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HANDWRITTEN CHARACTER RECOGNITION USING ARTIFICIAL NEURAL NETWORK

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Abstract: Handwriting recognition is the ability of a machine to receive and interpret handwritten input from multiple sources like paper documents, photographs, touch screen devices etc. Recognition of handwritten and machine characters is an emerging area of research and finds extensive applications in banks, offices and industries. The main aim of this seminar is to design expert system for, "Handwritten Character Recognition using Neural Network", that can effectively recognize a particular character of type format using the Artificial Neural Network approach. Neural computing Is comparatively new field, and design components are therefore less well specified than those of other architectures. Neural computers implement data parallelism. Neural computers are operated in way which is completely different from the operation of normal computers. Neural computers are trained (not Programmed) so that given a certain starting state (data input); they either classify the input data into one of the number of classes or cause the original data to evolve in such a way that a certain desirable property is optimized.

Keywords: Artificial Neural Network; Handwritten Recognition; Image Processing; Feature Extraction.

I. INTRODUCTION

The purpose of this project is to take handwritten English characters as input, process the character, train the neural network algorithm, to recognize the pattern and modify the character to a beautified version of the input. This project is aimed at developing software which will be helpful in recognizing characters of English language. This project is restricted to English characters only. It can be further developed to recognize the characters of different languages. It engulfs the concept of neural network.

One of the primaries means by which computers are endowed with humanlike abilities is through the use of a neural network. Neural networks are particularly useful for solving problems that cannot be expressed as a series of steps, such as recognizing patterns, classifying them into groups, series prediction and data mining.

Pattern recognition is perhaps the most common use of neural networks. The neural network is presented with a target vector and also a vector which contains the pattern information, this could be an image and hand written data. The neural network then attempts to determine if the input data matches a pattern that the neural network has memorized.

A neural network trained for classification is designed to take input samples and classify them into groups. These groups may be fuzzy, without clearly defined boundaries. This project concerns detecting free handwritten characters.

II. DESIGN

Block Diagram and Algorithm

The proposed methodology uses some techniques to remove the background noise, and features extraction to detect and classify the handwritten text.

The proposed method comprises of 4 phases:

1. Pre-processing.
2. Segmentation.
3. Feature Extraction.
4. Classification and Recognition.

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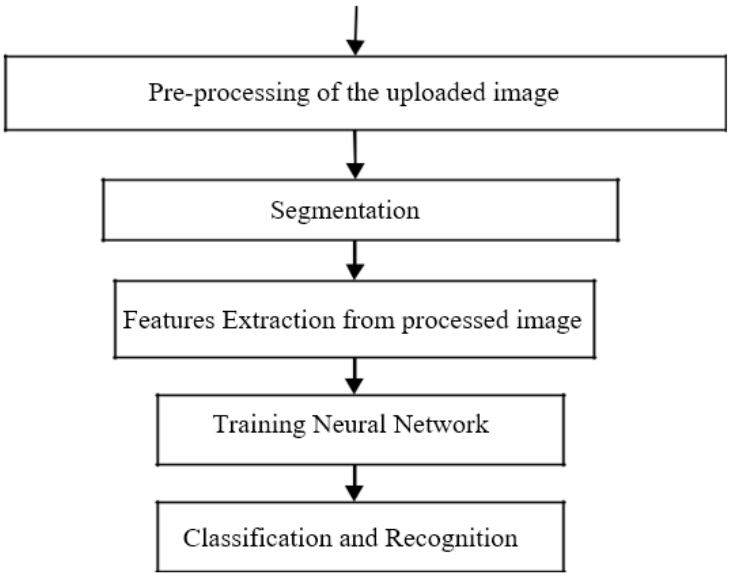

Figure 1: Block diagram of proposed method

1. Pre-processing

The pre-processing is a series of operations performed on scanned input image. It essentially enhances the image rendering it suitable for segmentation. The role of pre-processing is to segment the interesting pattern from the background. Generally, noise filtering, smoothing and normalization should be done in this step. The pre-processing also defines a compact representation of the pattern. Binarization process converts a Gray scale image into a binary image. Dilation of edges in the binarized image is done using sobel technique.

2. Segmentation

In the segmentation stage, an image of sequence of characters is decomposed into sub-images of individual character. The pre-processed input image is segmented into isolated characters by assigning a number to each character using a labelling process. This labelling provides information about number of characters in the image. Each individual character is uniformly resized into pixels. Normalization: After extracting the character we need to normalize the size of the characters. There are large variations in the sizes of each Character hence we need a method to normalize the size.

3. Feature Extraction

There are two techniques employed based on the efficiencies obtained, while training the neural network. They are as follows

- Feature Extraction based on Character Geometry.
- Feature Extraction Using Gradient Features.

Feature Extraction Based on Character Geometry.

It extracts different line types that form a particular character. It also concentrates on the positional features of the same. The feature extraction technique explained was tested using a Neural Network which was trained with the feature vectors obtained from the system proposed.

Universe of Discourse

Universe of discourse is defined as the shortest matrix that fits the entire character skeleton. The Universe of discourse is selected because the features extracted from the character image include the positions of different line segments in the character image. So, every character image should be independent of its Image size.

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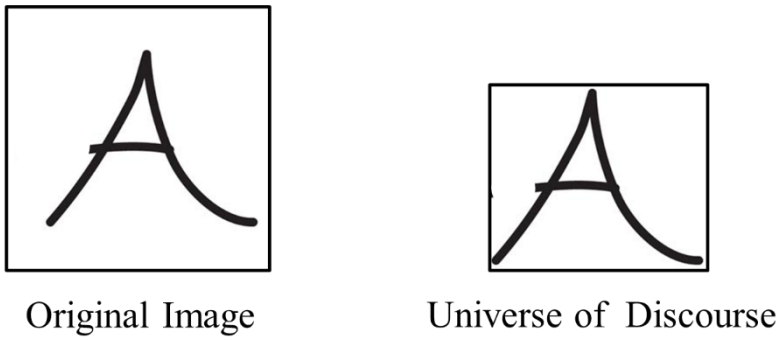

Figure 2: Universe of Discourse

Starters

Starters are those pixels with one neighbour in the character skeleton. Before character traversal starts, all the starters in the particular zone are found and is populated in a list.

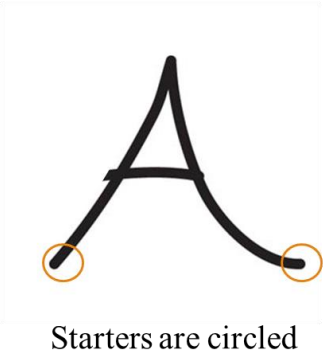

Figure 3: Starters are rounded

Intersections

The definition for intersections is somewhat more complicated. The necessary but insufficient criterion for a pixel to be an intersection is that it should have more than one neighbour. A new property called true neighbours is defined for each pixel. Based on the number of true neighbours for a particular pixel, it is classified as an intersection or not.

For this, neighbouring pixels are classified into two categories, Direct pixels and diagonal pixels. Direct pixels are all those pixels in the neighbourhood of the pixel under consideration in the horizontal and vertical directions. Diagonal pixels are the remaining pixels in the neighbourhood which are in a diagonal direction to the pixel under consideration.

Figure 4: Intersections

4. Classification and Recognition

Artificial Neural Network

Animals recognize various objects and make sense out of large amount of visual information, apparently requiring very little effort. Simulating the task performed by animals to recognize to the extent allowed by physical limitations will be enormously profitable for the system. This necessitates study and simulation of Artificial Neural Network. In Neural

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Network, each node performs some simple computation and each connection conveys a signal from one node to another labelled by a number called the "connection strength" or weight indicating the extent to which signal is amplified or diminished by the connection.

Different choices for weight results in different functions are being evaluated by the network. If in a given network whose weight are initial random and given that we know the task to be accomplished by the network, a learning algorithm must be used to determine the values of the weight that will achieve the desired task. Learning Algorithm qualifies the computing system to be called Artificial Neural Network. The node function was predetermined to apply specific function on inputs imposing a fundamental limitation on the capabilities of the network. Typical pattern recognition systems are designed using two passes. The first pass is a feature extractor that finds features within the data which are specific to the task being solved (e.g., finding bars of pixels within an image for character recognition). The second pass is the classifier, which is more general purpose and can be trained using a neural network and sample data sets. Clearly, the feature extractor typically requires the most design effort, since it usually must be hand-crafted based on what the application is trying to achieve.

Back propagation was created by generalizing the Widrow-Hoff learning rule to multiple-layer networks and nonlinear differentiable transfer functions. Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined by you. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities.

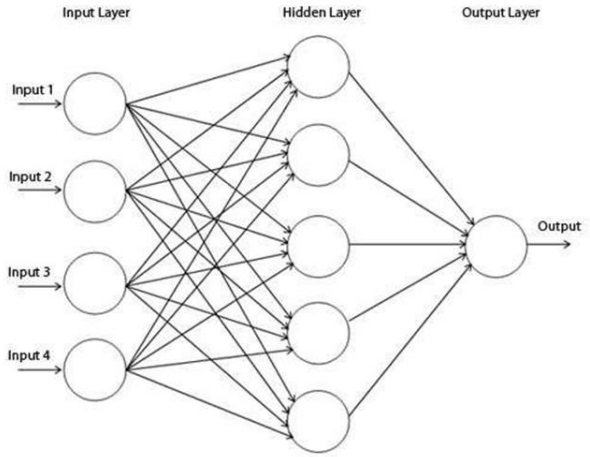

Figure 5: Neural Network

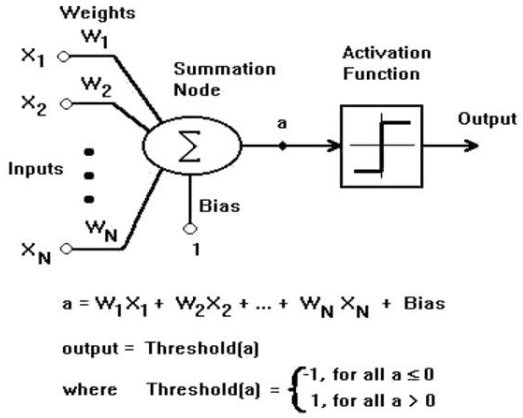

Figure 6: Typical Neural Network

III. IMPLEMENTATION

Software and Hardware Used

Using a PC with Intel core i5 – 6200u @ 2.30 GHz processor and 8GB RAM with Windows 10 premium environment.

MATLAB Image Processing Toolbox

We have used MATLAB Image Processing Toolbox for the development of this software. Image processing involves changing the nature of an image in order to improve pictorial information of the image for human interpretation for autonomous human perception. The Image Processing Toolbox is a collection of functions that extend the capability of the MATLAB numeric computing environment. The toolbox supports a wide range of operations on the image.

MATLAB Neural Network Toolbox

Key Features

•Supervised networks, including multilayer, radial basis, learning vector quantization (LVQ), time-delay, nonlinear autoregressive (NARX), and layer-recurrent

- Unsupervised networks, including self-organizing maps and competitive layers
- Apps for data-fitting, pattern recognition, and clustering
- Parallel computing and GPU support for accelerating training (using Parallel Computing Toolbox)
- Pre-processing and post-processing for improving the efficiency of network training and assessing network performance

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- Modular network representation for managing and visualizing networks of arbitrary size.

Training neural network

Design for the artificial neural network.

The proposed neural network for the research can be represented in graphical form as below figure. The training features from the characters are extracted using the feature extraction technique as mentioned in the above section. The ANN is provided 108 feature values from the character features.
The artificial neural network used for recognizing the handwritten and printed font characters is contained in three layers.

Implementation of the input layer.

The input layer for the neural network is contained 108 nodes itself, the layers of the ANN were represented through the two-dimensional matrix (108 x 850).

Number of layers	Node of layers	
3	Input	108
	Hidden	78
	Output	34

Table 1: Parameters used for Training ANN

Implementation of the hidden layer.

The hidden layers also represented through the one-dimensional array. The size of the array is depended on the number of nodes used for the hidden layer. For the implementation of the neural network, it was used 71 nodes for the hidden layer. The outputs calculation associated with the hidden nodes are based on the tangent sigmoid function.

Implementation of the output layer.

The output layer of the neural network is represented using a one-dimensional double type array with 34 indexes. The array may store the result values of hidden layer after applying the activation function on them.

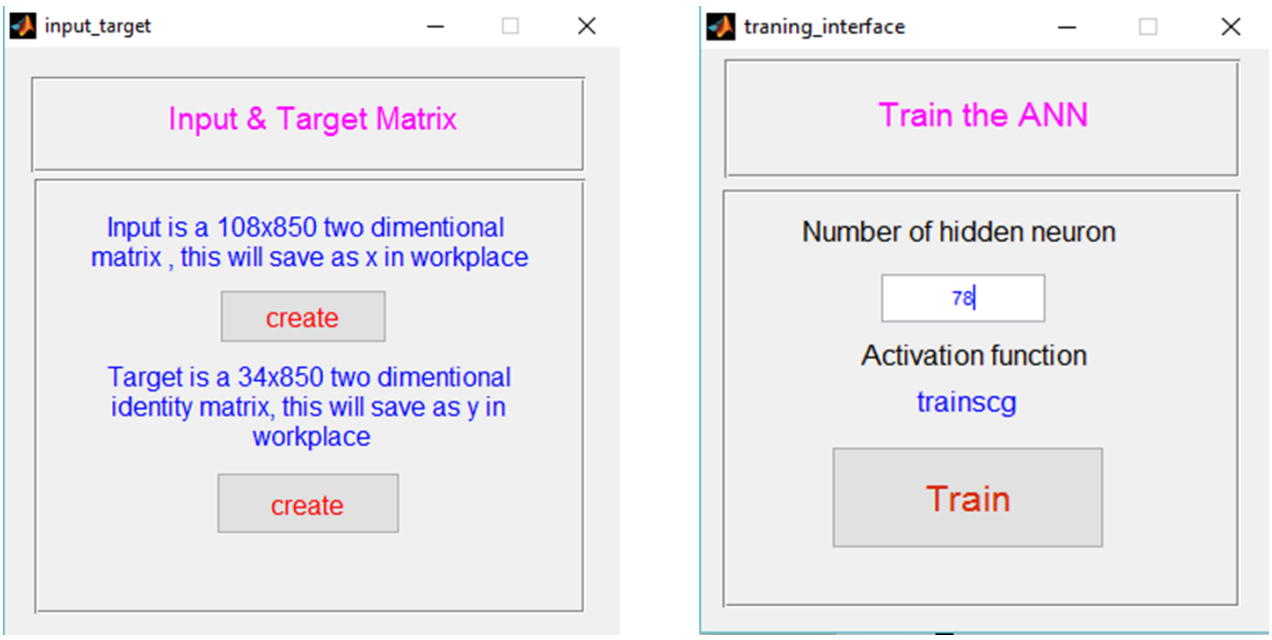

Figure 7: Input and Training Interface

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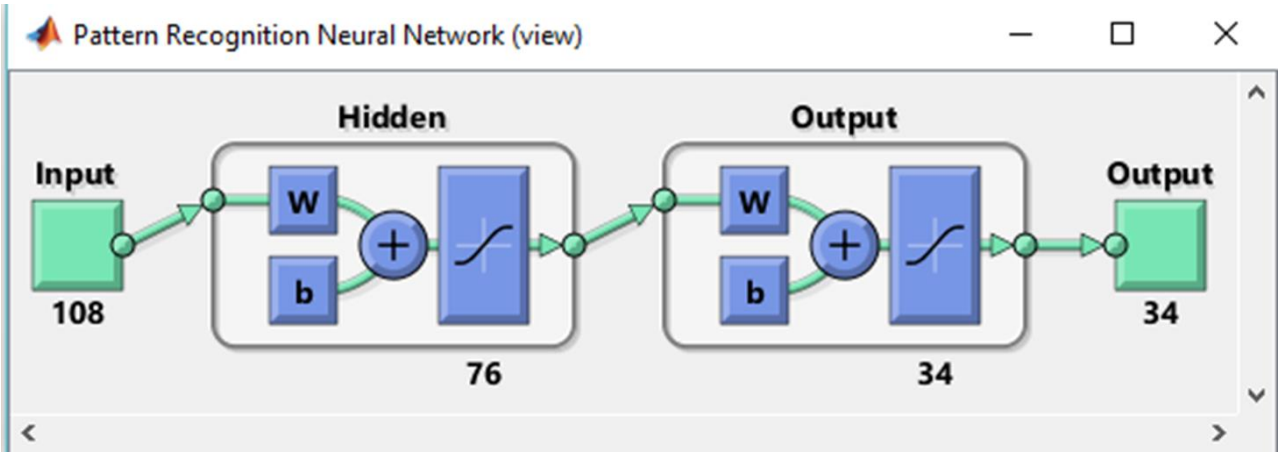

Figure 8: Neural Network Training Interface

IV. RESULTS

In order to test the ANN for the character identification, the neural network was trained using character patterns. The convergence of the ANN can be monitored using the graph drawn between mean square error and the number of iterations. With the time the error of the neural network has to be reduced.

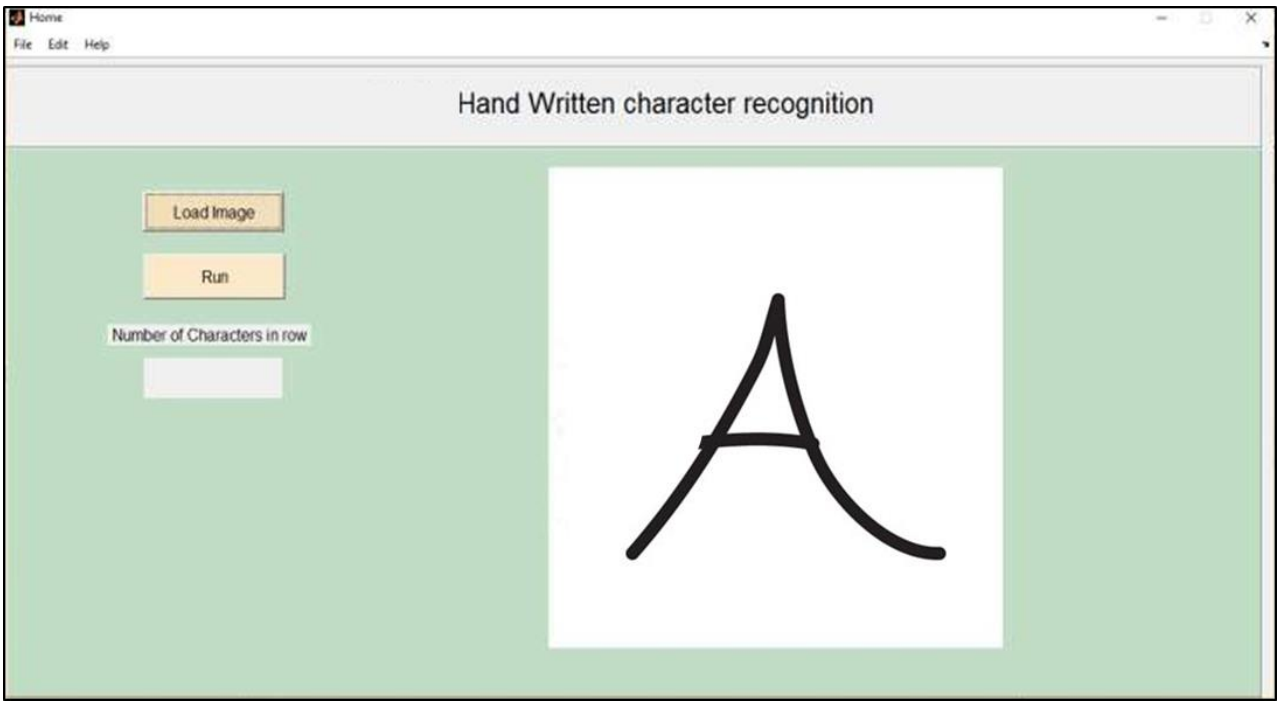

Figure 9: Image upload Interface

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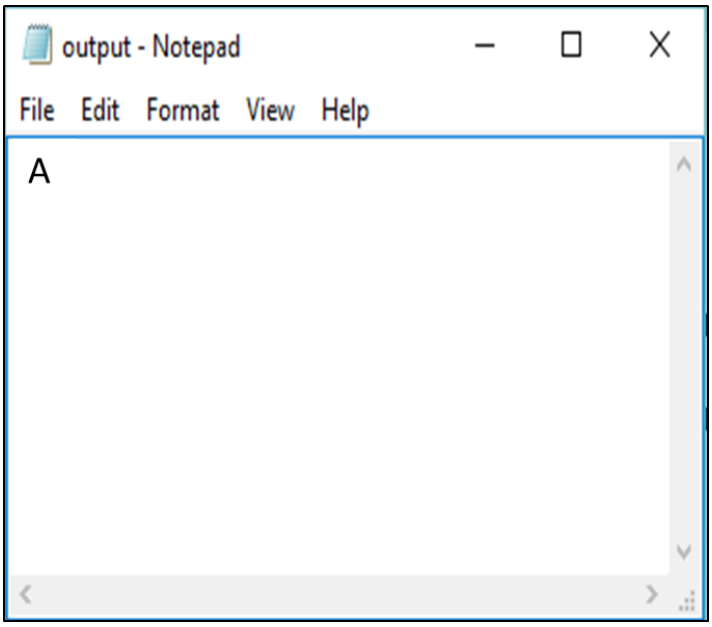

Figure 10: Output Interface

The following graph represented at the following figure shows the minimization of the error with the iterations. Using the PC with Intel core i5 – 6200u @ 2.30 GHz processor and 8GB RAM with Windows 10 premium environment the following result were obtained.

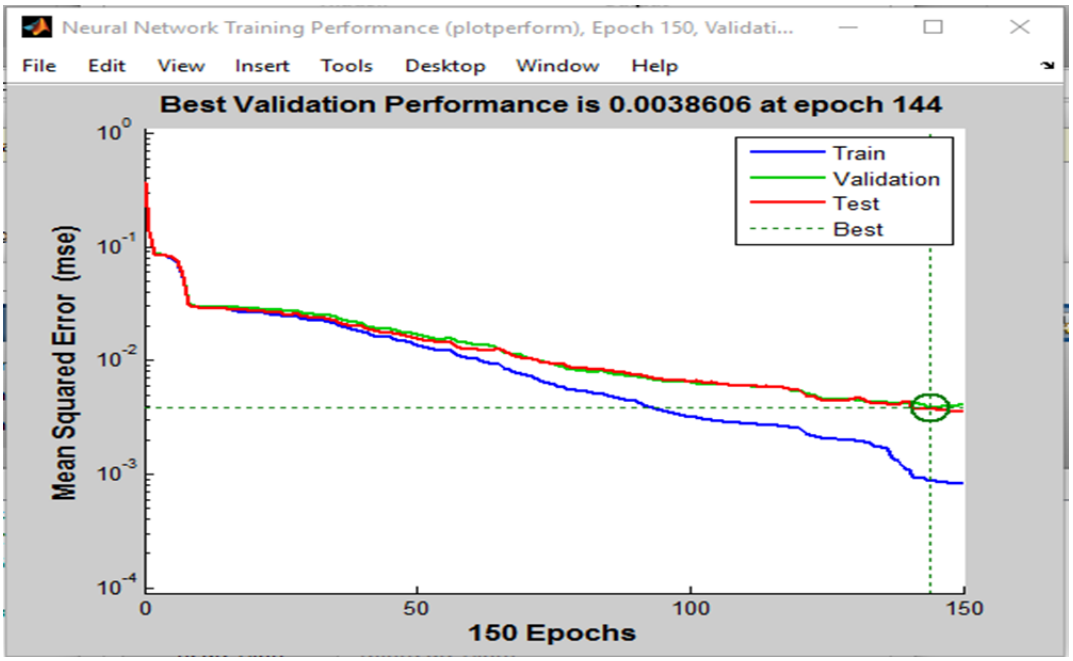

Figure 11: Iterations vs Mean squared error

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Technique Used	Total Character in database	No: of Training characters	No: of Testing characters	Performance
Artificial Neural Network	850	680	170	82.1%

Table 2: Final Results

V. CONCLUSION

The proposed Neural Network architecture has an ability to classify the character patterns in some degree. But it shows difficulties during the classification of unknown samples. Since as a future enhancement, it is expected to improve the current architecture of the ANN by increasing the number of nodes and layers.

Since all of the performance in the character pattern identification is based on feature extraction methodology, it is important to make error free (noise free) character features. Since as the next step, it is expected to insert high-level image processing techniques for the feature extraction process.

Since the system is not able to identify the touching characters, water reservoir concept has to be used in future. The performance of the neural network can be increased by adding some more features other than the existing ones. The classification rate can be increased by training the neural network with a greater number of test images.

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