

A Novel Approach to Classify Gujarati Handwritten Characters Using Convolutional Neural Network

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Abstract:

In recent years, handwritten character recognition has been an important area due to its applications in several fields. This paper proposes a methodology to recognize handwritten character for the Gujarati language using convolutional neural network. Gujarati character recognition that faces several challenges, including unlimited variation in human handwriting styles. Although such a network can be used as unified framework for both feature extraction and classification, it is more efficient as a feature extractor than as a classifier. This paper suggests how a deep learning technique can be effectively applied to recognize Gujarati handwritten characters.

Keywords: Convolutional Neural Network (CNN), Feature Extraction, Max pooling, Softmax

1. Introduction

Neural networks are recently being used in various kinds of pattern recognition. Handwriting of different persons is different; therefore it is very difficult to recognize the handwritten characters. Handwritten Character recognition is an area of pattern recognition that has become the subject of research during last some decades. Neural network is playing an important role in handwritten character recognition. Handwriting recognition is the ability of a computer to receive and interpret handwritten input from source such as paper documents, photographs, touch screens and other devices. It can be online or offline.

Several applications including mail sorting, bank cheques processing, reading aid for blind, document reading and postal address recognition require offline handwriting systems. Working in postal service need us to decode and deliver something like 30 million handwritten envelopes every single day. The challenges are to do mail-sorting that ensure all those millions of letters reach their destinations.

Character recognition complexity varies among different languages due to distinct shapes, strokes and number of characters. Gujarati is the medium of everyday communication in the Gujarat state. The Gujarati language is more than 700 years old and is spoken by more than 55 million people worldwide¹. Gujarati script is very similar to Devnagari but without the line at the top of the letters.

Although, a lot of work has been reported for handwriting recognition in English, Asian languages such as Japanese, Chinese etc., and very few attempts on Indian languages like Hindi, Tamil, Telugu, Kanada, Gujarati etc.

Since past few years, deep neural networks, because of their outstanding performance, are getting highly used in computer vision and machine learning tasks such as regression, segmentation, classification, object detection, pattern recognition etc. Recognition of handwritten Gujarati characters is challenging task, but Deep learning

can be effectively used as solution for various problems. In this paper, we proposed a model to classify handwritten Gujarati characters using convolutional neural.

2. Literature Survey

Gujarati characters OCR had been a challenging and tedious task due to the complexity of scripts either we are working on digitally typed printed Gujarati characters or handwritten Gujarati characters. A systematic approach using hybrid method based on binary tree classifier and k-Nearest Neighbor(kNN) for Gujarati hand written character had been introduced by author^[ii] and obtained overall 63.1% average accuracy.

Although, the authorsⁱⁱⁱ tried for the separation as well as identification of mixed bilingual (English-Gujarati) digits using kNN classifier and gained 99.20%,99.26% average accuracy for English and Gujarati digits respectively.

In^{iv} explained classification of offline Gujarati handwritten characters using three different methods combinations and achieved 87.22% accuracy for total 39 Gujarati characters.

In the study^v, authors performed certain amount of training of 5-layer CNN trained using samples of a standard 50-class Bangla basic character database and features have been extracted for 5 different 10-class numeral recognition problems of English, Devnagari, Bangla, Telugu and Oriya.

The paper ^{vi}, a CNN based Bangla handwritten character recognition was investigated. It employed 20000 handwritten characters with different shapes and variations were used in this study. The proposed method shown satisfactory recognition and outperformed the existing methods.

In the study^{vii} applied CNN for offline handwritten English character recognition. They used LeNet-5 model. Experiments are evaluated UNIPEN lowercase and uppercase datasets with 93.7% for uppercase and 90.2% for lowercase respectively.

The Bangla handwritten character recognition^{viii} integrates multilayer CNN followed by inception module and fully connected network. This model was trained for 1,66,105 images of Bangla handwritten characters of different shapes and strokes and evaluated the performance of the model, and thus allows a higher recall rate for the character in an image and outperformed some current methodologies.

3. Algorithm and Techniques

As shown in in Figure 1, a CNN is composed of three main parts which are convolution, pooling and fully connected layers. The convolution and pooling layers act as feature extractors from the input images while the fully connected layer acts as a classifier. The essential purpose of convolution is to extract features automatically from each input image. The dimensionality of these features is then reduced by the pooling layer. At the end of the model, the fully connected layer with a softmax activation function makes use of the learned high-level features to classify the input images into predefined classes. In summary, in this research work we are going to use CNN architecture which is composed of two main parts: the first part is the self-taught feature extraction model and the second part is the classification model.

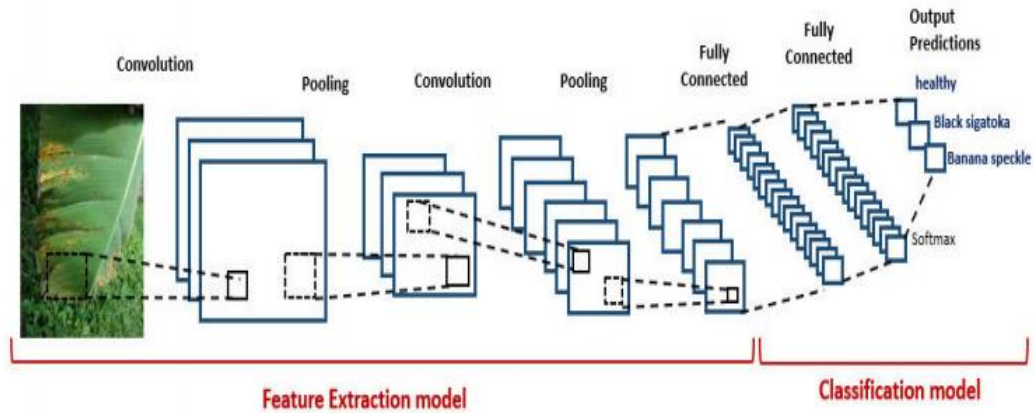


Figure 1 Architecture of Convolutional Neural Network

- Feature extraction model

The feature extraction model is the part where the network learns to detect different high level features from the input images. It consists of a sequence of convolution and pooling layers

- Convolution Layer:

This layer performs a convolution operation of a weight matrix (or filter) with the input image to produce a stack of filtered images. The filter is multiplied with patches of the image matrix chosen over a particular stride.

- Pooling Layer:

Pooling layer is responsible for reducing the number of parameters in the image stack, and in turn, reducing the amount of computation required. The most common form of pooling is MaxPooling, where from every small pooling window, the maximum value is selected.

- Classification model

In this classification step, fully connected layers where each neuron provides a full connection to all learned feature maps issued from the previous layer is used in the convolution neural network. These connected layers are based on the softmax activation function in order to compute the classes' scores. The input of the softmax classifier is a vector of features resulting from the learning process and the output is a probability that an image belongs to a given class.

4. Proposed Methodology

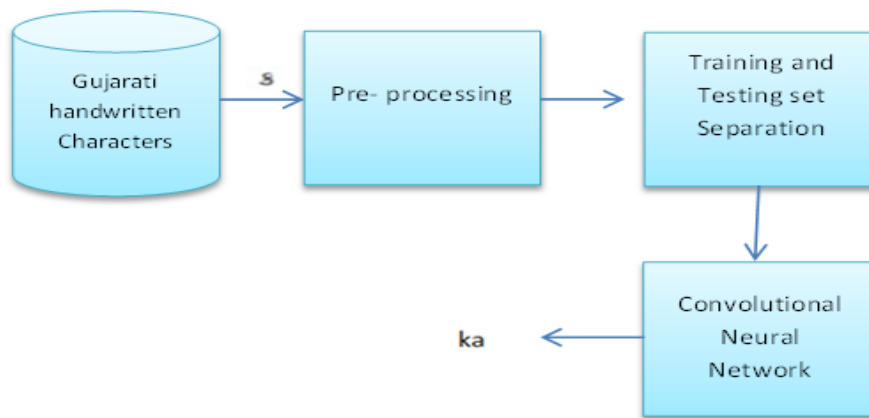


Figure 2 Proposed Gujarati handwritten character recognition model using CNN

5. Result and Discussion

The dataset of Gujarati characters can be created by taking images from different handwritten characters from the users.

Consonants (અક્ષરો)	Vowels (સ્વરો)
ક, ખ, ગ, ઘ, ચ, છ, જ, ઝ, ટ, ઠ	અ, આ, ઇ, ઈ, ઉ, ઊ, ઋ
ka, kha, ga, gha, ca, cha, ja, jha, ta, tha	a, ā, i, ī, u, ū, ṛ
ડ, ઢ, ણ, ત, થ, દ, ધ, ન, પ, ફ	પ, પા, પિ, પી, પુ, પૂ, પ્ર
ḍa, ḍha, ṇa, ta, tha, da, dha, na, pa, pha	pa, pā, pi, pī, pu, pū, pra
ભ, ભૂ, મ, ય, ર, લ, વ, શ, ષ, સ	એ, ઐ, ઓ, ઔ, અં, અઃ
bha, bhā, ma, ya, ra, la, va, śa, ṣa, sa	e, ai, o, au, am, ah
હ, ળ, ક્ષ, ઙ	પે, પૈ, પો, પૌ, પં, પઃ
ha, ḷa, kṣa, ṅa	pe, pai, po, pou, paṁ, paḥ

Figure 3 Gujarati Characters (vowels and consonants)

There are 13 vowels and 37 consonants in Gujarati language which is shown in Fig. 2. After creating datasets, model is trained and accuracy is measured. If the accuracy is reached at the desired accuracy



Figure 4 Classification of handwritten Gujarati characters

After successful training of model, this model should be able to classify handwritten Gujarati characters. The above Fig.3 shows how Gujarati handwritten character can be easily classified ‘ka’.

6. Conclusion

Handwritten Character Recognition for Gujarati characters is an active research area which always needs special attention. The proposed model can help normal user in their day to day life. Our future work will be focusing on the creating datasets for Gujarati characters. The dataset will be trained using underlying CNN architecture and will focus on improving the performance of this model using deep learning techniques.

7. References

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