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Handwritten Character Recognition: Training a Simple NN for Classification Using MATLAB

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Abstract: ***In this paper, we identify handwritten characters with the use of neural networks. We have to construct suitable neural network and train it properly. The program is able to extract the characters one by one and map the target output for training purpose. After automatic processing of the image, the training dataset has to be used to train for recognition purpose. The proposed method is based on the use of feed forward back propagation method to classify the characters. The ANN is trained using the Back Propagation algorithm. In the proposed system, numerical digits and alphabets are represented that are used as input then they are fed to an ANN. Neural network followed by the Back Propagation Algorithm which compromises Training. The program code is written in MATLAB and supported with the usage of Graphical User Interface (GUI).***

Keywords: Neural network, back propagation method, image processing toolbox, MATLAB

1. Introduction

Handwriting recognition is the ability of a computer to receive and interpret intelligible handwritten input from sources such as paper documents, photographs, touch-screens and other devices. The image of the written text may be sensed "off line" from a piece of paper by optical scanning (optical character recognition) or intelligent word recognition. Alternatively, the movements of the pen tip may be sensed "on line", for example by a pen-based computer screen surface, a generally easier task as there are more clues available.

Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network Function is determined largely by the connections between elements. We can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. Commonly neural networks are adjusted, or trained, so that a particular input leads to a specific target output. Such a situation is shown below. There, the Network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically many such input/target pairs are used, in this supervised learning, to train a network.

2. History

Early optical character recognition could be traced to activity around two issues: expanding telegraphy and creating reading devices for the blind. In 1914, Emanuel Goldberg developed a machine that read characters and converted them into standard telegraph code. Around the same time, Edmund Fournier d'Albe developed the Optophone, a handheld scanner that when moved across a printed page, produced tones that corresponded to specific letters or characters. Goldberg continued to develop OCR technology for data entry. Later, he proposed photographing data records and then, using photocells, matching the photos against a template containing the desired identification pattern. Paul W. Handel also obtained a US patent on such template matching OCR technology in USA in 1933. In 1949 RCA engineers worked on the first primitive computer-type OCR to help blind people for the US Veterans Administration It converted the typewritten reports into punched cards for input into the computer in the magazine's subscription department, for help in processing the shipment of 15-20 million books a year. In about 1965, Reader's Digest and RCA collaborated to build an OCR Document reader designed in 1965.

3. Stage 1

The first phase in our character recognition process is converting the image to Binary image by thresholding the given character image. Two intensity values are available in binary image. These values are Black and White. We are use zero for Black and one for white. With conversion to binary image and then processing it further to edge detection and object location.

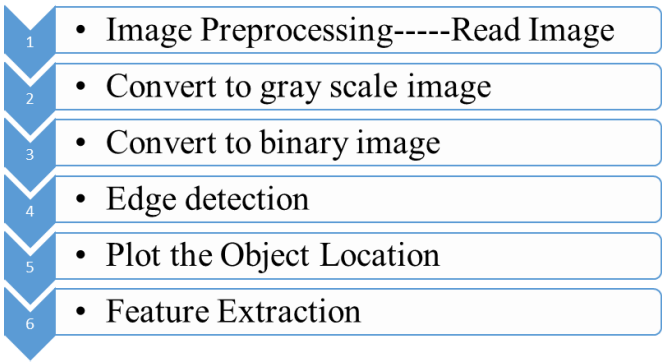

Figure 1: Data Flow

3.1 Input Image

Before Character Recognition can be used the source material must be scanned using an optical scanner to read in the page as a bitmap. The character recognition software then processes these scans to differentiate between images and text and determine what letters are represented in the light and dark areas.

- This cell of codes read the image to MATLAB workspace

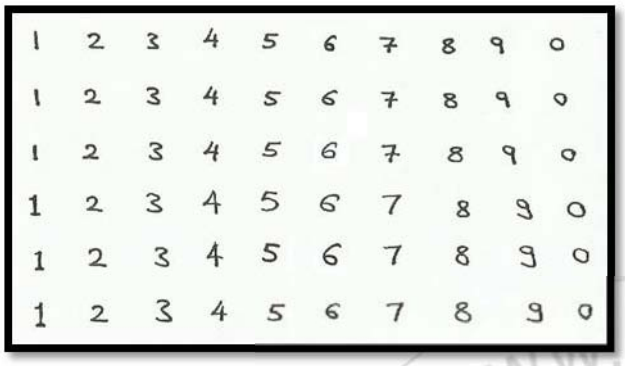

Figure 2: Handwritten Characters

- Conversion to gray scale image from RGB image format.

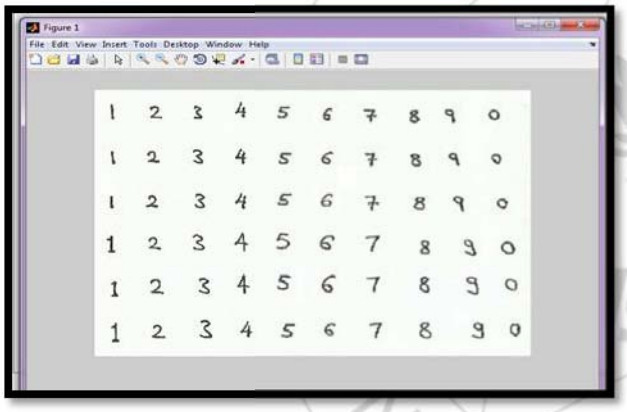

Figure 3: Gray scale converted characters

- Conversion to binary image, from gray scale format

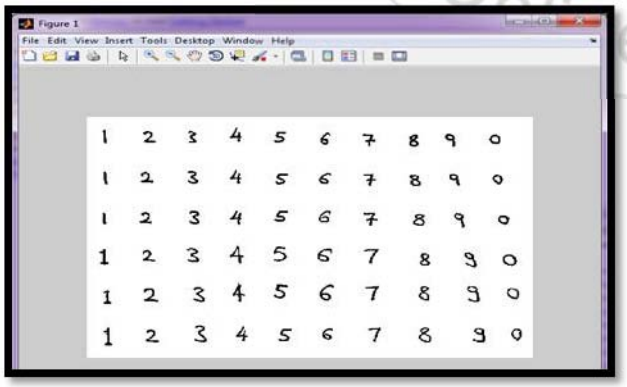

Figure 3: Binary conversion of characters

3.2 Binarization

Next step is binarization of gray-scale character images in offline character recognition. Binarization process converts a gray scale image into a binary image by using the fact that characters are usually composed of thin lines of uniform width. Good binarization facilitates segmentation and recognition of characters. Experimental results show that these methods give the best binarization results.

3.3 Edge Detection

Edges characterize object boundaries and are therefore useful for segmentation, registration, and identification of objects. Edge detection of an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. However, the majority of different methods may be grouped into two categories, gradient and Laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The Laplacian method which is being used in this test searches for zero crossings in the second derivative of the image to find edges

3.4 Object Location

Select a single number from the TEST image and the program identifies the number. If selecting more than one number, the program will identify a wrong one, so you must select a single number.

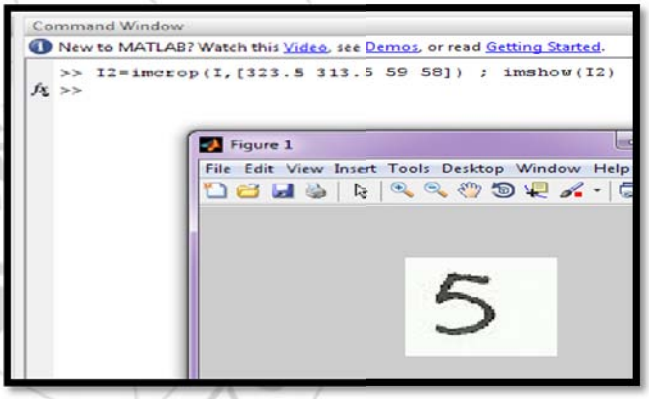

Figure 4: Object location in MATLAB

3.5 Feature Extraction

The next part is the feature extraction in which handwritten numbers must be cropped individually and converted to 7x5 bitmap images then (35x1) to be in the form of the ideal numbers for the training process of the NN i.e reshaping the image. Feature extraction is the process to retrieve the most important data from the raw data. The major role of feature extraction is to extract a set of features, which maximizes the recognition rate with the least amount of elements. In feature extraction stage each character is represented as a feature vector, which becomes its identity. Due to the nature of handwriting with its high degree of variability and imprecision obtaining these features, is a difficult task. Feature extraction methods are based on 3 types of features- Statistical, Structural, Global transformations and moments. Structural and statistical features appear to be complementary in that they highlight different properties of the characters.

4. Stage 2

1. Creating Vectors data for the Neural Network (objects)
2. Creating and training of the Neural Network
3. Testing the Neural Network
4. Encoding/Decoding
5. Graphical User Interface

Figure 5: Stage 2 Data Flow

In this system the Neural Network is trained for different handwritten numbers (every number is written 18 times in different forms to train the NN to identify any single number in different forms. An Artificial Neural Network as the backend is used for performing classification and Recognition tasks. In offline character recognition systems, the Neural Network has emerged as the fast and reliable tools for classification towards achieving high recognition. Neural network architectures can be classified into two major sets specifically; feed-forward and feedback (recurrent) networks and the majority common ANN used in the CR systems are the multilayer perceptron of the feed forward networks. In this we use feed- forward neural network, nodes are organized into layers; each "stacked" on one another. The neural network consists of an input layer of nodes, one or more hidden layers, and an output layer. Each node in the layer has one corresponding node in the next layer, thus creating the stacking effect. Back propagation is a learning rule for the training of multi-layer feed-forward neural network. Back propagation derives its name from the technique of propagating the error in the network backward from the output layer. To train a Back propagation neural network, it must be exposed to a training data set and the answers or correct interpretations of the set .Because of the nature of the problem, we used feed forward back propagation neural network for classification i.e multi layer perceptron (MLP).MLP structure with two hidden layers neurons and sigmoid, linear activation function.

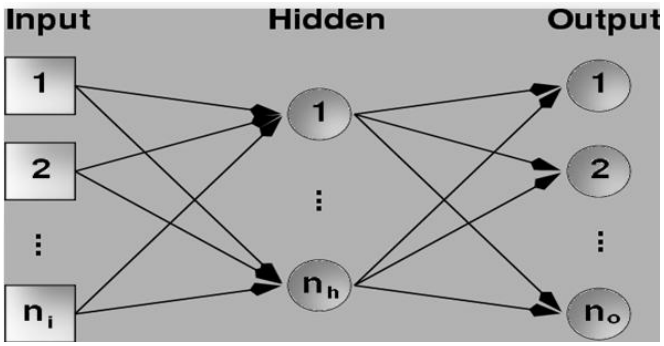

Figure 6: NN layers

For encoding and decoding we use/train the net with ten different signs (characters). The encoding is made with simple code table, in which every index gets a new value.

5. Results

5.1 Neural Network Training

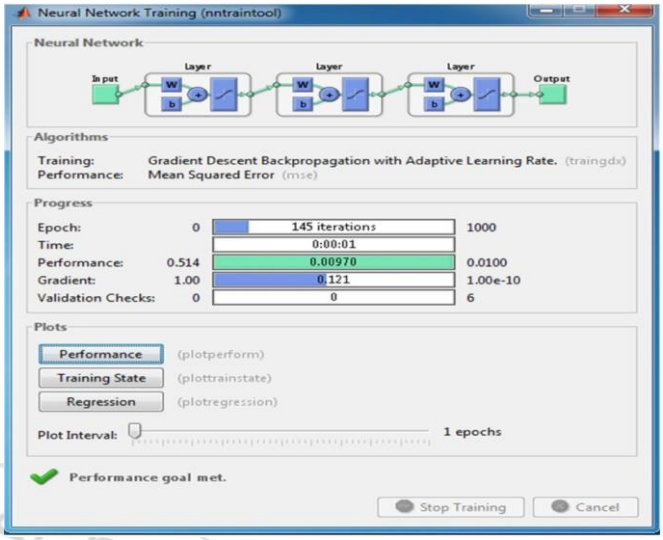

Figure 7: Neural Network Training

5.2 Performance Training

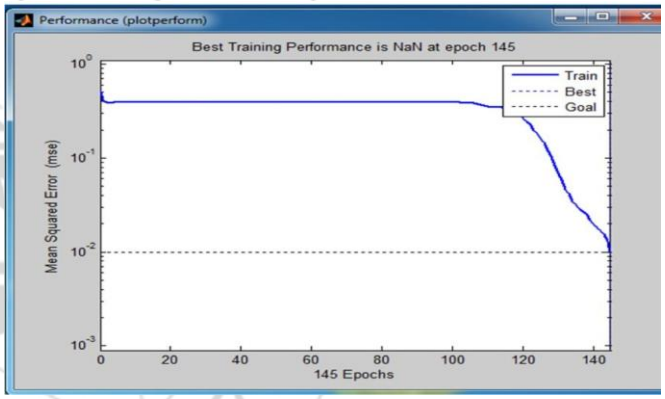

Figure 8: Performance Training

5.3 Object Location

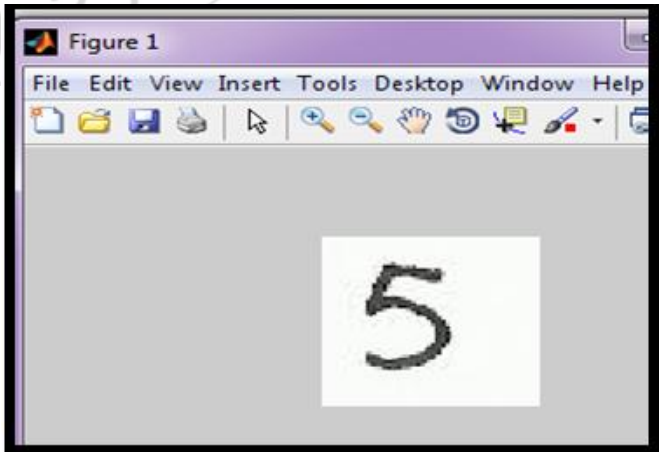

Figure 9: Object Location

5.4 GUI

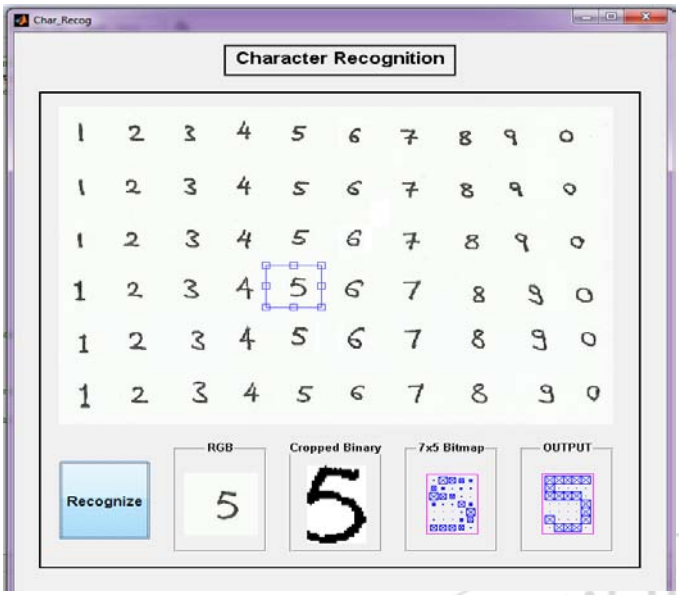

Figure 10: Recognized Characters (Number)

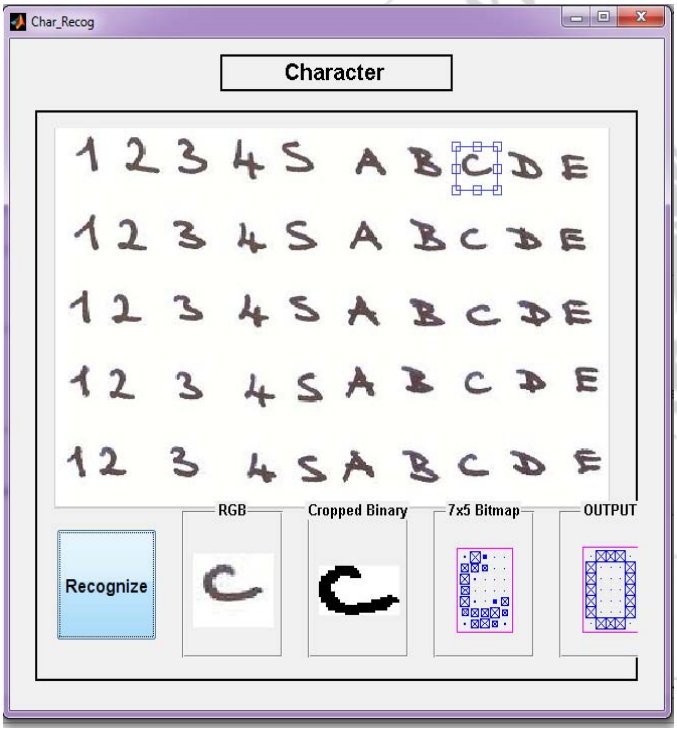

Figure 10: Recognized Character (Alphabet)

6. Conclusion

This Neural network method gives the accuracy of 85 %.The paper provides a useful method for the recognition of handwritten characters to a great extent. The proposed method has been applied on different unknown characters. It is hoped that this insight will be beneficial into various concepts involved, and boost further advances in the area. The accuracy of recognition is depending on the nature of the material to be read and its quality. This project establishes a system that converts scanned images of handwritten characters to text documents.

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