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MNIST Digital Classification and Handwritten Digit Recognition

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Abstract- One of the most well-known issues in computer vision and machine literacy operations is the handwritten digit recognition challenge. There are several machine literacy techniques that have been used to solve the handwritten number recognition issue. In this paper, neural network methods are the main topic. Deep neuralnetworks, deep belief networks, and convolutional neural networks are the three most widely used Neural Network techniques. In this paper, the three neural network approaches are compared and estimated in terms of numerous factors similar to delicacy and performance. Recognition, delicacy rate and performance, still, isn't the only criterion in the evaluation process, but there are intriguing criteria similar to prosecution time. Random and standard dataset of handwritten numbers have been used for conducting the trials. The results show that among the three neural network approaches, convolutional neural network is the most accurate algorithm; it has a 98.08 delicacy rate. Still, the prosecution time of convolutional neural networks is similar to the other two algorithms.

Keywords- Handwritten digit recognition, Deep Learning, Machine Learning, Convolutional Neural Network (CNN), MNIST dataset, Epochs, Hidden Layers.

I. INTRODUCTION

The capacity of computers to recognise human handwritten digits is known as handwritten digit recognition. It is considered to be a hard task for the machine because handwritten digits are notperfect and can be made with many different techniques. Handwritten digit recognition, which uses the image of a digit to identify the digit present in it, offers a solution to this issue. The automatic processing of postal addresses, bank checks, and other documents frequently uses handwritten digit recognition.

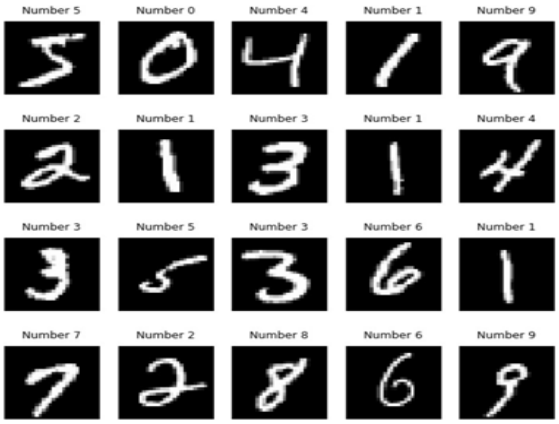

Fig 1. Handwritten Digits.

While some of the current systems use computational intelligence methods like artificial neural networks, others might just be big search tables. Although artificial neural networks had been developed since the 1940s, they have been widely applied to a large variety of disciplines only since the past fifteen years.

These days, there are many different types of neural networks, all of which can be traced back to a straightforward mathematical model of a biological neuron, or an artificial neuron. Although some are implemented in hardware, the majority are always simulated in software. Numerous instances of handwritten digitrecognition using artificial neural networks have been effective, with very small margins of error.

II. LITERATURE REVIEW

In this paper, the mnist data set is used as handwritten digital historical data. The mnist data set is a very classic data set in the field of machinelearning. An early notable attempt in the area of digit recognition research was made. The origin ofa great deal of exploration work in the early sixties was grounded on an approach known as analysis by conflation system. In view of the increasing demand for handwritten digit recognition, a handwritten digit recognition modelbased on convolutional neural networks is proposed.

The model includes 1 input layer and 2 convolutional layers (5*5 convolution Core), 2 pooling layers (2*2 pooling core), 1 fully connected layer, 1 output layer, and use the mnist data set for model training and prediction.

After a lot of training and participation, the accuracy rate of the training set was finally reached to 100%, and the accuracy rate of 98.25% was also achieved on the test set, which can meet the requirements of recognizing handwritten digits. With the humanization of machines, there has been a substantial quantum of exploration and development work that has given a swell to deep literacy and machine literacy along with artificial intelligence.

With time, machines are getting Further and more sophisticated, from calculating the introductory totalities to doing retina recognition they've made our lives more secure and manageable.

Likewise, handwritten text recognition is an important application of deeplearning and machine learning which is helpful in detecting forgeries and a wide range of research has already been done that encompasses a comprehensive study and implementation of various popular algorithms like works done by S M Shamim, Anuj Dutt, Norhidayu binti and Hongkai Wang to compare the different models ofCNN with the fundamental machine learning algorithms on different grounds like performance rate, execution time, complexity and so on to assess each algorithm explicitly.

S M Shamim concluded that the Multilayer Perceptron classifier gave the most accurate results with minimum error rate followed by Support Vector Machine, Random Forest Algorithm, Bayes Net, Na¨ıve Bayes, j48, and Random Tree respectively while Anuj Dutt presented a comparison between SVM, CNN, KNN, RFC and were able to achieve the highest accuracy of 98.72% using CNN (which took maximum execution time) and lowest accuracy using RFC.

Norhidayu binti did the detailed study-comparison on SVM, KNN and MLP models to classify the handwritten text and concluded that KNN and SVM predict all the classes of dataset correctly with 98.25% accuracy but the thing process goes little complicated with MLP when it was having trouble classifying number 9, for which the authors suggested to use CNN with Keras to improve the classification.

The comparison of the algorithms (Support vector machines, Multi-layered perceptron and Convolutional neural network) is grounded on the characteristic map of each algorithm on common grounds like dataset, the number of ages, complexity of the algorithm, delicacy of each algorithm, specification of the device (Ubuntu 20.04 LTS, i5 7th word processor) used to execute the program and runtime of the algorithm,under ideal condition.

III. EXISTING SYSTEM

X. Han et al. summarizes the latest development of CNN and expounds the relative research of image recognition technology and elaborates on the application of CNN in handwritten numeral recognition. However, every neural network has some error rate due to parallel in digit shape.

R. Sudhakar et al. developed a hybrid model by integrating a non-linear regression model and optimization-driven deep learner for video super resolution. Initially, the low-resolution frames are subjected to framing, and each frame is provided to both Fractional-Group Search Optimizer-based Deep Belief Network (FrGSO-DBN) classifier and the non-linear regression model.

Caiyun Ma et al. normalized the images of various sizes and stroke thickness in preprocessing to eliminate negative information and keep relevant features. The architecture of CNN for the existing system is shown below.

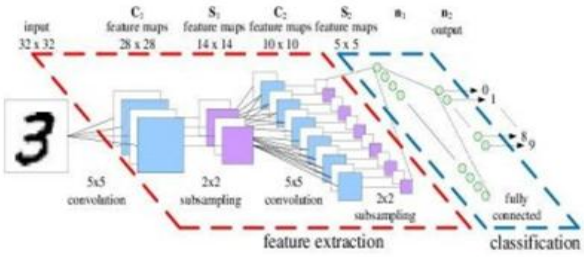

Fig 2. Existing system of HDR.

IV. PROPOSED SYSTEM

1. Architecture Diagram:

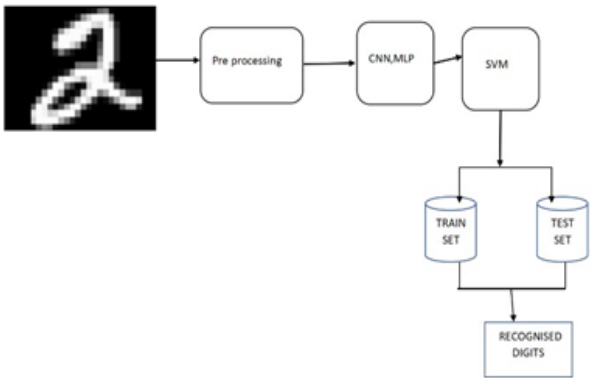

Fig 3. Architecture Diagram.

In this system we have used neural networks such as CNN, Multiple layer Perceptron with an SVM algorithm,such that the Handwritten digit is being predicted with high accuracy and less computational time. By using SVM our program showed a good outcome with accuracy of 98% and takes less time to compute, as accuracy,

Computational time is Paramount for each and every project when implemented in daily life problems which we encounter.

V. MODULES

There are four specific modules.

- Pre-processing
- Support Vector Machine
- Multilayer Perceptron
- Convolutional Neural Network

1. Pre-Processing:
Pre-processing is an initial step in the machine and deep learning which focuses on improving the input data by reducing unwanted impurities and redundancy. To simplify and break down the input data we reshaped all the images present in the dataset in 2-dimensional images i.e (28, 28, and 1). Each pixel value of the images lies between 0 to 255 so; we normalized these pixel values by converting the dataset into 'float32' and then dividing by 255.0 so that the input features will range between 0.0 to 1.0. Next, we performed one-hot encoding to convert the y values into zeros and ones, making each number categorical, for example, an output value 4 will be converted into an array of zero and one

2. Support Vector Machine:
The SVM in scikit-learn supports both dense (numpy.ndarray and convertible to that by numpy.asarray) and sparse (any scipy.sparse) sample vectors as input. In scikit-learn, SVC, NuSVC and LinearSVC are classes capable of performing multi-class classification on a dataset. In this paper we have used Linear SVC for classification of MNIST datasets that make use of a linear kernel implemented with the help of LIBLINEAR

3. Multilayer Perceptron:
The implementation of Handwritten digits recognition by Multilayer perceptron which is also known as feedforward artificial neural network is done with the help of Keras module to create an MLP model of Sequential class and add respective hidden layers with different activation function to take an image of 28x28 pixel size as input. After creating a sequential model, we added a dense layer of different specifications and Drop out layers as shown in the image below. The block diagram is given here for reference. Once you have the training and test data, you can follow these steps to train a neural network in Keras.

4. Convolutional Neural Network:
The implementation of handwritten digit recognition by Convolutional Neural Network is done using Keras. It is an open-source neural network library that is used to design and implement deep learning models. From Keras, we have used a Sequential class which allowed us to create model layer-by-layer.

VI. RESULT ANALYSIS

The output digit will be displayed along with its accuracy on the window created. Our model gives a good accuracy score with almost 90% prediction rate.

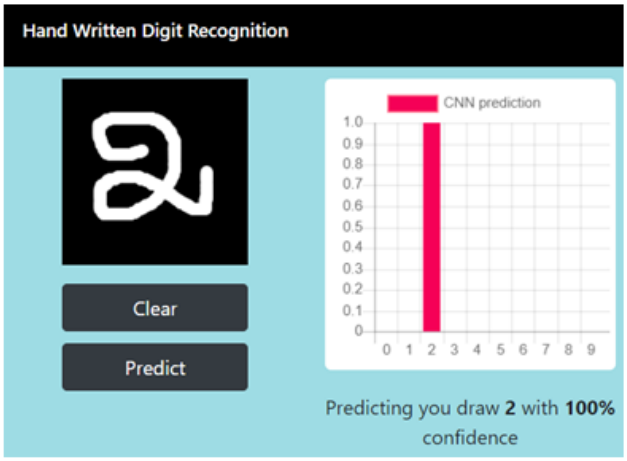

Fig 4. Output of digit recognition for numerical 2.

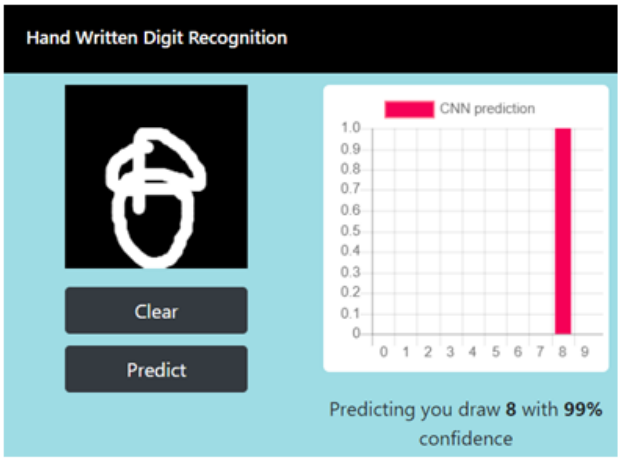

Fig 5. Output of digit recognition for numerical 8.

VII. CONCLUSION

The performance of CNN for handwritten recognition performed significantly. The proposed method obtained around 98.4% accuracy and is able to identify real-world images as well; the loss percentage obtained in both training and evaluation is almost negligible. The only difficult part is the noise present in the input canvas image, which needs to be taken care of. The learning rate of the model is much dependent on the number of dense neurons and the cross-validation measure.

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