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A NOVEL MODEL FOR IDENTIFYING DIGITS USING CONVOLUTIONAL NEURAL NETWORKS AND PYTORCH

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ABSTRACT: *Recognizing the digits has become an integral part in terms of real world applications. Since Digits are written in different styles. To identify the digits it is necessary to recognize and classify it with the help of machine learning techniques. The images of digits are recognized trained and tested. For training and testing purpose have used the MNIST dataset which consists of 70000 training samples of 28x28 pixels. Digits are trained using training data set and testing is applied to the images of digits. Resizing the digit image accordingly for better accuracy. And finally 98.29% of accuracy rate was obtained using proposed model.*

KEYWORDS: CNN, Pytorch, MINST, Handwritten digit recognization

I. INTRODUCTION

Digit Recognition is nothing but recognizing or identifying the digits in any document. Digit recognition framework is simply the working of a machine to prepare itself or interpret the digits. Handwritten Digit Recognition is the capacity of a computer to interpret the manually written digits from various sources like messages, bank cheques, papers, pictures, and identifying number plates of vehicles, handling bank cheques, digits entered in any forms etc. Using CNN, the computer learns to carry out classification works from pictures or contents from any document. The main objective was to actualize a pattern characterization method to perceive the handwritten digits provided in the MNIST data set of images of handwritten digits (0-9).

1.1 INTRODUCTION TO CONVOLUTIONAL NEURAL NETWORK

Convolutional neural network Have been one of the most influential innovations in the field of computer vision. They have performed a lot better than traditional computer vision and have produced state-of-arts results. These Neural network have proven to be successful in many different rea-life case studies and application, like:

- Image classification, object detection, segmentation, face recognition.
- Driving cars that leverage CNN based vision systems
- Classification of crystal structure using a convolutional neural network.

A Convolutional neural network (CNN) is a neural network that has one or more convolutional layers and are used mainly for image processing, classification, segmentation and also for other auto correlated data. Handwritten digit recognition using MNIST handwritten digit dataset is used to experiment the performance of the proposed minimal convolutional neural network.

1.2 MNIST DATASET

Samples provided from MNIST (Modified National Institude of standards and technology) dataset includes handwritten digits total of 70,000 images considering of 60,000 examples in training set and 10,000 examples in testing set, both with labeled images from 10 digits (0 to 9). This is a small segment from the wide set from NIST where size was normalized to fit a 20*20 pixel box and altering the aspect ratio. Handwritten digits are images in the form of 28*28 gray scale intensities of images representing an image along with the first column to be a label (0 to 9) for every image.

II.RELATED WORKS

In Paper [3] a convolutional Neural Network (CNN) is exploited for Farsi handwritten digit recognition, for training and evaluating the CNN, the “HODA” dataset was used which consists of 80000 images of Farsi handwritten digits.

In Paper [8] by using the primary usage of HWR (handwritten recognition) systems are image processing, segmentation and classification. Because the styles of the handwritten strings could be varied with lots of factors, the most challenging parts of HWR are segmentation and classification.

In paper [4] using the method combines basic image processing techniques as classifiers we are use K-NN (K-Nearest neighbour) and Support vector machine(SVM) and also using the method was offline and online for handwritten character recognition method.

In Paper [5]by using the method for ascertaining of the classical domain and node domain, Distinguishing rules of the integrated correlative Degree of recognizing object and the distance calculation they are using Traversing-time character, Digits physique character. In papers [4][5] Handwriting recognition generally has two types of online and offline.

In Paper [6] by using the method for famous approaches are Deep Neural Network (DNN), Deep Belief Network (DBN) and Convolutional Neural Network (CNN).In this three NN Approaches are compared and evaluated in terms of many factors such as accuracy and performance. The high performance of large-scale data processing ability is the core technology in the era of big data.

III. PROPOSED SYSTEM

The proposed system is to create a model that will be able to recognize and determine the handwritten digits from its image by using the concepts of Convolution Neural Network. Though the goal is to create a model which can recognize the digits, it can be extend to letters and an individual's handwriting. CNN object classification takes, analyzed and classifies an enter image which in our case is digits under a positive category. Deep learning allows CNN fashions to be skilled and tested. photograph is transmitted via a collection of filters (kernels), pooling and Fully connected convolution layers and makes use of Softmax to classify an object with probabilistic values between zero and 1.

IV. SYSTEM ARCHITECTURE

This is the architecture of the proposed model. First uploading the MINST dataset on the system User image goes under testing process. In the testing process both MINST data and the user image is compared in the Preprocessing which extracts it's shape, size etc. Then the building of classification model using CNN takes place after that data is trained and tested, in which training takes 70% of the data and testing takes 30%. After the training and testing process the result will comes out with more than 90% of accuracy rate.

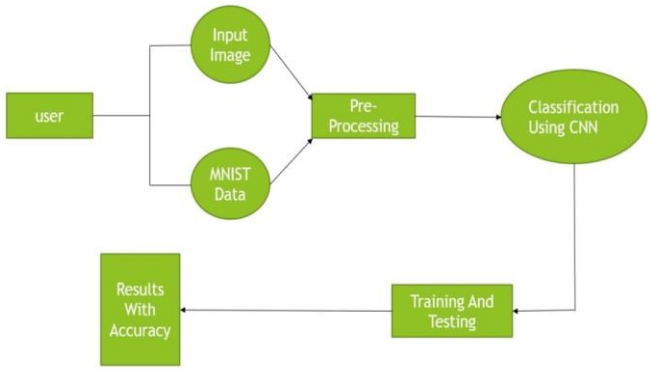

Fig-1: SYSTEM ARCHITECTURE

V. REQUIREMENT ANALYSIS

4.1 SOFTWARE REQUIREMENT

The software requirements document is the specification of the system. It should include both a definition and a specification of requirements. The software requirements provide a basis for creating the software requirements specification.

OS: windows7/10, linux mint

Software: anaconda , jupyter, vscode, google colab

4.2 HARDWARE REQUIREMENT

The hardware requirements may serve as the basis for a contract for the implementation of the system and should therefore be a complete and consistent specification of the whole system. They are used by software engineers as the starting point for the system design.

Processor - i3, i5, AMD PRO

Hard disk - 350GB, 500GB

Ram - 4gb (MIN)

VI. MODULE IMPLEMENTING

This project is divided into several modules, and they are follows,

Module 1 : Importing packages and libraries.

Module 2 : Data loading and preprocessing.

Module 3 : Feature Extraction.

Module 4 : CNN model building, training, testing.

Module 5 : Evaluating model accuracy.

Module 6 : Making Predictions.

IMPORTING PACKAGES AND LIBRARIES.

Download and install VScode then, launch python extensions to run the code and import the required packages .

To train a dataset we should need some software such as anaconda.

In anaconda there are multiple type of inner software such as spyder, jupyter and vs code etc.

DATA LOADING AND PREPROCESSING

In module 2 we are loading dataset directly from the internet called MNIST Dataset and preprocessing is done to that images. In preprocessing data cleaning, data normalizing and feature extraction will happen. After data preprocessing will get data predictions to the images.

FEATURE EXTRACTION

Feature extraction increases the accuracy of learned models by extracting features from the input data. This phase of the general framework reduces the dimensionality of data by removing the redundant data.

CNN MODEL BUILDING, TRAINING, TESTING

In module 4 we start to build the model that is CNN in which am using sequential model, convolution2D and maxpooling layers after that we using flatten layer to convert multidimensional parameters to vector. After building the model the training and testing process will happen.

The model type that we will be using is Sequential. Sequential is the easiest way to build a model in Keras. It allows you to build a model layer by layer.

The activation is 'softmax'. Softmax makes the output sum up to 1 so the output can be interpreted as probabilities. The model will then make its prediction based on which option has the highest probability.

In training the number of epochs is the number of times the model will cycle through the data. The more epochs we run, the more the model will improve, up to a certain point. After that point, the model will stop improving during each epoch. For our model, we will set the number of epochs to 5.

EVALUATING MODEL ACCURACY

In model evaluation we comparing the accuracy of training and testing set. After evaluating the model successfully we make our model to make predictions.

MAKING PREDICTIONS

The actual predictions that our model has made for the test data, we can use the predict function. The predict function will give an array with 10 numbers. These numbers are the probabilities that the input image represents each digit (0–9). The array index with the highest number represents the model prediction. The sum of each array equals 1 (since each number is a probability).

After making predictions will get the prediction figure for the handwritten digits using maximum probability. Then will getting output from the server by running local host using pytorch tools.

VII. RESULT

We present our results that we trained and tested the data set and concluded the primary result obtained from the implementation of a deep convolutional neural network was its substantial advantage over fully connected networks in terms of generality, efficiency, and accuracy. Trained against just the MNIST data set, our convolutional network managed an accuracy of 98.29%.

```python
import torch
from torch import nn, optim
from torch.utils import data

from utils import *
import pandas as pd
import numpy as np
from os import makedirs
from typing import Union
import matplotlib.pyplot as plt
from dataclasses import dataclass

import warnings
warnings.filterwarnings('ignore')


class MnistModel(nn.Module):
    """
    Custom CNN Model for Mnist
    """

    def __init__(self, classes: int) -> None:
        super(MnistModel, self).__init__()
```

```
PROBLEMS 25  OUTPUT  DEBUG CONSOLE  TERMINAL

Epoch [2/5]
Loss on Train Data : 0.3338988423347473
Accuracy on Valid Data : 96.76190476190476 %
Epoch [3/5]
Loss on Train Data : 0.15510618686676025
Accuracy on Valid Data : 97.90476190476191 %
Epoch [4/5]
Loss on Train Data : 0.11560653150081635
Accuracy on Valid Data : 98.33333333333333 %
Epoch [5/5]
Loss on Train Data : 0.1013379693031311
Accuracy on Valid Data : 98.29761904761905 %
```

Fig-2: Accuracy Rate

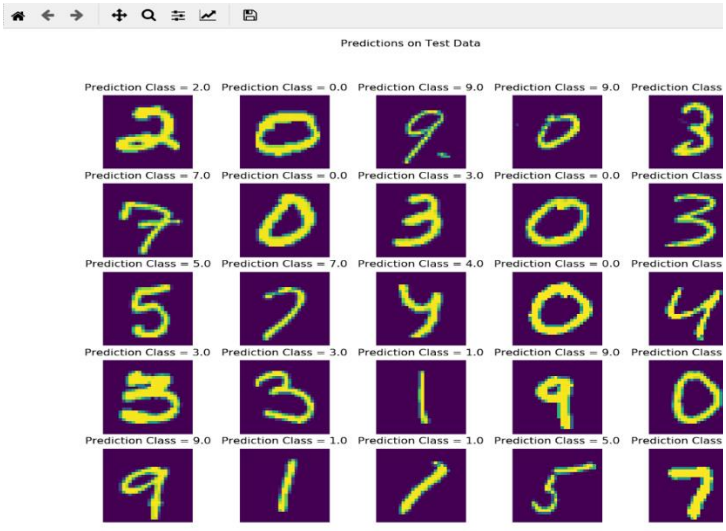

Fig- 3: predictions on test data

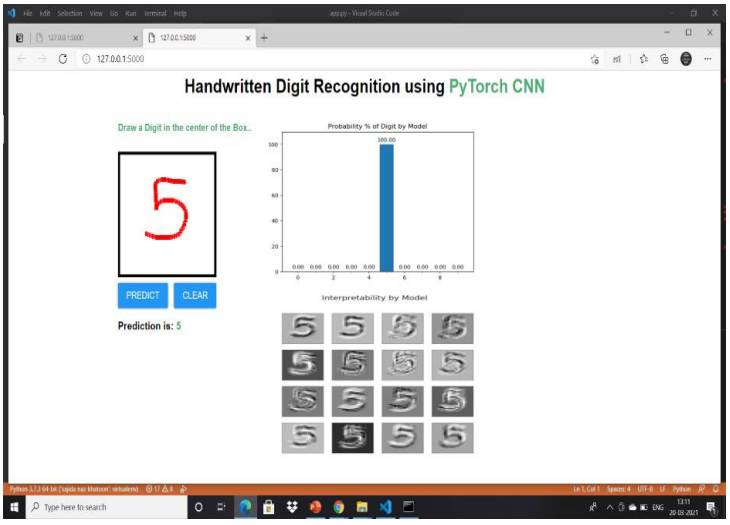

Fig- 4: Final output image

VIII. CONCLUSION AND FUTURE ENHANCEMENT

In our proposed system, we have applied CNN and supervised learning to classify the images of handwritten digits separately and analyzed recognition and got 99% of accuracy which is achieved by training the model.

The primary problems recently are the training data for each user is not enough and there are improvement potential for character recognition classifier, character classifier and string type classifier. More work on CNN model for these classifiers need to be done in the future.

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