



Gujarati Handwritten Word Recognition System by Transfer Learning of Deep Neural Network

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ABSTRACT:

OCR for handwritten Recognition is more difficult to implement due to every person has his/her own writing style. For Gujarati language there is no any handwritten Recognition system is available. In this paper, Offline Handwritten Gujarati Word Recognition System has been introduced using a segmentation approach. This system describes a Handwritten Recognition system for the Gujarati language based on Computer Vision and Machine Learning Approach using Google's inception v3 model. In which, for feature extraction, Convolutional neural network is used and for classification, fully connected network and SoftMax layer is used. This system was performed on a moderate sized database using 200 images of each character. In this approach first, whole word divided into individual character, recognize character individually and then generate an electronic text file of that word. This system is part of whole HCR system, which can be used in a post office to recognize Address, in Bank for Automatic Check reading, and for Conversion from a paper document to digital paper document etc.

Keywords - Handwritten word recognition, OCR, Segmentation, Inception-v3 model, Machine Learning, Artificial Intelligence, Convolutional Neural Network, Computer Vision, Transfer Learning.

1. INTRODUCTION

The Gujarati language is a modern Indo-Aryan language. It is the official language of the Indian state of Gujarat and one of the 23 official languages of India. In the Gujarati language, there are 34 Consonant and 12 Vowels [9]. In India there are 55.5 million people speaks the Gujarati language which is 6th most widely speaking language in India. [9] there are not any dataset is available for Gujarati handwritten recognition system. Figure 1 shows Gujarati consonant and vowels.



ક	ખ	ગ	ઘ	ચ	છ
જ	ઝ	ટ	ઠ	ડ	ઢ
ણ	ત	થ	દ	ધ	ન
પ	ફ	બ	ભ	મ	ય
ર	લ	વ	શ	ષ	સ
હ	ળ	ક્ષ	જ્ઞ		
અ	આ	ઇ	ઈ	ઉ	ઊ
એ	ઐ	ઓ	ઔ	અં	અઃ

Fig. 1. Gujarati consonants and vowels

The optical character recognition system is the more useful system because it converts scanned document to electronics document likes text file. By using that reduce man-hours for data entry where to convert paper document to electronic document. In industries, government offices, etc. they are now converting their old paper document into electronic document. If this system is used its time consuming and due to that they can easily search document by using keywords. The main purpose of this approach is to convert the scanned document of Gujarati handwritten word into a text document.

The optical character recognition system can be differentiated in two types, the first one is Printed character recognition system and the second one is Handwritten character recognition system. A printed character recognition system is a little bit easy than the Handwritten character recognition system because in the printed document there is style and size of the word is fixed but in the handwritten document style of the word is differ as person differ and also the size of a consonant is change. Handwritten character recognition can be classified again as Offline and Online character recognition. In offline character recognition, the whole word scanned and then converted it into electronic form. But in online character recognition, the document is scanned at the time of writing a document so one by one character is recognized in this recognition system.

In this paper, Offline Handwritten Gujarati Word Recognition System has been introduced. Word can be recognize using three different approaches: Segmentation approach, Holistic approach, and Hybrid approach. In the Segmentation approach, Word is divided into character and then recognize the word. In Holistic approach, the whole word is considered as a single unit and then recognize it. In Hybrid approach is a combination of both above approaches. In this paper, for recognition of the word Segmentation approach is used.



2. LITERATURE REVIEW

Lots of research done in the field of OCR, but for the Gujarati language, there is not much research done for handwritten. For Database collection, computer vision is used for image processing. For feature extraction and Classification, there are lots of methods available for that Paneri[1] introduce first ever handwritten word recognition system for the Gujarati language. In which they use a holistic approach to word recognition. They used 2700 dataset of 10 predefined city name of Gujarati language. They used a Holistic approach using a histogram of oriented gradients and kNN and SVM as a classifier with 76.87% and 85.87% accuracy respectively. While Macwan[2] Applied different methods of feature extraction like DWT, DCT, and DFT with SVM as a Classifier. Ans got accuracy 89.46%, 89.31%, 96.06% respectively. Kumar[3] uses Multi-Layer Perceptron (MLP) classifier for recognition of Devanagari handwritten word and get 80.8% accuracy. Purkaystha[5] use convolution neural network for Bengali handwritten characters recognition and achieve 98.66%, 94.99%, 91.60%, 91.23% accuracy on numerals, vowels, compound letters, alphabets respectively.

3. RESEARCH METHODOLOGY

3.1 Create Dataset

To create a database, Open Source Computer Vision library is used for image processing. In which following steps include: Raw data, Scanning, Binarization, Noise Elimination, Segmentation, Size Normalization. Figure 2 Shows Flowchart of database collection.

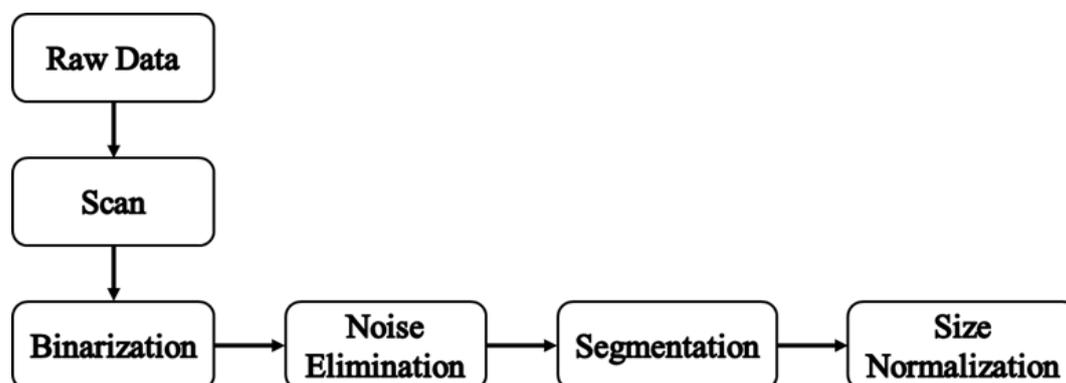


Fig. 2. Flowchart of database collection

3.1.1 Raw data and Scanning.

For database collection use A4 size plain paper with same size grid so can be segment it easily. Then scan image with the same dpi.

3.1.2 Binarization.

The scanned image is in the form of Gray image which has 256 gray levels, now have to convert it into a binary



image which has only 2 levels. For that use Otsu thresholding method[8].

3.1.3 Noise Elimination.

Due to the conversion of gray scale of 256 level to 2 level, get some noises like Salt Pepper noise, Gaussian noise etc. to remove that use median filter.

3.1.4 Segmentation.

Work of Segmentation is to partition. Now the whole image is segmented in each consonant. So can be processed further for training dataset. Due to the same size of the grid in a paper then we can easily segment the consonant. After the partition of consonant now have to remove the extra background from the image for that use openCV.

3.1.5 Size Normalization.

After the segmentation, all the image is not the same size. Normalization is the algorithm which resizes the image without change characteristics of the image. In this research work, use 50*50 sized image. In this research work, the author introduces a Gujarati handwritten word recognition system in which word having only 10 consonant listed in the following figure with its label.

No.	Consonant	label
1	ક	Ka
2	ખ	Kha
3	ગ	Ga
4	ઘ	Gha
5	ટ	Ta
6	ઠ	Na
7	ર	Ra
8	મ	Ma
9	વ	Va
10	લ	La

Fig. 3. Consonant with label



3.2 Flowchart of a proposed system

Figure 4 shows a flowchart of the proposed system for a handwritten word recognition system. To get good accuracy, dataset should be large and with good quality or model should have to robust. In this research work we created dataset of 200 images per class. So, for that Google's inception v3 model is use for Feature Extraction and Classification.

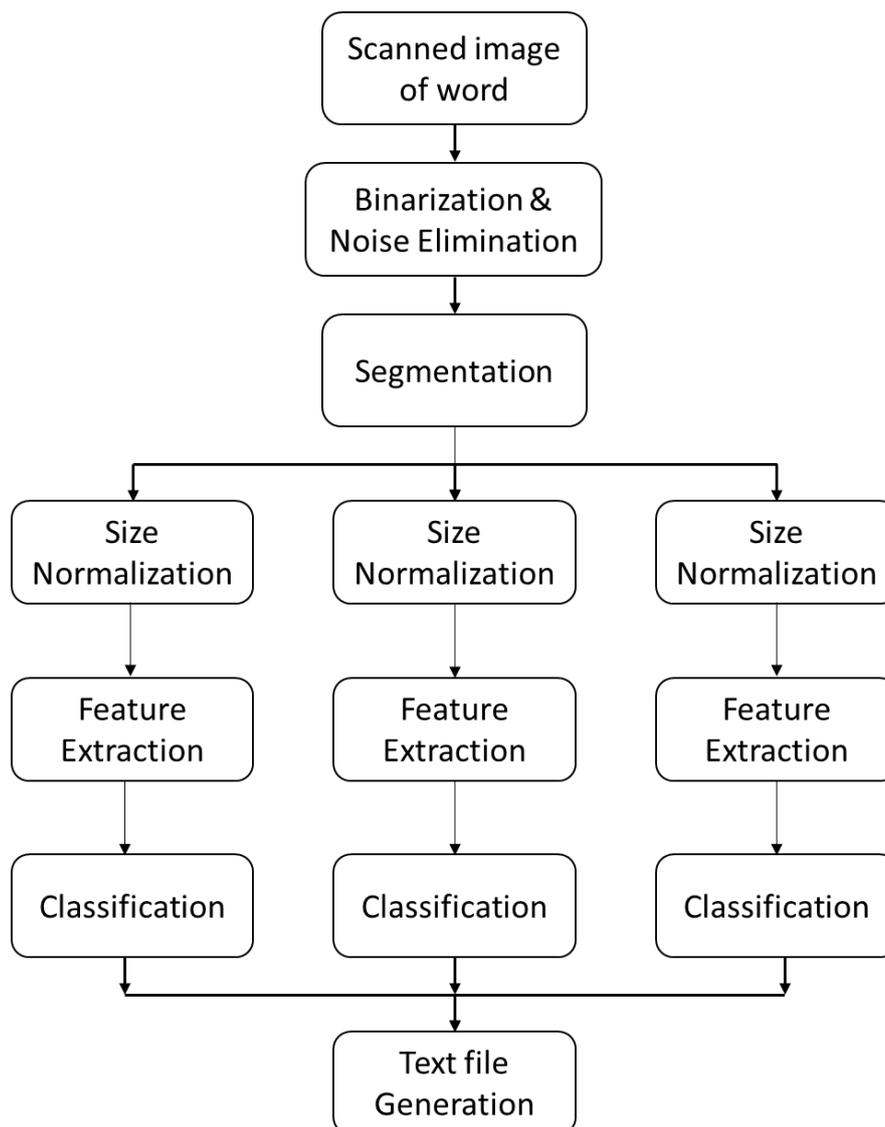


Fig. 4. Flowchart of a proposed system

3.2.1 Scanned image of word.

First scan the image of word which is written in the plane paper.

3.2.2 Binarization & Noise Elimination.



The scanned image is in the form of Gray image which has 256 gray levels, now have to convert it into a binary image which has only 2 levels. For that use Otsu thresholding method[10].

3.2.3 Segmentation of Word.

First of all, crop the image in which data is presented. For that use simple if loop to crop the image. After that whole word is segmented into Consonant. And save that segmented consonant in folder.

3.2.4 Size Normalization.

Now fetch that saved images and resize them so can be use it for next step. In this reseach work, 50*50 sized images are used for Feature Extraction and classification.

3.2.5 Feature Extraction and Classification.

In Google's Inception v3 model, Convolutional Neural Network is used for Feature Extraction[7]. This image recognition model is trained by large-scale ImageNet dataset. Most of deep Convolution Neural Networks are made by some basic layers: Convolution layer, sampling layer, dense layer, and a Soft-max layer. A typical CNN architecture made by group of several Convolution and Max-pooling layer. In Google's Inception v3 model, Fully-connected and Soft-Max layer is use for classification. Output of max-pooling layer is followed by Fully-connected layer to classify the image. Output of classification it generates text file.

4. CONCLUSION

The paper presents the Gujarati handwritten word recognition system using segmentation approach. Create a dataset of 10 consonants for the experimental purpose to check the accuracy. We are able to achieve 93% accuracy using Inception v3 model retraining on our Gujarati Character Dataset. This can be further modified for all consonants and vowels.

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