orientation and the details in three orientations such as horizontal, vertical, and diagonal. The feature estimated from bi-orthogonal wavelet is saved for the each image in the training set.

2.3 Recognition using Neural Network

In this work we chose Back Propagation Neural Network classifier. In real time to use neural network effectively the number of classes to be minimized and the structure should be simple. The system use 'trainrp' network training function that updates weight and bias values according based on resilient back propagation algorithm (Rprop). Neural Network Training stops when maximum number of epochs (13000) is reached. After training the network the input image is recognized

3. Results and Discussions

Simulation is done using matlab. Preprocessing and feature extraction is done in image processing, character recognition is done with back propagation neural network.

For example considering Hand written character h and preprocessed output is shown in Figure 2 and feature extracted image using bi-orthogonal wavelet is shown in Figure 3.

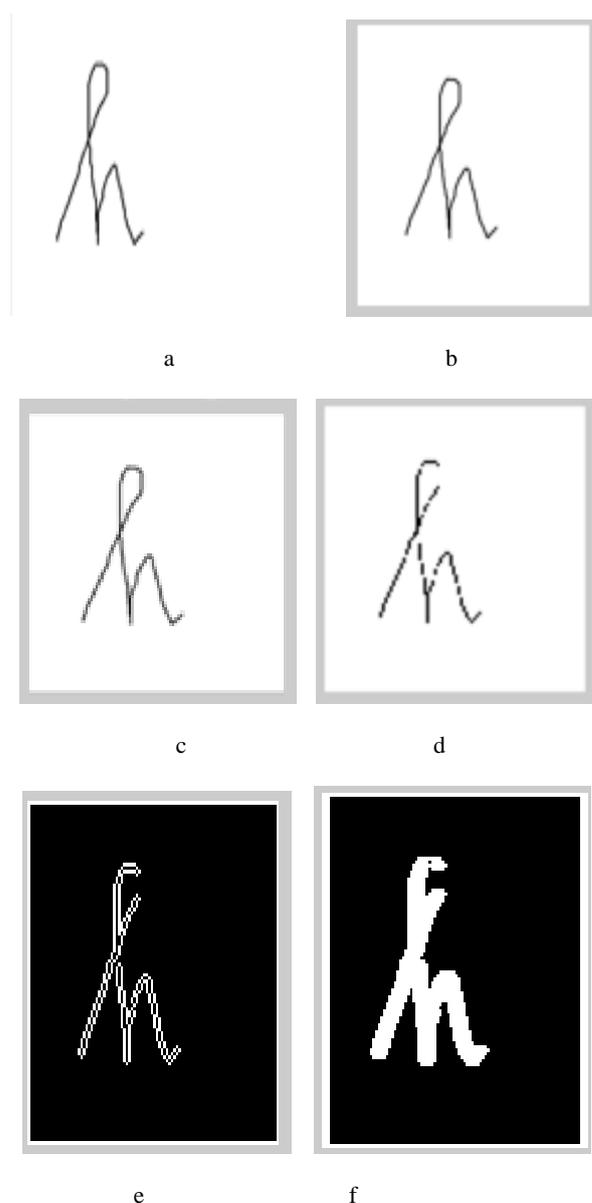


Fig. 2 Preprocessing Result: a. Input Image, b. Resized Image, c. Gray image, d. Binary image, e. Thinning and Edge detected image, f. Dilated image

For training purpose character samples of different handwriting styles are taken and trained the network.

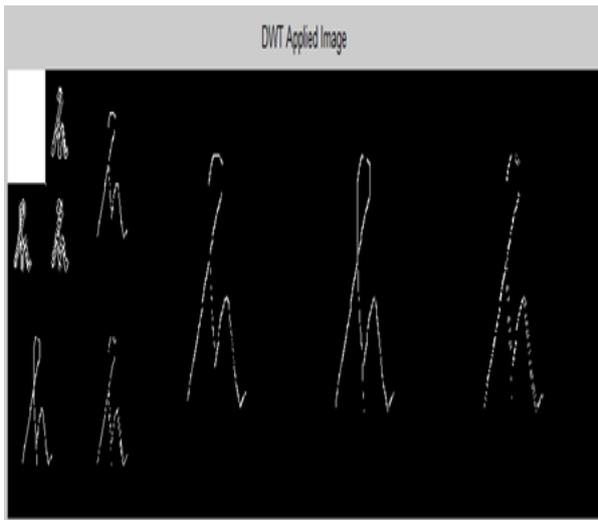


Fig. 3 Bi-orthogonal wavelet applied image

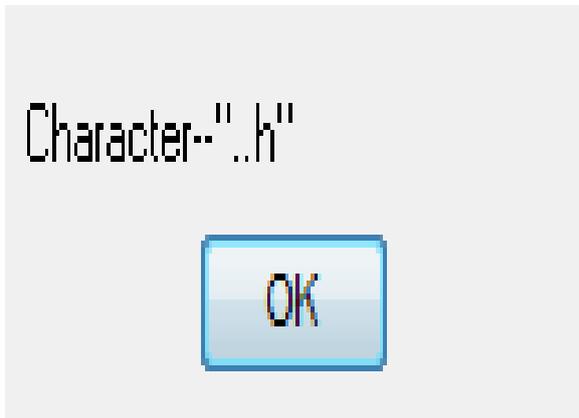


Fig. 4 Recognized Character

Selected character 'h' recognised image is shown in Figure 4. 13000 epochs are done to achieve the goal performance and performance plot is shown in Figure 5. Mean square error is decreased when epochs increased.

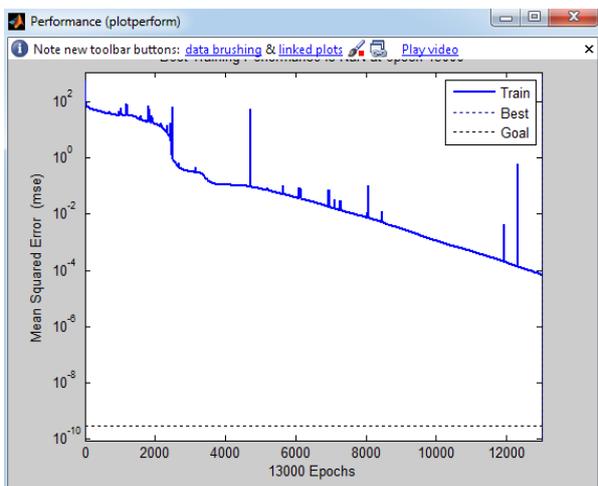


Fig. 5 Performance Plot

4. Conclusion and Future Work

Recognition of characters depends on the nature of the data trained. For feature extraction Bi-orthogonal wavelet is used and the back propagation neural network for that has reached 98% in recognizing characters.

The character set used for training here is less and thus by increasing the training set recognition is also increased. Work for the character recognition is done successfully and in future it can be extended for recognition of words and sentences.

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