DAYANANDA SAGAR UNIVERSITY

KUDLU GATE, BANGALORE – 560068

Bachelor of Technology
in
COMPUTER SCIENCE AND ENGINEERING

Major Project Phase-II Report

(IDENTIFYING HANDWRITTEN NUMERICALS USING DL METHODS)

By

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(2021-2022)

DAYANANDA SAGAR UNIVERSITY

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CERTIFICATE

This is to certify that the Phase-II project work titled **"IDENTIFYING HANDWRITTEN NUMERICALS USING DL METHODS"** is carried out by **Chandana A S (ENG18CS0068), Chethana A S (ENG18CS0074), Shubha Shree N (ENG18CS0271), Thanushree D K (ENG18CS0299),** bonafide students of Bachelor of Technology in Computer Science and Engineering at the School of Engineering, Dayananda Sagar University, Bangalore in partial fulfillment for the award of degree in Bachelor of Technology in Computer Science and Engineering, during the year **2021-2022**.

Prof Rashmi Mothkur	**Dr Girisha G S**	**Dr. A Srinivas**
Assistant Professor Dept. of CS&E, School of Engineering Dayananda Sagar University	Chairman, CSE School of Engineering Dayananda Sagar University	Dean School of Engineering Dayananda Sagar University
Date:	Date:	Date:

Name of the Examiner **Signature of Examiner**

1.

2.

DECLARATION

We,**Chandana A S (ENG18CS0068), Chethana A S (ENG18CS0074), Shubha Shree N (ENG18CS0271), Thanushree D K (ENG18CS0299),** are students of the Eighth semester B.Tech in **Computer Science and Engineering**, at School of Engineering, **Dayananda Sagar University**, hereby declare that the phase-II project titled **"IDENTIFYING HANDWRITTEN NUMERICALS USING DL METHODS"** has been carried out by us and submitted in partial fulfillment for the award of degree in **Bachelor of Technology in Computer Science and Engineering** during the academic year **2021-2022**.

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LIST OF ABBREVIATIONS

OCR	Optical Character Recognition
MNIST	Modified National Institute of Standards and Technology
ANN	Artificial Neural Network
ReLU	Rectified Linear Unit
CNN	Convolutional Neural Network
SVM	Support Vector Machine
SIFT	Scale Invariant Feature Transform
LSTM	Long Short Term Memory
RNN	Recurrent Neural Network
ROI	Region Of Interest
R-CNN	Region Based Convolutional Neural Network

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ABSTRACT

"**IDENTIFYING HANDWRITTEN NUMERICALS**" is a project implemented using the concept of neural networks.It is an ability of a computer to recognize and understand intelligible handwritten input from sources such as paper documents.

The purpose of this project is to create a neural net which can understand and predict the handwritten digits and text of different languages from the image. By training this neural network we can help users provide any image in any shape or form such that this neural network will be able to predict the digit written in the given image.

This project is a basic step towards understanding neural networks and computer vision.

The aim of a handwriting recognition system is to convert handwritten digits and text into machine readable formats. The main objective of this work is to ensure effective and reliable approaches for recognition of handwritten digits, text and make banking operations easier and error free.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

The aim of a handwriting recognition system is to convert handwritten digits and text into machine readable formats. The main objective of this work is to ensure effective and reliable approaches for recognition of handwritten digits,text and make banking operations easier and error free.

1.1 DIGIT RECOGNITION:

Handwritten digit recognition is the ability of computers to recognize human handwritten digits. It is a hard task for the machine because handwritten digits are not perfect and can be made with many different flavors. The handwritten digit recognition is the solution to this problem which uses the image of a digit and recognizes the digit present in the image.Digit recognition is an application of the image recognition and though considered as the first step towards pattern recognition and image recognition it is a major leap towards using Artificial Neural Networks to recognize the image. This project uses CNN to classify the given image of digits and text. Though considered as a solved problem in this field, using CNN to predict is much more efficient and accurate to predict the image and first steps towards accurate image recognition. In this project, there are various layers, which can also be called as Regular Nets which will be trained given the data i.e. images. These neural networks are trained on more than 60,000 images. And tested on more than 10,000 images of digits and text in different languages. The MNIST dataset is maintained by MNIST which contains more than 60,000 images. Various techniques are used to make the image into desirable form and shape. Then the images are given as the training set. After including the layers, we can test the output by giving the images to the model to predict.

1.2 ARTIFICIAL NEURAL NETWORK:

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons.

1.2.1 CONVOLUTIONAL NEURAL NETWORK

In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural networks, most commonly applied to analyzing visual imagery. CNNs use a variation of multilayer perceptron designed to require minimal pre-processing. Convolutional networks were inspired by biological processes in that the connectivity pattern between neurons resembles the organization of the animal visual cortex. Individual cortical neurons respond to stimuli only in a restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they cover the entire visual field.

CNNs use relatively little pre-processing compared to other image classification algorithms. This means that the network learns the filters that in traditional algorithms were hand-engineered. This independence from prior knowledge and human effort in feature design is a major advantage. They have applications in image and video recognition, recommender systems, image classification, medical image analysis, and natural language processing.

1.2.2 EASYOCR

EasyOCR is a python package that allows the image to be converted to text. EasyOCR, as the name suggests, is a Python package that allows computer vision developers to effortlessly perform Optical Character Recognition.

EasyOCR is an open-source and ready-to-use OCR with almost 80 supported languages. You can choose to train the model with your own data (you can follow their example dataset to format your own dataset) or use the existing models to serve your own application.It is by far the easiest way to implement OCR and it has access over many languages including English, Hindi , kannada and many more languages.EasyOCR doesn't have many software dependencies, it can directly be used with its API.

OCR tools analyze the handwritten or typed text in images and convert it into editable text.It can process multiple languages at the same time provided they are compatible with each other.

1.3 FIGURES AND TABLES

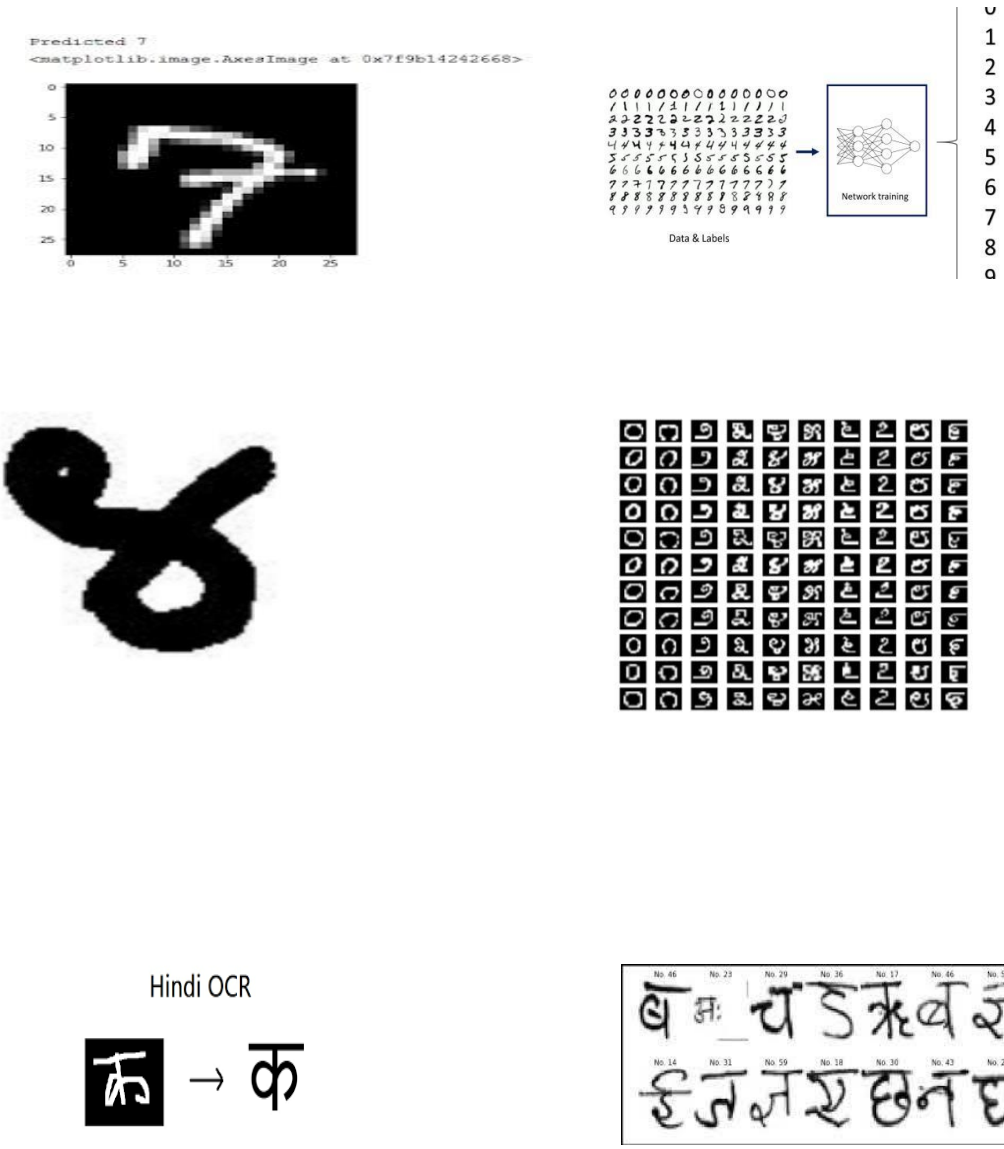

Fig 1.3 Sample data and labels

1.4 SCOPE

The scope of this project is handwritten recognition regarding the application of deep learning algorithms based on CNN. Additionally, the purposes are not only to improve the current recognition performance, but also to seek the highest reliability in the applications of handwritten digits and text.

CHAPTER 2
PROBLEM DEFINITION

CHAPTER 2 PROBLEM DEFINITION

Handwritten recognition is the ability of computers to recognize human handwritten digits and text. Here,we use a data set for predicting different languages by training the model.

This digit recognition is the solution to this problem which uses the image of a digit and recognizes the digit present in the image. If the system incorrectly recognizes a digit, it can lead to major damage which is not desirable. That's why an algorithm with high accuracy is required in these real world applications.

The handwritten recognition is the ability of computers to recognize human handwritten digits and text. This is the solution to the problem which uses the image of a digit and recognizes the digit present in the image.

CHAPTER 3
LITERATURE REVIEW

CHAPTER 3 LITERATURE REVIEW

Literature review in the immense research is going on in the field of handwritten recognition. Many people have developed systems for handwritten digit recognition and handwritten character recognition. We have studied some of the systems:

Md.Anwar Hossain, Md.Mohon Ali [1]. Recognition of handwritten digit recognition using convolutional neural networks",It shows that neural network classifiers with single-layer training can be applied efficiently to complex real-world classification such as the recognition of handwritten digits. The paper shows how MatConvNet is used.

Vijayalakshmi R Rudraswamimath, Bhavani Shankar [2]. Handwritten digit recognition using CNN, It trains and tests a set of classifiers for handwritten digit recognition using MNIST database. Most widely used ML algorithms, KNN,SVM,RFC,CNN.

Muzamil Nawaz,Sandesh Gangwani,Isma Farah Siddiqui [3].A keras based implementation for efficient handwritten digit Recognition using convolutional neural network.This paper defines process of handwritten Kannada digit recognition with high accuracy back-propagation of Kannada language

R. Vijaya Kumar Reddy,Dr. B. Srinivasa Rao,K. Prudvi Raju [4].Handwritten Hindi Digits Recognition Using Convolutional Neural Network with RMSprop Optimization,It is an efficient handwritten Hindi numeral digit recognition structure based on Convolutional Neural Network (CNN) with RMSprop optimization technique

S Ahlawat,A Choudhary [5].Hybrid CNN-SVM classifier for handwritten digit recognition,The aim of this paper is to develop a hybrid model of a powerful Convolutional Neural Networks (CNN) and Support Vector Machine (SVM) for recognition of handwritten digit from MNIST dataset. The receptive field of CNN helps in automatically extracting the most distinguishable features from these handwritten digits.

Feiyang Chen,Nan Chen,Hanyang Mao,Hanlin Hu [6]. Assessing Four Neural Networks on Handwritten Digit Recognition Dataset (MNIST),In this paper, we compare four neural networks on MNIST dataset with different divisions. Among them, three are Convolutional Neural Networks (CNN), Deep Residual Network (ResNet) and Dense Convolutional Network (DenseNet) respectively, and the other is our improvement on CNN baseline through introducing Capsule Network (CapsNet)to the image recognition area.

CHAPTER 4
PROJECT DESCRIPTION

CHAPTER 4 PROJECT DESCRIPTION

4.1. PROPOSED DESIGN

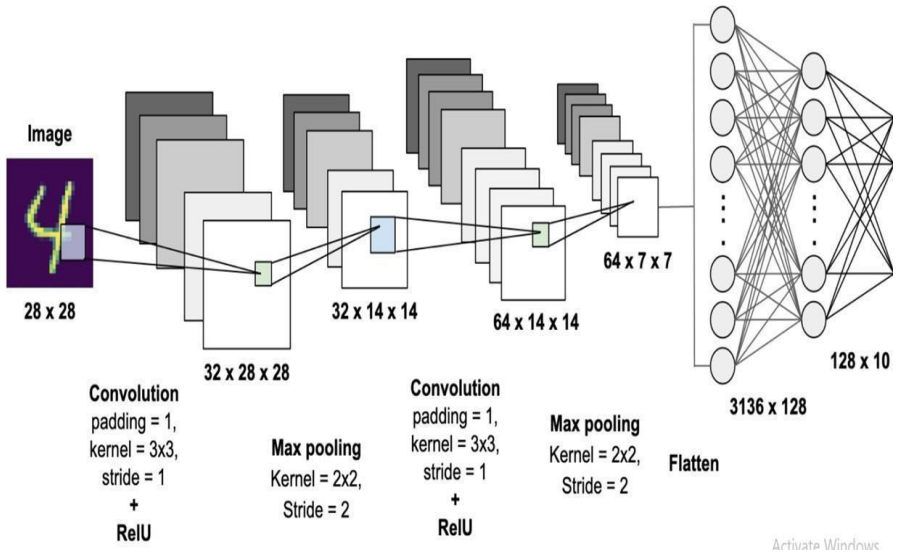

Fig 4.1 System Design

4.1.1 Sequential

This class configures the model for the training. This is the main class that is used to initialize the model. This is the first step to make an ANN (Artificial Neural Network). This class return an object that is used to build the model layer after layer

4.1.2 3 Conv2D

This layer creates a convolution kernel that is convoluted with the layer input over a single spatial (or temporal) dimension to produce a tensor of outputs. We use this layer as the first layer in a model. Convolutional layer is the very first layer where we extract features from the images in our datasets.

4.1.3 MaxPooling2D

Max pooling is a sample-based discretization process. The objective is to down-sample an input representation (image, hidden-layer output matrix, etc.), reducing its dimensionality and allowing for assumptions to be made about features contained in the sub-regions binned. Max pooling operation is done on temporal data.

4.1.4 Flatten

Flattening a tensor means to remove all of the dimensions except for one.

4.1.5 Dense

This class is used to make regular densely-connected NN layers. A dense layer is just a regular layer of neurons in a neural network. Each neuron receives input from all the neurons in the previous layer, thus densely connected.

4.1.6 ReLU

A Rectified Linear Unit(ReLU) is a non-linear activation function that performs on multilayer neural networksIn this layer we remove every negative value from the filtered image and replace it with zero. This function only activates when the node input is above a certain quantity.ReLU helps to prevent the exponential growth in the computation required to operate the neural network

4.2. ASSUMPTIONS AND DEPENDENCIES

The framework must be prepared completely before use ,when framework is prepared before leaving you are required to spare the framework for further use

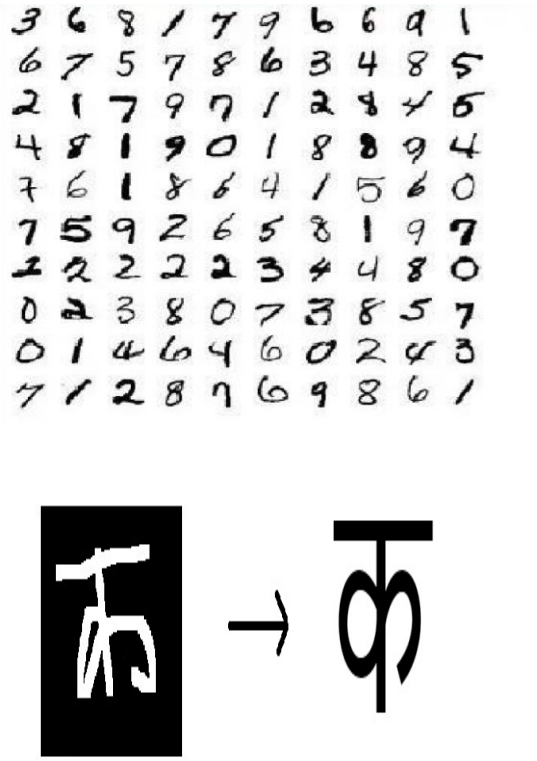

fig 4.2 Sample predictions

CHAPTER 5
REQUIREMENTS

CHAPTER 5 REQUIREMENTS

5.1 FUNCTIONAL REQUIREMENTS:

5.1.1 The Dataset: Getting the dataset is the first and foremost work in training the dataset. The dataset used in this project is MNIST Handwritten Dataset.

5.1.2 Python Distribution: Pycharm.

5.1.3 Libraries Used: Keras is the main library used for the execution of the Artificial Neural Network (ANN). This project uses TensorFlow Backend.

5.2 HARDWARE REQUIREMENTS:

- Processor – Min. Intel Core i3 processor, 1.2Ghz
- RAM – Min. 4 GB
- GPU – Min. 2 GB Integrated (For TensorFlow)

5.3 SOFTWARE REQUIREMENTS :

- Operating System - Windows 10
- Programming Language - Python
- Tool Used - Anaconda, Pycharm
- Library Used - Keras with TensorFlow Backend, OpenCV, TensorFlow and Numpy

CHAPTER 6
METHODOLOGY

CHAPTER 6 METHODOLOGY

"Identifying handwritten numericals using MNIST Dataset" is a project implemented using the concept of neural networks. To implement this project various components and methodologies are used.

6.1 Python Distribution:

Anaconda was used as the python distribution. Anaconda was used to install in the libraries and execute the python scripts.

6.2 Libraries Used:

Keras is the main library used for the execution of the Artificial Neural Network
This project uses Keras with TensorFlow Backend.
The classes used from the keras Libraries are :

1. Sequential
2. Conv2D
3. MaxPooling2D
4. Flatten
5. Dense

6.3 The Dataset:

Getting the dataset is the first and foremost work in training the dataset. The dataset used in this project is MNIST Handwritten Dataset. This dataset contains a training set of 60,000 examples, and a test set of 10,000 examples.

6.4 EasyOCR:

Python package that allows the image to be converted to text. It is by far the easiest way to implement OCR and it has access over many languages including English, Hindi , kannada and many more languages.EasyOCR doesn't have many software dependencies, it can directly be used with its API.It can process multiple languages at the same time provided they are compatible with each other.

6.5 FLOW CHART

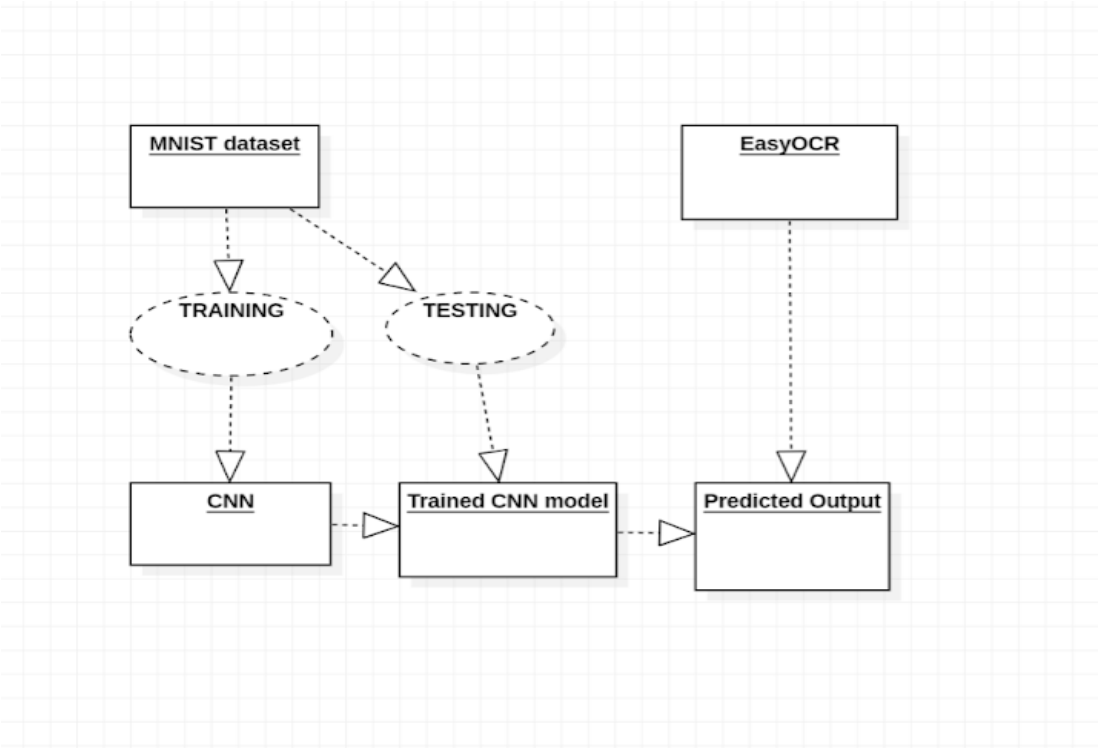

fig 6.1 flow chart

CHAPTER 7
EXPERIMENTATION

CHAPTER 7 EXPERIMENTATION

Algorithm :

Step 1: Get the Dataset
Step 2: Assign the images to respective directories where the directories work as labels
Step 3: Train the model Using CNN
Step 4: Perform number of epochs and end the train after accuracy>95%
Step 5: Evaluate the model
Step 6: Save the model using save() method
Step 7: Get input from the user and predict the image using predict() method.

def predict_using_trained():

In this module it takes the images that are present in the trained folder and uses the mnist training to predict the numbers and text.

def easy_ocr():

This module takes the images present in the directory and apply OCR techniques and does the prediction of the output.
reader = easyocr.Reader(['en','hi']) Here, we can add as many languages required.

def minist_traning():

This module is used for Training purpose.it takes a mnist dataset to train the model and training data will be created and it will be stored in the same directory.
model = minist_traning() Here, the model is trained , and all the training data is stored in the folder mnist.hi .

CHAPTER 8
TESTING AND RESULTS

CHAPTER 8 TESTING AND RESULTS

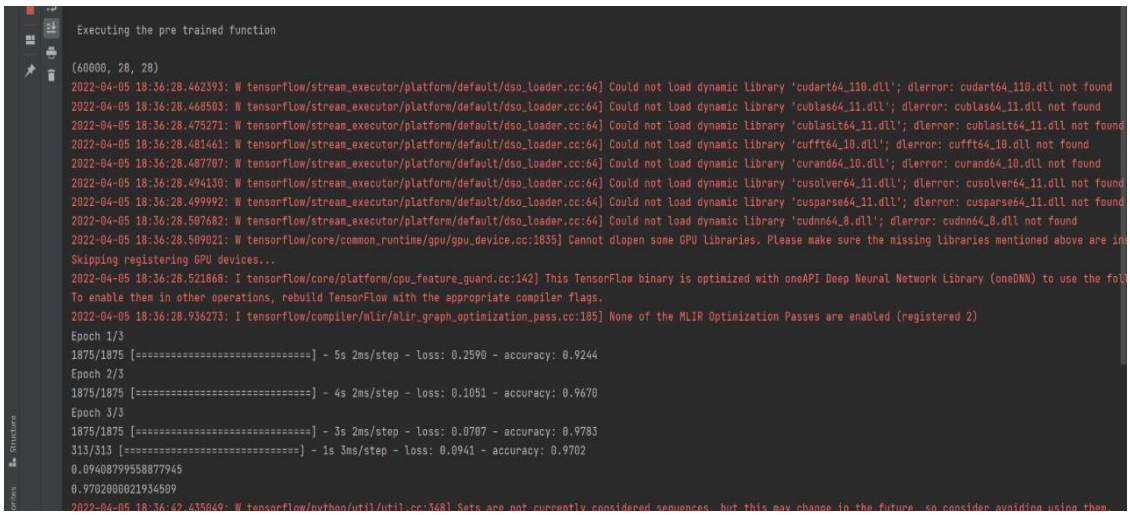

fig 8.1 Executing the Model and Training the model

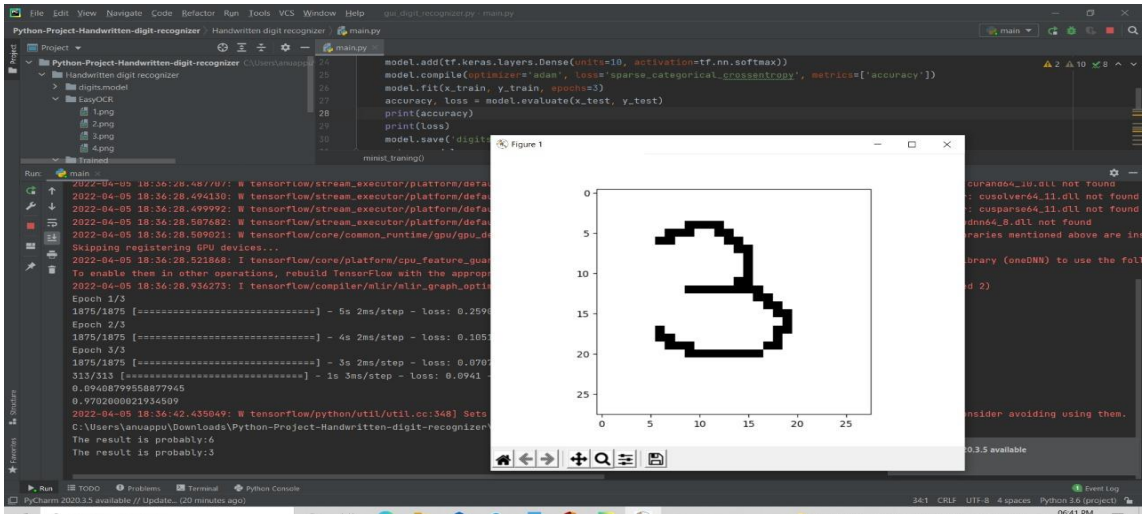

fig 8.2 predicting the digit

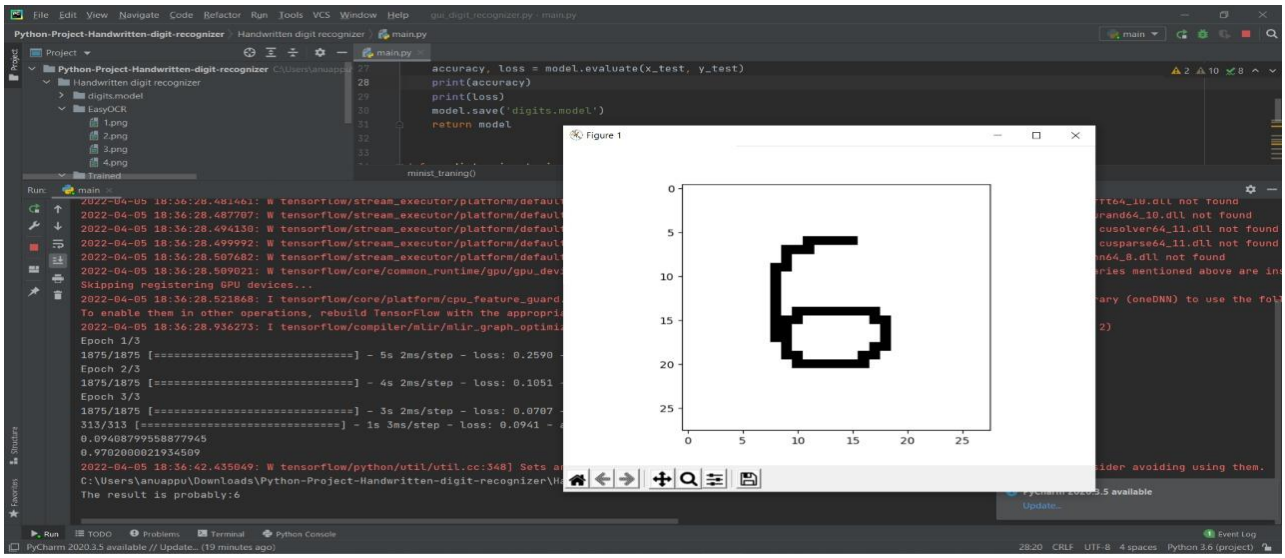

fig 8.3 predicting the digit

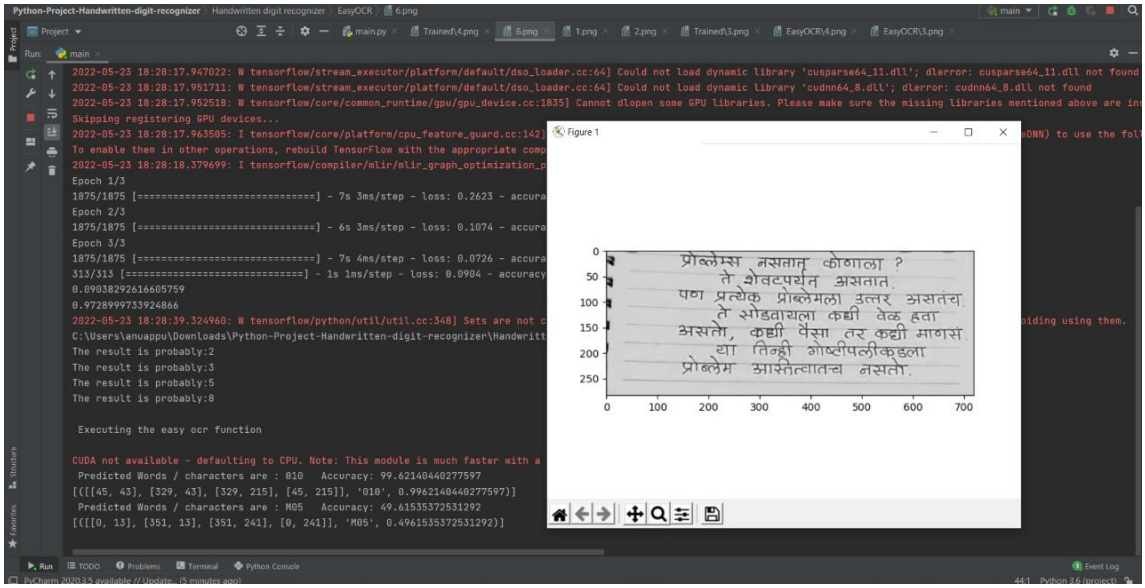

fig 8.4 predicting the text in hindi

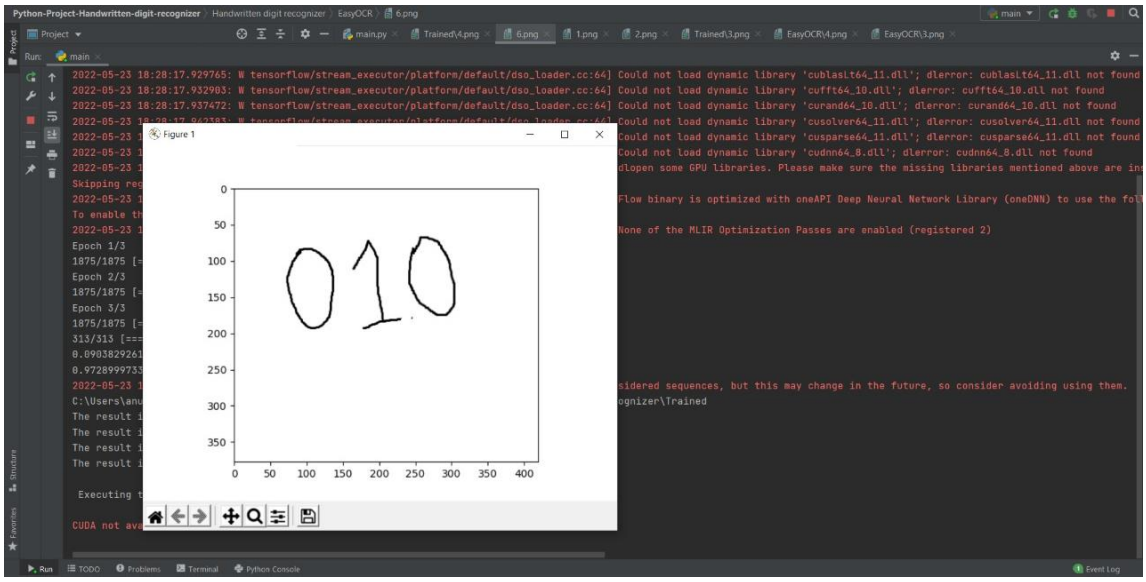

fig 8.5 predicting triple digits

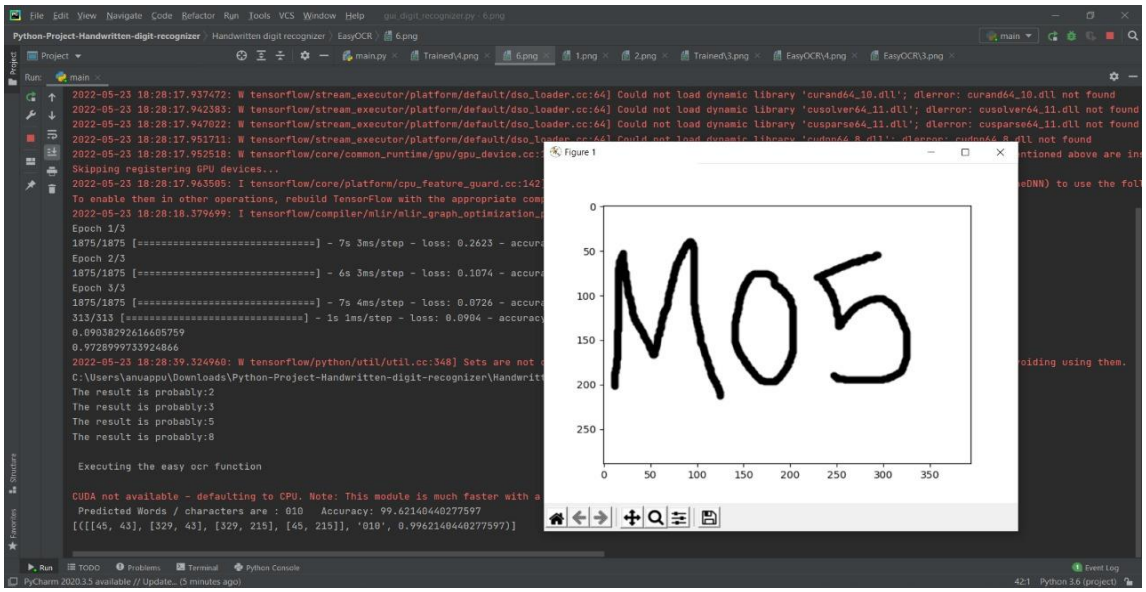

fig 8.6 predicting the Alphanumeric text

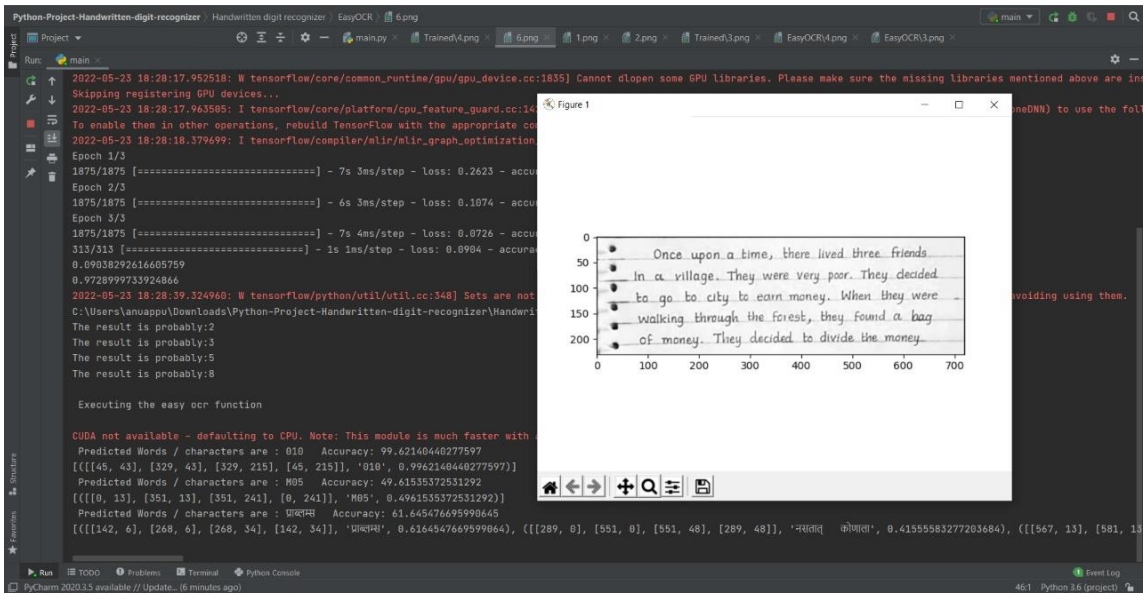

fig 8.7 predicting the text in english

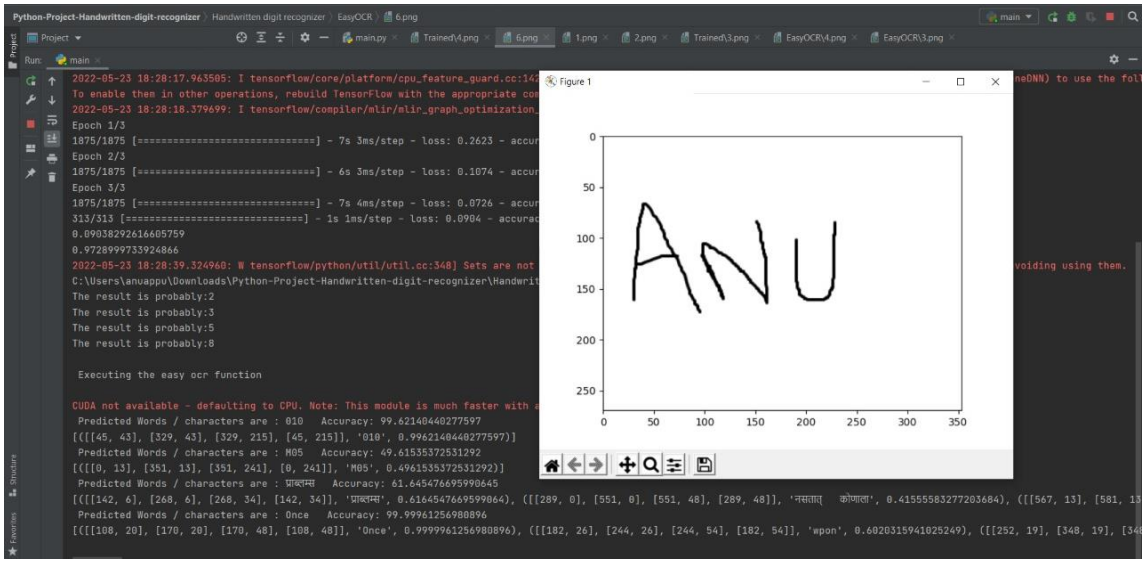

fig 8.8 predicting the text

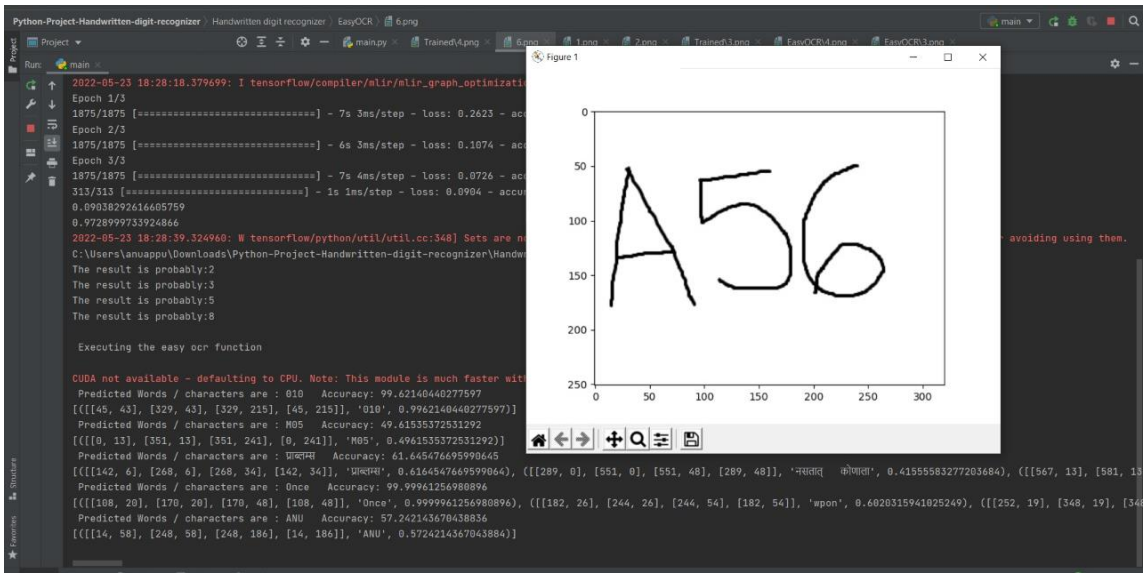

fig 8.9 predicting the Alphanumeric text

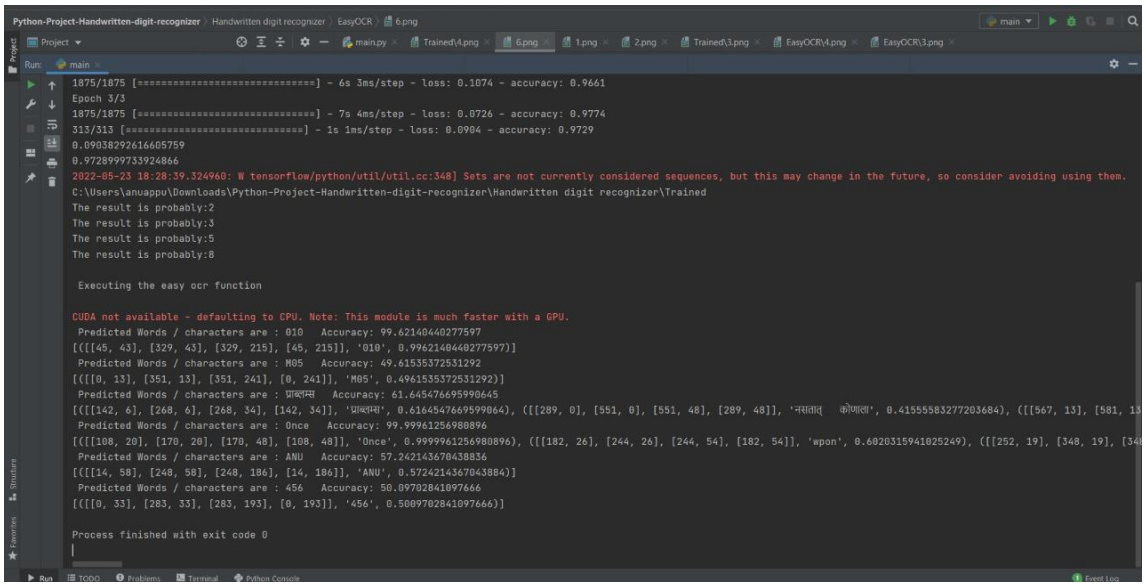

fig 8.10 Results of all the easyocr images

CHAPTER 9
CONCLUSION

CHAPTER 9 CONCLUSION

The Handwritten recognition using deep learning models identifies the digits, text in different languages such as English and Hindi .Project implemented using the concept of neural networks.It is an ability of a computer to recognize and understand intelligible handwritten input from sources such as paper documents.We have implemented our project using the data source called MNIST Dataset. The main objective of this work is to ensure effective and reliable approaches for recognition of handwritten digits, text and make banking operations easier and error free.Our algorithm successfully detects the text and the digit and text up to a 80% of accurate results are observed.This project is helpful for banking , postal address , check number and many other purpose

CHAPTER 10
FUTURE SCOPE

CHAPTER 10 FUTURE SCOPE

Future research and work should be devoted to:

- addition of many more languages to predict the handwritten languages.
- addition of more training and testing models.
- work on accuracy to predict the exact handwritten text or digit.
- addition of voice recognition

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[1] Md.Anwar Hossain, Md.Mohon Ali,"Recognition of Handwritten digit recognition using convolutional neural networks", Global journal of computer Science and Technology ,Volume 19 Issue 2 Version 1.0,2019

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[4] Feiyang Chen,Nan Chen,Hanyang Mao,Hanlin Hu"Assessing Four Neural Networks on Handwritten Digit Recognition Dataset (MNIST)",CHUANG XINBAN JOURNAL OF COMPUTING,20 Jul 2019

[5] S Ahlawat,A Choudhary,"Hybrid CNN-SVM classifier for handwritten digit recognition",International conference on computational intelligence and data science, 2019

[6] R. Vijaya Kumar Reddy,Dr. B. Srinivasa Rao,K. Prudvi Raju "Handwritten Hindi Digits Recognition Using Convolutional Neural Network with RMSprop Optimization" "Second International Conference on Intelligent Computing and Control Systems ,2018".

GITHUB LINK : https://github.com/shubhashreen/major-project.git

APPENDIX

```
import cv2 as cv
import numpy as np
import matplotlib.pyplot as plt
import tensorflow as tf
import os
# from IPython.display import Image
import easyocr


def minist_traning():
    """
    Does the traning from the MNIST dataset
    :return: None
    """
    mnist = tf.keras.datasets.mnist
    (x_train, y_train), (x_test, y_test) = mnist.load_data()
    print(x_train.shape)
    x_train = tf.keras.utils.normalize(x_train, axis=1)
    x_test = tf.keras.utils.normalize(x_test, axis=1)
    model = tf.keras.models.Sequential()
    model.add(tf.keras.layers.Flatten(input_shape=(28, 28)))
    model.add(tf.keras.layers.Dense(units=128, activation=tf.nn.relu))
    model.add(tf.keras.layers.Dense(units=128, activation=tf.nn.relu))
    model.add(tf.keras.layers.Dense(units=10, activation=tf.nn.softmax))
    model.compile(optimizer='adam',                loss='sparse_categorical_crossentropy',
metrics=['accuracy'])
    model.fit(x_train, y_train, epochs=3)
    accuracy, loss = model.evaluate(x_test, y_test)
    print(accuracy)
    print(loss)
    model.save('digits.model')
    return model
def predict_using_trained():
    """
    Takes the images that are present in the trained folder and uses the mnist traning to
predict the numbers
    :return: None
    """
```

```
    model = minist_traning()
    cur_wd = os.getcwd()
    path = cur_wd + "\\" + "Trained"
    print(path)
    imgs = os.listdir(path)
    for cur_img in range(1,len(imgs)+1):
        os.chdir(path)
        img = cv.imread(f'{cur_img}.png')[:,:,0]
        img = np.invert(np.array([img]))
        prediction = model.predict(img)
        print(f'The result is probably:{np.argmax(prediction)}')
        plt.imshow(img[0], cmap=plt.cm.binary)
        plt.show()
    os.chdir('..')

def easy_ocr():
    """
    This module uses the easy ocr library to predict the output
    :return: None
    """
    reader = easyocr.Reader(['en','hi'])
    cur_wd = os.getcwd()
    path = cur_wd + "\\" + "EasyOCR"
    imgs = os.listdir(path)
    for cur_img in range(1,len(imgs)+1):
        os.chdir(path)
        pre_img = cur_img
        img = cv.imread(f'{cur_img}.png')[:, :, 0]
        img = np.invert(np.array([img]))
        plt.imshow(img[0], cmap=plt.cm.binary)
        plt.show()
        output = reader.readtext(f'{cur_img}.png')
        tup1 = output[0]
        print(f" Predicted Words / characters are : {tup1[1]} ", end=" ")
        print(f" Accuracy: {tup1[2]*100} ",end= "\n")
        print(output)
    os.chdir('..')

if __name__=="__main__":
    print("\n Executing the pre trained function \n")
    predict_using_trained()
    print("\n Executing the easy ocr function \n")
    easy_ocr();
```

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Journal	International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) . Volume 11, Issue 5, May 2022
Year of Publishing	2022
Abstract	Handwritten recognition is an application based on the concept of an interconnected system. It is an ability of a system to recognise as well as understand intelligible handwritten input from sources, likely paper documents. The motive of identifying handwritten numerical is to create an interconnected net which can appreciate and predict the manuscript digits and texts of copious languages by the depiction. By training this network we can help users provide any image in any shape or form in which this will be able to recognise the given image. This is a basic step towards analyzing networks and cv.The aim of a handwritten prediction system is a conversion of manuscript digits and text into a system readable format. The main intent of this work is to ensure effective and reliable approaches for identification of the manuscript digits, text and make banking operations easier and error free.
Author	Chandana A S Chethana A S Shubha Shree N Thanushree D K Prof. Rashmi Mothkur


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