International Journal of Advanced Research in Arts, Science, Engineering & Management (IJARASEM)

| ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 8, Issue 4, July 2021 |

Recognition of Handwritten Digit Using CNN in Python with Tensorflow

Sumita Kulkarni[1], Yugesh Raut[2], Shubham Shrivastava[3]

U.G. Student, Department of Computer Engineering, Sinhgad Academy of Engineering, Pune, Maharashtra, India[1]

U.G. Student, Department of Computer Engineering, Sinhgad Academy of Engineering, Pune, Maharashtra, India[2]

U.G. Student, Department of Computer Engineering, Sinhgad Academy of Engineering, Pune, Maharashtra, India[3]

ABSTRACT: In recent times, with the increase of Artificial Neural Network (ANN), deep learning has brought a dramatic twist in the field of machine learning by making it more artificially intelligent. Deep learning is remarkably used in vast ranges of fields because of its diverse range of applications such as surveillance, health, medicine, sports, robotics, drones, etc. In deep learning, Convolutional Neural Network (CNN) is at the centre of spectacular advances that mixes Artificial Neural Network (ANN) and up-to-date deep learning strategies. It has been used broadly in pattern recognition, sentence classification, speech recognition, face recognition, text categorization, document analysis, scene, and handwritten digit recognition. The goal of this project is to observe the variation of accuracies of CNN to classify handwritten digits using various numbers of hidden layers and epochs and to make a comparison between the accuracies. For this performance evaluation of CNN, we performed our experiment using the Modified National Institute of Standards and Technology (MNIST) dataset. Further, the network is trained using stochastic gradient descent and the backpropagation algorithm.

KEYWORDS: Handwritten Digit recognition, Convolutional Neural Network (CNN), Deep learning, MNIST dataset, Epochs, Hidden Layers, Stochastic Gradient Descent, Backpropagation

I. INTRODUCTION

With time the numbers of fields are increasing in which deep learning can be applied. In deep learning, Convolutional Neural Networking (CNN) is being used for visual imagery analysis. Object detection, face recognition, robotics, video analysis, segmentation, pattern 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 Networking.

In handwritten recognition digits, characters are given as input. The model can be recognized by the system. A simple artificial neural network (ANN) has an input layer, an output layer, and some hidden layers between the input and output layer. CNN has a very similar architecture as ANN. There are several neurons in each layer in ANN. The weighted sum of all the neurons of a layer becomes the input of a neuron of the next layer adding a biased value. In CNN the layer has three dimensions. Here all the neurons are not fully connected. Instead, every neuron in the layer is connected to the local receptive field. A cost function generates to train the network.

It compares the output of the network with the desired output. The signal propagates back to the system, again and again, to update the shared weights and biases in all the receptive fields to minimize the value of cost function which increases the network's performance.

Paper is organized as follows. Section II describes automatic text detection using morphological operations, connected component analysis and set of selection or rejection criteria. The flow diagram represents the step of the algorithm. After detection of text, how text region is filled using an Inpainting technique that is given in Section III. Section IV presents experimental results showing results of images tested. Finally, Section V presents conclusion.

II. LITERATURE SURVEY

1) Image Pre-processing on NumtaDB for Bengali Handwritten Digit Recognition

The aim of this research paper is to find a benchmark forimage pre-processing of Bengali digits. Datasets that have beenused to conduct research on before are CMATERDB and ISIdatasets. But none have been done on NumtaDBdatasetbefore. In this paper, the main purpose is to find a set ofexisting methods that will be suitable for

image preprocessingof NumtaDB dataset. Finding out existingmethods that will give highest accuracy just by cleaning the
images from any noise, spots, gridlines etc.

2) MNIST-MAX: A multi-language handwritten digit recognition

In this letter, we contribute a multi-language handwrittendigit recognition dataset named MNIST-MIX, which is the largest datasetof the same type in terms of both languages and data samples. With thesame data format with MNIST, MNIST-MIX can be seamlessly applied inexisting studies for handwritten digit recognition. By introducing digitsfrom 10 different languages, MNIST-MIX becomes a more challengingdataset and its imbalanced classification requires a better design of models.

3) Flexible, High performance CNNs for Image Classification

The human visual system efficiently recognizes and localizes objects within cluttered scenes. For artificial systems, however, this is still difficult due to viewpoint-dependent object variability, and the high in-class variability of many object types. Deep hierarchical neural models roughly mimic the nature of mammalian visual cortex, and by the community consensus are among the most promising architectures for such tasks. Despite the hardware progress of the past decades, computational speed is still a limiting factor for CNN architectures characterized by many building blocks typically set by trial and error. To systematically test the impact of various architectures on classification performance, we present a fast CNN implementation on Graphics Processing Units (GPUs).

4) Isolated Handwritten Digit Recognition using adaptive unsupervised Incremental learning Technique

This paper presents a new approach to off-line handwrittennumeral recognition. From the concept of perturbation due towriting habits and instruments, we propose a recognitionmethod which is able to account for a variety of distortions dueto eccentric handwriting. The recognition of handwrittennumerals is a challenging task in the field of image processingand pattern recognition. It can be considered as one of thebenchmarks in evaluating feature extraction methods and theperformance of classifiers. The performance of characterrecognition system depends heavily on what kind of featuresare being used. The objective of this paper is to provideefficient and reliable techniques for recognition of handwrittennumerals. In this paper we propose Zoning based featureextraction system which calculates the densities of objectpixels in each zone. Firstly, the whole image is divided into 44 zones. Further in order to gain more accuracy these zones aredivided into 6 6 zones. The division of zones carried out upto 8 8 zones. Hence 116 features are extracted in all. Nearestneighbour classifier is used for subsequent classification andrecognition purpose.

5) Study and observation of variants of accuracies for handwritten digit recognition with various hidden layers and epochs using CNN

The primarycontribution of this paper is to analyze the impact of thepattern of the hidden layers of a CNN over the overallperformance of the network. To demonstrate this influence, weapplied neural network with different layers on the ModifiedNational Institute of Standards and Technology (MNIST)dataset. Also, is to observe the variations of accuracies of thenetwork for various numbers of hidden layers and epochs andto make comparison and contrast among them. The system istrained utilizing stochastic gradient and backpropagationalgorithm and tested with feedforward algorithm.

III. EXISTING SYSTEM APPROACH

These days, an ever-increasing number of individuals use pictures to transmit data. It is additionally the main stream to separate critical data from pictures. Image Recognition is an imperative research area for its generally used applications.

| ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 8, Issue 4, July 2021 |

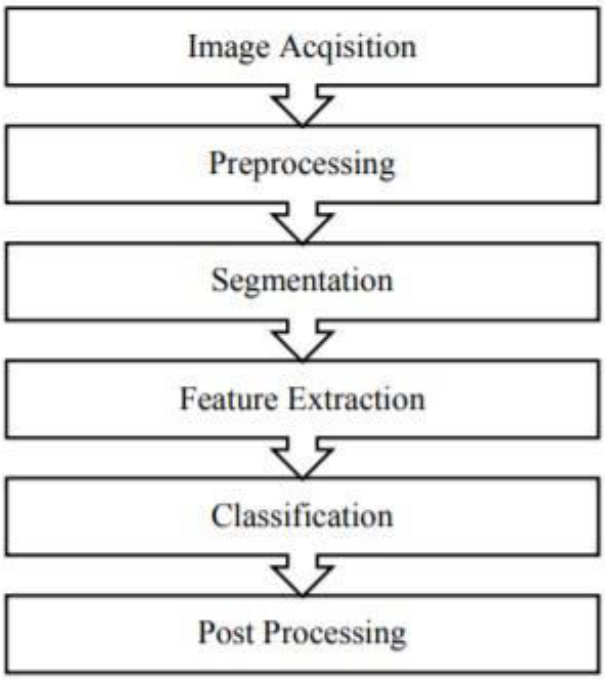

Fig 1:- Block Diagram of existing model

In general, in the field of pattern recognition, one of the difficult undertakings is the precise computerized recognition of human handwriting. Without a doubt, this is a very difficult issue because there is extensive diversity in handwriting from an individual to another individual.

In spite of the fact that this difference does not make any issues to people, yet, anyway it is increasingly hard to instruct computers to interpret general handwriting. For the image recognition issue, for example, handwritten classification, it is essential to make out how information is depicted onto images. Handwritten Recognition from the MNIST dataset is well known among scientists as by utilizing different classifiers for various parameters, the error rate has been decreased, for example, from linear classifier (1-layer NN) with 12% to 0.23% by a board of 35 convolution neural systems.

The scope of this is to implement a Handwritten Digit Recognition framework and think about the diverse classifiers and different techniques by concentrating on how to accomplish close to human performance. For an undertaking of composing diverse digits (0-9) for various people the general issue confronted would be of digit order issue and the closeness between the digits like 1 and 7, 5 and 6, 3 and 8, 9 and 8, and so forth. Additionally, individuals compose a similar digit from various perspectives, the uniqueness, and assortment in the handwriting of various people likewise impact the development and presence of the digits.

| ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 8, Issue 4, July 2021 |

IV. PROPOSED SYSTEM APPROACH

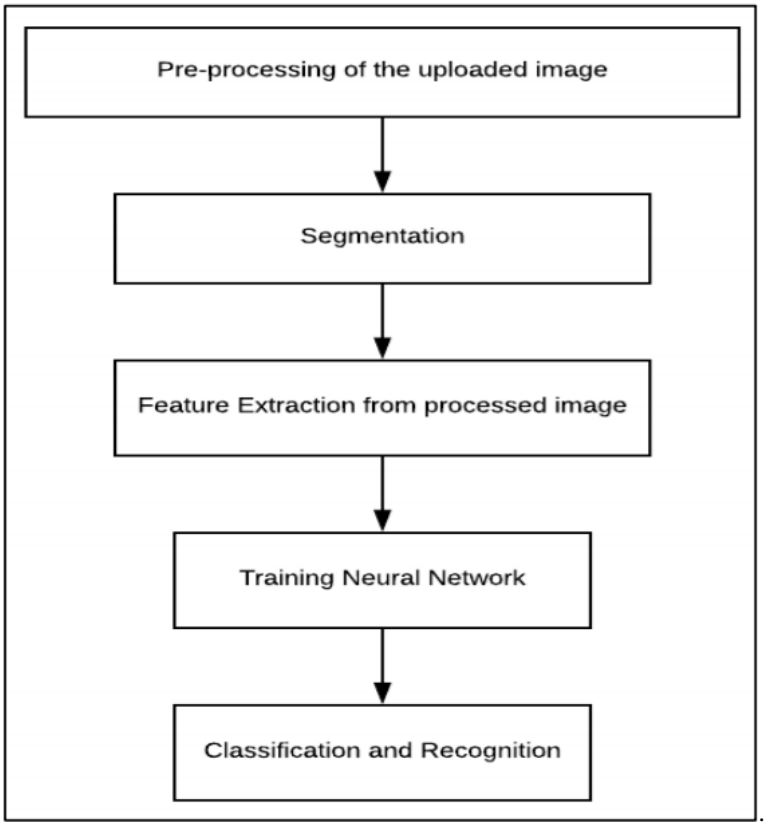

Fig 2:- Block Diagram of proposed model

A. Advantages:

There are many more advantages of the handwriting recognition system.

1. Data storage, for example, there are many files, contracts, and some personal records that contain some handwritten information and notes. Certain of these documents contain original signatures or notes that might not be electronically stored but these problems are overcome with the use of a handwriting recognition system. Handwriting recognition software allows users to translate all those signatures and notes into electronic words in a text document format. The advantage of this electronic storage is that this data only requires far less physical space than the storage of the physical copies. Another advantage of electronic storage is also that it requires fewer employees to sort the documents through, organize, and keep the data storage warehouse.

2. Data retrieval is another advantage of handwriting recognition. Physical data retrieval always requires personnel to sort through physical copies of old information. The data must always be stored and correctly organized and also it must have proper maintenance and upkeep on the physical copies. To retain this information or data, we perform electronic data retrieval by using a file search by using specific keywords, for example, the names and the dates of the file or document. Handwriting recognition software allows the old files to be saved in a proper electronic format. This is how handwriting recognition software helps in saving old files or important documents.

3. Another advantage of handwriting recognition is historical preservation. Historical papers that mostly exist have a physical format. Examples of historical papers are genealogical information, written manuscripts, old family records, and some personal diaries, and sometimes even shared old past stories. But still, sometimes, these historical papers might be damaged or corrupted due to some accidents and there are times when handwriting recognition software is very helpful. Handwriting recognition helps to transform the writings in the papers into a text document format which can also be said as readable electronic format. In this way, historical facts can be stored, reviewed, and shared easily by too many people.

| ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 8, Issue 4, July 2021 |

B. *Disadvantages:*

The disadvantage of handwriting recognition technologies is that not everyone's handwriting is the same, everyone writes differently. This starts the problem in the handwriting recognition technology when it need to translate a person's handwriting into type and because of this problem many companies failed to perform well because many couldn't effectively use the program well enough.

V. SYSTEM ARCHITECTURE

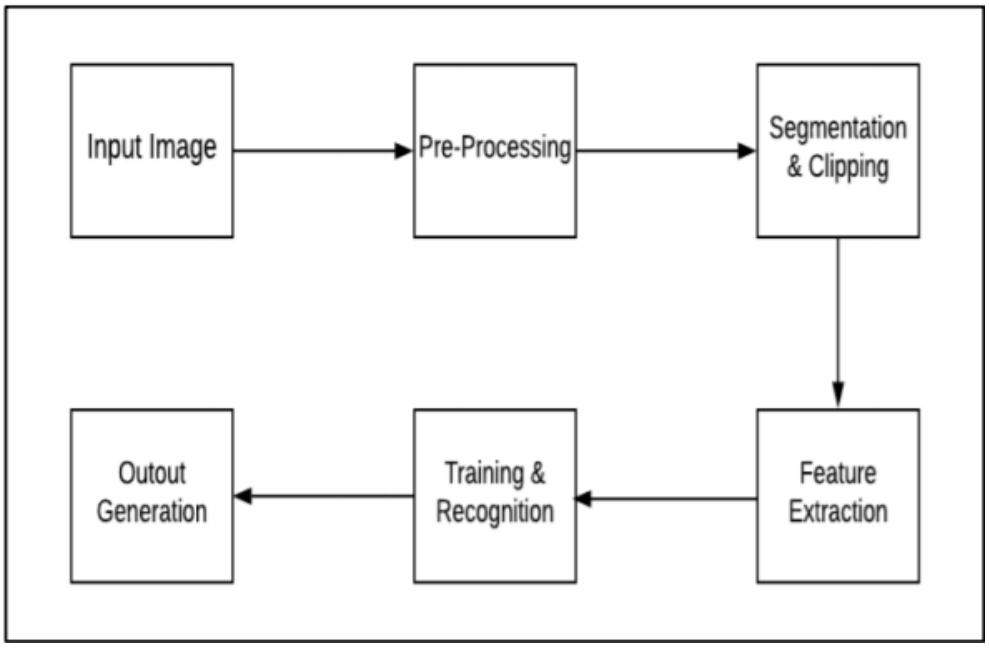

Fig 3:- Architecture of the Proposed System

The above Figure 3 illustrates the architecture diagram of the proposed system. The proposed model contains the four stages in order to classify and detect the digits:

A. Pre-processing
B. Segmentation
C. Feature Extraction
D. Classification and Recognition

A. *Pre-processing:*

The role of the pre-processing step is to perform various tasks on the input image. It basically upgrades the image by making it reasonable for segmentation. The fundamental motivation behind pre-processing is to take off a fascinating example from the background. For the most part, noise filtering, smoothing, and standardization are to be done at this stage. The pre-processing additionally characterizes a smaller portrayal of the example. Binarization changes over a grayscale image into a binary image.

| ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 8, Issue 4, July 2021 |

Fig 4:- Sample images taken from MNIST database

B. Segmentation:

Once the pre-processing of the input images is completed, sub-images of individual digits are formed from the sequence of images. Pre-processed digit images are segmented into a sub-image of individual digits, which are assigned a number to each digit. Each individual digit is resized into pixels. In this step, an edge detection technique is being used for the segmentation of dataset images.

C. Feature Extraction:

After the completion of the pre-processing stage and segmentation stage, the pre-processed images are represented in the form of a matrix that contains pixels of the images that are of very large size. This way, it will be valuable to represent the digits in the images which contain the necessary information. This activity is called feature extraction. In the feature extraction stage, redundancy from the data is removed.

D. Classification and Recognition:

In the classification and recognition step the extracted feature vectors are taken as an individual input to each of the following classifiers. In order to showcase the working system model extracted features are combined and defined using classifiers.

VI. CONCLUSION

We have implemented hand written digit recognition using CNN from an image. Our algorithm successfully detects the digit from the image. We have applied our algorithm on many images and found that it successfully detect the hand written digits.Here we demonstrate a model which can recognize handwritten digit. Later it can be extended for character recognition and real-time person's handwriting. Handwritten digit recognition is the first step to the vast field of Artificial Intelligence and Computer Vision.

VII. FUTURE WORKS

In future, we are planning to develop a real-time handwritten digit recognition system.The results can be made more accurate with more convolution layers and more number of hidden neurons. It can completely abolish the need for typing. Digit recognition is an excellent prototype problem for learning about neural networks and it gives a great way to develop more advanced techniques of deep learning.

REFERENCES

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

[2] A. Krizhevsky, I. Sutskever, and G. E. Hinton, "Imagenet classification with deep convolutional neural networks," in Advances in neural information processing systems, 2012, pp. 1097-1105.

| ISSN: 2395-7852 | www.ijarasem.com | Bimonthly, Peer Reviewed & Referred Journal|

| Volume 8, Issue 4, July 2021 |

[3] D. Hubel and T. Wiesel, "Aberrant visual projections in the Siamese cat," The Journal of physiology, vol. 218, no. 1, pp. 33- 62, 1971.
[4] Y. LeCun, Y. Bengio, and G. Hinton, "Deep learning," nature, vol. 521, no. 7553, p. 436, 2015.
[5] D. Cireşan, U. Meier, and J. Schmidhuber, "Multi-column deep neural networks for image classification," arXiv preprint arXiv:1202.2745, 2012.
[6] K. Fukushima and S. Miyake, "Neocognitron: A self-organizing neural network model for a mechanism of visual pattern recognition," in Competition and cooperation in neural nets: Springer, 1982, pp. 267-285.
[7] Y. LeCun et al., "Handwritten digit recognition with a backpropagation network," in Advances in neural information processing systems, 1990, pp. 396-404.
[8] Y. LeCun, L. Bottou, Y. Bengio, and P. Haffner, "Gradientbased learning applied to document recognition," Proceedings of the IEEE, vol. 86, no. 11, pp. 2278-2324, 1998.
[9] R. Hecht-Nielsen, "Theory of the backpropagation neural network," in Neural networks for perception: Elsevier, 1992, pp. 65-93.
[10] Y. LeCun, "LeNet-5, convolutional neural networks," URL: http://yann. lecun. com/exdb/lenet, vol. 20, 2015.
[11] Ovi Paul, "Image Preprocessing on numtaDB for Bengali Handwritten Digit Recognition," in International Conference on Bangla Speech and Language Processing(ICBSLP), 21-22 September, 2018
[12] W. Jiang, "MNIST-MAX: A multi-language handwritten digit recognition" in IOP SciNotes, vol 1, no. 2, arXiv:2004.03848v1 [cs.CV] 8 Apr 2020.
[13] D. Sharma, "Isolated Handwritten Digit Recognition using adaptive unsupervised Incremental learningTechnique," in International Journal of Computer Applications (0975 – 8887) Volume 7– No.4, September 2010.pp 0975 – 8887.
[14] D. C. Ciresan, U. Meier, J. Masci, L. M. Gambardella, and J. Schmidhuber, "Flexible, high performance convolutional neural networks for image classification," in Twenty - Second Internation al Joint Conference on Artificial Intelligence, 2011.
[15] R. B. Arif, M. A. B. Siddique, M. M. R. Khan, and M. R. Oishe, "Study and Observation of the Variations ofAccuracies for Handwritten Digits Recognition with Various Hidden Layers and Epochs using Convolutional NeuralNetwork," in 2018 4th Interna tional Conference on Electrical Engineering and Information & CommunicationTechnology (iCEEiCT) , 2018,pp. 112 - 117:IEEE.