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Artificial neural network-based approach for Mizo character recognition system

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ABSTRACT

This paper examines and compares different types of artificial neural networks for recognition of Mizo script. The Mizo script and English script are very similar in nature but special characters – Â, â, Ê, ê, Î, î, Ô, ô, Û, û, Ṭ, and ṭ – are incorporated in Mizo scripts which are not available in English script. In this experiment, an attempt was made to recognize Mizo script including capital letter, small letter, numerals, and special characters. The approach involves processing input images, conversion of image characters into binary matrix, analyzing and mapping the binary matrix, training and testing with a set of desired Mizo characters using different types of neural networks such as back propagation algorithm, radial basis function, learning vector quantization, and recurrent neural network. The results are compared with each other and suggest the best artificial neural networks algorithm for use in the recognition of Mizo script.

Key words: Mizo script; optical character recognition; learning vector quantization; radial basis function network; recurrent neural network; self-organizing maps.

INTRODUCTION

An optical character recognition (OCR) began as a field of research in pattern recognition, artificial intelligence and machine vision. Many academic research institutes continue to focus on implementation of proven OCR techniques because of its applications potential in banks, post-offices, defense organization, license plate recognition, reading aid for the blind, library automation, language processing and multimedia system design.[1-4]

Character recognition system is one of the most important tools for people around the world having different languages and script. Though Mizo script is very similar to English script, the language are uniquely different from each other and some of the special characters are also incorporated in Mizo script which are not available in English script. Therefore, it is very much important to have separate OCR for those who speak, read and write in Mizo language. There are many Mizo people living in Mizoram,

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Manipur, Nagaland and Myanmar using the same Mizo languages. Therefore, an attempt is made to recognize Mizo characters using different type of artificial neural networks.

Properties of Mizo script

Basic Mizo character set comprises of 19 consonant, 6 vowels, and 10 numerical. The Mizo scripts are mostly derives from English script and hence similar in nature except special characters incorporated in Mizo scripts such as Â, â, Ê, ê, Î, î, Ô, ô, Û, û, Ṭ, and ṭ. These special characters with their circumflex and dot at the bottom are not available in English script and hence Mizo fonts are used to generate Mizo script. In Mizo script, there are compound characters which are a combination of consonant and consonant as well as consonant and vowel such as "CH", "NG", and "AW". These compound characters are treated as a single character in Mizo script. But for the purpose of recognition, the character 'C' and 'H' are treated as separate character. In this study, the Mizo characters are divided into four classes such as:

Capital letter:
A B C D E F G H I J K L M N O P R S T U V W Z

Small letter:
a b c d e f g h i j k l m n o p r s t u v w z

Numerals:
0 1 2 3 4 5 6 7 8 9

Special characters:
Â â Ê ê Î î Ô ô Û û Ṭ ṭ

The special characters with circumflex and dot at the bottom have separate meanings and different pronunciation than the characters without circumflex and dot at the bottom. Hence, the special characters are very important characters in Mizo script while writing, reading and speaking.

METHODOLOGY

Preprocessing

The preprocessing is a series of operation performed on scanned input image. The image should have specific format such as jpeg, bmp, etc. This image is acquired through a scanner, digital camera or any other suitable digital input devices.[5] The role of pre-processing is to segment the interesting pattern from the background image. Generally, noise filtering, smoothing and normalization should be done in this step. The pre-processing also defines a compact representation of the pattern.

Binarization

Binarization is a technique by which the gray scale images are converted into binary images. Binarization separates the foreground (text) and background information.[9] The most common method for binarization is to select a proper threshold for the intensity of the image and then convert all the intensity values above the threshold to one intensity value ("white"), and all intensity values below the threshold to the other chosen intensity ("black").

After determining the threshold value, each pixel in the image is compared with the threshold value. If the value of the pixel is less than the threshold, reset the pixel to one. Otherwise, reset the pixel to zero as in Equation 1:

$$P(x,y) = \begin{Bmatrix} 1 : P(x,y) < threshold\ value \\ 0 : P(x,y) > threshold\ value \end{Bmatrix} \quad (1)$$

Where, P(x, y) is the pixel of the image and the threshold value 255 is the value between the dominant and the maximum value. After applying the binarization algorithm on the digital image, we obtain a binary image consisting of two values "1" as black and "0" as white.

```
clear dummy;
files=cell(1,num_files);
for i=1:num_files
imagepath=strcat(dirpath,filelist(i).name);
files{i}=imread(imagepath,'bmp');
```

```
if length(size(files{i}))>2 % checking if rgb image;
files{i}=rgb2gray(files{i});
files{i}=im2bw(files{i},graythresh(files{i}));
end
end
```

Segmentation

In the segmentation, an image of sequence of characters is decomposed into sub-images of individual character.[10] In the proposed system, the pre-processed input image is segmented into isolated characters by assigning a number of each character using a labeling process. This labeling provides information about number of characters in the image. Each individual character is uniformly resized into pixel.

Resizing the individual character into pixels

The individual character image is uniformly resized into pixels. The individual character images are normalized into a fixed size using the function image resize (imresize (x1, [10 15]), where x1 is the image which convert to binary. So the final size becomes 10×15 pixels. The background of the image takes the value 0, while the value 1 as foreground.

In Matlab,

```
>>x1 = imread('A.bmp');
>>x = imresize(x1, [10 15]);
```

Therefore, an inverse function should be applied to inverse background pixels into 0's and the object pixels into 1's in order to manipulate the image. The resizing of the character images has to be done carefully preserving the important features.

The individual character images are converted into binary matrix size of 10x15 which is uniformly maintained for all the characters of the Mizo script. In our experiment, we found that some characters have different width and height of the matrix. For example – 'V' character matrix size is 7x15 whereas 'W' character matrix size is 10x15. The character 'V' needs to resize uniformly with character 'W' and hence the character 'V' is padding with zeros to form 10x15 uniformly. Here, the matlab's function '*reshape*' is used which return the m-by-n matrix.

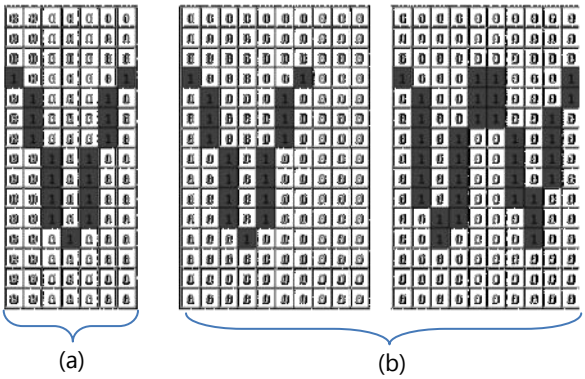

Figure 1. (a) before resizing the character matrix size 7x15 (b) after resizing the character matrix size 10x15.

The algorithm for resizing the character matrix uniformly

```
files{i}(height+1:max_height,:)=0;
files{i}(:,width+1:max_width)=0;
fprintf('Displaying the file : %s after padding\n\n',filelist(i).name);
for j=1:max_height
for k=1:max_width
fprintf('%d ',files{i}(j,k));
end
fprintf('\n');
end
fprintf('\n\n');  files{i}=reshape((files{i})',1,max_height*max_width);
```

Neural networks

Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. Neural Network can be trained to perform complex functions in various fields, including pattern recognition, identification, classification, speech, vision, and control systems. Neural networks can also be trained to solve problems that are difficult for conventional computers or human beings. The network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typi-

cally, many such input pairs (input vectors) and target pairs (target vectors) are needed to train a network.

In this paper, an attempt was made to implement Mizo character recognition using various neural networks model such as Back Propagation Algorithm (BPA), Learning Vector Quantization (LVQ), Radial Basis Function (RBF), and Recurrent Neural Network (RNN). Their results are compared based upon their perfection in the character recognition.

Back propagation algorithm (BPA)

Backpropagation Neural Network is a supervised neural network having three layers such as input layer, hidden layer and output layer.[2] In this paper, the transfer function 'tansig' is used in the hidden layer and 'purelin' in the output layer. The design of back propagation neural network has 150 input nodes for each character, 75 hidden nodes and 23 output nodes. The training function 'traingdx', variable learning rate gradient descent, is used in the experiment for training the network.

Radial basis function (RBF)

The RBF is designed to handle more neurons than standard feed forward backpropagation network and it takes a fraction of time to train standard feed forward network.[7] The RBF work best when many training vectors are available. In this paper, we used the function 'newrb' with 150x23 input vectors and 23x23 target vectors with the default mean square error goal is set at 0.01 and the spread value at 5. This makes the network function smoother and results in better generalization for new input vectors.

Learning vector quantization (LVQ)

The LVQ is a supervised version of vector quantization and has two layers i.e competitive layer and linear layer. The LVQ generates codebook vectors (code vectors) to produce 'near-optimal decision boundaries'. In LVQ network, each neuron in the competitive layer is assigned to a class, each class is assigned to one neuron in the linear layer.[8] The LVQ neural network combines competitive learning with supervision. In this paper, we have created LVQ network with the function 'newlvq' having 75 nodes in the competitive layer and 23 nodes in the linear layer with the learning rate of 0.01 for training the network.

Recurrent neural network (RNN)

The RNN, also known as Elman Network, is a two layer network with feedback from the first layer output to the first layer input. This recurrent connection allows the Elman network to both detect and generate time varying patterns. The Elman network has 'tansig' neurons in its hidden (recurrent) layer and 'purelin' neurons in its output layer.[7] In this paper, we have created recurrent neural network with the function 'newelm' having training function 'trainbfg' with transfer function 'tansig' in the hidden layer and 'logsig' in the output layer. The network has 75 nodes in the hidden layer and 23 nodes in the output layer with learning rate 0.01.

RESULTS

Experiments in this study were carried out in different stages which involves preprocessing of preprinted characters image, conversion of characters image into binary matrix with 10x15 pixels, analyzing and mapping the binary matrix (1 represent black and 0 represent white background), training and testing with a set of desired Mizo characters using different types of neural networks such as back propagation, learning vector quantization, radial basis function, and recurrent neural network. The results are compared with each other and suggest the best NN tools for use in the recognition of Mizo characters.

We used many samples with different fonts and sizes for training and recognition purpose. We used Matlab 7.0 for our experiment. The fonts used in our experiment include Mizo

Table 1. Analysis of BPA neural network for Mizo character recognition.

Characters	Accuracy (%)	Performance (MSE)	Epoch Reach	Time taken (s)
Capital letter	97.7	0.00997	391	5
Small letter	97.5	0.00998	540	8
Numerals	98.1	0.00973	54	2
Special characters	97.2	0.00957	63	2

Table 2. Analysis of radial basis function neural network for Mizo character recognition.

Characters	Accuracy (%)	Performance (MSE)	Epoch Reach	Time taken (s)
Capital letter	91.3	0.01130	17	64
Small letter	91.3	0.00945	17	64
Numerals	90.0	0.01000	8	4
Special characters	100.0	0.00690	10	4

Table 3. Analysis of learning vector quantization neural network for Mizo character recognition.

Characters	Accuracy (%)	Performance (MSE)	Epoch Reach	Time taken (s)
Capital letter	82.6	0.01510	300	57
Small letter	73.0	0.02270	300	56
Numerals	99.0	0.18000	231	18
Special characters	95.0	0.15270	260	23

Table 4. Analysis of recurrent neural network for Mizo character recognition.

Characters	Accuracy (%)	Performance (MSE)	Epoch Reach	Time taken (s)
Capital letter	89.0	0.00660	171	32
Small letter	84.0	0.00910	290	13
Numerals	99.6	0.00442	242	6
Special characters	99.5	0.00524	243	7

Arial, Mizo Times, and Mizo Sarif. The following results have been found during experiments.

Conclusion

This paper deals with a comparative study of different types of neural networks to recognize Mizo characters including capital letters, small letters, numerals, and special letters. The networks are used to learn different types of fonts generated from Mizo fonts such as Mizo Arial, Mizo Times, and Mizo Sarif. One can conclude from this study that multilayer back propagation neural network is quite effective in implementing character recognition of Mizo script which has an average accuracy of 97.625% and the total time taken to build the network is at 4.25 Secs. The back propagation neural network has an average error of 0.009813 which is less compared to others. These results suggest that among the four selected neural networks algorithm tested, multilayer back propagation neural network is the most suitable model for character recognition of Mizo script.

References

1. Shrivastava M, Sahu M & Rizvi MA (2012). Artificial neural network based character recognition using back-propagation. *Int J Comput Technol*, **3**, 184–188.
2. Sameeksha B (2012). Optical character recognition using artificial neural network. *Int J Adv Res Comput Eng Technol*, **4**, 131–133.

3. Pranob KC, Harish V, Swathi M & Deepthi Ch (2012). A review on the various techniques used for Optical Character Recognition. *Int J Eng Res Appl*, **2**, 659–662.
4. Kalaichelvi K & Ali AS (2012). Application of neural networks in character recognition. *Int J Comput Appl*, **52**, 1–6.
5. Prasad K, Nigam DC, Lakhotiya A & Umre D (2013). Character recognition using Matlab's neural network toolbox. International Journal of u– and e– Service. *Sci Technol*, **6**, 13–19.
6. Khlid AA (2006), Comparison of different self–feature extraction neural networks for license plate recognition of arabic letter and numbers. *Proceedings of the International Conference on Modeling and Simulation*, Kuala Lumpur, Malaysia, pp. 602–607.
7. Beale MH, Hagan MT & Demuth HB (2010). *The Neural Network Toolbox™ 7 User's Guide*. The Mathwork Inc., Massachusetts, USA.
8. Sivanandam SN, Sumathi S & Deepa SN (2006). *Introduction to Neural Networks Using Matlab 6.0*. Tata McGraw–Hill, New Delhi, India.
9. Alam MM & Kashem MU (2010). A complete Bangla OCR system for printed characters. *Int J Comput Inform Technol*, **1**, 30–35.
10. Casey RG & Lecolinet E (1996). A survey of methods and startegies in character segmentation. *IEEE Trans Pattern Analysis Mach Intel*, **18**, 690–706.