International Journal for Modern Trends in Science and Technology, 9(04): 345-349, 2023

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0904050
Available online at: http://www.ijmtst.com/vol9issue04.html

A Comparative Study of Deep Learning Techniques for the Recognition of Handwritten Digits

Priyanka Verma | Sakshi Maurya | Kaushlendra Yadav | Shilpi Khanna

Information Technology, Shri Ramswaroop Memorial College of Engineering and Management, Lucknow, Uttar Pradesh, India
Corresponding Author Email Id: priyankaverma1814@gmail.com , mauryasakshi7601@gmail.com

To Cite this Article
Priyanka Verma, Sakshi Maurya, Kaushlendra Yadav and Shilpi Khanna. A Comparative Study of Deep Learning Techniques for the Recognition of Handwritten Digits. International Journal for Modern Trends in Science and Technology 2023, 9(04), pp. 345-349. https://doi.org/10.46501/IJMTST0904050

Article Info
Received: 22 March 2023; Accepted: 19 April 2023; Published: 20 April 2023.

ABSTRACT

Handwritten digit recognition is a technique that automatically helps recognize and detect all handwritten digital data through various Machine Learning and Deep Learning Models. We have used different Deep Learning algorithms to reduce the complexity by using several models and helping to increase the efficiency of the technique. In this paper, our main objective is to provide an efficient and predictable approach to recognize handwritten digits.

Machine learning is the application of Artificial Intelligence that enables learning from previous experiences that improves itself through such experiences. Deep learning is the kind of machine learning technique that learns from the neural network through training models. Numerous applications of handwritten digit recognition include detection of vehicle numbers, postal services, extracting numbers from bank cheque, etc. Various Deep Learning algorithms are Convolutional Neural Networks, Artificial Neural Networks, Recurrent Neural Networks, etc.

This paper presents a study on detecting handwritten digits. Various techniques and models are used to identify and classify handwritten digits. The goal of this paper is to identify handwritten digits. We have also done a comparative study on different models namely, CNN, RNN, and ANN. Our evaluation shows that the proposed approaches have 97.91%, 95.12% and 88.68% accuracies respectively.

KEYWORDS:Convolutional Neural Network, Handwritten Digit Recognition, Artificial Intelligence, Machine Learning, Deep learning.

1. INTRODUCTION

Handwritten Digit Recognition is the proficiency of a computer that enables one to interpret the digits made by humans in their usual handwriting. It is a compact task for the machine, as handwritten digits are ambiguous and are of various shapes and sizes. This handwritten digit recognition system is a key that utilizes photos of digits and acknowledges that digit. In this paper, for recognizing handwritten digits, we compared the three deep learning models, namely, ANN, CNN, and RNN, based on their accuracy, epochs, and batch size.

ANN, which stands for Artificial Neural Network as the name suggests, it contains artificial neurons, just as the human brain

consists of neurons. ANN comprises three layers. They are the input layer, the hidden layer, and the output layer. These networks are trained using a training set.

Input layers get the data from the outside world that is interpreted by the neural network. After this, data can be passed through one or multiple layers which is helpful for the output layer by changing the input into data. Certainly, the output layer provides an output as artificial neural networks respond to the input data provided.

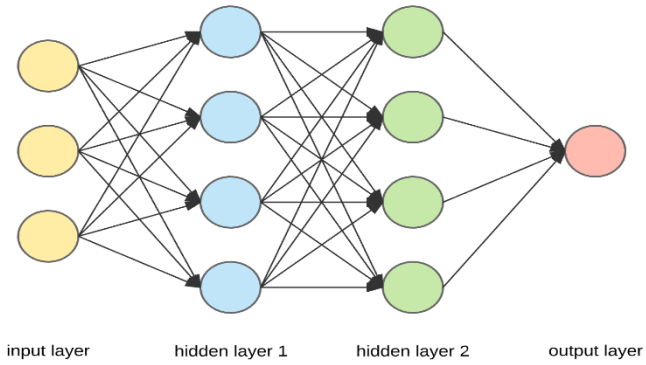


Fig 1: Representation of ANN layers

CNN, which stands for Convolutional Neural Network, it is a type of artificial intelligence used for image classification. It consists of a convolutional layer, a fully connected layer, and a pooling layer.

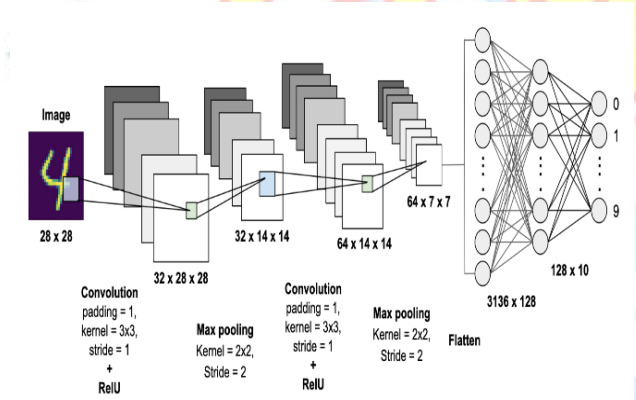


Fig 2: Representation of CNN layers

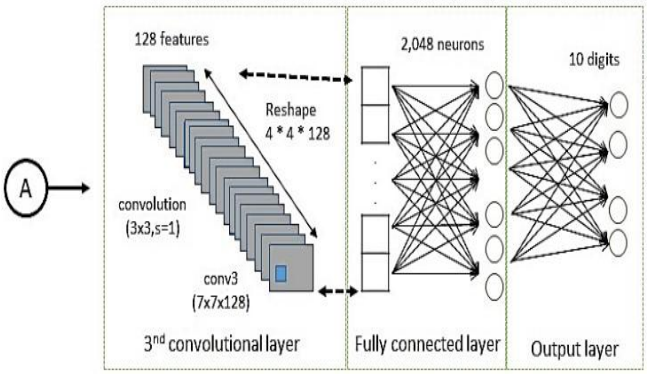


Fig 3: Illustration of different stages of fully connected layers

RNN stands for Recurrent Neural Network. This type of neural network handles sequential data. Instead of travelling in a linear direction, it follows recurrence relations and learns from back-propagation through time.

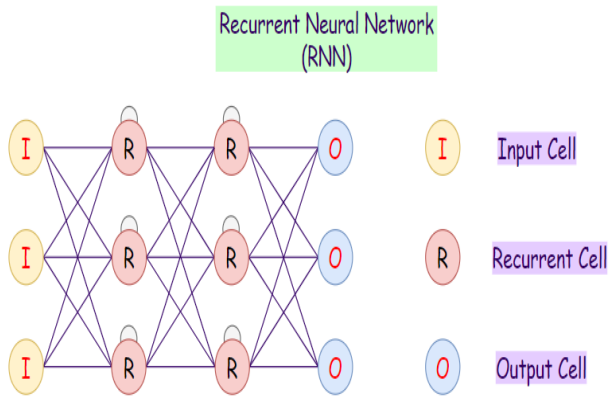


Fig 4: Representation of RNN layers

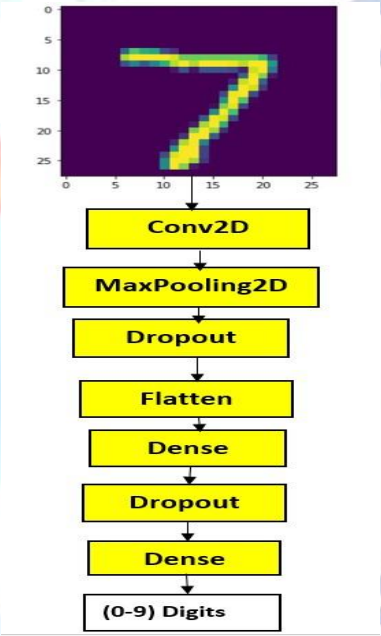
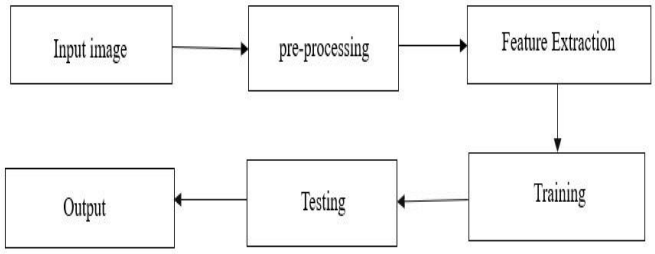


Fig 5: Various parameters using CNN layers

2. METHODOLOGY



1. Downloading the dataset

The first step comprises gathering the suitable dataset from different sources for handwritten digit recognition. Based on the performance and accuracy of handwritten digits, the MNIST Dataset is widely used.

It was introduced in 1998. It has many handwritten digits for training the model as well as testing the model. This dataset comprises images in the form of clusters of 28x28 values. It has been consistently utilized for testing classifying algorithms in handwritten digit recognition structures.

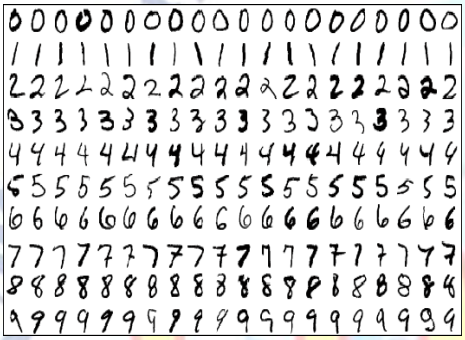


Fig 6: An Image from MNIST database

2. Pre-processing of the data

Pre-processing is one of the essential steps that focuses on improving the input data by reducing and removing unnecessary impurities as well as redundancy.

3. Visualizing the data

This is a process of representing data or information in the form of a visual format such as a graph, chart etc. This makes the data clear as well as understandable and makes this data easier to identify patterns and trends within large data sets.

4. Splitting the data

Next, the complete dataset is divided into training and testing datasets.

5. Training as well as testing the data

In any dataset, a training dataset is used for model building, and a test or validation dataset is used for validating the model. So, we have used the training data for the fitting of the model with testing data for testing it.

6. Analyzing the result

The models produced here are then used for predicting the results, which are not known, and this is called the test dataset. To test the model, some images are used from the test dataset.

3. IMPLEMENTATION

We have used python's library called Keras and TensorFlow frameworks for our implementations.

Keras is an open-source neural network library. It consists of MNIST dataset.

1. Firstly, we have imported all the important libraries that are required for the training.
2. Import the MNIST dataset. Loading it using Keras inbuilt dataset.
3. Data Pre-processing.
   - In this importing the data to create training and testing variables.
   - Reshaping and normalizing the data.
   - Creating the validation set of images.
4. Creating a deep learning model and comparing their accuracy among these three models.
   - Creating a CNN Model with a convolutional layer and a max pooling layer.
   - Creating an ANN Model
   - Creating a RNN Model.
5. Compiling the model with the optimizer.
6. Training the model using epochs, batch size and validation data.
   - Plotting the loss and accuracy on epochs.
7. Evaluating the model accuracy on the test dataset.

4. RESULT ANALYSIS

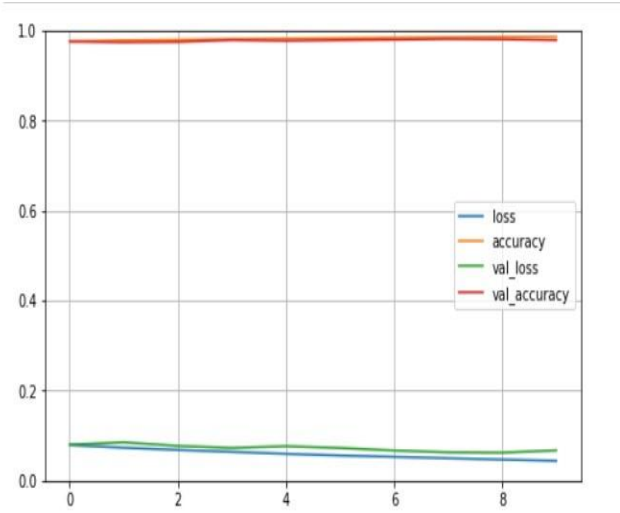
We have done the training and the testing of data using above mentioned Deep Learning Models. We found that CNN is the most efficient model for classification of images with the highest accuracy.

This table below shows the accuracy of three models.

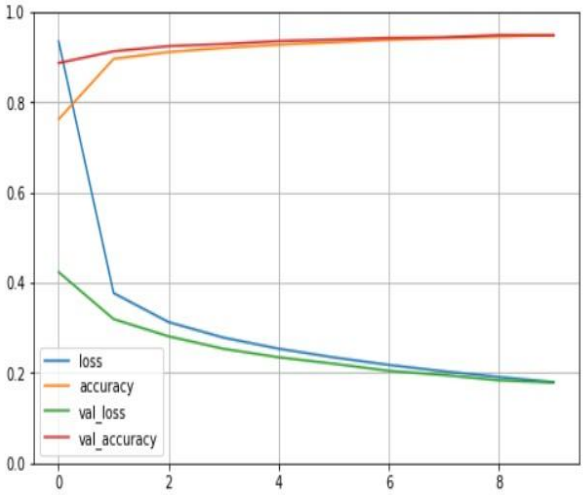
MODEL	ACCURACY
CNN	97.91%
ANN	95.12%
RNN	88.68%

5. GRAPH OF CNN, ANN, and RNN

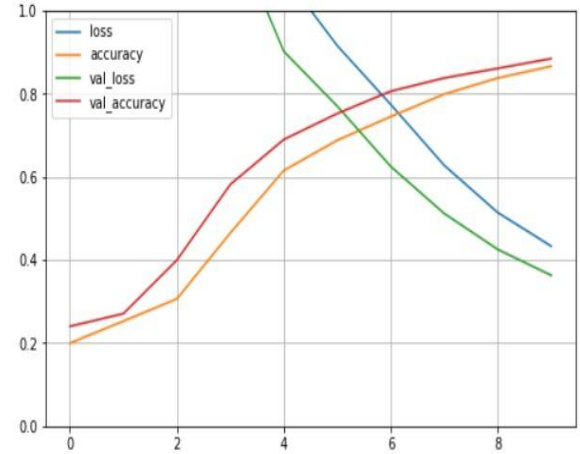
- **CNN: -**



- **ANN: -**

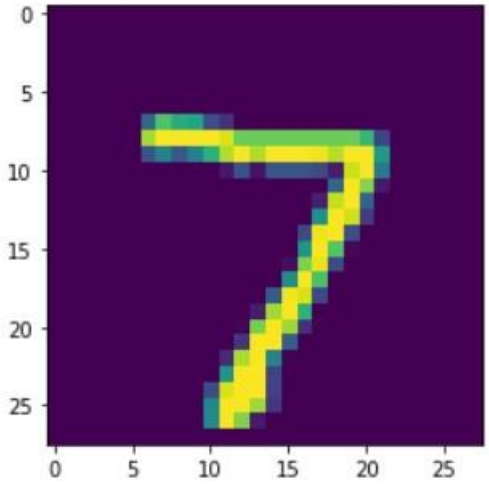


- **RNN: -**

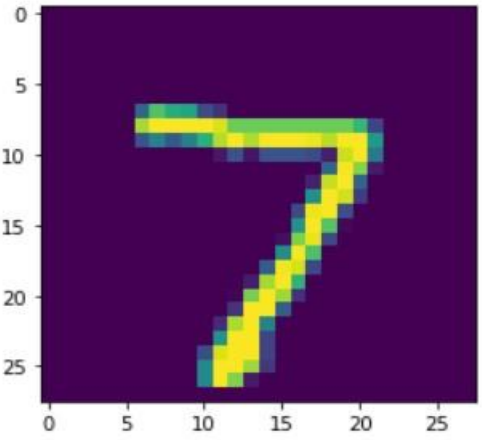


6. OUTPUT

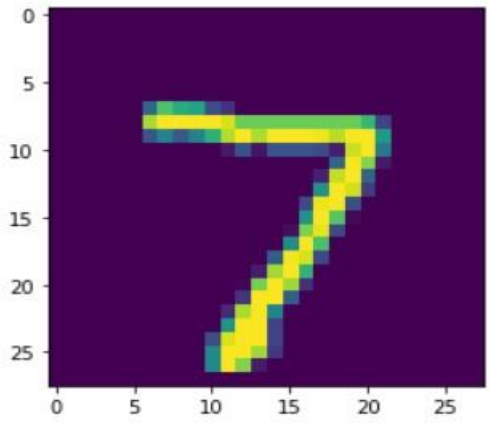
- **CNN: -**



- **ANN: -**



- **RNN: -**



7. CONCLUSION

In this paper, we have learned about the recognition of handwritten digits by machines through various deep learning models using the MNIST dataset. We compared several deep learning models using epochs and batch

size to obtain higher accuracy. Hence, we have reached the conclusion that the CNN model gives better and higher accuracy as compared to ANN and RNN, which we can also observe in the graph. Overall, working on this project was a nice experience for us.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Dan ClaudiuCires¸an, Ueli Meier, Luca Maria Gambardella, Jurgen Schmidhuber (March 2010), ¨Deep, Big, Simple Neural Nets for Handwritten Digit Recognition", arXiv, pp. 1-14.

[2] Y. Le Cun, L. D. Jackel, B. Boser, J. S. Denker, H. P. Graf, I. Guyon, D. Henderson, R. E. Howard, W. Hub, "Handwritten Digit Recognition: Applications of Neural Network Chips and Automatic Learning" NATO ASI series F: Computer and system sciences, Vol. 68, pp. 41-46.

[3] Radhey Shyam. Convolutional Neural Network and its Architecture. Journal of Computer Technology and Applications (JoCTA).2021;12(2): 6–14p.

[4] Vartika Srivastava and Radhey Shyam, Enhanced Object Detection with Deep Convolutional Neural Network, International Journal of All Research Education and Scientific Methods, 2021; 9(7): 27-36p.

[5] Kazheen, Ismael & Mohsin Abdulazeez, Adnan. (2021). Deep Learning Convolutional Neural Network for Speech Recognition: A Review. 10.5281/zenodo.4475361.

[6] Y. LeCun, "The MNIST database of handwritten digits," http://yann. lecun. com/exdb/mnist/, 1998

[7] Maitra DS, Bhattacharya U, Parui SK. CNN based common approach to handwritten character recognition of multiple scripts. In ICDAR. IEEE Computer Society, relocated from Tunis, Tunisia. 2015

[8] Simonyan K, Zisserman A. Very deep convolutional networks for large-scale image recognition. CoRR. vol. abs/1409.1556. 2014

[9] Liu W, Wang Z, Liu X, Zeng N, Liu Y, Alsaadi F. A survey of deep neural network architectures and their applications. Neurocomputing. 2017; 234(12), pp. 11–26.

[10] LeCun Y, Bottou L, Bengio Y, Haffner P. Gradient-based learning applied to document recognition. In Proceedings of the IEEE. 1998.