

# A NOVEL METHOD FOR HAND WRITTEN DIGIT RECOGNITION

## Abstract:

Recently, handwritten digit recognition technology has attracted the attention of scholars due to the development of different Machine Learning, Deep Learning, and Computer vision-based software. In this paper, we compare the performance of some of the most popular machine learning algorithms, such as CNN (convolution neural networks) and CNN (multilayer CNN utilising Keras with Theano and Tensorflow), with that of deep learning algorithms. MNIST is a dataset that is frequently used for recognising handwritten digits. 10,000 test photos and 60,000 training images make up the dataset. Artificial neural networks, which are a crucial component of the field of image processing, can all closely resemble the human brain. Convolution neural networks with back propagation, for instance, are used to process images. The banking industry, where it can be used to manage secure pin numbers, is one use for this handwritten digit recognition technology. It can also be utilised for blind persons by using sound output.

## 1.INTRODUCTION:

The ability of a computer system to detect handwritten inputs like digits, characters, etc. is known as HANDWRITTEN digit recognition from many other sources, including emails, documents, pictures, letters, etc. This has been a subject of study for many years. Verifying signatures, processing bank checks, deciphering postal addresses from envelopes, and other research topics are some of them.

Here is where deep learning is used. Deep learning has risen to prominence in the last ten years as a popular tool for image processing, object detection, handwritten character and digit recognition, etc.

Numerous machine learning tools, such as scikit-learn, scipy-image, etc., as well as pybrains, Keras, Theano, Tensorflow by Google, TFLearn, etc., have been developed for deep learning. These tools strengthen the applications, which increases their accuracy. Artificial neural networks, a crucial component of the image processing industry, are capable of closely resembling the human brain. Convolutional Neural Networks with Back Propagation for Image Processing, Google Deep Mind for producing Art by studying the work of existing artists, etc. are a few examples.

There is a thriving academic community researching handwriting recognition. The International Conference on Frontiers in Handwriting Recognition (ICFHR), held every even-numbered year, and the International Conference on Document Analysis and Recognition (ICDAR), held every odd-numbered year, are the two main conferences for handwriting recognition. The IEEE supports both of these conferences. Online and offline recognition, signature verification, address interpretation, bank check processing, and writer recognition are all active study fields.

One of the main applications of machine learning and artificial intelligence has been the classification of images and patterns. People are always working to develop computer intelligence so that they can perform nearly all human labour.

The most fundamental and critical step towards this enormous and fascinating domain of computer vision is the handwriting recognition system.

## II. METHODOLOGY:

In recent years, deep learning has become a key technique for self-perception issues like comprehension pictures, human voices, and robotic exploration the globe. The endeavour tries to put into practise Convolution neural network theory, which is a crucial component of deep space architecture. learning. Knowing CNN and utilising it to the main one is the handwriting recognition system. the system's planned objective.

CNN is used for handwritten digit recognition for a reason. Take a multi-layer feedforward neural network, for example.

Applied to the MNIST dataset, which includes images with a size of 784 pixels (28 x 28 pixels). In this case, the first layer weights total roughly 78k parameters, which is a substantial but reasonable number if a buried layer has about 100 units.

The scale of the image is substantially larger in the natural world. The first layer weights will contain about 560k parameters if the size of the usual image, which is about 256256 pixels (about 56,000 pixels), is taken into account. Thus, it becomes unscalable for real images due to the excess of parameters.

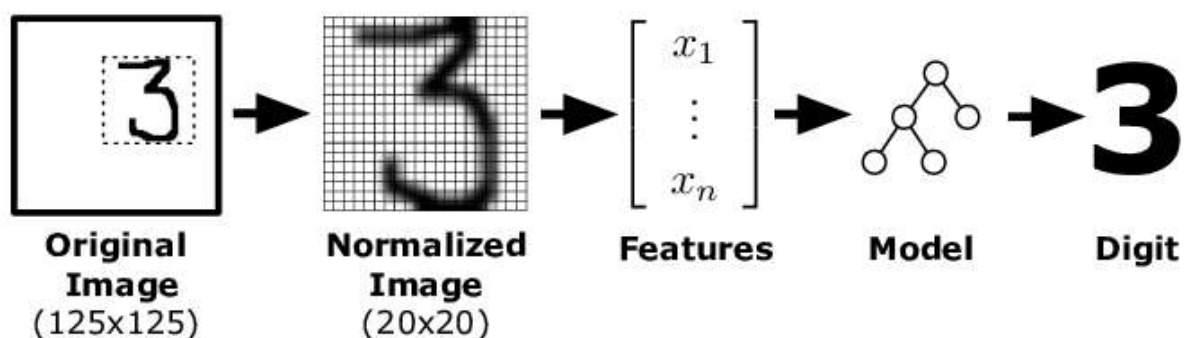


FIG.1: HANDWRITTEN RECOGNITION SYSTEM

It will therefore be so big that it will be exceedingly challenging to generalise the new data that is put into the network. By using filters, the convolution neural network extracts the feature maps from the 2D images, simplifying the process of feature extraction from the images. Convolution neural networks essentially take into account the mapping of image pixels with the neighbourhood space rather than having a layer of neurons that are fully connected. It has been established that Convolution Neural Networks are a crucial and effective tool for processing signals and images. Even in computer vision disciplines like handwriting recognition, natural object classification, and segmentation, CNN has proven to be a far superior technique than all other ones that have previously been used.

A more general goal was to create an M.L. model that could identify people's handwriting. However, as we worked on the model, it became clear that learning about the subject at hand would be extremely difficult and time-consuming.

It will be quite difficult to precisely categorise a cursive handwriting. So, using three alternative methods, we chose to identify a handwritten digit picture as the necessary digit. We then tested the accuracy of this classification.

### III. EXPLANATION OF THE PROPOSED SYSTEM

The User layer is the top layer of the architecture. The users who engage with the programme and get the desired outcomes make up the user layer.

The frontend architecture of the application is comprised of the following three levels. The HTML, CSS, and JavaScript development framework Bootstrap will be used to create the application. The localhost, which is displayed in the browser, is where the programme is deployed.

The user will be able to upload images of the handwritten numbers to the app to have them digitalized.

- The business layer, which consists of logical calculations based on the client's request, sits between the database and view layers. The service interface is also included.
- Training Data and Test Data make up the backend layer's two datasets. The training set, which consists of 60,000 cases, and the test set, which consists of 10,000 examples, have already been separated into the MNIST database.
- Convolution neural network training is the employed training algorithm. By doing this, the trained model will be ready to be used to categorise the digits found in the test data. As a result, the digits in the photos can be categorised as Class 0,1,2,3,4,5,6,7,8,9.

#### Algorithm:

Forward Propagation:

#### Architecture:

A sample workflow for the CNN module's feature extraction and image classification process is presented below. The network's input layer, hidden layers, and output layer. The feature extraction phase of the network involves multiple layers and uses convolution and subsampling.

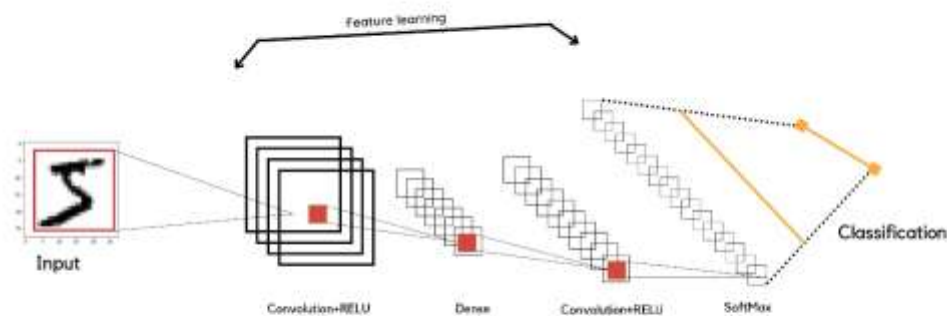


FIG.2: ARCHITECTURE OF CNN.

Neural networks take an input and alter it using a number of hidden layers, which is how it works.

- Each group of neurons in a hidden layer is completely connected to every other neuron in the layer below it.
- Each layer of neurons functions entirely separately.
- The "output layer" is the final layer that is entirely connected.

#### A. CONVOLUTION LAYER

The fundamental layer is the convolutional layer, a CNN building blocks. The parameters of the layer include consisting of a group of teachable filters (or kernels), which have a narrow receptive field yet penetrate the entire input volume's depth. While each filter is convolved across the forward pass of the dimensions of the input volume, the dot product between the entries is calculated of the input and the filter, creating a 2- the filter's three-dimensional activation map. As a consequence, the network discovers filters that are active when they notice a particular element at some location in space within the input.

##### Feature Extraction:

All of the neurons in a feature share the same weights during feature extraction. In this manner, the same feature is recognised by all neurons at various locations in the input image. Limit the number of unrestricted parameters.

##### Subsampling Layer:

The process of down sampling or subsampling a signal involves making it smaller overall. Each feature map's spatial resolution is decreased by the subsampling layers.

Shift or distortion invariance is attained, and the impact of sounds is lessened.

##### Pooling layer:

In a ConvNet architecture, it is typical to sporadically insert a Pooling layer between succeeding Conv layers. Reduce the number of parameters and computations in the network by gradually shrinking the spatial size of the representation, which also controls overfitting. Every depth slice of the input is independently processed by the Pooling Layer, which then applies the MAX operation to resize each slice spatially.

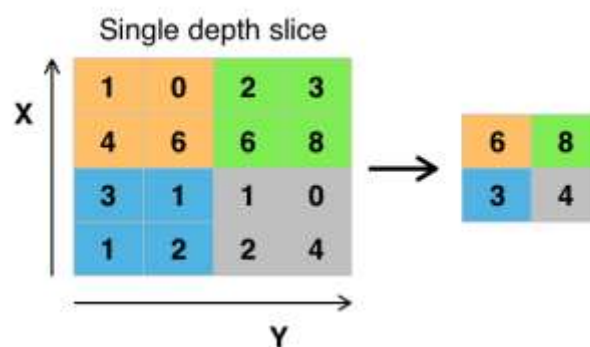


FIG.3: POOLING LAYER

#### B. TENSORFLOW:

An open-source machine learning library for both research and production is called TensorFlow. TensorFlow provides developers of all skill levels with APIs for desktop, mobile, web, and cloud

applications. To get started, refer to the sections below. We can achieve text output and sound output by scanning the number digit and converting it to PNG format using the python3 command in terminal.

#### IV. RESULTS:

We do not consider our results to be flawless, as with any study or project undertaken in the field of machine learning and image processing.

There is always opportunity for improvement in your methods because machine learning is a topic that is continually developing; there will always be a fresh new idea that solves the same problem better. Three models were used to test the application: Multi-Layer Perceptron (MLP), Convolution Neural Network, and (CNN). We obtain a different classifier accuracy with each model, indicating which is superior.

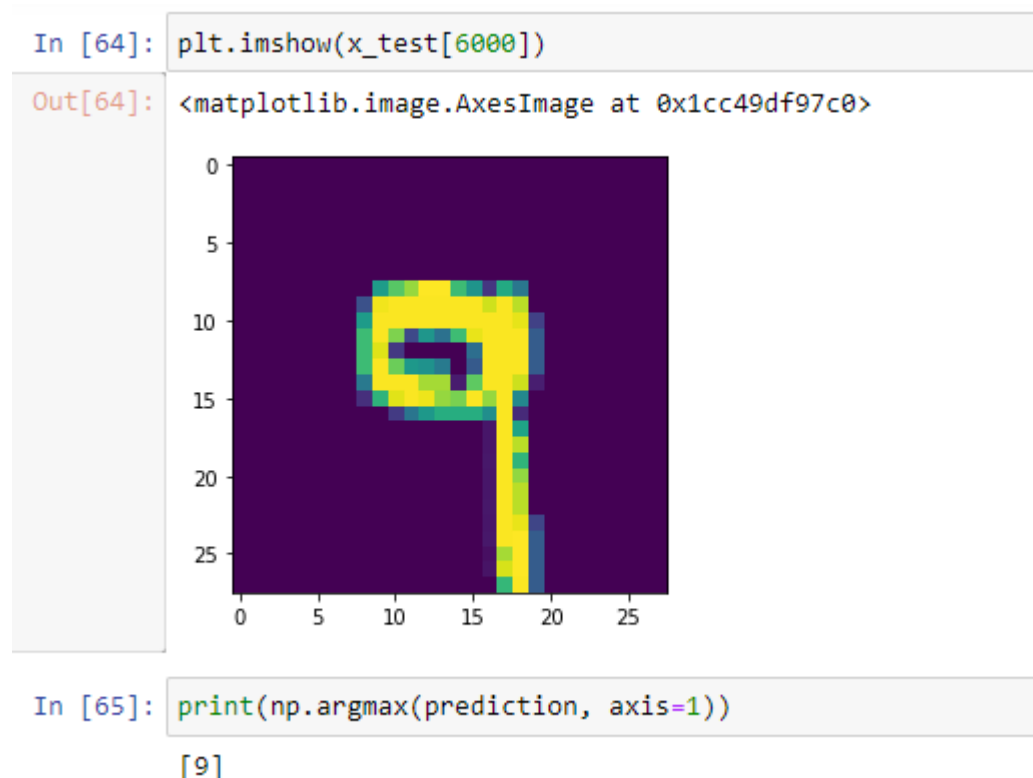


FIG.4: OUTPUT OF DIGIT RECOGNITION OF NUMERICAL '7'

The network's training results are saved in npz format so that the programme won't have to repeat the training process each time a user tries to recognise a digit. We employed a logistic classifier, the SoftMax function, one hot encoding, cross entropy, and loss minimization with mini batch gradient descent for classification. These are some of the fundamentals of neural networks that must be understood in order to process output from the network and present it to the user in an understandable manner.

#### A. DATASET USED:

The MNIST collection of handwritten digits served as the dataset. It has a test set of 10,000 cases and a training set of 60,000 examples.

The digits have been centred in a fixed-size image and size-normalized. The photos are 28\*28 pixels in size. It is a useful database for those who want to practise new skills and pattern recognition algorithms on actual data with the least amount of pre-processing and formatting work. The database comes in from <http://yann.lecun.com/exdb/mnist/>



FIG 6: MNIST DATASET

## B. ANALYSIS OF THE RESULTS:

System Analysis and Design is the term used in business to describe the process of analysing a business issue with the goal of improving it through improved practises and methodologies. Designing organisations, enhancing performance, and attaining goals for profitability and expansion are all related to system analysis and design. The focus is on systems in action, the connections between subsystems, and their role in achieving a common objective.

```
Epoch 1/5
1875/1875 [=====] - 79s 42ms/step - loss: 0.1941 - accuracy: 0.9557 - val_loss: 0.0773 - val_accuracy: 0.9763
Epoch 2/5
1875/1875 [=====] - 77s 41ms/step - loss: 0.0614 - accuracy: 0.9812 - val_loss: 0.0710 - val_accuracy: 0.9776
Epoch 3/5
1875/1875 [=====] - 79s 42ms/step - loss: 0.0447 - accuracy: 0.9866 - val_loss: 0.0787 - val_accuracy: 0.9784
Epoch 4/5
1875/1875 [=====] - 82s 44ms/step - loss: 0.0367 - accuracy: 0.9887 - val_loss: 0.0860 - val_accuracy: 0.9810
Epoch 5/5
1875/1875 [=====] - 75s 40ms/step - loss: 0.0285 - accuracy: 0.9916 - val_loss: 0.0820 - val_accuracy: 0.9808
```

FIG.7.DATA TRAINING AND ACCURACY

System analysis includes examining a system to determine its effectiveness, the necessary adjustments, and the output's quality. Organizations are intricate systems made up of connected and interdependent subsystems.

## V. CONCLUSION:

This work describes the application of deep learning to handwritten digit recognition. In order to compare why deep learning techniques are necessary for important applications like Handwritten Digit Recognition, some of the most popular machine learning algorithms, such as CNN using Tensorflow, have also been trained and tested on the same data. In this research, I've demonstrated how Deep Learning approaches can produce results with a very high level of accuracy. I am able to achieve an accuracy of 95.72% using the convolutional neural network with Keras and Theano as the backend.

Each tool has a unique level of accuracy and complexity. Although the code and procedure are a little more sophisticated than typical Machine Learning algorithms, the accuracy gained suggests that the extra effort was worthwhile. Additionally, the current implementation just uses the CPU. So, using three alternative methods, we chose to identify a handwritten digit picture as the necessary digit. We then tested the accuracy of this classification.

## References:

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