

Study of Techniques Used For Devanagari Handwritten Character Recognition

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Abstract- With the recent advances in the computing technology, many recognition tasks have become automated. Character Recognition maps a matrix of pixels into characters and words. Recently, artificial neural network theories have shown good capabilities in performing character recognition. In this paper, the application of neural networks in recognizing characters from a handwritten Devanagari script is explored. A simplified neural approach to recognition of handwritten characters is portrayed and discussed.

Keywords- character recognition, segmentation, image processing, feature extraction, neural network

I. INTRODUCTION

Optical Character Recognition is a process by which we convert printed or scanned document to ASCII character that a computer can recognize. Recognition of handwritten character is a challenging problem since there is a variation in same character due to different font size and different types of noises.

During the last decades, intensive research studies had been made for recognition of handwriting in various languages like English, Japanese and Arabic characters. Although recognition studies on Indian scripts did not receive enough attention till recently. In general the major stages in OCR problem is shown in fig.1.

The sample data is collected in [5] using different devices like Tablet PC, IPaq pocket PC and pen paper based devices such as Digital Notepad. Pen paper based devices have the advantage that they make data collection more natural to the writers which has much similarity with our common pen of everyday use.

II. FEATURES OF DEVANAGARI SCRIPT

Devanagari script is the most popular script. It is phonetic in nature and the writing system for this script maps the sound of the aksharas to specific shapes.

The basic set of aksharas for most languages consist of 13 vowels and about 33 consonants along with 14 vowel

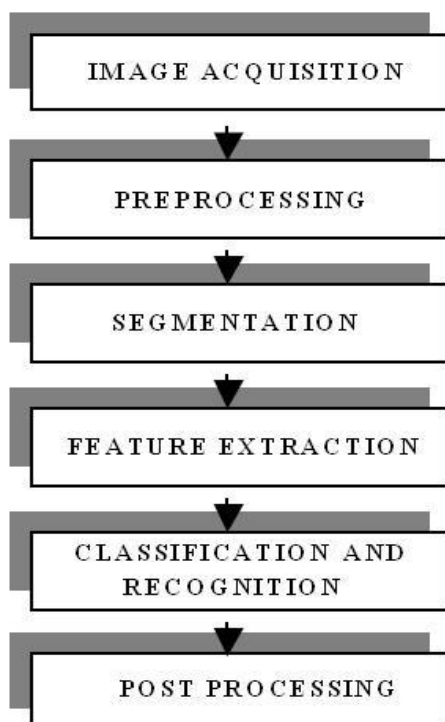


Fig. 1 Stages in Optical Character Recognition

extensions. These Vowels and Consonants are called as Basic Characters.



Fig. 2 Set of Vowels

A consonant or vowel following a consonant called as compound character. Compound characters can be combinations of two or more consonants as well as a consonant and a vowel. There are about 280 compound characters in Devanagari [9]. Hindi has a punctuation sign, the *puṛn-viraam*, which is a vertical line that terminates a sentence.



Fig. 3 Consonants in Devanagari Script

Shirorekha or headline is the horizontal line at the upper part of the characters. In the pattern of continuous handwriting from left to right, the Shirorekha of one character is attached with the Shirorekha of the previous or next character of the same word. The words can typically be divided into three strips: top, core, and bottom, as shown in Fig4. The header line separates the top and core strips and a virtual base line separates the core and lower strips. The top strip generally contains the top modifiers, and bottom strip contains lower modifiers.

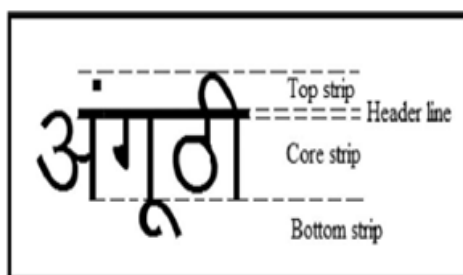


Fig. 4 Three strips of a word in Devanagari Script

The complexity of a handwritten character recognition system increases mainly because of various writing styles of different individuals. Most of the errors[9] in such system arise because of the confusion among the similar shaped characters. In Devanagari there are many similar shaped characters. From the Fig. 5 it can be seen that shapes of two or more characters of a group are very similar due to handwritten style of different individual and such shape similarity is the main reason of low recognition rate. The automatic processing of a document image[7] containing handwritten information can be divided into 3 stages-

- 3.1 Region extraction
- 3.2 Text line, word and character segmentation
- 3.3 Individual character recognition



Fig. 5 Similar characters in Devanagari Script

III. RECOGNITION OF HANDWRITTEN DEVANAGARI SCRIPT

There are various approaches which are proposed [7] to recognize handwritten characters and sentences in Devanagari.

Segmentation-based approach- In this the words are initially segmented into characters and then recognized.

Segmentation-free approach-This approach treats the whole word as single entity and recognizes without segmentation .

1. PREPROCESSING TECHNIQUES-

Data in a paper document are usually captured by scanning and stored in a file of elements called pixels. There is a preprocessing technique [4] in which there is use of Digitization, Median Filter and Derivative Operator.

4.1.1 Text Digitization is done by a Flatbed Scanner having resolution between 100 and 600 dpi. The digitized images are usually in gray tone.

4.1.2 Median Filter is used to provide excellent noise reduction capability. It replaces the value of pixel by the median of gray levels in the neighbourhood of that pixels. There are some other processing stages discussed in[3] which are-

4.1.3 Thresholding- A grayscale or color image is reduced to a binary image.

4.1.4 Noise Reduction- Prior to character recognition, it is necessary to eliminate the imperfections like disconnected lines, gap of lines, rounding of corners, erosion etc.

4.1.5 Skew Detection and Correction- In this Skewed lines are made horizontal by calculating skew angle and making proper correction in the raw image.



Fig. 6 Preprocessed images (a) Original, (b) Segmented Image, (c)Shirorekha Removed, (d) Thinned, (e) Image Edging.

4.1.6 Size Normalization- Each segmented character is normalized to fit within suitable matrix so that all characters have same data size.

4.1.7 Thinning- Thinning is an image preprocessing operation performed to make the image crisper by reducing the binary-valued image regions to lines that approximate the skeletons of the region.

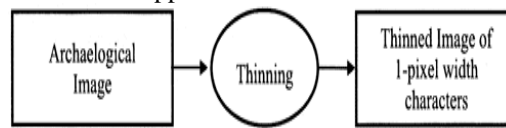


Fig 7: The process of thinning along with its inputs and outputs

In [2], there are various steps defined in preprocessing shown in fig.8.

4.1.8 Binarization process converts a gray scale image into a binary image using global thresholding technique. In [2] Detection of edges in the binarized image using sobel technique, dilation of the image and filling the holes present in it are the operations performed in the last two stages to produce the pre-processed image.

In [1], applied some algorithm for preprocessing which are character extraction algorithm, edge detection algorithm. It works on the pixels of the characters. And then normalization and skew detection is applied on characters.

1. SEGMENTATION TECHNIQUES-

In the segmentation stage, the pre-processed input image is segmented into isolated characters by assigning a number to each character using a labeling process [2]. This labeling provides information about number of characters in the image. Each individual character is uniformly resized for extracting its features.

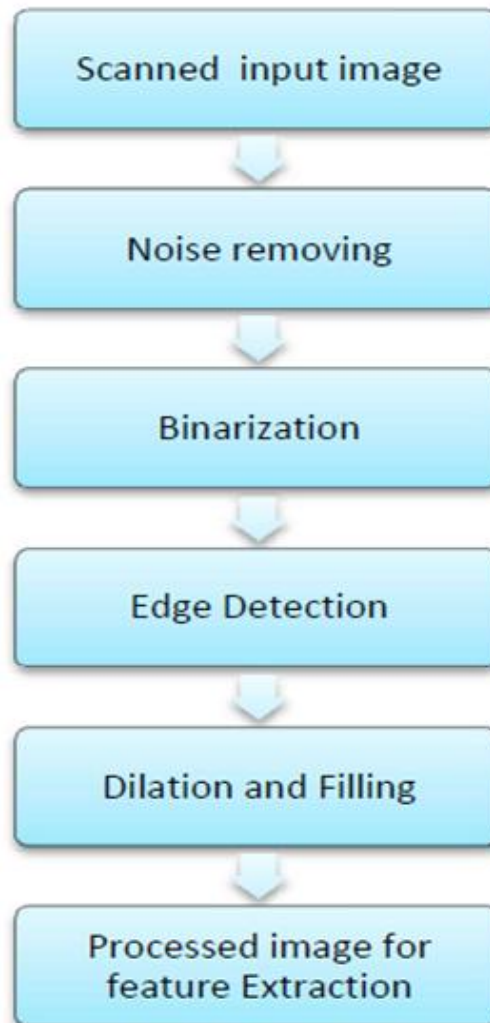


Fig. 8 Pre-processing stages of Handwritten Character

In [4], firstly text blocks are detected, then text lines are detected by horizontal scanning. Then segmentation of line is done on the entire page to find all the lines. At last words and then individual characters are segmented. After segmentation, each word is separated individually that makes the recognition easier.

2. FEATURE EXTRACTION METHOD-

The extraction methods which are used to extract and classify the features of the characters.

4.3.1 Feature extraction method-

In [2], each character image of random size is divided into 54 equal zones, each of 10×10 pixels. Then features are extracted from each zone by moving along the 19 diagonals.

The 19 sub-features are averaged to form a single feature for each zone as shown in fig. 10. In addition 9 and 6 features are obtained by averaging the value of rows and columns.

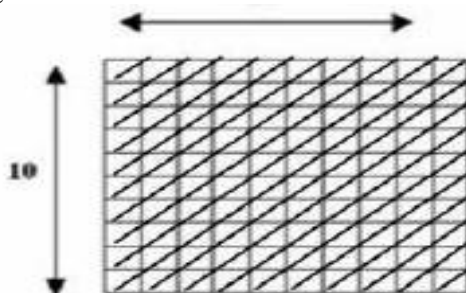


Fig. 9 Features extracted diagonally

So, in this every character is represented by 69 features.

4.3.2 Point-float feature-

This feature extraction method is described in [5] consider the 5- feature component at point (x,y)-x-value, y-value, sin(θ) ,cos(θ) normalized in the range

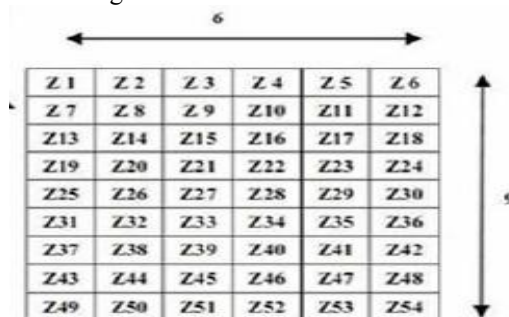


Fig.10 Features of all zones

0-10, status of the pen. In this, θ is the angle between x-axis and the line and status of the pen is either 1 or 0, if the trace terminates at (x,y) then the status is 0 otherwise 1. By this method, it produces a feature vector of length 300.

These methods improve the recognition rate and reduce the misclassification.

3. RECOGNITION/CLASSIFICATION METHODS-

The decision making part of a recognition system is the classification stage and it uses the features extracted from the previous stage. There are various methods which are used by different researchers defined below-

4.4.1 Artificial neural network-

It is the information- processing model. In Neural Network, each node performs some computation and associated with weight which conveys a signal from one node to another. Learning algorithms are used to determine the values of the weight at the output. It[1] implements a standard Back- propagation network and Widrow-Hoff learning rule to the multiple layers of the network. To train a network, input vectors and their corresponding output vectors are used.

The other method [2] uses the feed forward back propagation neural network having two hidden layers. The no. of input neurons are determined by the length of the feature vector and the hidden layers use log sigmoid activation function. At the output layer, the character is to be identified.

Total Input $y_{in} = x_1w_1 + x_2w_2 + \dots + x_nw_n$

$$\sum_{i=1}^n x_i w_i$$

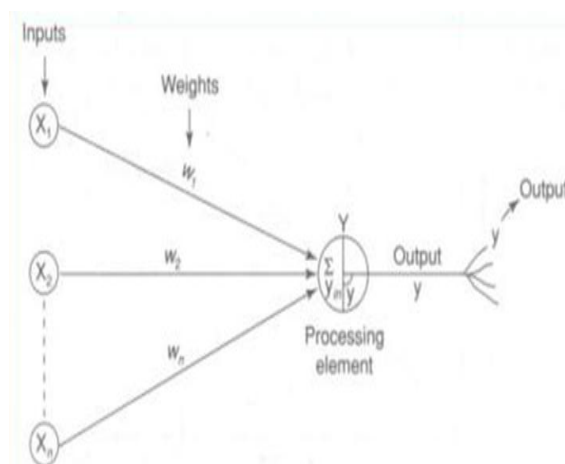


Fig. 11 Artificial Neural Network

OUTPUT $y = f(y_{in})$ // applying activation function

where $x_i =$ input
 $w_i =$ weight associated to the input

4.4.2 Multilayer perceptron classification-

Popular neural network used in Handwritten recognition is multilayer perceptron trained by the back propagation network [5]. In this, one hidden layer consists of large no. of nodes and select random value of learning rate and momentum factor. The issues of using MLP include selection of architecture and values of different learning parameters of Back propagation Algorithm.

IV. OBSERVATION

Artificial neural network classification method consistently provide better recognition accuracy as compared to the other two classifiers in [5] and this is true irrespective of the feature vector and database.

When we use Back-propagation Network [1], accuracy is increased by increasing no. of cycles, no. of hidden layers, large no. of neurons in hidden layer and increasing the training set.

In devanagari script, there is a challenging problem if the size and shape of devanagari vary. Characters in devanagari script are joined together using Shirrekha. When people doesn't use Shirrekha, then it will be difficult to apply Skew Detection on words of Devanagari.

V. CONCLUSION

The back-propagation neural network discussed in this review paper can also be used for image recognition applications such as face detection and fingerprint detection but it cannot handle major variations in translation, rotation or scaling.

Hindi is the national language of India and is world's third most popular language after English and Chinese. There is a great scope of research in the area of Devanagari Character Recognition for future research. It is noted that the errors in recognizing Handwritten Devanagari characters are mainly due to incorrect character segmentation of touching or broken characters. Because of upper and lower modifiers of Devanagari text, many portions of two consecutive lines may also overlap and proper segmentation of such overlapped portions are needed to get higher accuracy.

VI. FUTURE WORK

Future work that can be done on the issues of segmentation ambiguity and character shape variability. The errors in recognizing Devanagari characters are mainly due to incorrect character segmentation of touching

or broken characters. Proper segmentation and the use of dictionary words are needed to reduce the misclassification and get the higher accuracy.

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