

# DEVNAGRI SCRIPT RECOGNITION USING ARTIFICIAL NEURAL NETWORK CLASSIFIER

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## Abstract

In India, Devnagari script is used by 500 million people and more. Now-a-days Special attention is given to Devnagari so that examination or investigation of ancient Indian literature can be done efficiently. The paper focus on the innovative methods for stepwise segmentation line segmentation and segmentation of character which are overlapping characters of Devnagari text. The steps followed to complete the process initially the character are segmented into lines, lines into words and then from each line the header lines of words are detected and then transformed as straight lines. Finally artificial neural network is used for classification.

**Keywords:** Devnagari, Backpropagation, and Blob Analysis.

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## 1. INTRODUCTION

Devnagari script is a type of Hindi script which is widely used in India. Millions of people use it in daily conversation also. The main focus in now-a-days is to make automatic detection of the script, fortunately image processing has that much advancement so that a system can be developed with the aim of detection or recognition of a script. The main step focused in this system would be segmentation of the printed text. Number of research are done for segmenting of English script among them some are like Hough transform based method [3]; smearing method [4]; grouping method [5]; graph based method [6]; CTM (Cut text Minimum) approach [7]; Block covering method [8]; linear programming method [9] and curve based [15].

Segmentation is basically divided into three major steps such as first is line segmentation, second is word segmentation and third is character segmentation. These three steps are to be done in a proper manner so as to process each letter and train the system. If any of the step fail in processing line segmentation then complete segmentation process works improper.

This paper is organised section wise where the first section consist of introduction to the topic and the need of the system designed in this research work. Second section consist of the methodology used to design the system, all the steps are discussed in details. Third section consist of the result analysis where the final obtained result are analysed and compared. Lastly the fourth section is of conclusion.

### 1.1 A Review: Hindi Language

Approximately 500 million population speaks all over the world. Hindi is considered as the world's mostly used language after Chinese and English. The Devnagari script is written in left to right format along a horizontal line. The set

of basic character consist of 13 'SWARS' called as 'VOWEL' and 33 'VYANJANS' known as 'CONSONANTS' as shown in the figure 1.

### Learn Consonants



Figure 1: Set of Character for Devnagari script

## 2. METHODOLOGY

Presented method is Optical Character Recognition using sequential segmentation of line, word and letter then the feature extraction based on image processing technique and lastly the classification using neural network. In the proposed system currently the dataset used is of total 39 character by which the system is trained.

### A. Pre-processing

According to the standard process each image is pre-processed and then segmentation is carried on it, to make them noise free. Some Pre-processing methods are discussed in [9] for the initial stage of character recognition.

**1. RGB to Gray scale conversion:** The data used in the research are generally captured and stored in a file of picture elements, called pixels. The stored image can be in any format among JPEG images, BMP, TIFF etc which is in RGB format.

The RGB format defines the image having values from 0-255 with all the three color channel i.e. red, green, blue. The binary conversion makes the image pixels values into 0/1. While the gray conversion makes the image pixel values be in the range of 0-255 but for only one channel.

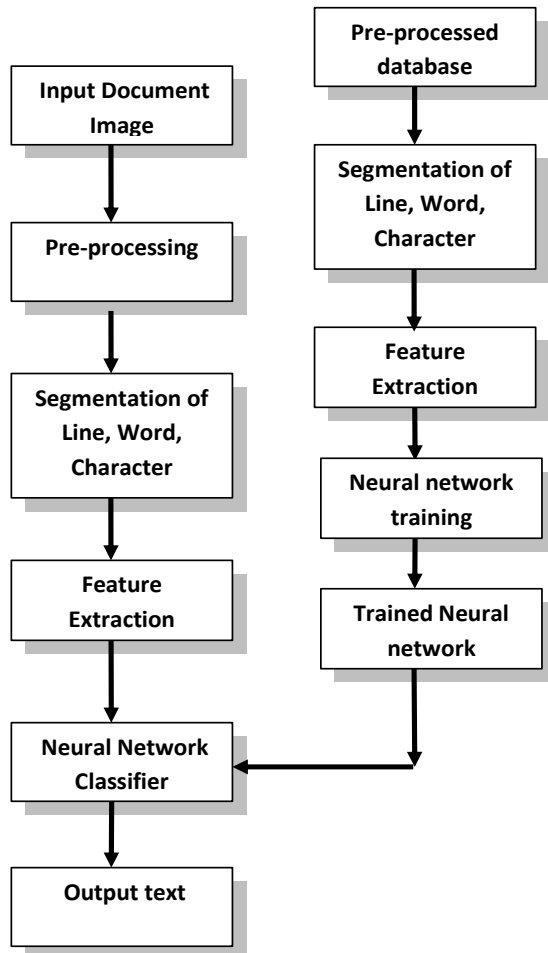


Figure 2: Complete Flow of the system stepwise.

**2. Thresholding/Binarization:** The binarization is the process in which the input image is converted into the black (0) and white (1) pixels. The conversion is done using the threshold level calculated by using Otsu's threshold technique. The input for this step is gray scale image.

**3. Noise reduction:** The noise is introduced due to the scanning device or the printing instrument which causes disconnected line segments, bumps and gaps in lines, filled loops etc. The distortion including local variations, rounding of corners, dilation and erosion, is also a problem. Prior to the character recognition, it is necessary to eliminate these imperfections [15]. Noise Reduction techniques can be categorized as (a) Filtering (b) Morphological operation (c) Noise modeling.

**a) Filtering:** Normally, Gaussian Filtering is used as primary filter in character segmentation techniques. This smoothens the input text image leading to noise elimination and textual part enhancement..

**b) Morphological operation:** Visual perception needs transformation of images so as to make neglect some particular shape information. The main principle Distinguish meaningful shape information from irrelevant one. The vast majority of shape processing techniques and analysis techniques are based on designing a shape operator which satisfies advantageous properties. The elementary two steps in mathematical morphology operations are Erosions and dilations. More complicated mathematical morphology operators can be designed by means of combining erosions and dilations in combinations.

#### Dilation

The *dilation* is performed using the structuring element which is nothing but the pattern of pixels.

$$A \oplus B = \{s | (B)_s \cap A \neq \emptyset\}$$

#### Erosions

The *erosion* process is similar to dilation, but we turn pixels to 'white', using the structuring element

$$A \ominus B = \{s | (B)_s \subseteq A\}$$

Use of logical calculations is the main strength of morphological operation. Connection of weak strokes and smoothing of contours are some of the advantages by these operations [13].

**c) Noise modelling:** Prediction of noise is a very difficult task but can be achieved by various calibrating techniques. In this study the speckle noise and salt and pepper noise present in document images is removed by MATLAB filtering functions.

**d) Segmentation:** Segmentation is of dividing the complete into small images so as to make it easy for processing. In this process the region of interest is also separates out using different image processing techniques. Segmentation is essential stage in Character recognition system. In this proposed system the segmentation method used is blob analysis. The basic principal of blob analysis is to divide the image into small parts and then make that segmented part ready for the feature extraction input. Hence the blob analysis is subdivided into basic three processing step as follows:

1. Separating the text line in the pages.

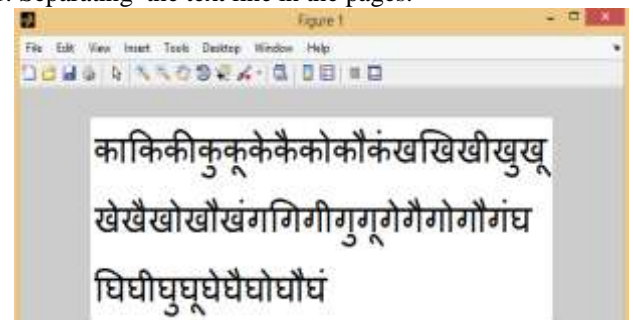


Figure 3: Input image after pre-processing

2. Separating the word in individual line [11]

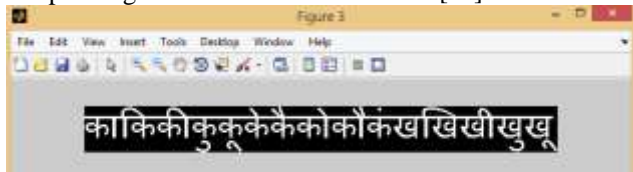


Figure 4: Input image after segmenting a single line

3. Finally Separating individual character in each word[10].

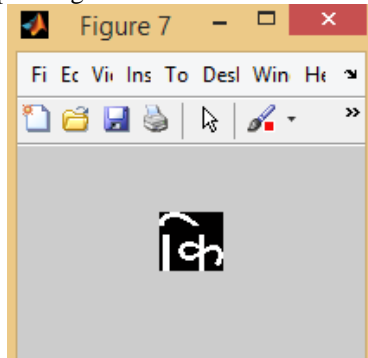


Figure 5: Input image after segmenting a word

The result image after performing segmentation is a set of segments that combined together cover the whole image,

**a) Thinning:** Thinning is the process used for making the boundaries of the selected region more prominent for segmentation and further processing.

**B. Feature extraction:** Features extraction is the process to store some key pixel values of each segmented letter. Which finally creates a set of training data. This training data is further used for classification of the input letter. The feature extraction process calculates a feature vector by calculating the Transform the thinned image of size 42x24 into a one-dimensional 1008x1 vector form. This formed vector it fed as an input to the backpropagation neural network for training and recognition purpose.

**C. Classification:** Classification is the last stage of the proposed method flow. Where the main decision making is done of proposed character recognition system. The classification phase is basically dependent on the how efficiently the features are extracted in the previous stage for deciding the input character belongs to which class or type. In the proposed system Neural network(NNs) [13] [14] is used for classification purpose. The character set to be recognized define the complexity of the character recognition problem. Template matching is a technique which is used for printed text recognition. But a great disadvantage of this method is that it gives more accuracy when applied on English script as compared to the Devnagri script [13]. Hence most widely used and accepted techniques is Neural Network for character recognition. This research work implements the classification and recognition of printed Hindi Vowels and Consonants using Artificial Neural Networks.

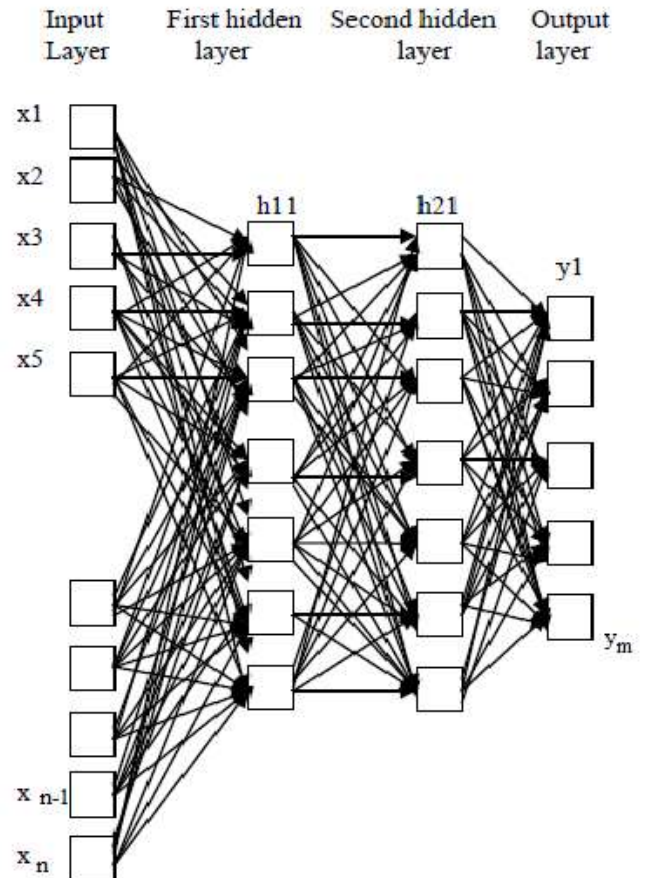


Figure 5: Backpropagation network diagram used for the proposed system

**Recognition Using Backpropagation Neural Net:**

The main implementation of neural network was done on creating the backpropagation neural network. Using MATLAB 2014a this backpropagation neural network was created and the following parameters were used to train the net:

Table 1: Backpropagation parameters

1 <sup>st</sup> layer Transfer function	<i>logsig</i>
2 <sup>nd</sup> layer Transfer function	<i>logsig</i>
Training function	<i>traingdm</i>
Maximum number of epochs	20
Performance function	Sum-Squared Error performance function
Mu	0.95
Error goal	0.1
number of hidden layers	2
number of input layers	1008
number of output layers	39

When one of the following conditions occurs training stops:

- (i) The time when the maximum numbers of epochs is gained.
- (ii) Performance is minimized to the goal.
- (iii) Mu exceeds the maximum value.
- (iv) Number of validation checks exceeds the maximum value.

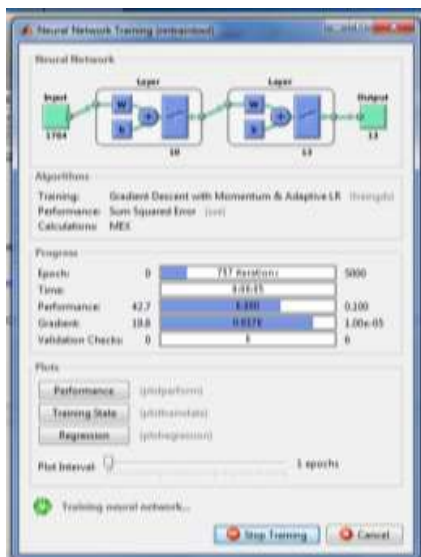


Figure 6 Neural network output

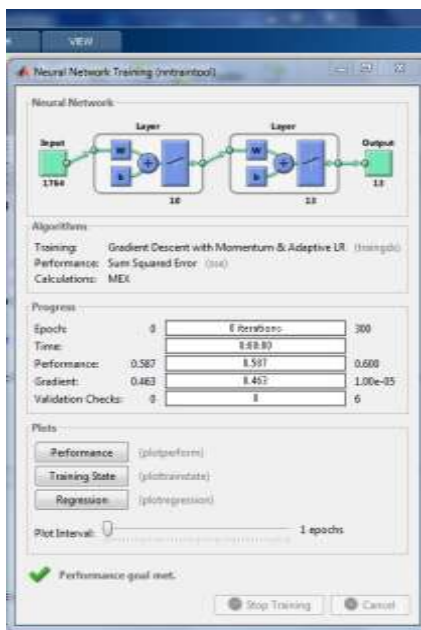


Figure 7 Neural network output



Figure 8 final output images

### 3. RESULTS ANALYSIS

The complete process as discussed above was performed on the dataset used. Hence the training of the system was done by this way. The testing was performed by giving the printed Devnagri script in two types : first on all the individual letters and then secondly on the sentences. For the letters the accuracy of individual character recognition is 95% while working on the sentence the accuracy decreased by few count. The final accuracy for sentence as input and the proposed method is 90%

Table 2: Comparison table

S. No	Method proposed by	Features Extracted	Classifier Method	Comparison points	Accuracy obtained
1	Surendra. P. Ramteke [17]	GLCM, color domain	ANN	Basic features of characters presentation namely, loop, line, and Location of loop and line connection.	89.53%
2	Divakar Yadav [05]	Mean distane Pixel value	ANN	Less modifiers are used. Paragra-ph recognition accuracy is less	85%
3	Dr G.S Sable[20]	moment invariant	ANFIS	Not possible to represent feature of all character	95%
4	Kasturi S. Upasani	Intensity features in the form of templates	ANN	Intensity features with a combination of backpropagation Neural Network classifier overcomes above discussed drawbacks	90%

Compared to previous work more detailed and accurate feature extraction is done by using MATLAB toolbox function which proved to be efficient. Neural Network parameters are fined tuned to for complete use of ANN. Various types of modifiers are used. Concept of shirolekhya removal is included. This results into more accurate recognition of Devnagri Script. The proposed work can also handle composite words.

### 4. CONCLUSIONS

The Devnagri script recognition can be done efficiently by segmentation, feature extraction and classification techniques. Neural network classifier used for our dataset and segmentation method 90% accuracy that is more accuracy as compared to other classifiers and hence is used for Devnagri Script Recognition.

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