SCRIBBLED DIGIT RECOGNITION USING CNN

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Abstract - *Handwritten digit recognition is gaining enormous demand within the branch of computer vision. We are implementing a far better and accurate approach to perceive and foresee manually written digits from 0 to 9. In this project, we have tried to recognize handwritten digits and convert them into a standard form. A class of multilayer sustains forward system called Convolutional neural network is taken into consideration. We will take the MNIST dataset for training and recognition, which contains a total of 70,000 images. Each digit is represented as 28 by 28 greyscale pixel intensities for better results.*

The digits are passed into the input layers of CNN then into the hidden layers, which contain convolutional, activation, and pooling layers. Finally, it's mapped onto the fully connected layer and given a softmax classifier to classify the digits. We are getting to implement this network using Keras deep learning inbuilt python library. And we created a web application for better user interaction. The user will give input in the web application. The output is developed by the model connected to the web application will be displayed on the web application screen.

Key Words: **Deep learning, Convolution neural network, MNIST dataset**

1.INTRODUCTION

A handwritten digit sensing device uses machines to automatically train or recognize real- life numbers from various sources, such as email, search, notes, photographs, etc., to detect online manuscripts on tablets or systems for automatic inspection of vehicles, processing control quantities, and hand filling forms. To ensure such real-life conditions in computer tablets or system handwriting recognition, consider numeric platforms for vehicles, operating checks, and number details. This project has developed the model of recognizing, transforming, educating, and validating manuscript numbers. To execute this project, we have used the CNN algorithm.

Neural computing Is a comparatively new field, and design components are therefore 144less well-specified than those of other architectures. Neural computers implement data parallelism. The neural computer is operated in a way that is completely different from the operation of normal computers. Neural computers are trained (not Programmed) so that given a certain starting state (data input); they either classify the input data into one of the numbers of classes or cause the original data to evolve in such a way that a certain desirable property is optimized.

1.1 Synopsis

This application is useful for recognizing all digits given as input images. Once the input image of a digit is given to the proposed system, then it will recognize the input digit which is given in the image. Recognition and classification of digits can be done by Neural Network. The main aim of this project is to effectively recognize a particular digit using the Artificial Neural Network approach.

1.2 Benefits of Digit Recognition

1. The idea of Neural Network in Handwritten digit recognition will bring us the reading of various combined styles of writing a digit.
2. It will also help to reduce noise from the original digit
3. Our method develops accuracy in recognizing digits in divert font and size.
4. More set of samples invites more accuracy rate because of heavy training and testing session.

1.3 Deep Learning

Deep learning may be a deep learning methodology that builds neural networks to imitate human brain structure and output. Suppose that the pc file is also a pixel matrix. Typical pixels are abstracted from the first layer, and functional edges are identified in the image. Easy elements such as leaves, and branches may be made in the next layer. Then a tree may be recognized by the following layer. The knowledge passed from one layer to the next is a transition that transforms the 1-layer output into the next input. The computer will also understand which features the data to each layer correlates to a certain abstraction level.

The knowledge passed from one layer to the next is a transition that transforms the 1-layer output into the next input. The computer will also learn the characteristics of the data placed at which layer/level on its own, and each layer coincides with a certain abstraction. Deep learning means approaching and extracting complex non-linear functions with minor errors via multilayer IP. In deep learning, evolutionary and recurrent neural networks and new neural networks play a functional role. In statistical predictions, recurrent neural networks have better accuracy. But the gradient of the neural network may disappear with in-depth training.

Deep Learning Vs Machine Learning

FACTORS	DEEP LEARNING	MACHINE LEARNING
Data requirement	Requires large data	Can train on lesser data
accuracy	Provides high accuracy	Gives lesser accuracy
Training Time	Takes longer to train	Takes less time to train
Hardware Dependency	Requires GPU to train properly	Trains on CPU
Hyperparameter Tuning	Can be tuned in various different ways	Limited tuning capabilities

Figure 1.1: ML vs. DL

1.4 Neural Networks

Mathematical patterns using brain-based computing algorithms to store the information are neural networks. Neural networks are called the 'artificial neural network' collectively since they are used in machinery. Neural neurons are built like the brain with several neurons with many connections. In many implementations, neural networks are used to model uncertain associations between different parameters accompanied by many examples. Examples of effective neural network implementations include handwritten digit classifications, voice recognition, and consequently inventory price prediction .

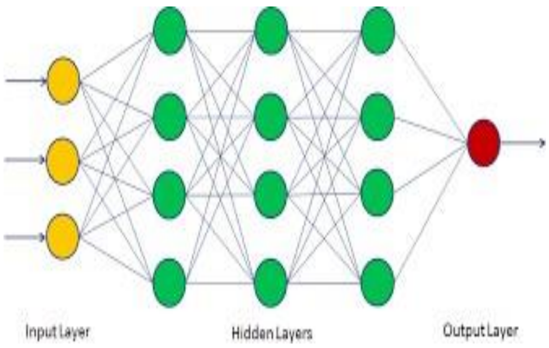

Figure 1.2: Neural network

All this indicates that neural networks operate on a picture. Deep learning networks, also referred to as convolutional networks, are more accurately recognized like artificial neural networks. The CNN combines learning and data entry with 2D convolutional layers, which make it better suitable for the manipulation of 2D data like pictures. CNN can't determine which features are used to identify images, so the extraction of handheld attributes does not take place.

CNN works by directly removing photo features. The associated characteristics are not pre- trained but discovered on a photo set as network trains. This automated extraction of features makes deep learning algorithms particularly precise for computer vision tasks such as object recognition. Deep learning also reduces human efforts in the areas of interpretation, research, prediction, and various other areas. The manuscript digits (0-9) of the popular MNIST dataset are recognized in this project.

The MNIST (Modified National Institute of Standards and Technology) dataset provided handwritten numbers totaling 70,000 photographs, with 60, 000 in the training set and 10,000 in the test set of numbered 10-digit images (0 to 9). Handwritten figures are 28*28 grey images that mirror a picture, each of which has a first column photograph (0 to 9). To test and optimize the learning models for the handwritten classification, Yann Lecun, Corinna Cortes, and Christopher Burges have developed the MNIST data collection. Because everybody is writing interestingly and excitingly, handwriting is a recognition. This is the power of the machine to automatically identify and decipher manuscripts or characters .

2. REQUIREMENT ANALYSIS

2.1 Objective

The objective of our project is to identify the handwritten numbers which are given to the system in the form of images. We are making use of the Convolutional Neural Network algorithm for recognizing and classifying the digits into a specific categorical type.

2.2 Purpose

As handwriting varies from person to person, handwritten numbers do not always have the same height, weight, orientation, or marginal justification. The general problem is to distinguish the digits due to the similarity of digits such as 1 and 7, 5 and 6, 3 and 8, 2, five, two and seven. We would like to produce a model that transforms the handwritten digits into a typical type in various types so that no misunderstanding is created.

2.3 DATASET DESCRIPTION

A total of 70,000 handwritten digits from the MNIST data collection is shown, with 60,000 training examples and 10,000 evaluation examples, all with numeric images 10 digitally.

The scale was normalized to match a 20* 20pixel box without adjusting the ratio of a small segment from the comprehensive NIST set. Handwritten digits are pictures of 28*28 images that represent an entity, with a label (0 to 9) for each image in the primary column. The same is true for the test kit, consisting of ten thousand images with a mark of 0 to 9.

To evaluate and improve machine learning models for the manuscript digit classification query, Yann Lecun, Corinna Cortes, and Christopher Burges have developed this MNIST dataset. The MNIST dataset was created by a combination of unique database 3 (USA Census Office workers) and unique database 1, the binary representations of handwritten digits in NIST's unique datasets (high school students). The instruction was considered SD-3 (unique database –3) and the study considered SD-1 (unique data database –1) and it was simpler to understand SD-3. The NIST data collection was used to maintain the stuff in various learning classifications that are interesting, divided, and equivalent.

The array of MNIST instruction contains 30,000 SD-3 designs and 30,000 SD-1 motifs. Our testing kit consisted of 5,000 SD-3 patterns and 5,000 SD-1 patterns. The set of 60,000 models contained some 250 drawings by poets. A research set consists of 5,000 SD-3 samples and 5,000 SD-1 samples. A number of digit photographs were taken, standardized and justified as cantered from a range of digits. This provides an excellent dataset for the analysis of models and enables machine learners to concentrate on profound learning and machine learning with little or no data cleaning.

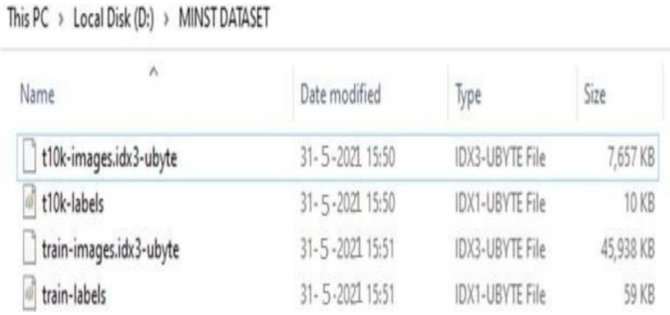

Figure 2.1: Files in the dataset

Figure 2.2: Digits in dataset.

Pixels are ranked from 0 to 255 RGB color code, with a set backdrop to white (0 RGB) and a set backdrop to black (255 value from RGB).Digital marks are broken down into 10 groups with digits 0 to 9.

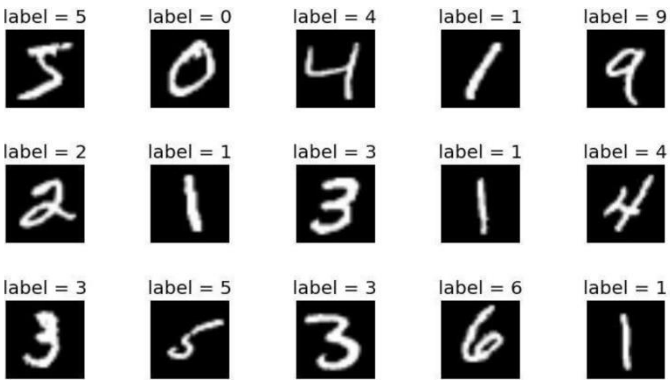

Figure 2.3: Labels.

3. ALGORITHM AND METHODOLOGY:

In this project, we have used CNN. PYTHON can be used to implement convolutional neural networks. In our execution, we use Python, and our Python is incorporated with the Keras deep learning repository. We will use Keras models to construct our network, and we will write a driver program to call the network for inputs in the data set. Instructions, algorithms, and datasets for analysis are also included in the driver program.

MNIST data sets are the simplest, most widely accessible, and simplest to interpret data in the computer vision industry, and they are the machine we will use for our deep learning journey. With less preparation time, our network will categorize the digits up to 98 percent. of the time after implementation. This implantation may often be removed by either CPU or GPU-enabled systems, but the CPU needs more planning than the GPU.

We will use 66% of the data to prepare our network to test it. The MNIST data set has 28 grey images that are per digit taken as 28 and 28 and can be downloaded directly. The grayscales' pixel intensities range from 0 to 255. With a light background, all digits are shown as black, white, the digit itself, and various grey shades.

3.1 CONVOLUTION NEURAL NETWORK

The word "convolutional neural network" refers to a network that employs convolutional measurement. "Convolution" refers to the operation and summation of weight multiplying variable values. In at least one-layer, convolutional networks are used to evaluate special neural networks instead of the general mathematical form. A convolutional neural network is a type of deep neural network widely used to examine visual eidetic processes. Since Facebook's predictive tagging algorithms are built on neural networks, CNN's use was obnoxious. Google for Amazon's pic-scan and search infrastructure, Instagram for product analysis for home feed personalization. For pattern recognition and image method problems, square neural network measurements are commonly used. CNN is made up of the input, output, and hidden layers within the input and output layers. In any neural feed-forward network, the activation process and final convolution hide the inputs and outputs of any intermediate-level area unit known as hidden. In an extremely convolutional neural network, the hidden layers embrace layers and perform convolutions. This typically includes the multiplying layer or other scalar items, which are usually ReLU enabled. Pooling layers fully linked layers, and standardization layers are examples of alternative layers.

Since CNN has parameter sharing and dimensionality reduction choices, it is a healthier network than a feed-forward network. When all neurons in a function map share weights, this is known as parameter sharing. This reduces the number of parameters in the whole method and makes the computation more cost-effective. Dimensionality reduction is a term that describes strategies for reducing the number of input variables in a dataset.

Another reason CNN is superior is that it detects critical information without the need for human intervention.

Yann LeCun, a postdoctoral science researcher, introduced the first groundbreaking neural networks, known as ConvNets, in the 1980s. LeCun engineered fictitious fame, a basic image recognition neural network, by Kunihiko Fukussima, a Japanese organization affiliated with the United Nations, a few years ago. For the first version, referred to as LeNet, CNN will accept written numbers (after LeCun).

In our implementation of Convolutional networks, we use LeNet engineering, which is based on locally suitable fields and kernels, as well as sub-sampling or pooling for the invariance of several distortions. A typical convolutional neural network for digital classification and recognition is shown in Figure 3.4. The input layer provides images from the MNIST dataset, which are downloaded by available libraries. They are oriented and standardized. With local receptive fields, neurons may learn various optical characteristics such as terminals, aligned boundaries, and curves. The layers that follow extract these characteristics more precisely.

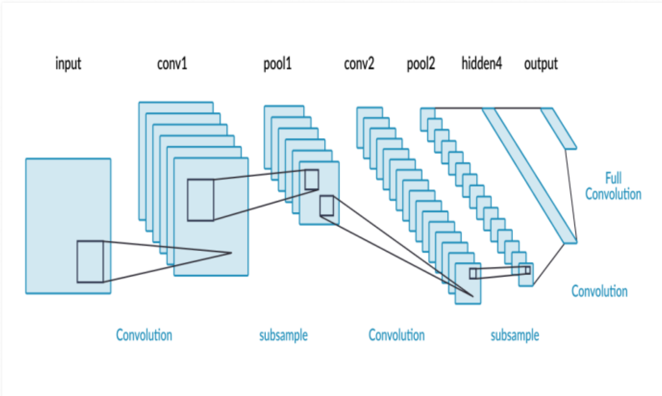

Figure 3.4: LeNet Architecture

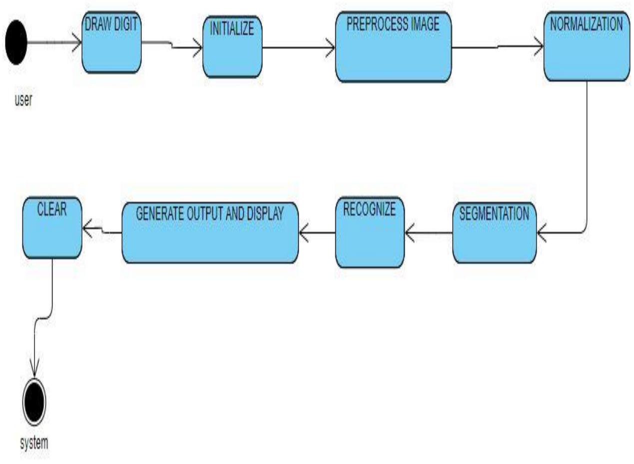

Figure 3.5 State chart diagram

4. ACCURACY

To show the working accuracy of Machine Learning algorithms, I am using three classifiers as follows:

1. Random Forest Classifier [RFC]

2. K-Nearest Neighbors [KNN]

3. Supervised Vector Machine [SVM]

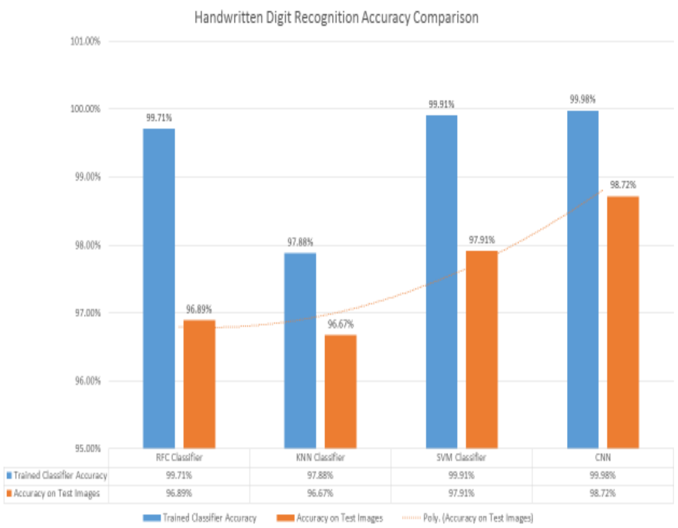

Figure 4.1 Accuracy Comparison of all Techniques

contents	RFC	KNN	SVM	CNN
Trained Classifier Accuracy	99.71 %	97.88 %	99.91 %	99.98%
Accuracy on Test Images	96.89 %	96.67 %	97.91 %	98.72%

Figure 4.2: Percent Accuracy of Each Classification Technique

5. Training & Testing Time Comparison

Model	Training Time	Testing Time
Random Forest Classifier	10 min	6 min
K Nearest Neighbors	15 min	9 min
Supervised Vector Machine	14 min	10 min
Convolutional Neural Network	70 min	20 min

Figure 5.1 Training & Testing Time Comparison

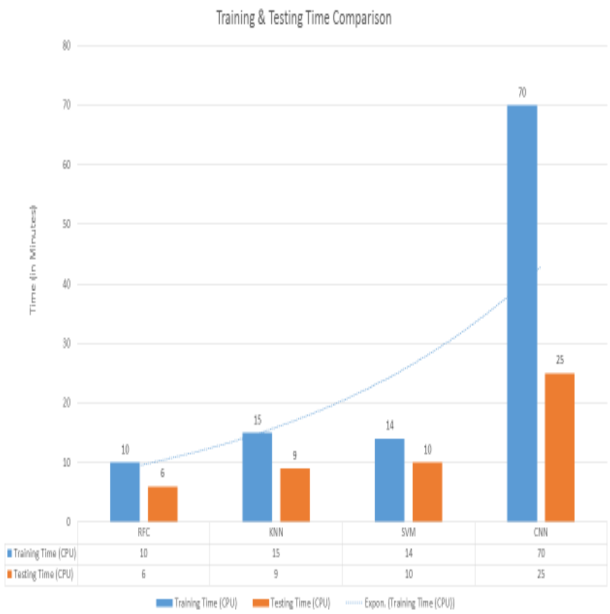

Figure5.2: Classifiers Training & Testing Time Comparison

6. Working model CNN and Outputs

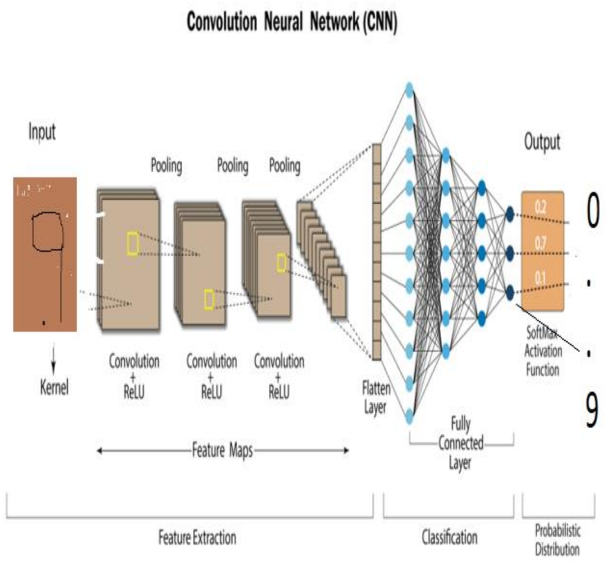

Figure 6.1 working model of CNN

Conclusion

The performance of the network is calculated by different factors such as low memory requirements, short duration, and better accuracy. The main objective of this paper, however, is to improve the precise definition. While artificial neurons are more precise, deeper learning features, such as convolutional neural networks, are now heavily used in computer vision. Research in this field is continuing and several different variants of LeNet architecture such as LeNet-1, LeNet-4, LeNet-4 Boost, and KNN's are being built by researchers. Yet our LeNet architecture has long been regarded as state-of-the-art. Several additional approaches, including Tangent Distance Classifier, were developed using the LeNet architecture. This project's primary objective is to address one of its methods. They can be done in different ways with different systems like the mat laboratory and the octave. The primary objective of the artificial intelligence machine vision division is to build a stronger network for any performance measure and to provide results for any kind of dataset that can be studied, educated, and remembered.

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