

Development of ANFIS based offline classifier for Handwritten Devanagari Script recognition

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Abstract— Hindi is the most popular language in India and the world's third most commonly used language after Chinese and English. Hindi script presents great challenges to design due to the large no of letters present in the script and the sophisticated way, in which they combine. Automatic recognition of handwritten characters [1] has long been a goal of many research efforts in the pattern recognition field. In this paper, we deal with the recognition of handwritten Devanagari Script using Adaptive Neuro-fuzzy Inference system. The proposed system will achieve good recognition rate. In the classifier module the adaptive Neuro-fuzzy inference system (ANFIS) will be investigated, as some research has been done for printed text but negligible in handwritten characters and words of different user. The number of training and testing images will be tested to evaluate the performance of the recognition system

Index Terms— OCR, ANFIS, Neural network ,Fuzzy logic.

I. INTRODUCTION

Handwriting recognition is the ability of a computer to receive and interpret intelligible handwritten input from sources such as paper documents, photographs, touch screens and other devices. The image of the written text may be sensed "off line" from a piece of paper by optical scanning (optical character recognition) or intelligent word recognition. Handwriting Recognition has been one of the most fascinating and challenging research areas in field of image Processing and pattern recognition in the recent years.

There are two types of OCR namely On-line and Off-line character recognition[2] system based on the data acquisition process. On-line recognition system also known as dynamic or real time recognition which obtains the position of pen or captures temporal or dynamic information of number and order of each of stroke of character, directly from the interface while typing or writing itself. After completion of writing or printing task, the Off-line character recognition is carried out. The scanned copy of handwritten or printed character is used as input to the recognition system. The main difference between the On-line and Off-line character recognition is that On-line recognition has real time, contextual information but Off-line character Devanagari recognition [3] systems don't have that information. Character recognition systems are further classified into machine printed and handwritten recognition systems based on the type of text. Handwritten character recognition system is mainly motivated to improve man and machine communication. Off-line handwritten recognition system is very hard and complex. In case of cursive writing, the recognition process becomes even harder. Handwritten characters tend to show large variation in basic shape of characters due to the factors like width of pen, pen ink type, accuracy of recognition device and location of character in word.

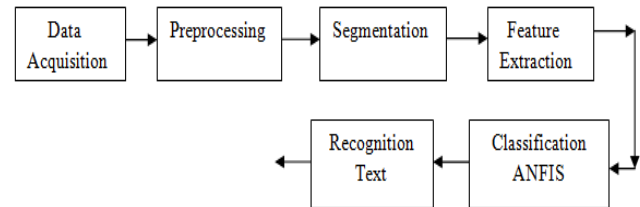


Fig. 1 Block Diagram of Recognition System

Data Acquisition:

Data acquisition is the first phase in any image processing or pattern recognition task. We have designed special kinds of forms to collect the handwritten samples from the writers. The form contains different boxes in which a writer has to write all the name of the cities and compound characters words in the lexicon in a specified order. Most of the writers were from the age group 16 to 25. There was no restriction imposed on the writer regarding the style and speed of writing.

We collected data from writers belonging to diverse population strata. They belonged to different age groups, genders, educational backgrounds professions. Hundred writers participate in this experiment. In order to collect their personal information and handwriting samples we designed two forms. The data base as shown in Figure 1 is for words that contains name different cities of Madhya Pradesh. The last block is reserved for writer information where every writer wrote his/her name, profession, signature and date of writing.

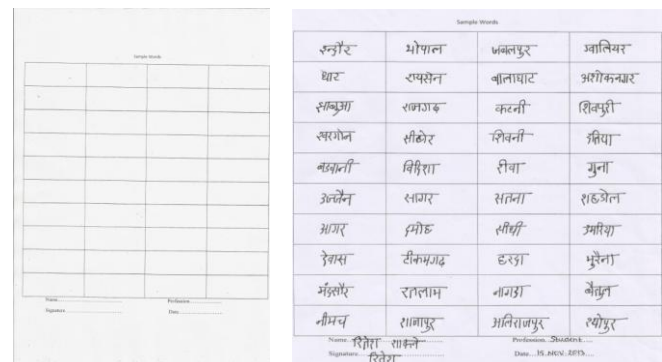


Fig.2 Sample Form → Scanned Images

Digitization

Digitization is a process to convert printed documents into digital images. It is done by scanning the documents using a scanner. To scan the documents Deskjet Scanner is used with a resolution of 300 dots per inch (dpi). The scanner converts the hard-copy of document into gray-scale images.

Sample Words			
इन्दौर	भोपाल	जबलपुर	ज्वालियर
धार	रायसेन	बालाघाट	अशोकनगर
झाबुआ	राजगढ़	कटनी	शिवपुरी
खरगोन	सीहोर	शिवनी	उतिघा
बडवानी	बिहिरा	रीवा	गुना
उज्जैन	सागर	सतना	शहडोल
आगर	इमोह	सीधी	उमरिया
देवास	टीकमगढ़	हरडा	भुरैना
मंडलौर	रतलाम	नागडा	बैतुल
नीमच	शामापुर	अनिराजपुर	श्यापुर
Name: रितीरा शास्त्री		Profession: शिक्षक	
Signature: रितीरा		Date: 15.05.2015	

FIG. 3 SCANNED IMAGE OF DATA BASE

Preprocessing

Preprocessing [4] is an important step of applying a number of procedures for smoothing, enhancing, filtering, etc. for making a digital image usable by subsequent algorithm in order to improve their readability for optical character recognition software. The system performs character recognition by exploring the feature matching for its ability to recognize handwritten Devanagari Script. After performing the algorithm words written by different user are collected in the single folder.

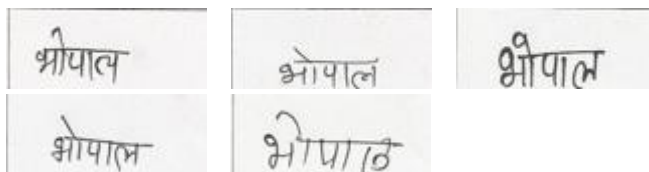


Fig. 4 Image collection after preprocessing

Binarization

Since the information contained in the text image is bi-level (text and background), we convert the gray scale images into binary images, and this process is called binarization. Binarization should be done carefully; otherwise it may lead to breaks in characters.

Normalization

Normalization is applied in order to get characters of uniform size. It provides a tremendous reduction in data size. Each segmented character is normalized to fit within suitable matrix like 32x32 or 64x64 so that all characters have same data size.

Filtering of Binary Image

Noise reduction (also called smoothing or noise filtering) is one of the most important processes in image processing. Median Filter is used in this study due to its edge preserving feature. Now next step is removal of spikes present the noise median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges free image. Median filtering is a nonlinear operation often used in image processing to reduce "salt and pepper" noise.

Segmentation

Character segmentation is an operation that seeks to decompose an image of a sequence of characters into sub images of individual symbols. It is one of the decision processes in a system for character recognition. Its decision, that a pattern isolated from the image is

that of a character (or some other identifiable unit), can be right or wrong. It is one the most important process that decides the success of character recognition technique. It is used to decompose an image of a sequence of characters into sub images of individual symbols by segmenting lines and words.

Feature Extraction

Feature extraction [5] and selection can be defined as extracting the most representative information from the raw data, which minimizes the within class pattern variability while enhancing the between class pattern variability. For this purpose, a set of features are extracted for each class that helps distinguish it from other classes, while remaining invariant to characteristic differences within the class. Feature extraction using chain coding is done.

Adaptive Neuro-Fuzzy Inference System(ANFIS)

Adaptive Neuro fuzzy inference system (ANFIS) [6] is a kind of neural network that is based on Takagi– Sugeno fuzzy inference system. Since it integrates both neural networks and fuzzy logic principles, it has potential to capture the benefits of both in a single framework. Its inference system corresponds to a set of fuzzy IF–THEN rules that have learning capability to approximate nonlinear functions. Hence, ANFIS is considered to be universal approximator. Here we have used ANFIS for recognition. We used two parameters x and y as input and output by using segmentation and feature extraction data. Then we set Membership function (MF) and type of Membership function. After setting the epoch number, we train data and get output as recognized character. Neuro-fuzzy systems being the first and probably the most successful hybrid approach till now. Neuro-fuzzy[7] systems incorporate the elements from Fuzzy logic (FL). AND Neural Hybrid approaches could be considered as one of the main contributions of soft computing with Networks (NN). This idea of hybridization originates from two observations:

1. Fuzzy systems neither capable of parallel computation, whereas these characteristics are clearly attributed to NNs.
2. NNs lack flexibility human interaction which lies at the core of FL. Thus we have used ANFIS for classification purpose. In Fuzzy logic and Neural Networks, we have to adjust weights and Number of hidden layers in order to achieve approximate 100% accuracy. So, Neural network and Fuzzy logic are not capable to get approximate 100% accuracy. So, we are using Neuro-fuzzy integrated system to achieve approximate 100% recognition rate.

II. PROPOSED METHODOLOGY AND DESCRIPTION

The scanned image of a handwritten Hindi document is first binarized. The binary image is used for line, word and character segmentation. Features extracted from segmented characters are fed to a classifier that gives the class labels. Based on the classifier outputs, Unicode is generated and output text is displayed. Segmentation of an images following by Chain Code for Feature Extraction and later training phase for performing decision using Adaptive Neuro Fuzzy Inference System

Now the proposed methodology has applied which shows the improved results as compared to previous techniques, the proposed methodology known as ANFIS using Tree Classifier with Template Matching. In this method instead of single character whole character is being recognized with accurate recognition rate, it has potential to capture the benefits of both in a single framework. Its inference system corresponds to a set of fuzzy IF–THEN rules that have learning capability to approximate nonlinear functions. Hence, ANFIS is considered to be universal approximator. Template matching[8] is the simplest approaches to pattern recognition. In this approach a prototype of the pattern that is to be recognized is available. Now the given pattern that is to be recognized is

compared with the stored patterns. The size and style of the patterns is ignored while matching.

III. RESULT AND SIMULATION

GUI (Graphic user Interface): MATLAB supports developing applications with graphical user interface features. It also has tightly integrated graph-plotting features. The structure of application m-files generated by the MATLAB GUI development environment. In our project we use this GUI for reorganization of Devanagari character. In this GUI there are 3 buttons and 3 panels are used for making GUI of training phase also 4 buttons, 3 panel and 4 label is used for creating GUI of testing phase.



Fig. 5 GUI of Character Recognition

Following MATLAB windows represents the samples taken to generate data base. The feature of each character is calculated and stored in structure files and denoted by <1×1struct> and form Template for training the system. The structure consists of height, width, chain code and energy. Each character has unique value of these perimeters. All this values are stored in find chardata file. Format of findchardata file is .mat file

Reference No.	Classifier	Accuracy (%)
[9]	Neural Network	Recognition rate was 61.8%.
[10]	Hausdorff image comparison	Recognition rate was 66.78%
[11]	Tree classifier and template matching	Recognition rate was 83.67%
[12]	Stochastic finite state automation	Recognition accuracy was 87%
[13]	Adaptive Neuro Fuzzy Interference System	Recognition accuracy Average is 92.66%
Proposed system	ANFIS with Tree classifier and template matching	Recognition accuracy Average is 98.75%

Comparison of result between reference method and proposed method

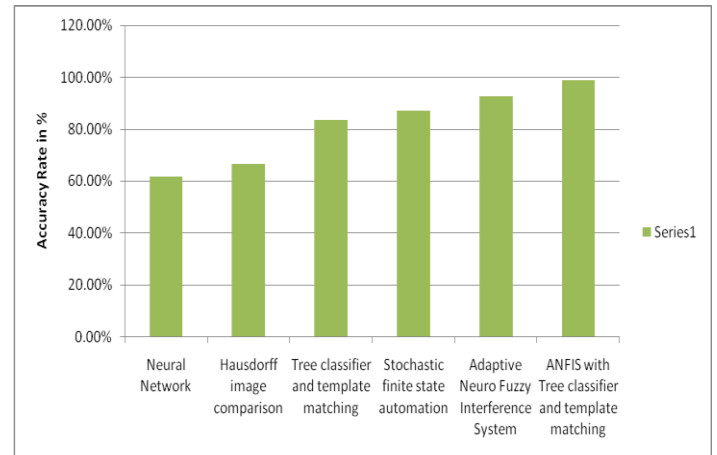


Fig. 6 Comparison graph of recognition rate

IV. CONCLUSION

Automatic recognition of handwritten characters has long been a goal of many research efforts in the pattern recognition field. In this paper we have studied the reference papers and concluded that, our proposed methodology had given best result as compared to all the other techniques which had been discussed in the table. ANFIS using Tree classifier with Template Matching is promising technique.

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