Simulation and Modeling of Handwritten Meitei Mayek Digits using Neural Network Approach

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***Abstract*— Handwriting recognition is one of the most challenging research areas during last few decades. It is often useful to have machine perform pattern recognition, than the human beings. Many research works has been carried out in handwritten recognition of different Indian languages. This paper describes simulation and modeling of handwritten Meitei Mayek (Manipuri script) digit recognition (HMMDR) using a neural network approach. We have collected 1000 samples of handwritten Meitei Mayek digits from various persons. Various pre-processing steps are applied on collected sample images before passing it to the neural network. Then the Neural Network has been trained and tested on these samples.**

***Keywords*— Meitei Mayek Handwritten digit recognition, Neural Networks, back propagation training.**

I. Introduction

Pattern recognition is one of the very interesting topics for researchers during last few decades with numerous applications in the field of science and technology. Handwriting recognition problem is one of the thrust area of pattern recognition with various practical applications[1], like postal code verification, vehicle number plate recognition, bank cheque processing, Assigning ZIP Codes to letter mail, automatic reading of area code and address from the letter, various data form processing etc.

Meitei Mayek (Manipuri script) is the script of Manipuris, also called Meeteilon [2, 3], Meiteiron and Meithei [4] in linguistic literature, is the official language of the State of Manipur, India and is primarily spoken in the valley region of the State. It is the mother tongue i.e., the first language of the ethnic group Meitei.

Manipuri is a tonal language of Tibeto-Burman language family. This script contains Iyek Ipee/Mapung Iyek, which have 27 alphabets (18 original plus 9 letters called Lom Iyek, derived from original 18 alphabets), Lonsum Iyek (8 letters), Cheitek Iyek (8 symbols), Khudam Iyek (3 symbols), Cheishing Iyek (10 numeral figures). In addition to these there are 6 vowel letters. The basic character may appear only as the main character of a word and it may be modified using one of the extended symbols (vowel modifiers) to produce the required vocal sound. All the original figures of the Manipuri alphabets are drawn, winded and wreathed from human anatomy and accordingly, the alphabetical names are the names of the different parts of the same where the characters are winded and drawn from [3]. To the best of our knowledge, research in Manipuri script recognition has not yet been widely introduced to the research community while much research on other scripts of different languages has been published and introduced internationally. A survey of Indian script recognition can be found in the literature [5].

Neural Networks are widely applied to pattern recognition areas [6-8]. Neural Networks can be trained and then tested on various handwritten digits. This paper describes feed forward neural network with back propagation learning approach for the handwritten digit recognition.

II. neural networks

Neural networks solve problems by self-learning and self organization. Back propagation is a systematic method of training multilayer artificial neural networks. It is built on high mathematical foundation and has very good application potential. In [9] the authors presented a clear and concise description of the back propagation algorithm. The back propagation network (BPN) is probably the most well known and widely used among the currently available neural network systems. Back propagation network has been applied to a wide range of practical problems and many pattern recognition applications and has successfully demonstrated its power. This paper presents the most popular Artificial Neural Network (ANN) architecture, the multilayer Feed forward neural network with back propagation (BP) learning for the Handwritten Meitei Mayek digit recognition (HMMDR) application.

III. proposed recognition model

A typical handwriting recognition system consists of preprocessing, segmentation, feature extraction and recognition stages. Figure 1 shows the Meitei Mayek digits and corresponding English digits are also mentioned. Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar.

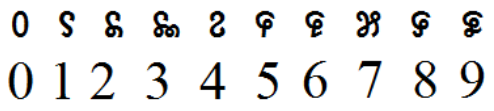

Figure 1. Meitei Mayek digits and English digits

A. *Image Acquisition*

To model the handwritten Meitei Mayek digit recognition system we have collected around 1000 samples from different persons with different age groups and different genders on an A4 size Paper. Figure 2 shows a sample input image which was scanned through the scanner and stored in a jpg file. After acquiring the image, it will be processed through sequence of preprocessing steps to be ready for the recognition step.

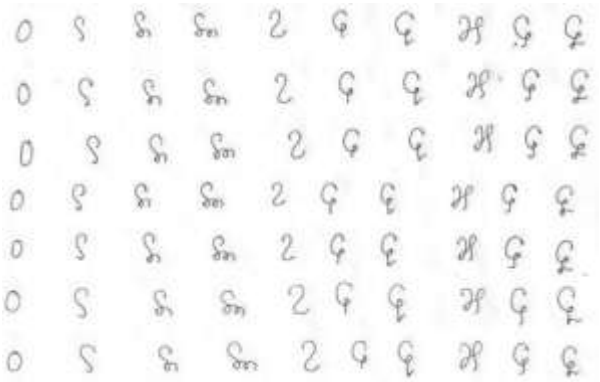

Figure 2. A sample input image

B. *Preprocessing*

The pre-processing is a series of operations performed on the scanned input image. It essentially enhances the image rendering it suitable for segmentation. Binarization process converts a gray scale image into a binary image using global thresholding technique. Detection of edges in the binarized image using Laplacian technique, dilation the image and filling the holes present in it are the operations performed in the last two stages to produce the pre-processed image suitable for segmentation [10]. Following are the pre-processing steps applied on the input image.

1. Read an input image.
2. Convert given image into binary image.
3. Remove noise, in off-line mode, the noise may come from the writing style or from the optical device that captures the image.
4. Dilate the image by applying morphological operations.
5. Line Segmentation
6. digit Segmentation
7. Finally resize each individual digit with 14X10. The pixel density is calculated as binary patterns and therefore a vector is created.

IV. neural network architecture for meitei mayek digits recognition

In this paper we have proposed multilayer feed forward neural network with Back propagation learning for the handwritten Meitei Mayek digit recognition. The network consists of three layers input layer, hidden layer and output layer to recognize 0-9 Meitei Mayek digits. The simulation and modeling of the system is done in MATLAB. Back-propagation neural network with Gradient descent with momentum & adaptive learning rate is used. Figure 3 shows the neural network architecture.

The neural network uses 140 neurons in the input layer as image size is 14 x 10 , 10 neurons in the output layer as it has to recognize 10 digits (0-9). Output vector is a 10 element vector with a 1 in the position of the digit it represents, and 0's everywhere else. For example, the digit 0 is to be represented by a 1 in the first element and 0's in elements two through ten. Digit 1 is to be represented by a 1 in the second element and 0's in all other elements and so on for other letters.

The network is a two-layer log-sigmoid/log-sigmoid network. The log-sigmoid transfer function was picked because its output range (0 to 1) is perfect for learning to output Boolean values.

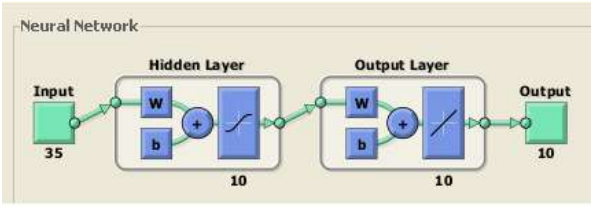

Figure 3. Neural Network Architecture

Training of a neural network involves two passes. In the forward pass, the input signals propagate from the network input to the output. In the reverse pass, the calculated error signals propagate backwards through the network where they are used to adjust the weights. The output of one layer in weighted manner will be the input to the next layer. In the reverse pass, the weights of the output neuron layer are adjusted first since the target value of each output neuron is available to guide the adjustment of associated weights.

For training neural network we have used traingdx function. Traingdx is a network training function that updates weight and bias values according to gradient descent momentum and an adaptive learning rate. Performance goal is 0.10000 and momentum constant is kept 0.9. Performance function we have used is sse (sum squared error). It measures performance according to the sum of squared errors.

v. experiments and results

In this section we present the experimental results from the simulation analysis under MATLAB environment. Out of 1000 samples 700 samples are applied for training the above specified neural network and 300 samples of each digits are used for testing the performance and recognition of neural network. The testing results of the system are shown in table I and table II.

Table I shows the performance of the neural network for all the testing patterns. For each digit (0-9) 300 patterns are tested and results are shown in Table I. CR means (Correct Recognition) and FR means (False Recognition).

TABLE I. PERFORMANCE OF THE NETWORK FOR THE TEST DATA SET

Digits	Attempts	CR	FR	% Accuracy
0	300	300	0	100
1	300	294	6	98
2	300	276	24	92
3	300	294	6	98
4	300	258	42	86
5	300	264	36	88
6	300	180	120	60
7	300	294	6	98
8	300	180	120	60
9	300	222	78	74

Table II shows results for all 300 test set digits. It shows number of times digit is Correctly Recognized and number of times digit is False Recognized and False Recognized as which digit. This matrix is called the confusion matrix

TABLE II. CONFUSION MATRIX

	0	1	2	3	4	5	6	7	8	9
0	300	0	0	0	0	0	0	0	0	0
1	0	294	0	0	0	0	6	0	0	0
2	0	12	276	0	0	0	0	6	6	0
3	0	0	0	294	0	0	6	0	0	0
4	0	0	42	0	258	0	0	0	0	0
5	0	0	0	0	0	264	18	0	18	0
6	0	24	0	0	0	54	180	0	18	24
7	0	0	6	0	0	0	0	294	0	0
8	0	12	0	0	0	96	6	0	180	6
9	0	6	0	0	0	12	12	0	48	222

From table II it can be observed that some digits are almost perfectly recognized and misclassification occurs among some digits because of the similarity among the digits.

Figure 4 shows the graph of neural network performance for correct and false recognition of handwritten Meitei Mayek digits. Figure 5 show the graph of neural network with % accuracy for the handwritten Meitei Mayek digit recognition.

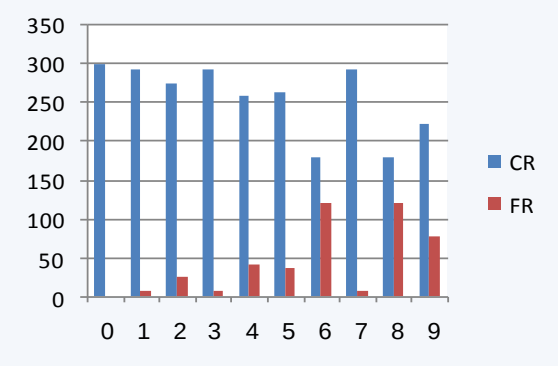

Figure 4. Graphical representation of CR and FR

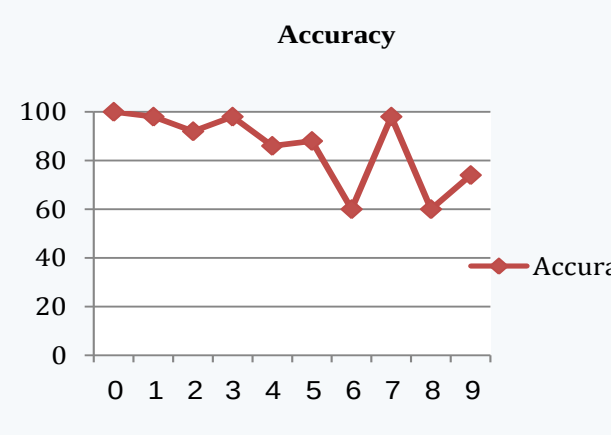

Figure 5. % accuracy of handwritten meitei mayek digit recognition

VI. conclusion

In this paper we have presented the multilayer feed forward neural network approach with back propagation learning for the handwritten Meitei Mayek digit recognition. Preprocessing steps are applied before digits are recognized. The overall performance of the system we achieved is about 85 %. The system is only implemented for digit recognition. Some of the digits are confusing like 1 & 2, 5, 6 & 8 that have to be recognized properly. So, still we need to improve the performance of our system. In future, the same algorithm will be tested for different sizes of the image that is 16x16, and 32x32 to improve the results. Different feature sets and other

classification algorithms like support vector machines (SVM) may be considered.

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