

# Optimized Handwritten Character Recognition Using Artificial Neural Network

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**Abstract:** Handwritten character recognition (HCR) plays important role in the modern world and is one of the focused area of research in the field of image processing and pattern recognition. Handwritten character recognition refers to the process of conversion of hand-written character into printed/word file character which can immensely improve the interface between man and machine in numerous application. It is difficult to process with great variations in writing styles, different size and orientation angle of the character that are existing. Also segmentation of cursive handwritten text is difficult as the edges can't be detected easily. There are numerous approaches to recognize handwritten data. The images are acquired using a digital camera or scanner and stored in standard format like JPG, PNG etc. The second stages include pre-processing techniques like Binarization, Skeletonization, thinning, resizing the image and segmentation. In our work we mainly concentrated on extracting statistical features of alphabets like mean, variance, standard deviation, Skewness and kurtosis, which differentiates a character from another. We used feed forward algorithm to train Artificial Neural Network (ANN). The features of input character after pre-processing are fed into ANN. A database of 650 samples is created to test input samples for recognition of character by neural net-work. The Experimental results that we have achieved show 88.46 % accuracy rate with minimum time taken for training.

**Index Terms:** character recognition, image processing, pattern recognition, segmentation, Artificial Neural Network, Binarization, Skeletonization, Skewness, kurtosis.

## 1 INTRODUCTION

Handwritten character recognition is one of the challenging area in the pattern recognition. It is useful in a wide range of application which includes mailing address, bank check documentation, signature verification etc. Offline and online character recognition are the two approaches of the pattern recognition. In this paper we work on offline character recognition technique using artificial neural network. Offline character recognition is more difficult compare with the on line character recognition because different peoples will have different handwriting styles. Handwritten character recognition is done in three stages.

- Pre-processing and Segmentation process
- Feature Extraction
- Neural Network

The task of the pre-processing is to remove the noise from the input image and to increase the quality of the image. The processed image is been segmented to each characters and then calculate its some features which is feeds as the input of the artificial neural network. Neural network is composed of elements operating parallel to each other. The features that are extracted from each character is created as an input vector that are trained so that a particular input leads to the specific target output. We can train the neural network by performing some particular functions in order to adjust the values of the weights between elements. Off-line character recognition continues to be the active area in the research field in order to increase the accuracy to recognize the characters.

## 2 LITERATURE SURVEY

Sanjay Kumar et al [1], proposed work on offline hand written character recognition mainly to recognize doctors hand writing using neural network and to match the most probable prescribed medicine. In the whole process OCR algorithm will guess the character and store them. It concluded that it only guess can be done on doctors handwriting but exact words can't be detected. Mansi Shah et al [3], has done a literature survey on handwritten character recognition and compared OCR and HCR. They have also provided a clear study on existing methods to recognize handwritten characters. It concluded stating that neural network is the prime choice for training and it is not possible to design a fully automated that can recognize all handwriting styles. Manoj Sonkusare et al [4], presented a survey on handwritten character recognition techniques for English alphabets. In their paper they have discussed global skew correction technique which corrects the text line to be horizontally aligned while scanning the image. Also slant correction is done in the pre-processing stage which adjusts the inclination of writing style. They have concluded stating that much more work has to be done in the area of HCR to build up a practical solution that is accessible to everyone. Nisha Sharma et al [11], presented their review on recognition of handwritten English letters and mentioned various approaches towards handwritten character recognition and their performances. Also different feature extraction methods have been compared and the best stood out to be is Fourier descriptor with magnitude and phase with 98% efficiency and uses SVM classifier. They concluded stating even though various methods exist a much more research have to be done in this area to come up with a complete software solution. J. Pradeep et al [2], presented their work in offline handwritten alphabetical character recognition using multilayer feed forward network and a new feature extraction method called diagonal based feature extraction is used. The images that contain the handwritten data are first kept in standard format like JPG, PNG etc. In this paper feed forward back propagation neural network with 54-100-100-38 architecture is performed for classification. Log sigmoid activation function is been used by the hidden layers and the output layer is a competitive layer. The Experimental results

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show that highest recognition accuracy of 97.8% is obtained 54 features diagonal method and an accuracy of 98.5% for 69 features diagonal method. Abdulloh Al Mubarak and Hertog Nugroho [8] have worked on handwritten character recognition using hierarchical graph matching. Here handwritten alphabets are transformed into graphs based on their underlying skeleton structure. CEDAR dataset is been used for training purpose, which consists 5632 city words, 4938 state words and 9454 zip codes. Also CEDAR dataset has unrestricted writing style, implementation method and writer. The accuracy rate of the proposed methodology was found to be 93.40% and false recognition causes were similar looks, forced recognition result and pre-processing deformation.

Suman Avdhesh Yadav et al [5], proposed a robust approach for offline English character recognition and have made a data base of 2600 samples collected from 100 writers for each character. Neural network is been trained with 1041 samples and the remaining are tested with recognition model. They have used feed forward neural network algorithm. TRAINING ROUTINE algorithm is been implemented after the network is with corresponding symbol and error back propagate error across link is computed. They have got a good recognition rate of 86.74% using the above mentioned work. A.George and V.J. Pillai [12] proposed their work on VNPR system using artificial neural network. They created a database of 40 images of different vehicle number plates. Otsus method of thresholding which maximises the inter class variance between the pixel was implemented to convert grey-scale image to binary image. A new concept probabilistic neural network has been discussed in this paper. They have trained 100 characters to create a database and have attained a total accuracy of 91% using this algorithm. Their future work included increasing database for better results.



Fig. 1 Input image in JPG format

### 3 PROPOSED METHOD

1. **Image Acquisition:** In an image acquisition, the require Image has to be scanned using the cam-scanner. Those images should have a specific format such as Jpg, bnp etc.

2. **Preprocessing:** The preprocessing is an initial operation to perform on the input image. The pre-processing techniques may enhance the input image and prepare it for a next stage in a character recognition system. The various task perform on the input image in pre-processing stage are

- Grayscale** :- It is a process of convert color image RGB to the gray scale intensity image.
- Binarization** :- It is a process of converting a gray scale image into the binary image by thresholding.
- Noise Removal** :- Noise can be random or salt and pepper noise introduced by the device mechanism. There are various methods in order to reduce the noise from an image.

- Edge Detection** :- It is used for finding the boundaries within images. Morphological gradient operators are used in edge detection because they enhance the intensity of edges of a character.
- Skeletonization** :- It is a process of reducing all lines to a one single pixel thickness which reduces the memory space and to store the information of the input characters and it also reduces the processing time.

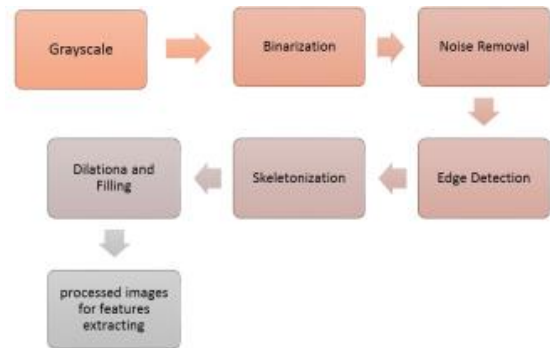


Fig. 2. Skeltonised Image

3. **Segmentation:** The sequence/series of characters in an image is divided into the individual set of characters. The processed image is divided into line and character segmentation.

- Line Segmentation:** - Each line is been segmented with a weight based algorithm for easy processing purpose. The major challenges encountered in text line segmentation of handwritten character recognition are: (i) Each text line may have a different skew angle and (ii) part of the neighboring text line may be connected.
- Character Segmentation:** - After separating each line, now we need to segment each character. The character segmentation is a major step, as the accuracy of characters is based on how the characters are segmented. There are various methods are used for character segmentation but in these we proposed our own algorithm for segmenting each characters, so that the accuracy to recognize these characters are its easily trained in artificial neural network.

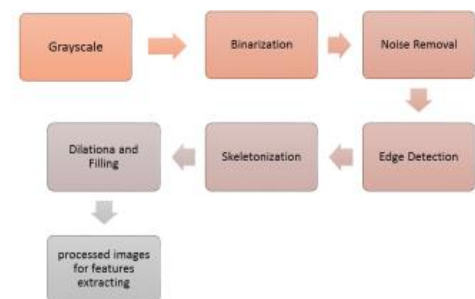


Fig.3 Various steps involved in our method.



Fig. 4. Line wise segmentation



Fig. 5. Segmenting each character

#### 4. Feature Extraction

Features extraction aims to extract the information of each character. The extracted features are to form in a vector and then used to recognize the input and the target output unit. These features are allowed to distinguish each character which becomes its identity. Some of the features used in this are as follow

- (a) **Mean**:-It gives the contribution of the individual pixel for the entire image.

$$Mean = \frac{Sum(image(:))}{(r*c)}$$

- (b) **Standard Deviation**: - It indicates how the pixel varies from the neighboring pixel and is used to classify into different region.

$$TotalDiff = (image - mean)^2$$

$$Totalsum = sum(Totaldiff(:))$$

$$Nelement = (r \times c) - 1$$

$$Totalvar = \frac{Totalsum}{(Nelement)}$$

$$Totalstd = \sqrt{(Totalvar)}$$

- (c) **Column Variability**:- It computes the difference between pixel values of the columns.
- (d) **Row Variability**: - It computes the difference between pixel values of the row.
- (e) **Kurtosis**:-It is used to check whether the data are peaked or flat relative to the normal distribution. Negative kurtosis indicates the thin tale data distribution. Positive kurtosis indicates the flat tailed data distribution.
- (f) **Skewness**:-It measures the asymmetry of data around the sample mean. If the data distribution in the left hand side is equal to the right hand side then it is a normal distribution.
- (g) **Median**:-The median is the mainly used to calculate the average pixel value of an image.

5. **Artificial Neural Network (ANN)**: ANN is a computational model and perform functions similar to that of biological neural networks. They are typically organized in layers and the layers are made up of interconnected nodes, which contain an activation function. In the proposed algorithm a database of 650 samples were created for testing purpose. We used single layer feed forward network algorithm for training ANN with architecture 108-39-26-26 to perform the classification. Logistic sigmoid

function is used in the hidden layers. In general sigmoid functions are used to compress the outputs out of neurons and to introduce nonlinearity. A reason for its popularity in neural networks is because the sigmoid function satisfies a property between the derivative and itself such that it is computationally easy to perform. An activation function is used to transform the activation level of neuron to output signal.

The network parameters are as follows:

- Input nodes: 108
- Hidden nodes: 39 each
- Output nodes: 26 (26 alphabets)
- Training algorithm: Scaled conjugate gradient training.
- Perform function: Mean Square Error
- Training goal achieved: 0.000001
- Training epochs: 1000
- Validation performance: 0.25013 at epoch 92.

The input character is first pre-processed using above mentioned techniques and the required features are extracted. All these features are fed into ANN and this input matrix is compared with target matrix. Target matrix contains the samples created for testing purpose. Later the required changes are made and the output matrix finally recognizes and prints the output.

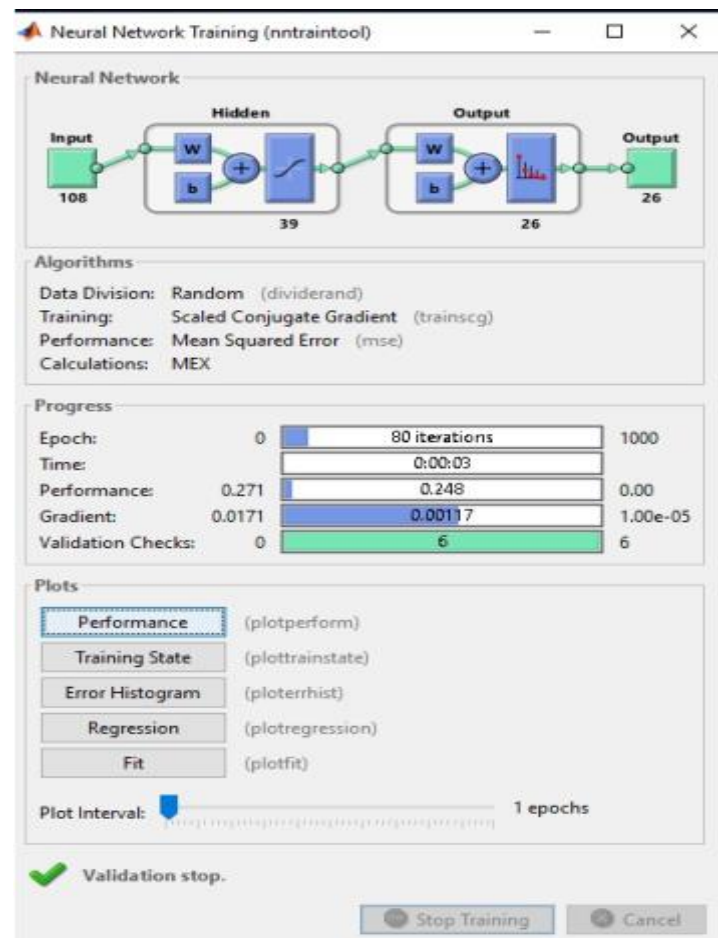


Fig. 6. Training session of ANN

## 4 RESULTS AND CONCLUSION

The Experimental results that we have achieved showed an accuracy rate of 88.46% for minimum training time. The training goal is achieved at 0.000001 and the validation performance is observed to be 0.25013 at epoch 92. The features that we have extracted for training ANN haven't been sufficient to recognize some alphabet pairs like B and E, Y and V. Much more detailed features have to be extracted in order to get the best accuracy rate. The offline handwritten character recognition is depending on the material that has to be read by its quality. Current research is not only entanglement with the characters but also with words and phrases and even the complete document. Our proposed algorithm in order to recognize the offline handwritten English characters produces a satisfactory result. As scrutinize to other handwritten techniques, our proposed algorithm takes lesser training time. In addition our algorithm is easier to implement.

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