

# Malayalam Handwritten Character Recognition System Using Convolutional Neural Network

Neena K Pius<sup>1</sup> and Mrs.Alphonsa Johnny<sup>2</sup>

<sup>1</sup>Department of Computer Science and Engineering, St.Josephs College of Engineering, Palai, Kerala, India.

## Abstract

Malayalam, the official language of Indian state Kerala includes vowels, Dependent vowels, Consonants, Compound characters and Chillus. Handwritten Malayalam characters are difficult to recognize due to their curved nature and there are characters which are formed by the combination of two characters. These along with the presence of 'chillu' make recognizing Malayalam characters a challenging task. when considering handwritten character recognition it is difficult to achieve 100 percent accuracy due to wide interpersonal and intrapersonal variations in writing styles. Recognition of similar shaped characters is difficult and lead to misclassification. Convolutional Neural Networks (CNN) is a popular deep learning method and is state of the art for image recognition. This involves six main steps :Pre-processing, Dataset creation, Dataset augmentation, CNN modelling (LeNet and ResNet), Classification and Testing. Dataset is the handwritten images collected from different people in different styles. For CNN modelling LeNet architecture is used .But the accuracy can be improved by using a ResNet model which uses Skip connection.Adding more number of features as well as layers show better accuracy. This paper proposes an efficient method on feature extraction for Malayalam handwritten character recognition and compare the performance of two CNN models, LeNet and ResNet.

**Keywords:** Residual network (ResNet),LeNet, deep learning, Convolutional neural network (CNN), ReLU, Malayalam Handwritten Character Recognition, Optical Character Recognition.

## I. INTRODUCTION

Character recognition by machines is very important in many situations.Many old documents are in the form of hard copies.To make it a soft copy OCR is the method used. But if the case is different like when the document is in handwritten format, it will be very difficult to recognize.Recognition systems are mainly of two types.

- online
- offline

In offline mode the handwritten document is scanned and thereby corresponding image file. In online mode, to obtain a character a touch sensitive screen is used.

The idea behind OCR is to convert any printed or handwritten text into a file that can be recognized by the system. The major advantage of using OCR is that it reduces the human involvement and it will store the text in an efficient manner. The main steps in OCR include image acquisition and preprocessing, feature extraction and classification. In image preprocessing enhance the image by removing noise, correlation, binarization, dilation, color adjustment, line segmentation etc. In feature extraction the important features are extracted for classification. In the last step the actual image is compared with the textual representation.

The techniques in OCR belong to two categories, traditional methods and deep learning methods. Extraction of handcrafted features is involved in the traditional method but the problem is the quality of these features will be low and will affect the accuracy.

The low quality features can be recognized by the deep learning techniques.Deep learning dominates the field of OCR due to its easy recognition procedure and high performance. The handwritten character recognition is difficult due to wide interpersonal and intrapersonal variations in writing styles. Offline malayalam character recognition is used here.

## II. MALAYALAM SCRIPT

Malayalam is the south indian language used by the people of kerala for the written and verbal communication. Due to its variations in scripting malayalm is one of the richest languages in india. Malayalam is curved in nature and is nor cursive. It consists of vowels, consonants, compound characters and chillus.

## III. CONVOLUTIONAL NEURAL NETWORK CNNs

have the best algorithm for understanding image. CNNs are used in many applications like image classification and segmentation, object detection,natural language processing, speech recognition etc. Advantages of using CNN include, it has multiple feature extraction stages that can automatically learn features from the image file .

Topology of CNN includes a combination of convolution layers, non linier processing units and subsampling layes. CNNs has feed forward multilayered hieracheal networks.

Typical CNN consists of alternate layers of convolutional and pooling layers,then fully connected layer.To optimize the CNN performance batch normalization and dropout are also used.

Vowels	അ	ആ	ഇ	ഈ	ഊ
Dependent vowels signs	ാ	ി	ീ	ൂ	ു
Consonant signs	െ	േ	ൈ	ഌ	഍
Consonants	ക	ഖ	ഗ	ഘ	ങ
	ച	ഛ	ജ	ഝ	ഞ
	ട	ഠ	ഡ	ഢ	ണ
	ത	ഥ	ദ	ധ	ന
	പ	ഫ	ബ	ഭ	മ
	യ	ര	റ	ല	ള
	ഴ	വ	ശ	ഷ	സ
Pure consonants	ൺ	൹	റ	ൺ	ൾ
Compound characters(new script)	കാ	ക	ഓ	ച	
	ട	ണ്ട	ണ്ണ	ത	
Compound characters(old script)	കാ	ക്ഷ	റ	ൻറ	
	ന	ന്ധ	ള	ല	

Fig. 1. Malayalam characters and signs.

**IV. PROPOSED METHOD**

The proposes system aim to reduce the misclassification during the malayalam character recognition.This uses the deep learning methods for the recognition process.LeNet and ResNet are the two models used for the charater recognition.This system uses a comparison of these two models.

Draset for the malayalam characters is collected from different people in different formats.To have greater accuracy CNN should have more layers as well as there should be a large training set of images.The overall architecture of the system is shown in figure 2 The main steps in this method include Pre-processing,Dataset creation,Dataset augumentation,CNN modelling,Classification and Testing.

The data samples collected from different people are augmented using scaling,transformations etc.Then the augmented dataset is divided for training and testing.In pre-processing the quality of the image is improved.Then the model gets created by training the network.Here we create using the models-LeNet.This model is used for classification of characters.Then the performance of these two models are compared.

**A. LeNet**

LeNet was the first CNN used for the hand written recog-

inition tasks. Small distortions, rotations and variations in position are not affected by this model. It is a feed forward network consists of five alternative layers of convolutional and pooling then to fully connected layer.

LeNet not only reduces the number of parameters but also was able to automatically learn features from raw pixels.

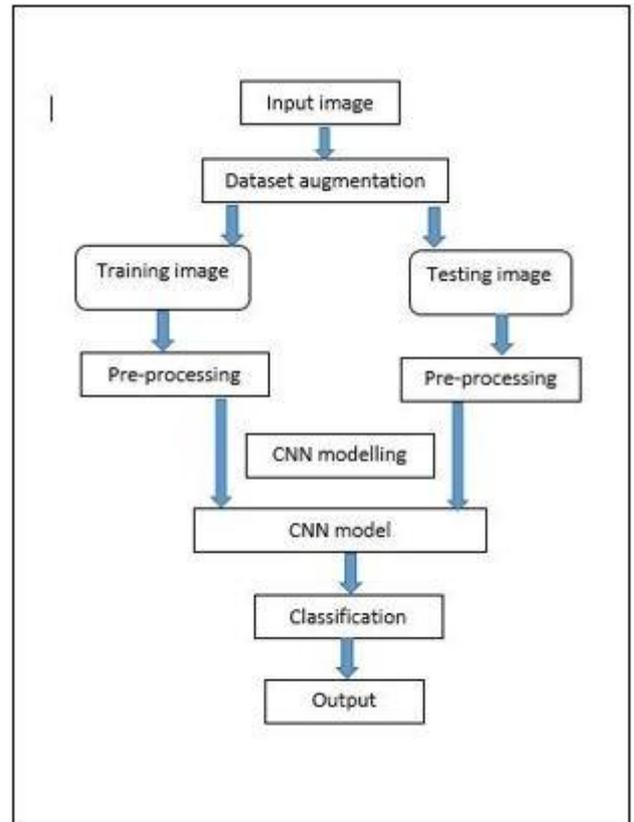


Fig. 2. Overall System Architecture.

ReLU activation function is used in this model and max pooling strategy is used. The drop out layer will decrease the complexity and training time of the network. The output is flattened and is given to the fully connected layer. The final layer ,softmax will generate a probability value and the maximum probability will be taken as the output.

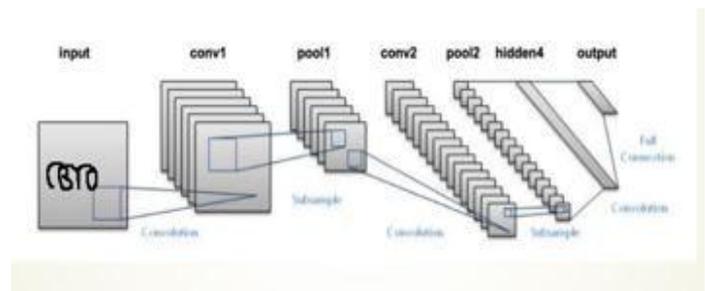


Fig. 3. LeNet Architecture.

## B. ResNet

It is a feed forward network. The deep neural network consists of many layers. When the network goes into deeper the error rate also increases. This is called the vanishing gradient problem. Residual blocks are the main building blocks of residual network which has skip connections. Figure 4 shows the skip connection instead of feeding the input  $x[i]$  only to layer  $i$ , it is also directed to layer  $i+2$ . Thus it can easily go to the deeper layers and thereby the performance can be improved.

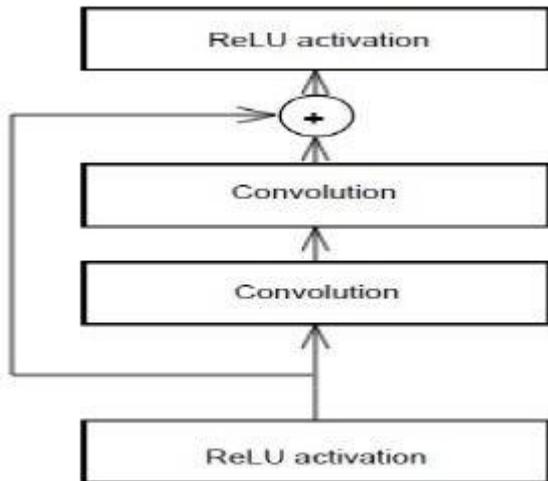


Fig. 4. Residual Block.

## V. CONCLUSION

In this paper, proposed a method for offline character recognition using deep learning methods. By pre-processing the quality of images are improved. Data set creation involves the images collected from different people in different formats. Multiple variations of the images can be developed using the dataset augmentation. LeNet shows better performance since it involves number of layers.

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