Optical Character Recognition (OCR) for Printed Devnagari Script Using Artificial Neural Network

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ABSTRACT-There are about 300 million people in India who speak Hindi and write Devnagari script. Research in Optical Character Recognition (OCR) is popular for its application potential in banks, post offices, defense organizations and library automation etc. However most of the OCR systems are available for European texts. In this paper, we have proposed a technique for OCR System for different five fonts and sizes of printed Devnagari script using Artificial Neural Network. The recognition rate of the proposed OCR system with the image document of Devnagari Script has been found to be excellent.

Index Term- OCR, Preprocessing, Segmentation, Feature Extraction, Classification, ANN, Skew Detection and Correction.

1.INTRODUCTION

With the advent of devlopment in computer power machine simulation of human reading become important topic of research Optical Character Recognition is a phenomenon by which we can convert printed document or scanned page to ASCII character or some other standard code like unicode that can be recognized by computer. Lot of research is done in developed countries But still there is need to carry out research in indian language there are two approaches to recognize isolated devnagri words. 4 first is to segment the word into its character part and individually recognize the character. The major drawback of this approach is Devnagari script word contains mantras ,shirorekha conjuct characters, modifiers and lack of benchmark database to train classifier . The second scheme is to recognize word in its entirety the recognizer are complex if it is general purpose and simpler if it is for specific lexion. The document image itself can be either machine printed or handwritten, or the combination of two. The speed of input operation is improved and decrease some possible human errors by using computer system equipped with such an OCR system. Recognition of printed characters is itself a challenging problem since there is a variation of the same character due to change of fonts or introduction of different types of noises. If preprocessing, feature extraction and recognition are not robust then recognition task difficult due to difference in font and sizes There may be noise pixels that are introduced due to scanning of the image. Besides, same font and size may also have bold face character as well as normal one. Thus, width of the stroke is also a factor that affects recognition. Therefore, a good character recognition approach must eliminate the noise after reading binary image data, smooth the image for better recognition, extract features efficiently, train the system and classify patterns. Till now there is no complete OCR for printed Devnagari Script which gives 100% success rate.

In this paper, we present a scheme to develop complete OCR system for different five fonts and sizes of Devnagari characters so that we can use this system in Banking and Corporate sectors. Steps of the OCR have being implemented by us in the system like preprocessing, segmentation, feature extraction and classification. In preprocessing step it is expected to include noise removal, skew detection & correction. After finding out the feature of the segmented characters artificial neural network (ANN) [1], [3] and [4] will be used for classification purpose. Efforts have been made to improve the performance of character recognition using artificial neural network techniques. The proposed OCR system shall be capable of accepting document images from a file or from a scanner directly. Recognized characters can also be displayed and edited.

2. DESIGN OF OCR

Various approaches used for the design of OCR systems are discussed below:

Matrix Matching: Matrix Matching converts each character into a pattern within a matrix, and then compares the pattern with an index of known characters. Its recognition is strongest on monotype and uniform single column pages.

Fuzzy Logic: Fuzzy logic is a many-valued logic in which truth value of variable may be any number between 0 and 1inclusive, between conventional evaluations like yes/no, true/false, black/ white etc. An effort is made to get a more human-like way of logical thinking in the programming of computers. Fuzzy logic is used when answers do not have a distinct true or false value and there is uncertainly involved. It is employed to handle the concept of partial truth, where truth value may range between completely true and completely false.

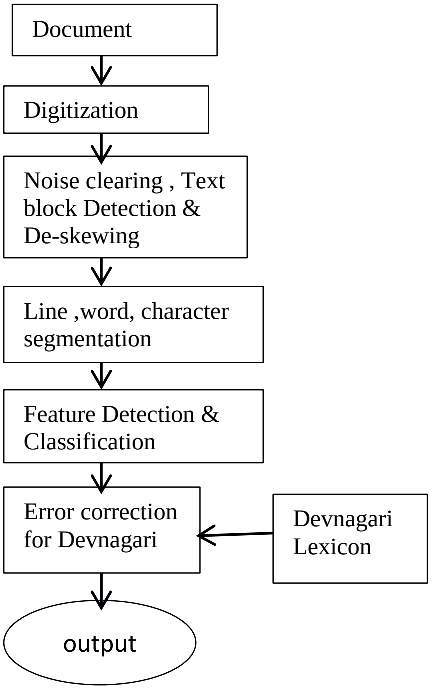
Feature Extraction: After preprocessing features relevant to classifier are extracted from the smoothened image . extracted features are organized in database which is input for recognization phase of classifier. This method defines each character by the presence or absence of key features, including height, width, density, loops, lines, stems and other character traits. Feature extraction is a perfect approach for OCR of magazines, laser print and high quality images.

Structural Analysis:-Identification of character can be done in structural Analysis by examining their sub features- shape of the image, sub-vertical and horizontal histograms. . Its character repair capability which removes certain type of information from it is excellent for low quality text and news prints.

Neural Networks: This strategy implement the way the human neural system works. It samples the pixels in each image and matches them to a known index of character pixel patterns. The ability to recognize characters through abstraction is challenging for faxed documents and damaged text. Neural networks are ideal for specific types of problems, such as processing stock market data or finding trends in graphical patterns.

2.1. Structure of OCR Systems

Diagrammatic representation of the structure of an OCR system is given in figure 1.


Document
Digitization
Noise clearing , Text block Detection & De-skewing
Line ,word, character segmentation
Feature Detection & Classification
Error correction for Devnagari
Devnagari Lexicon
output

2.2. Stages in Design of OCR Systems

Various stages of OCR system design are given in figure 2.

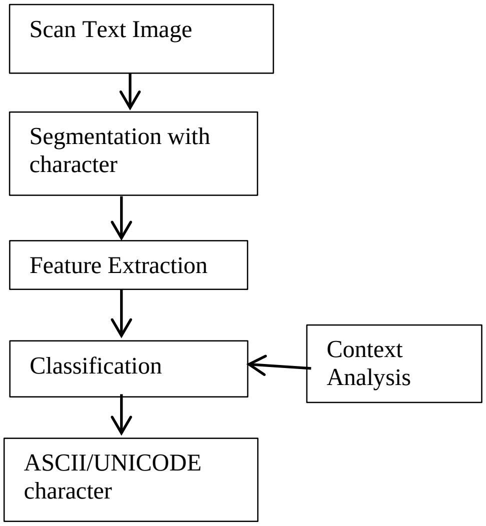


Fig 2: Stages in OCR Design

2.3. Reasons for Poor Performance of OCR Systems

Existing OCR systems generally show poor performance for documents like old books: print and paper quality inferior due to aging, Copied Materials: documents like photocopies or faxed documents, where print quality is inferior to the original, News papers: generally printed on low quality paper etc.

For such degraded documents, the system recognition accuracy comes down to 80- 90%. But if we want to use the OCR system for Banking and Corporate sector, this accuracy rate is not up-to-mark.

Devnagari is most popular script to write Hindi as well as Sanskrit, Marathi, Sindhi, and Nepali language with minor modifications

3. PROPOSED OCR SYSTEM

Following steps have been followed in the design of proposed OCR system:

- Preprocessing;
- Segmentation;
- Feature Extraction;
- Classification.

3.1. Preprocessing

Preprocessing aims to produce data that are easy to OCR system to operate correctly In the proposed OCR system, text digitization is done by a flatbed scanner having resolution between 100 and 600 dpi. The digitized images are usually in gray tone, and for a clear document, a simple histogram based threshold approach is sufficient for converting them to two tone images. The histogram of gray values of the pixels shows two prominent peaks and middle gray value located between the peaks is good choice for threshold. For salt and pepper noise we generally use median filter Median filter replace the value of pixel by median of gray levels in neighborhood of that pixel. (the original value of the pixel is included in the computation of the median), Median filters provide excellent noise reduction capabilities, with considering less blurring than linear smoothing filters of similar size as shown in figure 3 and 4.

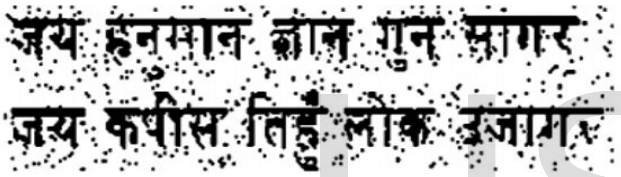

जय हनुमान ज्ञान गुन सागर
जय कपीस तिहुँ लोक उजागर

Fig 3: Image with Salt and Pepper Noise

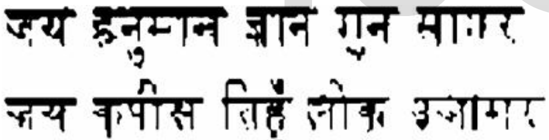

जय हनुमान ज्ञान गुन सागर
जय कपीस तिहुँ लोक उजागर

Fig 4: Image without Salt and Pepper Noise

Derivative operator enhances edges and other discontinuities (noise) and deemphasizes area with slowly varying gray level values.

3.2. Segmentation

Segmentation is one of the most important phases of OCR system. By applying good segmentation techniques we can increase the performance of OCR. Segmentation technic allows recognizer to extract feature from each individual character. It subdivides an image its constituent regions or objects. Basically in segmentation, we try to extract basic constituent of the script, which are certainly characters. This is needed because our classifier recognizes these characters only.

Segmentation phase is also critical in contributing to this error due to touching characters, for classifier it is difficult to deal with this error. Even in good quality documents, some adjacent characters touch each other due to inappropriate scanning resolution. Numbers of constituent characters touching each other in Devnagari and Bangla scripts are shown in table 1.

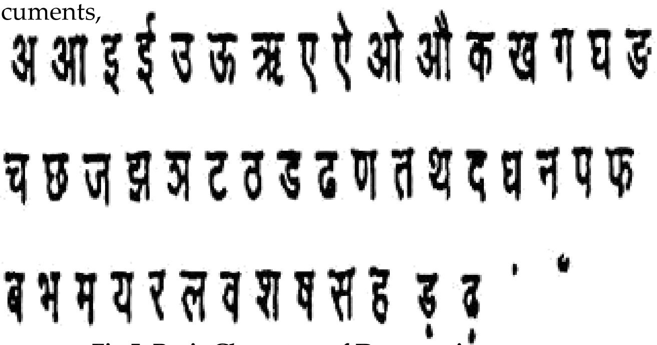

अ आ इ ई उ ऊ ऋ ए ऐ ओ औ क ख ग घ ङ
च छ ज झ ञ ट ठ ड ढ ण त थ द ध न प फ
ब भ म य र ल व श ष स ह ड़ ढ़

Fig 5: Basic Characters of Devnagari

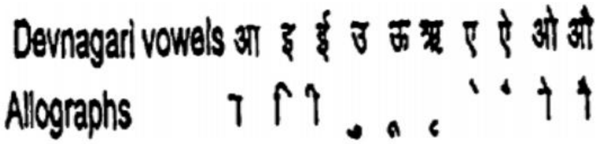


Fig6: Vowels Modifiers of Devnagari

Table 1
Constituent Characters Touching each other

Script	*Touching Characters*	*An Image of Touching Characters of Consists*		
		Two	*Three*	*Four*
Devnagari	11577	11183 96.6%	394 3.4%	nil
Bangla	16714	15277 91.4%	953 5.7%	484 2.9%

To overcome the touching characters in Devnagari documents, at first, we attempt to identify the touching characters. Next, they are segmented into constituent ones using a fuzzy decision making approach.

Basic characters and vowels modifiers of the Devnagari are shown in figure 5 & 6.

As shown in figure 7, in Devnagari script, there is no concept of uppercase and lowercase in Devnagari script It is phonetic and syllabic script,word are written as they are pronounced. Words are written using Consonants and vowels .Presence of horizontal line at the top of character is specific feature of Devnagari script. This line is known as header line and denoted as shirorekha.

a text word may be divided into three zones. The upper zone denotes the portion above the headerline, the middle zone covers the portion of basic and compound characters below the headerline, and the lower zone may contain where some vowel and consonant modifiers can reside. For a long number of characters (basic as well as compound) The imaginary line separating the middle and lower zone may be called the base line

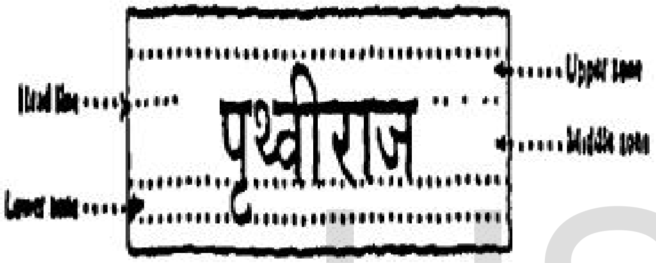


Fig 7: Partitioning of a Text Word into Zones

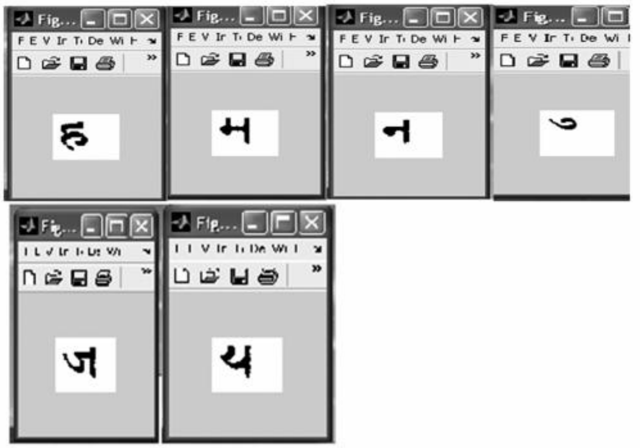
Line, Word and Character Segmentation: Once the text blocks are detected, the OCR system automatically finds individual text lines, segments the words, and then separates the characters accurately.

Segmentation of Line: For segmentation of line, we scan scanned document page horizontally from the top to find initial darker pixel. Then we find the first row containing entire white pixel just after the end of black pixels. Thus first line is detected. We repeated this process on entire page to find out all lines.

Segmentation of Words: After Detecting a particular line we separate individual words. This is done by vertical scanning.

Segmentation of Individual Characters: Once we get the words we segment it to individual characters. Before segmenting words to individual characters, we locate the head line. This is done by finding the rows having maximum number of black pixels in a word. After locating head line we remove it i.e. converts it in white pixels. After removing head line our word is divided into Three horizontal zones known as upper zone ,middle zone and lower zone. Individual character are segmented by vertical scanning.

Output of segmentation algorithm is shown in figure 8.



3.3. Classification

Classification is performed based on the extracted features. Here we are using ANN approach.

For initial classification of characters, we consider three features as follows:

- Mean Distance;
- Histogram of projection based on spatial position of pixel;
- Histogram of projection based on pixel value.

ANN Approach for Classification: Artificial Neural Network approach has been used for classification and recognition. Where the problem is complex and data is subject to statistical variation The. computational model widely used in situation is Artificial neural network model.. Training and recognition phase of the ANN has been performed using conventional back propagation algorithm with two hidden layers. The architecture of a neural network determines how a neural network transfers its input into output. This transfer can be viewed as a computation

3.4. Feature Extraction

Feature extraction is one of the most important steps in developing a classification system. This step describes the various features selected by us for classification of the selected characters.

Classification based on the above three features has been shown in figure 9(a), 9(b) & 9(c).

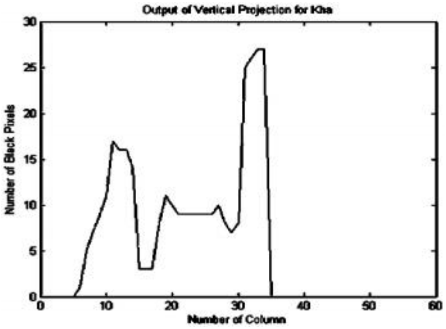


Fig 9(a): Output of Vertical Projection of Kha

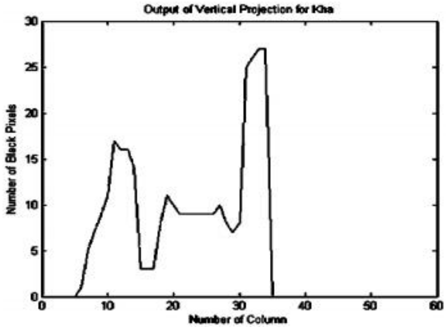


Fig 9(b): Output Fig of Mean Feature Vector of Kha

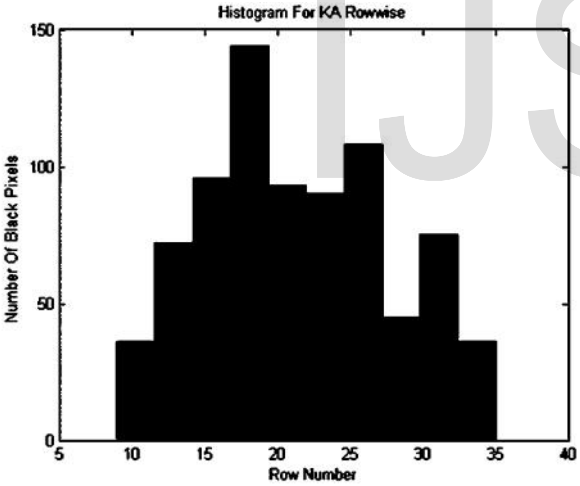


Fig 9(c): Histogram of KA Rowwise

4. RESULTS AND DISCUSSIONS

The experiments have illustrated that the artificial neural network concept can be applied successfully to solve the Devnagari Optical Character Recognition Problem. There are many factors that affect the performance of OCR system for Devnagari Script. It is concluded that the input matrix of size 48X57 gives better results than other choices. The recognition rate of OCR system with the image document of Devnagari Script is quite high as shown in the output.

However, other kinds of preprocessing and neural network models may be tested for a better recognition rate in the future research in OCR System. Character segmentation method which is incorporated in this paper could be improved to handle large variety of touching characters that occur often in images obtained from inferior-quality documents. The test set used in this experiment is of 77 characters of five different types of fonts. This can be increased for better results. The toughest phase in the experiment is getting a good set of characters for classification.

5. FUTURE SCOPE OF WORK

Future enhancements that can be done on this paper include use of a dictionary of words to correct the output [8]. Implementing use of dictionary words may improve the performance of OCR system. One can also implement the project for classifying hand-written text. Segmentation of characters in hand written documents is very complex as compared to printed documents. Multi factorial Fuzzy System can be used for segmenting the characters in hand written documents.

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