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Hand written Digit Recognition Using CNN

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ABSTRACT: This research paper is on the verge of Handwritten digit recognition is the capability of a computer to recognize the human handwritten digits from different sources like images, papers, touch screens, etc., and classify them into 10 predefined classes (0-9). Recognition of handwritten numbers is the process that enables machines to recognize human handwritten numbers. This is not an easy task for the machine because the figures written by hand are not perfect, vary from person to person, and can be manufactured with many different flavours. The images of the manuscript numbers are shown as a 28*28 matrix where each cell is composed of a gray-scale pixel value. We have performed handwritten digit recognition with the help of MNIST datasets using Convolution Neural Network (CNN) model. Our main objective is to get the accuracy of the model along with their execution time to get the best possible model for digit recognition. We are getting 99% accuracy with CNN.

KEYWORDS: Handwritten Digit Recognition, MNIST Dataset

I. INTRODUCTION

Inthis paper, recognition of handwritten numerals is the abilityof a computer to recognize handwritten human numerals from variou s sources such as images,papers, touch screens, etc., and classify them into 10 predefined classes (0-9). Digit recognition has many applications like number plate recognition, postal mail sorting, bank check processing, etc. [2].

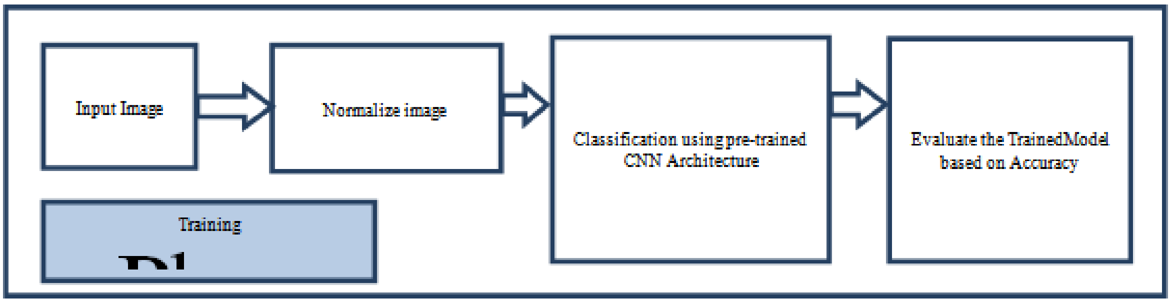
Recognition of handwritten numbers is the process that enables machines to recognize human handwritten numbers.It is not an easy task for the machine because handwritten digits are not perfect, vary from person-to-person, and can be made with many different flavours. Among thousands of datasets available in the market, MNIST is the most popular dataset for enthusiasts of machine learning and deep learning.So, there are 10 different categories in the MNIST dataset. The images of manuscript numbers are shown as a matrix of 28*28 where each cell consists of agrayscale pixel value.

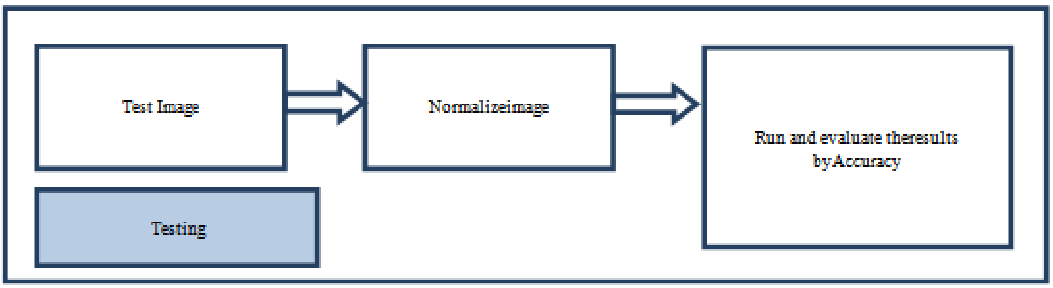
In Handwritten digit recognition, we face many challenges because of different styles of writing of different peoples as it is not an Optical character recognition. For this, we have used Convolutional Neural Network. These algorithms are carried out on the basis of their accuracy.

E.g. For an automated cheque processing system where the system recognizes the amount and date of the cheque, high accuracy is critical.If the system recognizes an incorrect number, it may cause significant damage that is not desirable.That's why an algorithm with high accuracy is required in these real world applications [1].

So that the most accurate algorithm with the least chances of errors can be employed in various applications of handwritten digit recognition [3].

II. PROPOSED WORK





Working of CNN (Convolution Neural Network)
CNN, also known as ConvNets, are made up of several layers and are mostly used for image processing and object detection.Yann LeCun developed the original CNN in 1988 under the name LeNet.It was used to recognise characters such as ZIP codes and numbers. The CNN is widely used to identify satellite images, process medical images,forecast time series, and detect anomalies.

How Do CNNs Work?
CNN's have multiple layers that process and extract features from data:
Convolution Layer

- CNN has a convolution layer that has several filters to perform the convolution operation.

Rectified Linear Unit (ReLU)

- CNN's have a ReLU layer to perform operations on elements. The output is a rectified feature map.

Pooling Layer

- The rectified feature map next feeds into a pooling layer. Pooling is a down- sampling operation that reduces the dimensions of the feature map.
- The pooling layer then converts the resulting two-dimensional arrays from the pooled feature map into a single, long, continuous, linear vector by flattening it.

Fully Connected Layer

- A fully connected layer forms when the flattened matrix from the pooling layer is fed as an input, which classifies and identifies the images.

Below is an example of an image processed via CNN.

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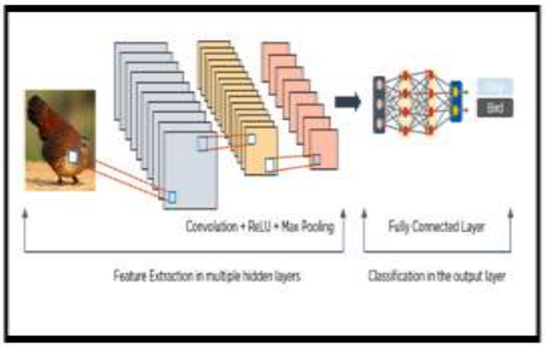

Figure 2.1: Convolution Neural Network

III. IMPLEMENTATION

The implementation of handwritten digit recognition by Convolutional Neural Network [11] is done using Keras. It is an open-source neural network library that is used to design and implement deep learning models. Based on working accuracy and the number of epochs (in deep learning algorithms) we have used Convolutional Neural Network Classifier.

Step:1 First we have handwritten images with labels of images taken as input images that is shown below also taken from MNIST dataset which is already in database of Keras library.

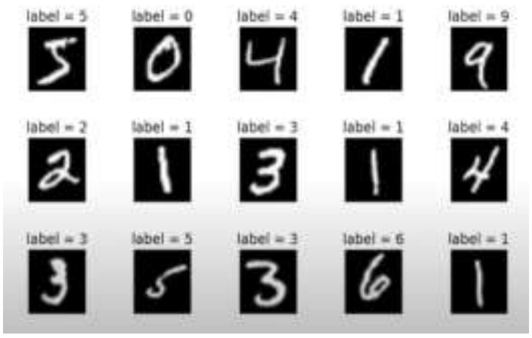

Figure 3.1: Handwritten Input data images from MNIST dataset

Step: 2 Pre-processing is an initial step in the deep learning which focuses on improving the input data by normalizing the input data we reshaped all the images present in the dataset in 2-dimensional images i.e. (28, 28, 1)

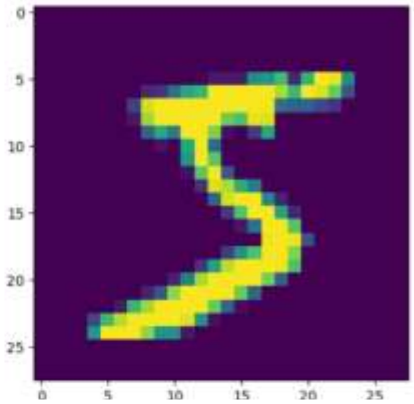

Figure 3.2: Normalized image-1

Step: 3 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. The dimension of the input image is set to 28(Height), 28(Width), 1(Number of channels).

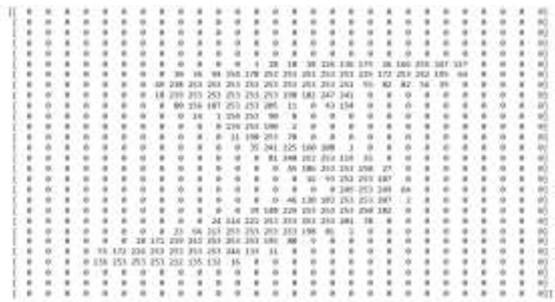

Figure 3.3: Normalized image-2

Step: 4 Then we divide data in two parts training data and testing data. For training data we are using 60000 data and for testing we are using 10000 data with dimension 28(width)*28(height).

Step: 5 Then we create a neural network and we train data into neural network shown in below figure like,

Figure 3.4: created CNN model

Step:6 now from that first image is flatten and then relu activation function is applied at hidden layer and at output layer 10 neurons apply with softmax activation function by running the CNN model we

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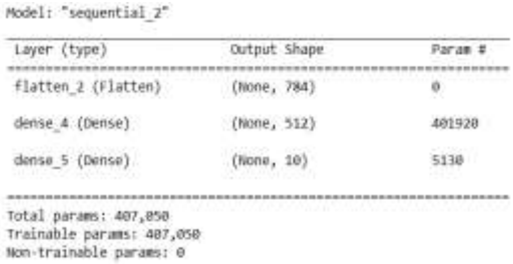
compile model with adam optimizer and generate accuracy in matrics then increasing by epoch we get accuracy that shows in tabular format. Which is describe as a result of model. Summary of model shown below.



```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                Output Shape              Param #
=================================================================
flatten_2 (Flatten)         (None, 784)               0

dense_4 (Dense)             (None, 512)               401920

dense_5 (Dense)             (None, 10)                5130

=================================================================
Total params: 407,050
Trainable params: 407,050
Non-trainable params: 0
```

Figure 3.5: Summary of CNN model

IV. RESULT

After executing the models, we found that CNN has the highest accuracy on training data. We have trained our deep learning model up to 5 epochs.

Epoch	Loss Rate	Accuracy
1	0.20	0.94
2	0.07	0.97
3	0.05	0.98
4	0.03	0.98
5	0.02	0.99

Table 4.1: Loss and accuracy of CNN with increasing number of epochs

At last testing result shown which is almost nearer to training result as shown in below figure

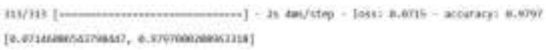


Figure 4.1 Testing evaluation result

V.CONCLUSION

We have implemented models for handwritten digit recognition using MNIST datasets, based on deep learning algorithms CNN. We have found that CNN gave the most accurate results for handwritten digit recognition. So, this makes us conclude that CNN is best suitable for any type of prediction problem including image data as an input.

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