DEEP LEARNING APPROACH USING CONVOLUTIONAL NEURAL NETWORKS FOR HANDWRITTEN DIGIT RECOGNITION

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ABSTRACT

Handwritten Marathi Digit Recognition remains unsolved due to excessive cursive in Marathi handwriting. The existing classifiers do not give satisfactory performance in real world applications. This paper presents an approach based on Deep Neural Network to improve the performance of Marathi handwritten digit recognition. In this study, Primary database has been used which consists of ten Marathi numerals, A sample was collected from ten different users having different age group and gender for each digit. So hundred samples were collected for the study. The Convolutional Neural Network (CNN) was used to recognize the samples. This network helps to extract feature information, recognition of shapes, scaling and other pattern distortions. Deep Convolutional Network gives better results as compared to traditional classifiers. This approach gives highest average recognition test accuracy of 98 % on our dataset.

Keywords: Deep Learning, Recognition, CNN.

INTRODUCTION

Automatic Handwritten Character Recognition is of academic and commercial interests. The handwritten character recognition is a challenge due to enormous variety of handwriting styles by different writers in different languages [1].

Hand written digit recognition is used to recognize digits from various sources like images, papers, touch screens etc and classify them in ten predefined classes (0-9). Digit recognition is used in number plate recognition, postal mail sorting, bank cheque processing and so on [2].

Optical character recognition systems are not frequently used for Devnagari sripts which presents some useful segmentation and recognition techniques [3]. In this study, primary dataset with 100 samples and a Convolution Neural Network has been used for digit recognition. Deep Neural network do not requires any feature, it works on raw pixels. This network consists of multiple hidden layers as well as various parameters, so the numbers of connections are too large [4].

The objectives behind caring out this research is to recognize the Marathi Handwritten digits using a CNN model of deep learning. Following are the specific research objectives:

- To Study deep learning technique specifically CNN.

- To Design a recognition system using CNN deep learning model

- To implement Proposed System on Local Database

Convolutional Neural Network
Convolutional Neural networks is a deep learning paradigm which has found to be useful in image classification. CNNs learns features on their own which gives them edge over the traditional machine learning algorithms. Figure shows generic architecture of CNN.
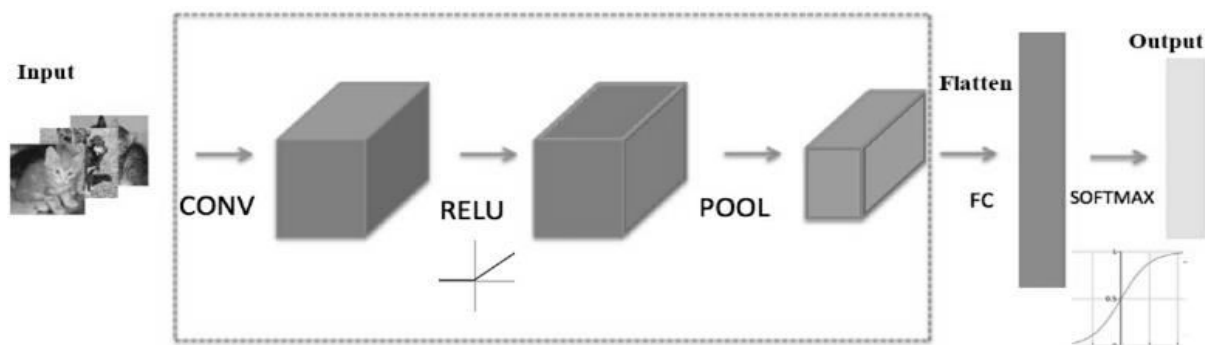
Figure 1: CNN Architecture [5]

As shown in above figure; it has four layers namely Convolutional layer, Non-linear Relu activation layer, a Pooling layer, and FC layer.

Convolutional Layer

This layer is the basic building block of CNN. A convolution mask is slided over the image to get feature map. CNN can have one or more such layers depending on the complexity of problem and other parameters.

Pooling Layer

In this layer, dimensions of input and number of learning parameters are reduced. It results in short training time, avoids overfitting. It does this by down sampling every feature map independently. We have used Max pooling technique which is the most common type of pooling technique for CNN.

ReLU Activation Layer

Robustness of any type of Neural network depends on amount of non-linearity it contains. CNN uses Rectified Linear Unit (ReLU) as activation function in this layer. Mathematical formula for ReLU is given as follows:

$$f(x) = \begin{cases} 0, & x < 0 \\ x, & x \geq 0 \end{cases}$$

Fully Connected Layer

This is the last layer of CNN model. Its job is to finally classify input data into predefined classes. It uses SoftMax activation which is one of the popular activation functions across the deep learning models. It normalizes the output of a network to probability distribution among output classes. Mathematical formula for SoftMax function is as follows

$$S(y)_i = \frac{\exp(y_i)}{\sum_{j=1}^{n} \exp(y_j)}$$

Proposed Algorithm

Algorithm: Handwritten Digit Recognition using CNN
Input   : Handwritten Marathi digit image
Output: Recognized Class of digit
1: Input image of Marathi digit
$I \leftarrow \sum_{x=1}^{m} \sum_{y=1}^{n} \mathbf{img_{xy}(f)}$

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2. Pre-process input image

3. Create CNN model

4. Train the model using training data set

5. Evaluate model using validation data set

6. Predict output class of digits in test data set

Experimental Results

A Convolutional Neural Network is formed by giving 100 samples as an input and by setting required parameters. The recognition accuracy for each digit has been recorded by simulating the network as shown in the Table 1.

Table 1: Performance evaluation of CNN

Digit	Total no of samples tested	No of samples correctly classified	Recognition Accuracy (%)
0	10	10	100
1	10	10	100
2	10	10	100
3	10	09	90
4	10	10	100
5	10	10	100
6	10	09	90
7	10	10	100
8	10	10	100
9	10	10	100

The Table 1 shows that digit 0,1,2,4,5,6,7,8,9 gives 100 % recognition accuracy and digit 3,6 gives 90 % accuracy. The Average recognition accuracy of CNN is 98%

CONCLUSION AND FUTURE SCOPE

In this research, we have developed a deep learning model using Convolutional Neural network. The Proposed model was then tested on primary database of Marathi handwritten digits. From experimental results it can be concluded that CNN is one of the efficient Deep learning paradigms for recognition problems. Further research in this area can be done using more advanced and hybrid deep learning models.

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