High Accuracy Myanmar Handwritten Character Recognition using Hybrid approach through MICR and Neural Network

Dr. Yadana Thein , San Su Su Yee

University of Computer Studies Yangon (UCSY)
Yangon, Myanmar

Abstract

This paper contributes an effective recognition approach for Myanmar Handwritten Characters. In this article, Hybrid approach use ICR and OCR recognition through ***MICR*** (Myanmar Intelligent Character Recognition) and back-propagation neural network. MICR is one kind of ICR. It composed of statistical/semantic information and final decision is made by voting system. In ***Hybrid approach***, the features of statistical and semantic information of MICR have been used in back-propagation neural network as input nodes. So it needs a few input nodes to use. The back-propagation algorithm has been used to train the feed-forward neural network and adjustment of weights to require the desired output. The purpose of Hybrid approach to achieve the high accuracy rates and very fast recognition rate compare with other recognition systems. The experiments were carried out on 1000 words samples of different writer. Using Hybrid approach, over-all recognition accuracy of 95% was obtained.

Keywords: *MICR (Myanmar Intelligent Character Recognition), Hybrid approach, Feature of Statistical and Semantic Information, Back-propagation Neural Network, ICR, OCR.*

1. Introduction

Handwritten character recognition is the process of classifying written characters into appropriate types based on the features extracted from each character. It can be performed either online or offline. The researches on the recognition of the handwritten writing tend is a difficult task because of the differences of handwritings and of the irregularity of the writing of the same writer. Maybe among difficult tasks of handwritten character recognition, it is easier to recognize English character than Myanmar character. There are two main types of character recognition methods: Optical Character Recognition (OCR) and Intelligent Character Recognition (ICR). OCR is prospered in machine printed (i.e. typed) character recognition field. It translated the digitized images of text into machine-readable format. In handwritten character recognition field, OCR occur errors such as misrecognition, inconvenient, etc. ICR can successfully overcome these problems. ICR is an advanced version of OCR, which is used to enhance the accuracy in recognition levels.

Myanmar language is the official language and widely used in many Myanmar states. In many offices were used the Myanmar language such as passport, bank, sales tax, railway, embassy, etc. So, it is a very importance to develop the high accuracy character recognition system for Myanmar language. Texts in the Myanmar language use the Myanmar script.

MICR (Myanmar Intelligent Character Recognition) is a technique based on ICR. High speed recognition rates can be gained by using MICR. It was trained and experienced with successfully in both typeface and handwritten characters. It is used to recognize effectively hand-printed characters. But, it also has broken, overlapped and noisy characters. *Hybrid approach* can successfully overcome these problems. In this paper, Hybrid approach is used the result of MICR and back-propagation neural network (BPNN). BPNN is a good recognition engines. It has the ability to generalize by making decisions about imprecise input data. It also offer solutions to a variety of classification problems such as speech, character and signal recognition.

The arrangement of this paper is as follows: Section (2) express the Myanmar Language, Section (3) explain Myanmar character research field and MICR, Section (4) show the composition of the proposed system, Section (5) present the new contribution of Hybrid approach, Section 6) show output. Experimental results and conclusion are in Section (7) and (8), respectively.

2. Myanmar Language

The Myanmar language is the official language and is more than one thousand years old. Myanmar script is considered a complex script by software developers, as it

originated from Indic scripts like Thai or Khmer. The Myanmar (formerly known as Burmese) script developed from the Mon script, which was adapted from a southern Indian script during the 8th century. The earliest known inscriptions in the Burmese script date from the 11th century. Myanmar alphabet consists of 33 consonants, 12 vowels, 4 medials, 10 digits and a lot of Pali character as shown in Figure 1.

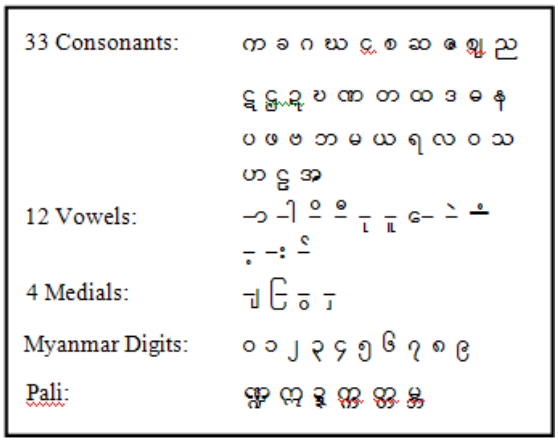


Figure 1. A set of Myanmar alphabet

In Myanmar (Burmese) writing system: syllabic alphabet - each letter has an inherent vowel. Other vowels are indicated using separate letters or diacritics which appear above, below, in front of, after or around the consonant. The rounded appearance of letters is a result of the use of palm leaves as the traditional writing material. Straight lines would have torn the leaves. The Burmese name for the script is 'round script', is written from left to right, as shown in Figure 2.

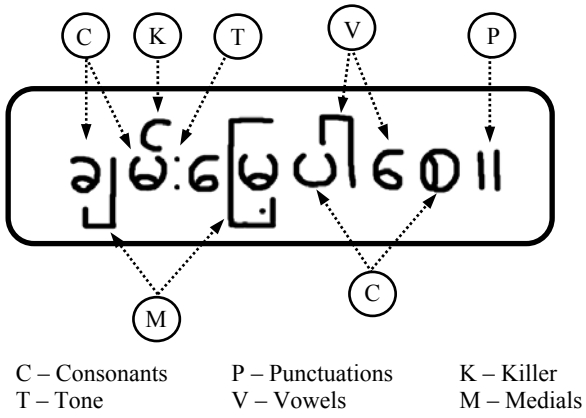


Figure 2. Terms of Character's samples

3. Myanmar Character Research Area

The interests in Myanmar handwritten characters recognition research have grown over the past few years but practical research is only a few works in research field. Because, the problem of Myanmar characters recognition is more difficult than English languages in respects including the similarity of characters, absence space between each word, etc. So, various character recognitions method not enough complete recognize Myanmar character. They are still in research field, not complete work. MICR is an interesting algorithm to recognize Myanmar characters that has been developed recently in Myanmar.

3.1 MICR

MICR (Myanmar Intelligent Character Recognition) system is one category of ICR (Intelligent Character Recognition) methods and it can recognize not only on-line characters but also off-line too. But it is more suitable for noise free images and isolated characters. It used statistical and semantic approach to collect information. That information includes the data of width and height ratio, horizontal and vertical black stroke count, number of loops, end point, open direction, histogram values and character type, etc.

After gathering this required information for each character, we put them on the properties array to record them. Properties of each character are compared with Pre-Defined Database: Basic characters (B-database), Extended characters (E-database), Medials (M-database). When the incoming character matches with the database, the voting system is used to make the final decision of the image on that information. If the incoming character is equivalent to the predefined database, the voting system produces the relative code number for that character. This code number is stored in the code buffer. Otherwise, reject message is generated, as shown in Figure3.

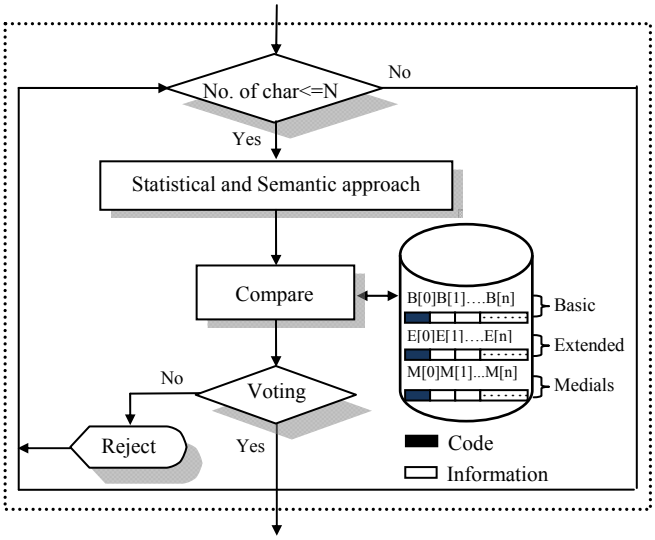


Figure 3. MICR System schematic diagram

3.2 Applications of MICR

MICR has been successfully applied in a lot of application such as:

- Speed limited road signs recognition
- Car license plate reader
- Recognition of Myanmar basic characters and compound words(vowels)
- Online Myanmar medial hand-printed characters into machine editable text
- On-line Handwritten Myanmar Pali Character recognition
- Handwritten English Characters to Machine editable text by applying MICR
- Converting Myanmar Portable Document format to machine editable text with format using MICR
- Voice production of Handwritten Myanmar Compound Words
- Enhancing the Myanmar Pali Recognition based on MVM (Myanmar Voice Mixer)

4. System Composition

This section describes the simple technique involved in our proposed online handwriting recognition system. This is a writer-independent system based on the Hybrid approach. In this system includes four stages: Data acquisition, Pre-processing, Hybrid approach and Output, as shown in Figure 4.

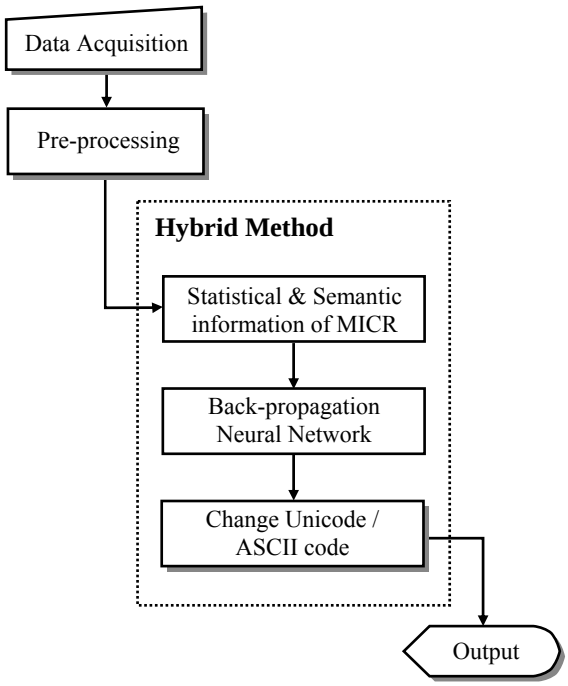


Figure 4. Proposed system design

4.1 Data Acquisition

Two different types of data input method: *online* and *offline*. In online data acquisition, data inputs are stored as images that are concurrently written by the users through Tablet, hand-held PDA devices, etc. In offline data acquisition, data inputs are stored as images that are captured by scanner. , the proposed system can handle on only online data input by users. Isolated characters are needed to process the image.

4.2 Pre-processing

Various preprocessing operation are: Gray Scale Converting, Noise Filtering, Binarization, Extraction, Resizing and Normalization. Firstly, convert the incoming original image into gray level image and then filtering the noise of the image result from gray scale conversion of image. If conversion of a grayscale image into a binary image, the system extract row and column for each character. In normalization, it is performed on the digitized image to enhance the quality of the image. Then, labeling scheme is used in this system for the one character lonely.

5. Hybrid Method

The system used to combine the MICR and back propagation neural network. Each of these algorithms has its own specific strengths and weakness. The idea of Hybrid method in order to compensate their individual weakness and to prevent their individual strength has been widely used in Myanmar character recognition field. In this system, back-propagation neural network uses the features of statistical and semantic information of MICR as input nodes. So, training time is very quickly and received the high accuracy rate.

5.1 Statistical and Semantic Information of MICR

After the pre-processing stage, feature information of each character is extracted by using MICR. MICR used statistical and semantic approach to collect information such as width and height ratio, horizontal and vertical black stroke count, number of loops, histogram values and character type, etc, shown in Figure 5.

A statistical approach looks for a typical spatial distribution of the pixel values that characterize each character. It is searching for the statistical characteristics of various characters. These characteristics could be very simple, like the ratio of black pixels to white pixels, width and height ratio, histogram, etc. Some of handwritten characters indeed consist of pixels. Statistical methods ignore is that the pixels also form lines and contours. A

semantic approach recognizes the way in which the contours of the characters are reflected in the pixels that represent them and try to find out typical characteristics for each character. Semantic data: black stroke count, loop, open, end point, etc.

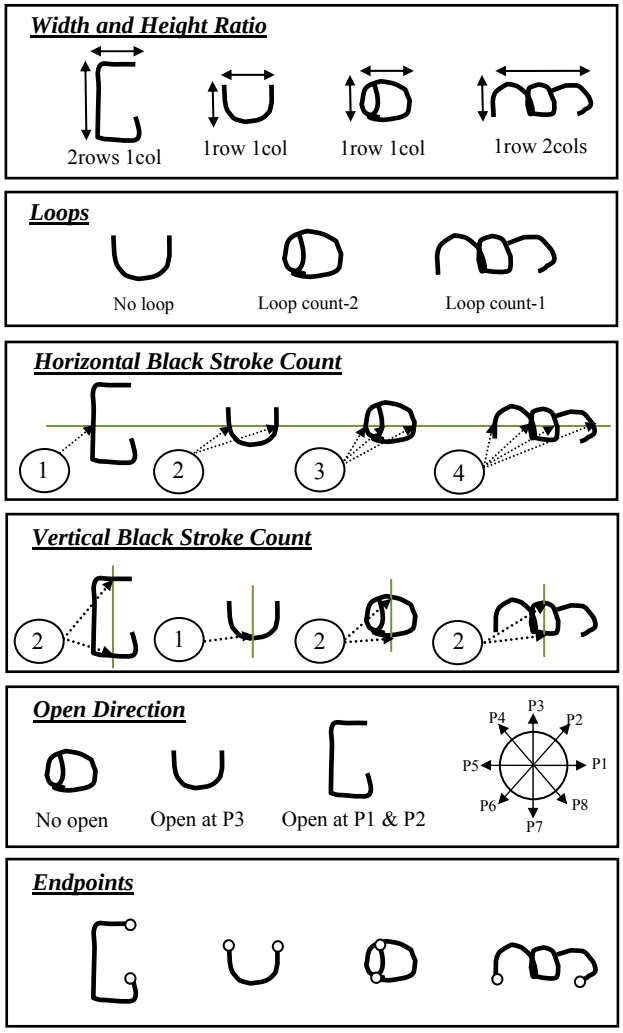


Figure 5. Some statistical and semantic information

5.2 Back-propagation Neural Network

In this system, feed-forward neural network and back-propagation learning algorithm is used. The recognition performance of the Back propagation network will highly depend on the structure of the network and training algorithm. It is consists of three layers forward structure that has hidden layer between input layer and output layer interconnected by links that contains weights. Figure 6, shows the architecture of network.

Its input has two forms: features extraction of image and pixels of image. Training time will be very long if pixels are used as an input for neural network. In this system, statistical and semantic information of MICR has been used the inputs of neural network to save the training time.

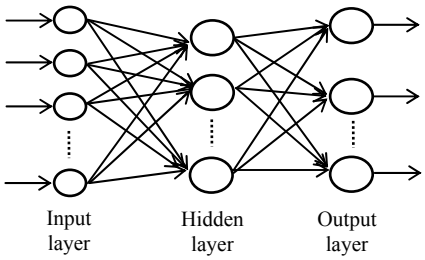


Figure 6 . Network architecture

5.3 Back-propagation Algorithm

First, the training sample is fed to the input layer of the network. For unit j in the input layer, its output is equal to its input, that is, $O_j = I_j$ for input unit j. The net input to each unit in the hidden and output layers is computed as a linear combination of its inputs. A unit j in a hidden or output layer, the net input, I_j, to unit j is

$$I_j = \sum w_{ij} O_i \quad (1)$$

where w_{ij} is the weight of the connection from unit i in the previous layer to unit j; O_i is the output of unit i from the previous layer. The net input I_j to unit j, then O_j, the output of unit j, is computed as

$$O_j = \frac{1}{1+e^{-Ij}} \quad (2)$$

For the output layer, the error value is:

$$\delta_j = O_j (1 - O_j)(T_j - O_j) \quad (3)$$

And for hidden layer

$$\delta_j = O_j (1 - O_j) \sum_k \delta_k w_{jk} \quad (4)$$

where w_{jk} is the weight of the connection from unit j to a unit k in the next higher layer, and δ_k is the error of unit k. Weights are updated by the following equations, where Δw_{ij} is the change in weight w_{ij} :

$$\Delta w_{ij} = \beta \delta_j O_i \quad (5)$$

$$w_{ij} = w_{ij} + \Delta w_{ij} \quad (6)$$

The variable β is a constant learning rate.
The parameters used in the back-propagation neural network experiments are listed in Table1.

Table 1. Parameters used for back propagation neural network

Parameter	Values
Input Layer neurons	165
Hidden Layer neurons	100
Output Layer neurons	6
Number of Epochs	50000
Performance Function	Mse (Mean square error)
Back-propagation learning Rate	0.1
Momentum Term	0.9
Minimum Error Exist in the Network	0.01
Initial weights and biased term values	Randomly Generated Values Between 0 and 1

5.4 Change Unicode/ASCII Code

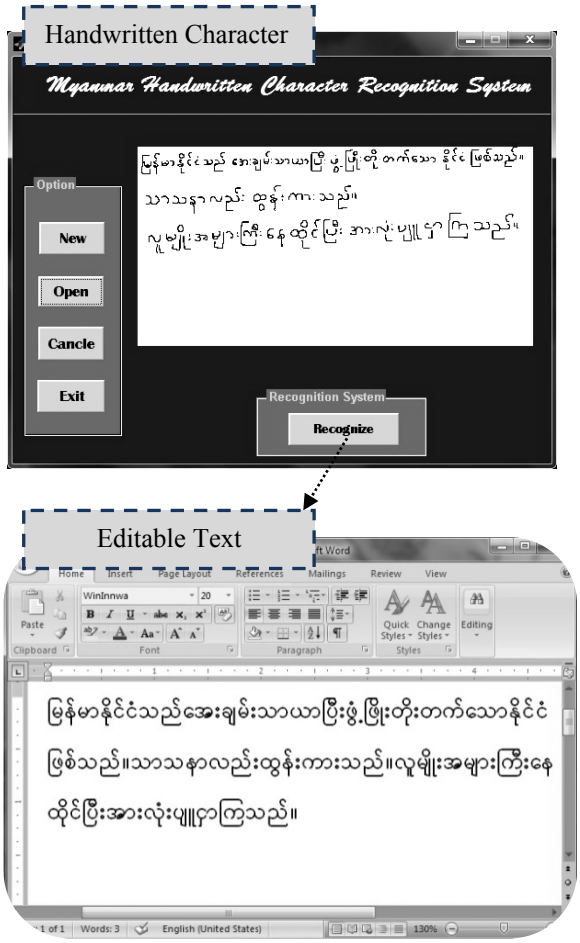
In this step, the code numbers of characters are changed into their relative native code (Unicode or ASCII) for output. Some Myanmar character and their relative code sequences are shown below:

Table 2. Sample words and their native code

Word	Unicode sequence	ASCII sequence
ကို	U+1000 U+102D U+102F	117 100 107
ခေါ်	U+1031 U+1001 U+003A	97 99 58
ထင်	U+1011 U+1004 U+1039	120 105 102
အချိန်	U+1021 U+1001 U+103A U+102D U+1014 U+1039	116 99 115 100 101 102
ကြည်နူး	U+1029 U+1000 U+100A U+1039 U+1077 U+1030 U+1038	77 117 110 102 69 108 59
သဘော်	U+101E U+1031 U+1018 U+102C U+1064	111 97 98 109 70

6. Output

After that, the recognized combined words are produced as output. This output can be shown in the Microsoft Word file as the editable text format. To connect Microsoft Word, rich text format (rtf) function is used. The output result for before recognition and after recognition output file is provided as example:



7. Experimental Result

In order to check the accuracy of the individual recognition method, handwriting samples were collected from various people. In this paper, the system was trained and tested over 1000 sample.

Table 3. Recognition rate for MICR

No of samples	Recognition accuracy rate for noisy image	Recognition accuracy rate for noise free image
100	90%	94%
300	88.1%	92.7%
500	86%	90%
700	84.3%	87.2%
1000	78%	85%

Shown in Table (3) is the recognition accuracy rate of MICR recognizer. This table shows noisy and noise free image of handwritten Myanmar characters and digits.

Table 4. Recognition rate for Back-propagation Neural Network

Using Pixel Input		
No of samples	**Recognition accuracy rate for noisy image**	**Recognition accuracy rate for noise free image**
100	88.13%	91%
300	86%	88.75%
500	82.85%	85%
700	80%	83.41%
1000	74%	81%

Table (4) shows the recognition accuracy rate of back-propagation neural network recognizer. Pixels of image are used input node for neural network.

Table 5. Recognition rate for Hybrid

Using feature Input		
No of samples	**Recognition accuracy rate for noisy image**	**Recognition accuracy rate for noise free image**
100	94.59%	98.89%
300	93%	97%
500	92.38%	95.85%
700	89.10%	94.50%
1000	86%	93%

The hybrid method was used to combine the MICR recognizer and back-propagation neural network to create the high accuracy rate. Features of image are used input node for this method. So, processing time is very quickly.

Table 6. Average processing time for recognizers

Kinds of recognizer	**No of samples**	***Average processing time***
MICR recognizer	1000	4.5 seconds
Back-propagation recognizer	1000	6.5 seconds
Hybrid recognizer	1000	3 seconds

8. Conclusion

The paper has presented a new contribution of handwritten recognition using a robust combination of hybrid approach through MICR (Myanmar Intelligent Character Recognition) and back-propagation neural network. This paper has compared the forecasting accuracies of MICR recognizer, back-propagation recognizer and hybrid method. Hybrid method can recognize not only similar characters in different language but also different handwritten styles. In this system, it can recognize only Myanmar handwritten characters.

Acknowledgments

The authors would like to thank all participants in MICR (Myanmar Intelligent Character Recognition) research field from the University of Computer Studies in Yangon. We would like to thank the reviewers and editors of IJCSI. Finally, we appreciate all the readers who spend their precious time to read this paper.

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Dr. Yadana Thein I received M.Sc (Master Computer Science) degree in 1996 and PhD (I.T) degree in 2007. I am now associated professor of U.C.S.Y (University of Computer Studies, Yangon). I have written about 25 papers altogether. About 10 of them are local papers and 15 are foreign papers. My first paper is "Recognition of Myanmar Handwritten Digits and Characters "for ICCA conference in 2007. My research interests include Image Processing, Neural Network and MICR (Myanmar Intelligent Character Recognition) field.

San Su Su Yee I am a Master Thesis Student. I received B.C.Tech degree in 2008 and B.C.Tech (Hons.) degree in 2009. I got one distinctions (English) in Master course work exam.