International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 02 | Sep 2023 www.irjet.net p-ISSN: 2395-0072

Devanagari Digit and Character Recognition Using Convolutional Neural Network

Suresh Mestry [1], Bhagyasha Patil[2], Anushka Pede[3], Shreya Raul[4]

[1] *Assistant Professor, Department of Computer Engineering, MCT's Rajiv Gandhi Institute of Technology, Maharashtra, India*
[2] *Student, Department of Computer Engineering, MCT's Rajiv Gandhi Institute of Technology, Maharashtra, India*
[3] *Student, Department of Computer Engineering, MCT's Rajiv Gandhi Institute of Technology, Maharashtra, India*
[4] *Student, Department of Computer Engineering, MCT's Rajiv Gandhi Institute of Technology, Maharashtra, India*

Abstract - *In recent decades, Convolutional Neural Network (CNN) has achieved remarkable results in both the research field and the application field due to the significant achievement acquired in image recognition which is abundantly used in the field of machine learning. Handwriting recognition is the bridge between handwriting and machines, and can play a huge role in finance, accounting, education and other fields reducing labor cost. At present, the recognition of handwriting has received great degree of attention from many researchers. Handwritten digit and character recognition becomes vital scope and it is appealing many researchers because of it's using in variety of machine learning and computer vision applications. However, due to its complexity handwritten digit and character recognition still has a great development space. The recognition of handwritten digits and character remains a difficult problem, particularly in some scripts, there exists a large variation of style across writers. This large variation is an interesting challenge for algorithms in image processing and pattern recognition. There are deficient works accomplished on Devanagari scripts because Devanagari scripts are more challenging than English. The proposed system evaluates handwritten Devanagari character and digit recognition. CNN model is used to determine the result to achieve character and digit recognition. This system will be implemented using Python and its different library functions.*

Key Words: CNN, Handwritten, Machine Learning, Devanagari.

1. INTRODUCTION

Over the period of time the numbers of fields in which deep learning is applied is increasing. In deep learning, visual imagery analysis uses Convolutional Neural Networking (CNN). Object detection, video analysis, segmentation, pattern recognition, face recognition, natural language processing, spam detection, topic categorization, regression analysis, speech recognition, image classification are some of the examples that can be done using Convolutional Neural Networks. The accuracies in various such fields including handwritten digits recognition using Deep Convolutional Neural Networks has reached human level perfection. Devanagari script is based on the ancient Bramhi script used in the Indian subcontinent. Devanagari Script consists 47 primary characters including 14 vowels and 33 consonants. Handwritten character and digit recognition refers to the automatic identification of handwritten alphabets and numbers through computers or other equipment.

2. OBJECTIVES

- To overcome the difficulty in recognition of Devanagari digit and characters due to variation in writing patters; using Convolutional Neural Network.
- Perform an efficient pre-processing to make data suitable for analysis.
- Create a CNN model to perform classification process by training the model with training data to fit and test the model to evaluate the accuracy rate.

3. PROPOSED SYSTEM

We intend to develop a system where the application recognizes Devanagari digits and characters based on CNN. In the recognition of handwritten characters and digits particularly in the Devanagari script; there exists a larger variation of style across writers which is an interesting challenge in image pre-processing and recognition.

4. METHODOLOGY

A Convolutional Neural Network, which is also known as CNN or ConvNet, is a class of neural networks that specializes in processing data which has a grid-like topology, such as an image. A digital image is a binary representation of visual data which contains a series of pixels arranged in a grid-like fashion that contains pixel values to denote the brightness of the pixel and what color each pixel should be.

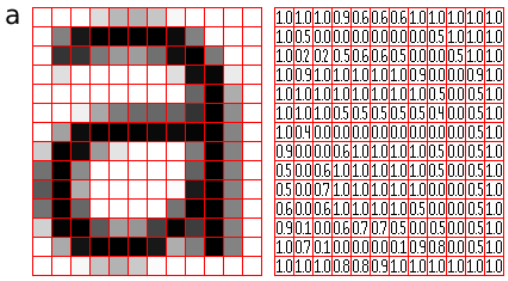

Fig -1: Digital image with pixel values

Layer helps a Neural Network (NN) to gain complexity in any problem. Increasing number of layers (with units) can increase the non-linearity of the output of an NN. Each layer contains some amounts of Units. The amount is entirely up to the creator. However, having too many layers for a simple task can unnecessarily increase its complexity and decrease its accuracy. The opposite also holds true. Every NN has 2 layers. Those are the input and output layers. Layers in between those are called hidden layers. The NN in the picture below contains an input layer (with 8 units), an output layer (with 4 units) and 3 hidden layers with each containing 9 units.

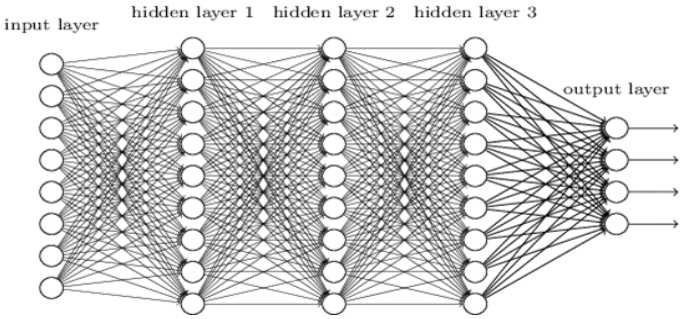

Fig -2: Deep Neural Network

A neural network with 2 or more hidden layers with each layer containing a large amount of units is called a Deep Neural Network.

A CNN typically has three layers:

- Convolutional layer
- Pooling layer
- Fully connected layer.

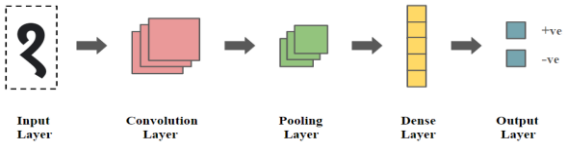

Fig -3: CNN hidden layers

The core building block of the CNN is convolution layer. It carries the main part of the network's computational load. It performs a dot product between two matrices, where first matrix is the set of learnable parameters known as a kernel, and the second matrix is the restricted portion of the receptive field. The kernel is smaller than an image but has larger depth. Which means, the height and width of the kernel will be spatially small, but the depth will extend up to all the three channels if the image is composed of three (RGB) channels. During the forward pass, the kernel slides across the height and width of the image which produces the image representation of that receptive region. This produces a two-dimensional representation of the image which is known as an activation map which gives the response of the kernel at each spatial position of the image.

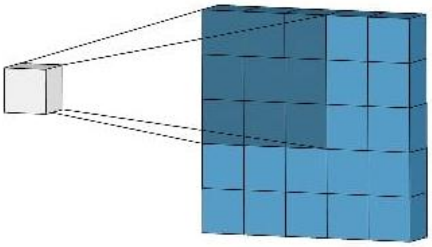

Fig -4: Two- Dimensional Represenation

The pooling layer is used to replace the output of the network at certain locations by deriving a brief statistic of the nearby outputs. It helps in reducing the spatial size of the representation, decreasing the required amount of computation and weights. The pooling operation is individually processed on each and every slice of the representation. There are various pooling functions such as the average of the rectangle neighborhood, L2 norm of the rectangular neighborhood and weighted average based on the distance from the central pixel. Max pooling reports the maximum output from the neighborhood and is the most popular process.

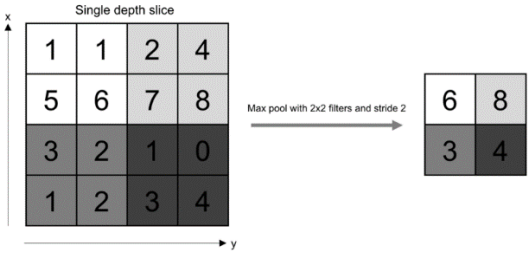

Fig -5: Max Pooling

Neurons in this layer are fully connected with all neurons in the preceding and succeeding layer as seen in regular FCNN. This is why it can be computed by a matrix multiplication followed by a bias effect. The FC layer assist in mapping the representation between the input and the output.

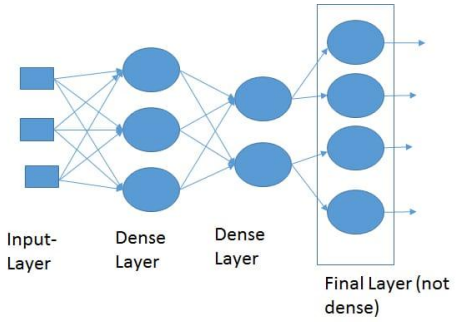

Fig -6: FC Layer

5. ARCHITECTURE

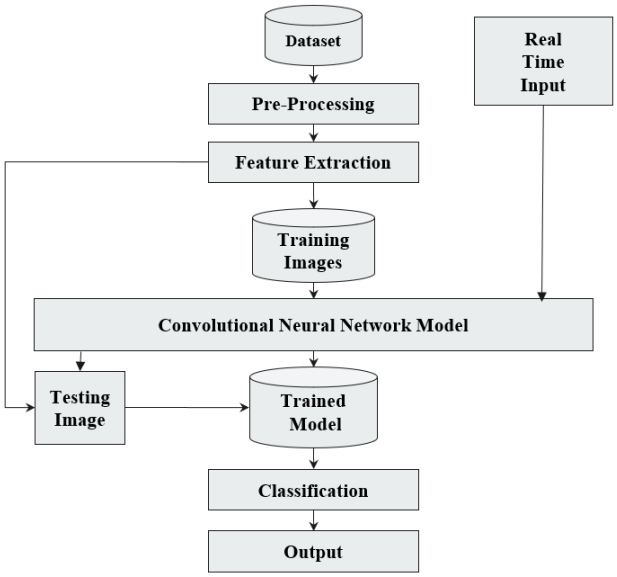

Fig -7: The System Architecture

Figure below gives the system architecture of proposed system. To train the model first the dataset is pre-processed. After pre-processing feature extraction is done for the dataset from which we get training images. These training images are passed to the CNN model which further gives us a trained model. On the basis of this trained model classification is done and output is generated. While testing the model first the dataset is pre-processed. After pre-processing feature extraction is done for the dataset from which we get testing image. This testing image is passed on to trained model and using CNN model classification is done for the testing image and further output is generated. Now when we give a real-time input, this input is passed to the CNN model and using the trained model input is classified and an appropriate output is generated.

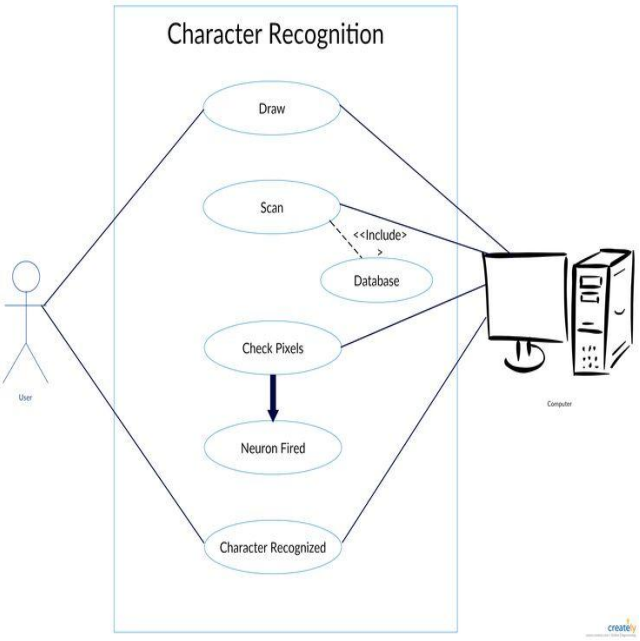

Fig -8: System's Detailed Design

6. EXPERIMENTAL RESULT

Our Kaggle dataset consists of multiple images of Devanagari digits and characters. This dataset is used to train our CNN model. The model trained with this dataset is used to predict the output or we can say recognize the user input. The user input is given as drawing the digit or character that are to be recognized with the help of cursor on the whiteboard which appears on the user interface. In total there are 92,000 images of Devanagari digits and characters. There are 10 digits from 0 to 9 and 36 characters from Ka to Nya each having 2000 images respectively.

Fig -9: Dataset images

The above few images are from the dataset of Devanagari character Ka and Devanagari digit 2 displaying variety in handwritten patterns. The following images represents how user input is to be given on the whiteboard window using the cursor.

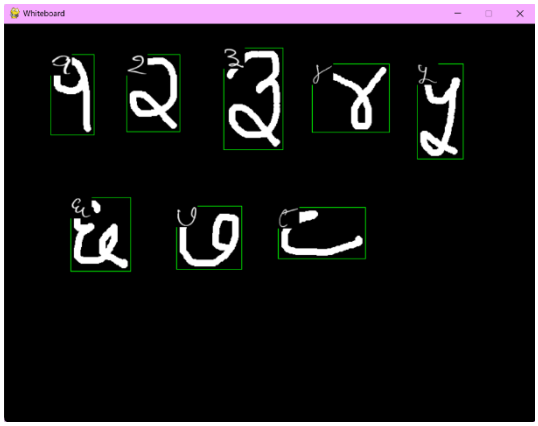

Fig -10: Devanagari Digit Recognition

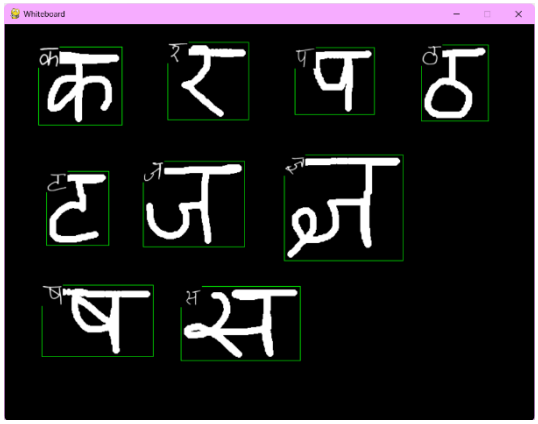

Fig -11: Devanagari Character Recognition

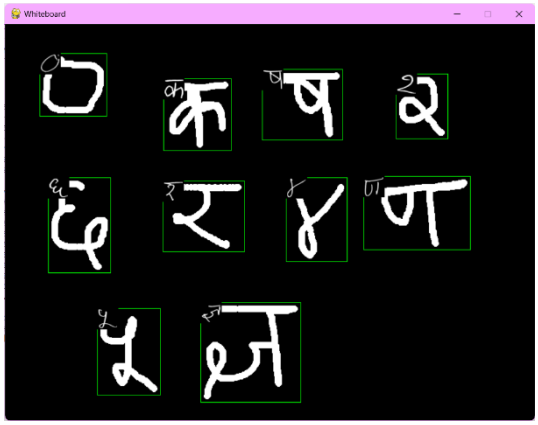

Fig -12: Devanagari Digit and Character Recognition

7. CONCLUSIONS

Our model is based on multilevel classification using CNN is useful in recognizing Devanagari digit and characters written in various styles. Using the classification obtained, researchers can efficiently study the ancient Indian literature.

ACKNOWLEDGEMENT

This system is implemented under the guidance of Prof. Suresh Mestry, Department of Computer Engineering at MCT'S Rajiv Gandhi Institute of Technology, Mumbai, India.

REFERENCES

[1] Burel, G., Pottier, I., &Catros, J. Y. (1992, June). Recognition of handwritten digits by image processing and neural network. In Neural Networks, 1992. IJCNN, International Joint Conference on (Vol. 3, pp. 666-671) IEEE.

[2] Niu, X.X.; Suen, C.Y. A novel hybrid CNN–SVM classifier for recognizing handwritten digits. Pattern Recognit. 2012, 45, 1318– 1325.

[3] Wells, Lee & Chen, Shengfeng&Almamlook, Rabia&Gu, Yuwen. (2018). Offline Handwritten Digits Recognition Using Machine learning.

[4] Y. LeCun, B. Boser, J. Denker, D. Henderson, R. Howard, W. Hubbard, and L. Jackel, "Handwritten digit recognition with a back-propagation network," in Advances in Neural lnformation Processing Systems (NIPS) 2, 1990, pp. 396-404.

[5] D. Ghosh, T. Dube, and A. Shivaprasad, "Script recognition: A review," IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 32, no. 12, pp. 2142-2161, Dec. 2010.

[6] Y. LeCun et al., "Backpropagation applied to handwritten zip code recognition," Neural computation, vol. 1, no. 4, pp. 541-551, 1989.

[7] L. Bottou, "Notes on convolutional neural networks", 2006.

[8] Sueiras, J.; Ruiz, V.; Sanchez, A.; Velez, J.F. Offline continuous handwriting recognition using sequence to sequence neural networks. Neurocomputing. 2018, 289, 119-128.

[9] Hubert Cecotti, "Handwritten Digit Recognition of Indian Scripts", IEEE, 2015

[10] Jinze Li, Gongbo Sun, Leive Yi, Qian Cao, Fusen Liang, Yu Sun, "Handwritten Digit Recognition System based on Convolutional Neural Network", IEEE, 2020

[11] Mayank Jain, Gagandeep Kaur, Muhammad Parvez Quamar, Harshit Gupta, "Handwritten Digit Recognition using CNN", IEEE, 2021