Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 2, Issue 20; October-December, 2015, pp. 1790-1793

http://www.krishisanskriti.org/Publication.html

Printed Assamese Vowels Recognition using Morphological Operators on Binary Images

Kalyanbrat Medhi[1] and Sanjib Kr. Kalita[2]

[1]Department of Computer Science Gauhati University Guwahati, India
[2]Dept. of Computer Science Gauhati University Guwahati, India
E-mail: [1]kmedhi@gauhati.ac.in, [2]sanjib959@gauhati.ac.in

Abstract—*The aim of this paper is to describe an algorithm to recognize Assamese vowels using mathematical morphology. The structural feature blob is used as feature in this study. The vowels are extended to blob by drawing line. A decision tree algorithm has been designed. The proposed algorithm has been applied and tested for various printed Assamese fonts. Experiment result shows that the recognition rate that can be achieved by this algorithm is 85% to 100%.*

1. INTRODUCTION

Character recognition remains as an active research field since 1950. Most successful commercial applications of OCR are available for English, Chinese, Roman and Japanese language Arabic. These OCR are able to recognize characters with different fonts and sizes even intermixing text and graphics. The OCR systems have been already developed for [1] Bangla, [8] Devanagari, [9] Gurumukhi, [10] Kannada, [11] Malayalam, [12] Tamil, [13] Telugu. Thus, OCR systems for Indian scripts have just started appearing. Areas of application are numerous ranging from OCR recognition, license plate recognition, price recognition, house number recognition etc.

OCR can be two types; on-line OCR and off-line OCR. In the present study the off-line technique for vowel recognition is discussed. In on-line technique characters are written on some kind of digital device and recognition is performed while writing. In off-line method document needs to be digitized by scanner or camera. After that characters are cropped for further processing.

Most successful commercial applications of OCR are available for English, Chinese, Roman and Japanese language Arabic. These OCR are able to recognize characters with different fonts and sizes even intermixing text and graphics. The OCR system has been developed for Bangla, Devanagari, Gurumukhi, Kannada, Malayalam, Tamil, Telugu [14].Thus, OCR systems for Indian scripts have just started appearing. It is seen thatresearch on Assamese language is very tiny and that is why this is our approach to design a system for this language. A lot of challenges exist for developing complete OCR in Assamese language due to existence of complex and compound characters.Another challenge is lack of proper dataset for this work causing the experiment more time consuming. This is why it is an approach towards this work.

Fig. 1 depicts a sample of vowels from Assamese script.

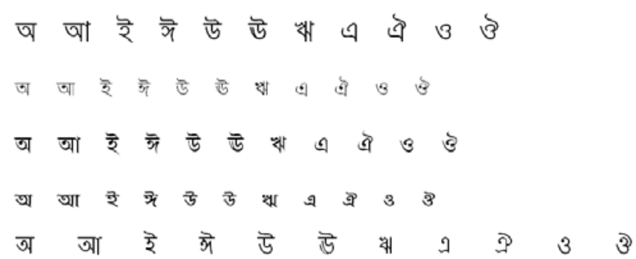

Fig. 1: Assamese Printed vowels of different size

2. LITERATURE REVIEW

In the year 2013, Richa Sharma, Arun Jain, Ritika Sharma and JyotiWadhwahas proposed digits recognition system for English language [2]. In this experiment the collected data are preprocessed using primitive morphological operations. After preprocessing the data they have used a decision tree classifier. They have claimed that average digit recognition rate is 90.1%. Recently, Cheng-Lin Liu, Fei Yin, Da-Han Wang, Qiu-Feng Wang [4] has performed experiments on online and offline handwritten Chinese character. They have used character datasets OLHWDB1.0 and HWDB1.0 (called DB1.0 in general), OLHWDB1.1 and HWDB1.1 (called DB1.1 in general) for their experiments. The normalization is done with 1D and pseudo 2D normalization methods. For offline binary images and gray scale images feature is extracted using gradient direction feature extraction method, normalization-based gradient feature (NBGF) and normalization-cooperated gradient feature (NCGF). The contour feature extraction method normalization-cooperated contour feature (NCCF) is used. For online sample they used two types of direction features: histograms of original stroke direction and normalized direction. Thus obtained features dimensionality is 512. The dimensionality is reduced by Fisher discriminant analysis (FDA). They have used four types of classifiers: modified quadratic discriminant function (MQDF), nearest prototype classifier (NPC), NPC with discriminative feature extraction (DFE), and discriminative quadratic discriminant function (DLQDF). They have claimed that the highest accuracy achieved using the MQDF classifier is 89.55% for off-line and 93.22% for on-line on the HWDB1.1 and OLHWDB1.1 dataset respectively. BeantKaur and Sangeet Pal Kaurin 2013 have described another application of mathematical morphology in image processing [3]. They describe the problem of Fingerprint Feature Extraction, Recognition of Handwritten Digits, License Plate Detection, Denoising using Morphological Filters, Text Extraction, Border Extraction and Detection of Imperfection in Printed Circuit Boards. Marwan A. Abu-Zanona, Bassam M. El-Zaghmouri (2012) also wrote a paper on current Arabic (Hindi) hand written numbers segmentation and recognition with advance image processing and Neural Network [5]. They did all the necessary image preprocessing tasks by mathematical morphology operators.P. Anishiya and S. Mary Joansin 2011, used morphological dilation and erosion for number plate recognition of Indian cars [6]. They used morphological operation to extract the location of the number plate in the image. Accuracy of the system as they claimed is above 96%. Usha Rani,Balwinder Singh andRavinder Singhused morphological operator on binary image to detect machine printed Panjabi character in 2012 [7].

3. DATA COLLECTION AND PREPROCESSING

Assamese vowels are printed and document is scanned with HP scanner with 300 dpi. The images are saved in jpeg format. After digitizing the documents individual character are cropped using Photoshop software where only one vowel contains in the image. Printed Assamese font Vrinda with font size 18, 20, 22, 24, 26, ... , 72 are consideredduring data collection. The images are in RGB and color is not necessary for detection of vowels. So the images are converted to gray scale image. After that the images are preprocessed.

Preprocessing is necessary to remove noise that may present in the images which may occur during printing or scanning process. These noises may subsequently degrade the recognition rate. A binary version of the image is created from the grayscale image considering a threshold value calculated using Otsu's method. After that binary images are morphologically opened to remove small background noise. It will remove pixel smaller than certain pixels.

4. METHODOLOGY

Work is done through morphological operators and a decision tree algorithm. The process extracts structural features using basic morphological methods and applies them over a decision tree where at each node a feature will place them into a particular class. Finally at the bottom of the tree the vowel with certain features will be identified properly. After preprocessing morphological-dilation operation is performed on that binary image. If A and B are sets in Z^2, the dilation of A by B is denoted for some $a \in A$ and $b \in B$ as

$$A \oplus B = \{c \in Z^2 \mid c = a+b\} \quad (1)$$

In general dilation expand an image, so that, small holes that present inside foreground can be filled.

We have used two features to detect vowels; blobs and stems. Blobs are that part of a number that is surrounded by blackpixels. To identify blobs first image needs to be filled using morphological region filling method as described below.

Begin with a point p inside the boundary, and fill the entire region with 1's. All non-boundary (background) points are labeled 0. The procedure to fill the region with 1's is defined as [14]

$$X_k = (X_{k-1} \oplus B) \cap A^c, \ k= 1, 2, 3, \ldots \quad (2)$$

Initially $X_0 = p$, and B is 3x3 symmetric structuring element. The algorithm terminates at iteration step k if $X_k = X_{k-1}$. The set union of X_k and A contains the filled set and its boundary.

Then original image is subtracted from the filled image. Objects present is determined by a connected component approach as equation (3).

Let Z represent a connected component contained in a set A and assume that a point p of Z is known. Then the following iterative expression yields all the elements of Z [14].

$$X_k = (X_{k-1} \oplus B) \cap A, \ k= 1, 2, 3, \ldots \quad (3)$$

Where $X_0 = p$, and B is 3x3 symmetric structuring element. If $X_k = X_{k-1}$, the algorithm has converged and we let $Z = X_k$.

Thus we obtain the number of blobs.

A decision tree is designed where each node check a particular feature and further operation are performed according to the result of feature detection. The algorithm works as follows

Step 1. Read the image and convert into gray scale image.

Step 2. Scan for *matra*. If font has *matra* then draw line middle of font and go through step 3 to step 10.

Step 3. Count the number of blobs in that image obtained after step 2

Step 4. If number of blobs in step 3 is two remove previous line and draw line 2/3 th of the image horizontally.

Step 5. Count the number of blobs in that image of step 4.

Step 6. If number of blobs is greater than two then it is *dergho woo.* If number of blobs is one then it is *dergho e.*

Step 7. If number of blobs of step 3 is three then its*Aa*. If number of blobs of step 3 is four then it is *Aaa.*

Step 8. If number of blobs in step 3 is zero remove previous line and draw line 2/3 th of the image horizontally.

Step 9. Count the number of blobs in that image of step 10.

Step 10. If number of blobs of step 9 is zero then it is *haso e*. If number of blobs of step 9 is one then it is *haso woo*

Step 11. If font has no *matra* then count the number of blobs in that image of step 1 goes through step 12 to 17.

Step 12. If number of blobs of step 11 is one then it is *Ri*.

Step 13. Draw line middle of font horizontally.

Step 14. Count the number of blobs in that image obtained after step 13.

Step 15.If number of blobs of step 14 is zero then it is *a*. If number of blobs of step 14 is one then it is *o*.If number of blobs of step 14 is two then remove line and draw line 2/3 th line horizontally.

Step 16.Count the number of blobs in that image obtained after step 15.

Step 17.If number of blobs of step 16 is zero then it is *0i*. If number of blobs of step 16 is one then it is *ow*.

The decision tree algorithm separates the vowels into two groups as following diagram. The following Fig. 2 depicts it.

There are six vowels in Assamese language that has matra অআইঈউঊ. Another five vowels has no matra ঋএঐওঔ.

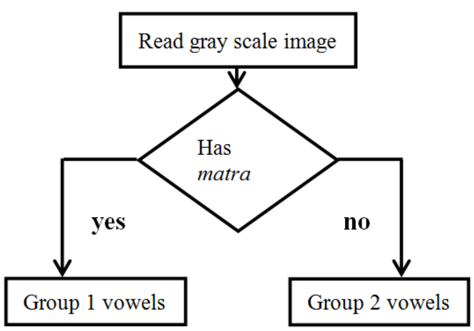

Fig. 2: Decision tree puts the vowel in particular group

The vowel that has matra are placed under group one and goes through the decision sub tree as depicted in Fig. 3.

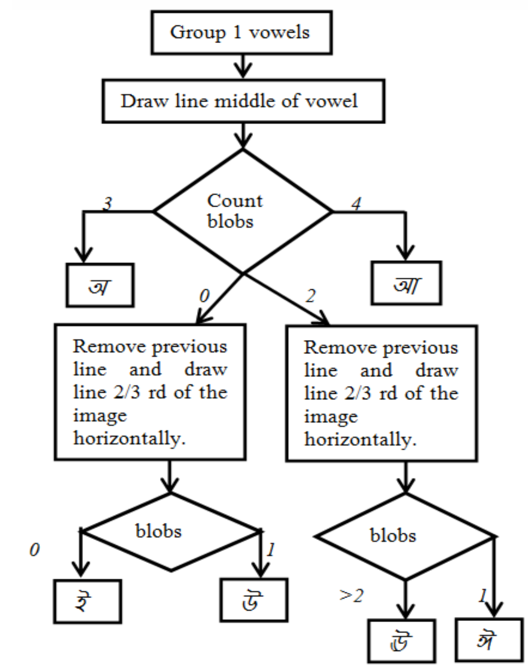

Fig. 3: decision tree identify particular vowel of group one

The vowel that has no matra is placed under group two and goes through the decision sub tree as depicted in Fig. 4.

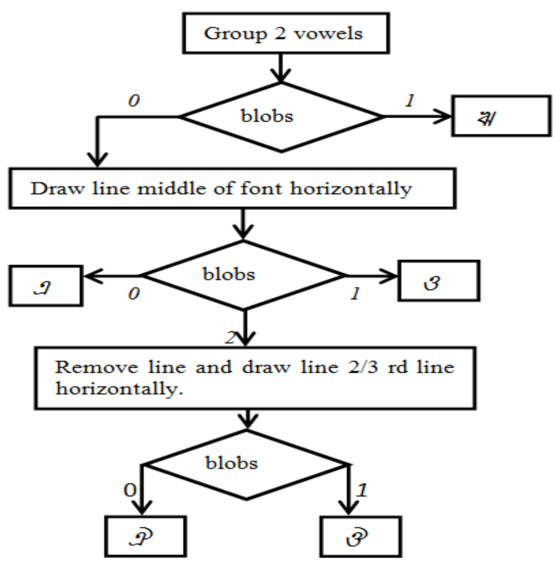

Fig. 4: Decision tree identify particular vowel of group two

5. RESULT OF EXPERIMENT

Recognition of vowel is aided by using of morphological decision tree algorithm. The algoritm first check the *matra* of the character and those which has *matra*are put in group 1 and others are put in group 2. Group 1 character goes through the flowcharts of Fig. 3. Group 2 character goes through the flowcharts of Fig. 4. The following Fig. 5 depicts the recognition steps.

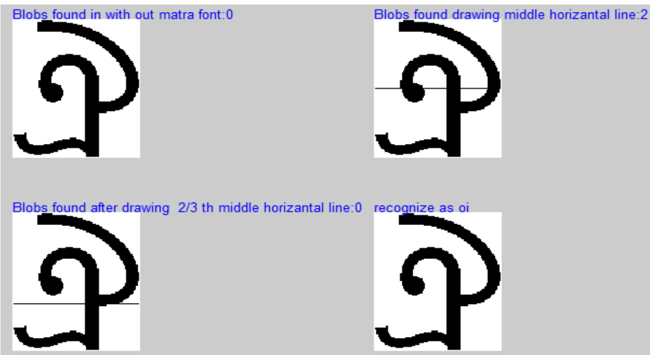

Fig. 5: Recognition of vowel *Oi*

Printed Assamese font Vrinda, Kalpurush, Shonar Bangla, Nikosh, Rupali, Ekushey Sumit, Ekushey Mohua and Shimanto were chosen for vowel recognition. It is seen these font are widely used in printing purpose. That is why those fonts were chosen. Experimental results for these fonts are shown in the table 1.

Table 1: Experimental results

Font	Recognition rate
Vrinda	100%
Shonar Bangla	90%
Kalpurush	86.36%
Nikosh	83.63 %
Rupali	81.5 %
Ekushey Sumit	85.45%
Shimanto	83.63%
Ekushey Mohua	86.36%

6. CONCLUSION

The algorithm is tested for printed Assamese vowels particularly in the mentioned font of table 1. This is first approach towards Assamese vowel recognition using mathematical morphology according to our best knowledge. This is a superior algorithm for printed vowel recognition. Accuracy for printed vowel recognition in the present experiment is 100% maximum for the font 'vrinda'.

REFERENCES

[1] *A. Choudhury and J. Mukherjee, "An Approach towards Recognition of Size and Shape Independent Bangla Handwritten Numerals", International Journal of Science and Research (IJSR), pp. 223-226, 2013*

[2] R. Sharma, A. Jain, R. Sharma and J. Wadhwa, "Character And Digit Recognition Aided by Mathematical Morphology", International Journal of Computer Technology & Applications, Vol 4 (5),828-832, 2013, ISSN:2229-6093.

[3] B. Kaur and S. P. Kaur, "Applications of Mathematical Morphology in Image Processing: A Review", International Journal of Electronics & Communication Technology, Vol. 4, Issue Spl - 3, April - June 2013, ISSN : 2230-7109 (Online) | ISSN : 2230-9543 (Print).

[4] Cheng-Lin Liu, Fei Yin, Da-Han Wang, Qiu-Feng Wang, "Online and offline handwritten Chinese character recognition: Benchmarking on new databases", Pattern Recognition 46 (2013) 155–162

[5] M. A. Abu-Zanona and B. M. El-Zaghmouri, "Current Arabic (Hindi) Hand Written Numbers Segmentaion and Recognition Advance Image Processing and Neural Network", Journal of Emerging Trends in Computing and Information Sciences, VOL. 3, NO. 6, June 2012, ISSN 2079-8407.

[6] P. Anishiya and S. Mary Joans, "Number Plate Recognition for Indian Cars Using morphological Dilation and Erosion with the Aid Of Ocrs", 2011 International Conference on Information and Network Technology , IPCSIT vol.4 (2011), IACSIT Press, Singapore

[7] U. Rani, B. Singh and R. Singh, "Machine Printed Punjabi Character Recognition Using Morphological Operators on Binary Images", International Journal of Engineering Research & Technology, Vol. 1 Issue 3, May – 2012, ISSN: 2278-0181.

[8] N. Sankaran and C.V Jawahar , " Recognition of printed Devanagari text using BLSTM Neural Network", Pattern Recognition (ICPR), 21st International Conference on, Tsukuba, pp. 322 – 325, 2012

[9] K. S. Siddharth, M. Jangid, R. Dhir, R. Rani, "Handwritten Gurmukhi Character Recognition Using Statistical and Background Directional Distribution Features", International Journal on Computer Science and Engineering, Vol. 3, pp.2332-2345, 2011

[10] H.R Mamatha, S. Sucharitha and K. Srikanta Murthy, "Multi-font and Multi-size Kannada Character Recognition based on the Curvelets and Standard Deviation", International Journal of Computer Applications, Vol. 35, Dec. 2011

[11] A. Sampath, C. Tripti, V. Govindaru, "Freeman code based online handwritten character recognition for Malayalam using Back propagation neural networks", Advance computing: An international journal, Vol. 3, pp. 51-58, Jul. 2012

[12] A. Kokku and S. Chakravarthy, "A Complete OCR System for Tamil Magazine Documents", Guide to OCR for Indic Scripts, Springer London, pp. 147-162, 2010

[13] S. Dewan, S. Chakravarthy, "A System for Offline Character Recognition Using Auto-encoder Networks", 19th International Conference, ICONIP 2012, Doha, Qatar, Nov. 2012, Vol. 7666, pp. 91-99, 2012

[14] Available:http://tdil-dc.in/index.php?option=com_vertical&parentid=77 Accessed on 1st June 2014.