VISVESVARAYA TECHNOLOGICAL UNIVERSITY BELGAVI-590 014

B.V.V. SANGHA’S

BILURU GURUBASAVA MAHASWAMIJI INSTITUTE OF TECHNOLOGY, MUDHOL 2021-2022

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Project Report On

“Handwritten Recognition In Air For Physically Challenged Using Deep Learning Techniques”

KSCST

Student Project Program – 45th Series

(KSCST Reference No. 45S_BE_1081)

Guide	HOD	Principal
Prof. M. S. Gabasavalagi	Prof. B. G. Kumbar	Dr. S. B. Kerur

Project Associates:

1. Ms. Disha Ballur	USN: 2LB18CS002
2. Mr. Akshay Joshi	USN: 2LB17CS002
3. Ms. Sahana Chittaragi	USN: 2LB17CS003

B.V.V SANGHA’S

BILURU GURUBASAVA MAHASWAMIJI INSTITUTE OF TECHNOLOGY, MUDHOL

2021-2022

(Affiliated to VTU, Belagavi)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the project work entitled “Handwritten Recognition In Air For Physically Challenged Using Deep Learning Techniques” is a bonafide work carried out by Ms. Disha Ballur, Mr. Akshay Joshi, Ms. Sahana Chittaragi bearing USN: 2LB18CS002, 2LB17CS002, 2LB17CS003 in partial fulfillment for the award of the degree of Bachelor of Engineering in Computer Science and Engineering of Visvesvaraya Technological University, Belgaum during the year 2021-22. It is certified that all corrections/Suggestions indicated for internal assessment has been incorporated in the report deposited in the department library. The Project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering Degree 2021-22.

Guide	HOD	Principal
Prof. M. S. Gabasavalagi	Prof. B. G. Kumbar	Dr. S. B. Kerur

Name of the Examiners: **Signature with Date:**

1.

2.

DECLARATION

We, **Ms. Disha Ballur USN: 2LB18CS002, Mr. Akshay Joshi USN: 2LB17CS002, Ms. Sahana Chittaragi USN: 2LB17CS003,** the students of VIII semester B.E in Computer Science and Engineering, **Biluru Gurubasava Mahaswamiji Institute of Technology, Mudhol**, affiliated to Visvesvaraya Technological University, Belgavi. Hereby we declare that we have independently carried out project titled **"Handwritten Recognition In Air For Physically Challenged Using Deep Learning Techniques"**, and submitted in partial fulfillment of the requirements for the award of degree in Bachelor of Engineering during the academic year **2021-22**.

Project Associates	**Signature of the Students**
1. Ms. Disha Ballur USN: 2LB18CS002	
2. Mr. Akshay Joshi USN: 2LB17CS002	
3. Ms. Sahana Chittaragi USN: 2LB17CS003	

ACKNOWLEDGEMENT

We express our sincere gratitude to **Dr. Shravankumar B. Kerur,** Principal, BGMIT, Mudhol, for his support and encouragement. We are grateful to **Prof. Basavaraj G. Kumbar** Head of the Department of Computer Science & Engineering, for permitting us to make use of facilities available in department to carry out the project successfully.

We place on record and warmly acknowledge the continuous encouragement, in valuable supervision, timely suggestion and inspired guidance offered by our guide **Prof. Manjunath S. Gabasavalagi,** Department of Computer Science & Engineering, BGMIT, Mudhol in bringing this project to a successful completion. We would like to extend our thanks to the management, teaching and non teaching staff of our department, parents, friends and well wishers for their timely help either directly or indirectly for the completion of project.

PROJECT ASSOCIATES:

Ms. Disha Ballur

Mr. Akshay Joshi

Ms. Sahana Chittaragi

LIST OF CONTENTS

LIST OF FIGURES

ABSTRACT

Touch less Sensing and Gesture (or Gestural) Recognition is two technologies in fast-paced growth mode because both are part of the paradigm shift in human-machine interfaces. The typical use of these technologies is to detect the motion of a person within an area covered by a sensor. Camera is used to capture hand movements of the user and object tracking technology of computer vision used to identify coordinate points of the colour object.

Character recognition is a process which allows computers to recognize written or printed characters such as numbers or letters and to change them into a form that the computer can use. The character recognition system used to develop cost effective assistive technologies to provide physically challenged people (deaf and dumb) with greater degree of confidence in their (300 million are deaf and 1 million are dumb all over the world) activities. Not only for physically challenged. In present days the learning is through conventional mode i.e., classroom teaching, we may reach the students effectively through smart methods. From the perspective of engineering, it seeks to automate tasks that the human visual system can do.

This project presents a real time video based pointing method which allows sketching and writing of English text and numbers over air in front of camera. Proposed method have two main tasks: first it track the finger tip in the video frame and then apply English OCR over plotted images in order to recognize the written character. Air-writing refers to writing of linguistic characters or words in a free space by hand or finger movements. Air-writing differs from conventional handwriting.

The hand motion while writing the text in the air was captured as images by a camera. We intended to develop effective methods to manage and represent he text. Text, which carries high-level semantic information, is a kind of important object that is useful for this project. Our model generates text, which is written freely in air is printed on frame, and then it is converted to a computer Text using machine Learning techniques. Moreover, proposed method provides a natural human-system interaction in such way that it do not require keypad, pen or etc for character input.

The current paper accuracy is 63.71% using linear discriminate analysis and our accuracy is 68% by using CNN and Kaggle dataset.

HANDWRITTEN RECOGNITION IN AIR FOR PHYSICALLY CHALLENGED USING DEEP LEARNING TECHNIQUES.

Chapter 1

OBJECTIVE AND SCOPE

1.1 Objectives:

The main objectives of this proposed scheme are as follows:

1. The main aim of this project is Recognition of handwritten in air analyzing the image based on Machine Learning Technique i.e., Convolutional Neural Network (CNN) with the help of Tenser Flow and Extended Modified National Institute of Standards and Technology (EMNIST) dataset is obtained from kaggle.
2. This project recognizes both the digits (0-9) and alphabets.

1.2 Scope:

The text which is written in air must be recognized and processed using machine learning techniques in order to obtain the system text.

1.3 Problem Statement:

The advancement in technology that we have studied is capable of detecting the text, extracting the text from images, videos and speech synthesis. The model that we are proposing will recognize alphabets and numbers written in air and coverts the alphabets and numbers into system font.

1.4 Problem Solution:

Our project aims to recognize the alphabets and numbers written in air using Convolutional Neural Network (CNN) with the help of Tensor Flow, OpenCV and Kaggle dataset.

Chapter 2

INTRODUCTION

In the past decade there has been great technological development like machine learning, IOT, computer vision. Object tracking is considered as an important task within the field of computer vision. The advancement in technology, innovations and support for ideas has given popularity to object tracking techniques. Generally, video analysis procedure has three major steps: detecting of the object, tracking its movement from frame to frame and finally analyzing the behavior of that object. For object tracking, four different issues are taken into account; selection of suitable objects representation, feature selection for tracking, objects detection and object tracking. In real world, object tracking algorithms are primarily part of different applications such as: automatic surveillance, video indexing and vehicle navigation etc.

Computer vision is an interdisciplinary field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do. “Computer vision is concerned with the automatic extraction, analysis and understanding of useful information from a single image or a sequence of images. It involves the development of a theoretical and algorithmic basis to achieve automatic visual understanding.” As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems.

The primary goal of this proposed technology is that to reach the audience effectively using digitized presenting skills or communicating skills with our air written text recognition model.

Convolutional Neural Network

The convolution of f and g written f*g denoting the operator with the symbol*.

Integral transform:

$$(f * g)(t) \triangleq \int_{-\infty}^{\infty} f(T)\, g(t-T)dT$$

$$(g * f)(t) \triangleq \int_{-\infty}^{\infty} f(t-T)g(T)dT$$

Where, t=time domain.

f(τ)=Weighted average of the function.

g(-τ)=weighting is simply shifted by amount of t.

As t changes, the weighting function emphasizes different parts of the input function.

The name “Convolutional Neural Network” indicates that the network employs the mathematical operation called convolution. Convolution is a specialized kind of linear operation.

Convolutional networks are simply neural network that use convolution in place of general matrix multiplication in at least one of their layers. For functions f, g supported only [0, ∞) (i.e., zero for negative arguments), the integration limits can be truncated.

TenserFlow

Tensor Flow is a free and open-source platform for machine learning and deep learning applications. It has a comprehensive, flexible ecosystem of tool, libraries and community resources that lets developers easily build and deploy ML powered applications.

OpenCV

OpenCV is a highly optimized library mainly aimed at real-time computer vision. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and computer vision and machine learning algorithms.

Deep Learning

Deep learning (also Known as deep structured learning or hierarchical learning) is part of a broader family of machine learning methods based on learning data representations, as opposed to task specific algorithms. Learning can be supervised, semi supervised or unsupervised. Deep learning models are closely related to information processing and communication patterns in a biological nervous system, such as neural coding that attempts to define a relationship between various stimuli and associated neuronal responses in the brain.

Kaggle

It allows users to find and publish data sets, explore and build models in a web based data science environment, work with other data scientists and machine learning engineers, and enter competitions to solve data science challenges.

Chapter 3

LITERATURE SURVEY

The review and comparison of various handwritten character recognition algorithms using various classification algorithms are provided.

Title of paper	Author Name	Problem Identifier	Methods Used	Result Obtained	Remarks
1) Writing on the air: Unconstrained Text Recognition From Finger Movement using Spatiotemporal Convolution.	Ve-Hwankim	They introduced the new benchmark dataset for the challenging to writing in the air and the text written from the finger movement.	Spatiotemporal convolution	The Benchmark dataset is most comprehensive and captured the finger movement with RGB cameras (33.16%).	-
2) Extracting Text information from Digital Images.	-MD.Mijimayrrahaman -Mahanumarahmanrinty	Extracting text from image was the difficult task. Their main Project intention was to Developing System to Extract a test from Digital Image.	Canny edge–detection (Canny Algorithm)	Extraction of text is successful in this part their further to implement an intelligent information Extraction system.	It is very huge process.
3) Zernike moments based handwritten Pashto character Recognition using linear discriminate Analysis.	-Sarderjehangir -Sohailkhan -Shahnazir	They developed system for recognition of handwritten characters varies among individual.	Linear discriminant	They got 63.71% accuracy.	They failed in word recognition.
4) Handwritten character recognition using convolution neural network.	-Hemange Sonata -Dr. Gayatri S Pandi	They approached for recognition of handwritten character for various languages this is used for writer's	Neural Network	It has got better accuracy Neural Network will help in better performance of recognition.	Machine Learning Technique will improve the better quality.

		identification and Bank cheques.			
5) Text Writing in Air.	-Saira Beg -M. Fahad Khan -Faisal Baig	One serious issue that it is color sensitive in such a way that existence of any red color in the background before starting the analysis can lead to false results.	OCR Optical character recognition.	The proposed method gains the average accuracy of 92.083% in order to recognize the accurate alphabets. The overall writing delay gained by the proposed method was 50ms per character.	
6) Trajectory-Based Air-Writing Recognition Using Deep Neural Network and Depth Sensor.	-Md. Shahinur Alam -Ki-Chul Kwom -Md. Ashraful Alam -Mohammed Y Abbass -Shariar Md Imtiaz -Nam Kim	Especially, it is useful when Traditional writing is difficult such as gesture-based interaction, augmented reality (AR), virtual reality (VR), etc. Air-writing solves such issues. In pen and-paper-based systems, characters are written in a Multi-stroke manner. However, air-writing has no such option [1], which represents its principal drawback. The gesture-based writing is a helpful way to avoid this problem.	Fingertip detection, data collection, normalization and network design.	The highest recognition accuracies for RTD and 6DMG datasets for CNN are 99.06% and 99.26%, respectively. However, the highest recognition. Accuracy was found for LSTM, which is 99.17% and 99.32% for RTD and 6DMG datasets, respectively.	

From the above detailed survey it is being observed that most of the authors used a new benchmark dataset for the challenging writing in the air (WiTA, EMNIST) an elaborate task bringing vision and NLP. Most of the authors implemented a video based pointing method that allows sketching and writing of English text over air in front of a mobile or laptop camera. LSTM and CNN are been used as a recognizer. The highest accuracy that is observed throughout the survey ranges from 92.083%-99.32%. The overall writing delay gained by the proposed method is 50ms per character. And also one serious issue observed is that it is color sensitive in such a way that existence of any red color in the background before starting the analysis can lead to false result.

Chapter 4

METHODOLOGY

A convolution tool that separates and identifies the various features of the image for analysis in a process called Feature Extraction. A fully connected layer that utilizes the output from the convolution process and predicts the class of the image based on the features extracted in previous stages.

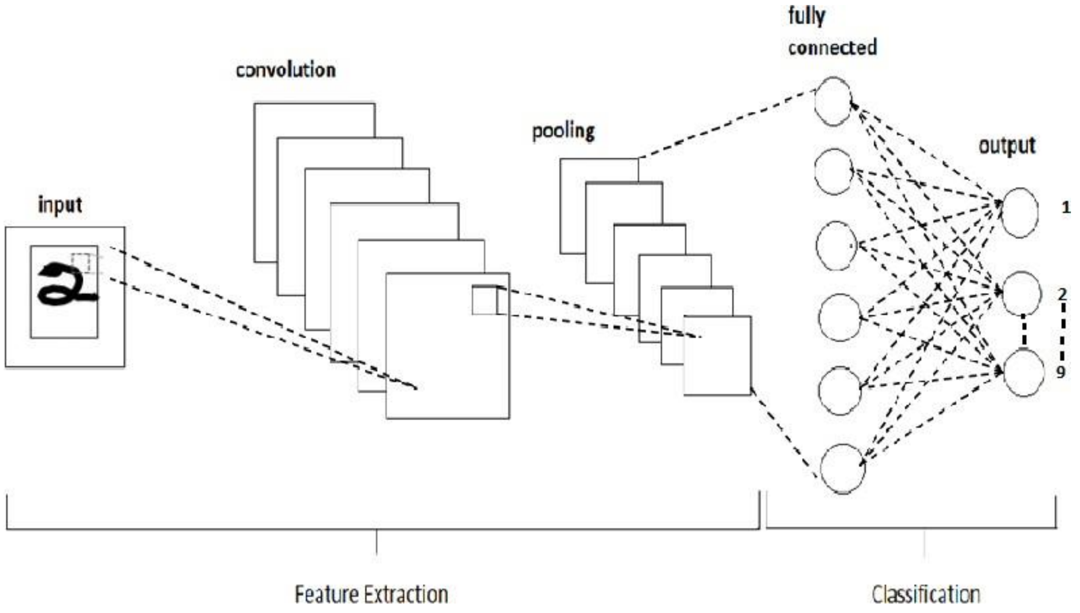


Fig 4.1: CNN architecture

Convolution Layers:

There are three types of layers that make up the CNN which are the convolutional layers, pooling layers, and fully-connected (FC) layers. When these layers are stacked, CNN architecture will be formed. In addition to these three layers, there are two more important parameters which are the dropout layer and the activation function which are defined below:

- Input layer.
- Convolution layer.
- Pooling layer.
- Fully connected (FC) layer.
- Output layer.

1. Input layer:

The input layer is the input of the whole CNN. In the neural network of image processing, it generally represents the pixel matrix of the image.

2. Convolutional Layer:

This layer is the first layer that is used to extract the various features from the input images. In this layer, the mathematical operation of convolution is performed between the input image and a filter of a particular size MxM. By sliding the filter over the input image, the dot product is taken between the filter and the parts of the input image with respect to the size of the filter (MxM).

3. Pooling Layer:

In most cases, a Convolutional Layer is followed by a Pooling Layer. The primary aim of this layer is to decrease the size of the convolved feature map to reduce the computational costs. This connections between layers and independently operates on each feature map. Depending upon method used, there are several types of pooling operations. In Max Pooling, the largest element is taken from feature map. Average Pooling calculates the average of the elements in a predefined sized Image section. The total sum of the elements in the predefined section is computed in Sum Pooling. The Pooling Layer usually serves as a bridge between the Convolutional Layer and the FC Layer.

4. Fully Connected Layer:

The Fully Connected (FC) layer consists of the weights and biases along with the neurons and is used to connect the neurons between two different layers.

5. Output layer:

The output layer in a CNN as mentioned previously is a fully connected layer, where the input from the other layers is flattened and sent so as the transform the output into the number of classes as desired by the network.

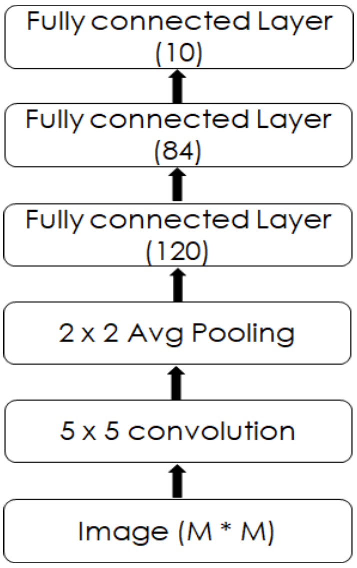

Fully connected Layer (10)
Fully connected Layer (84)
Fully connected Layer (120)
2 x 2 Avg Pooling
5 x 5 convolution
Image (M * M)

Fig 4.2: Block diagram

Chapter 5

FLOWCHART

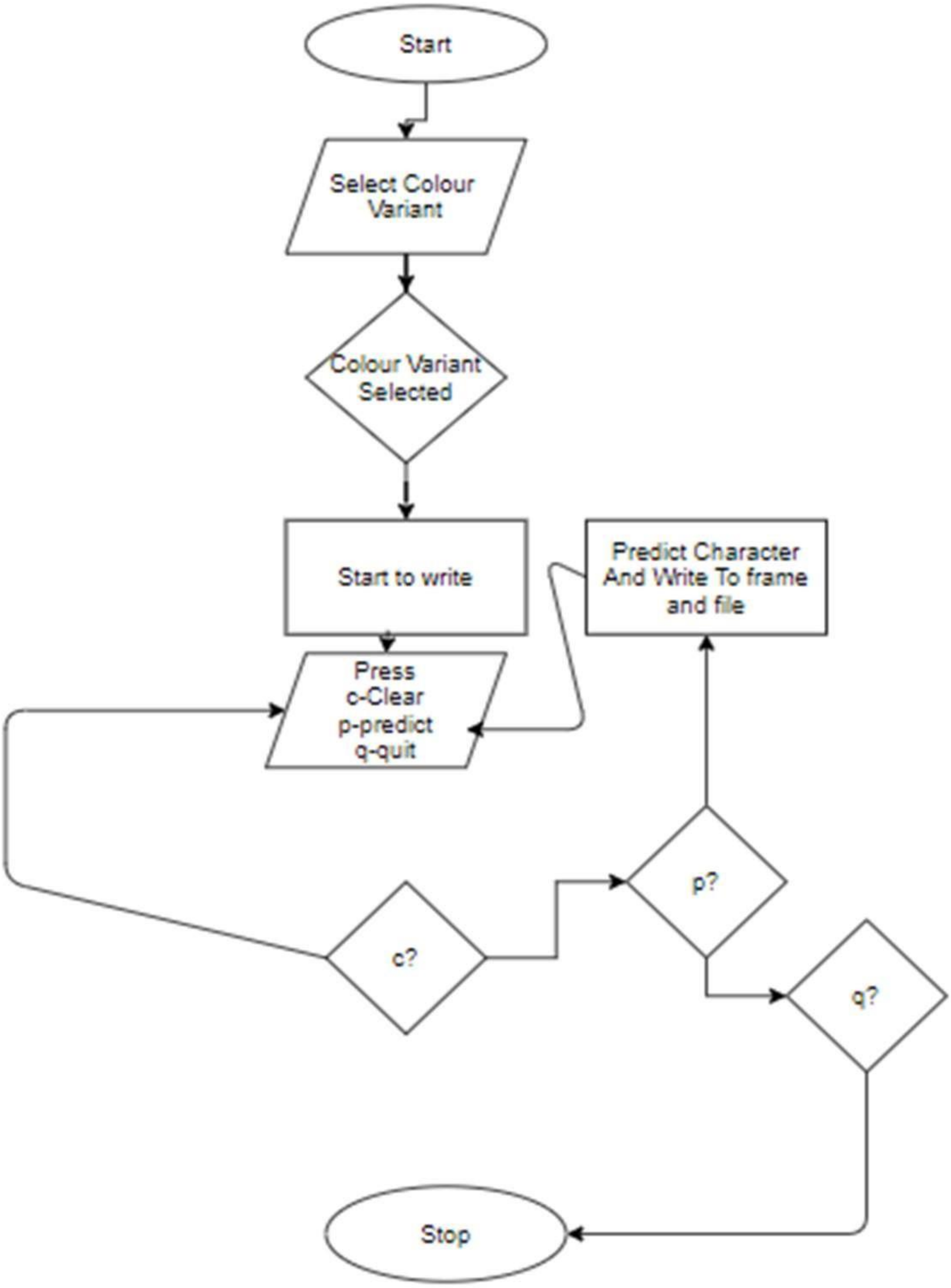


Fig 5.1: Flowchart of our model

Chapter 6

SIMULATION

a) Objectives:

The text which is written in air must be recognized and processed using machine learning Techniques in order to obtain the system text.

b) Software Requirements:

- Windows 10.
- Python 3.
- Tkinter.
- OpenCV, PIL, NumPy.
- TensorFlow, Pandas.
- Dataset from Kaggle.

c) Hardware Requirements:

- Laptop or desktop.
- Webcam.
- Colored objects.

Chapter 7

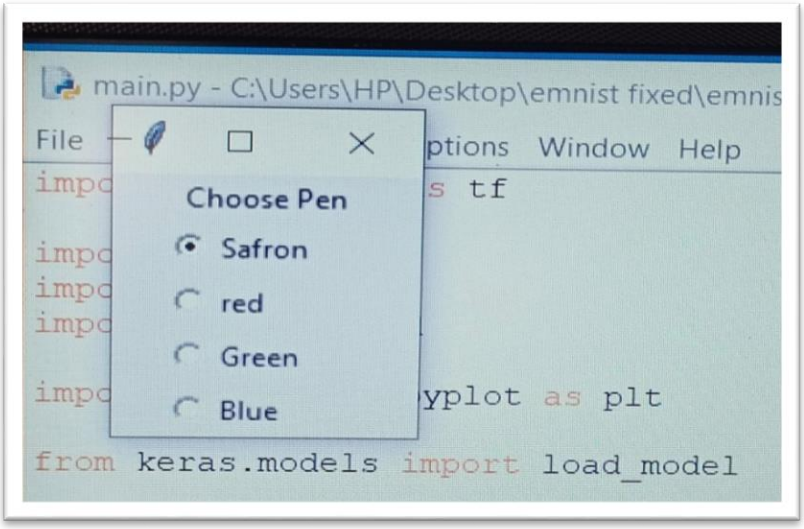
SYSTEM DESIGN AND IMPLEMENTATION

Python:

Python is an interpreted, high-level, general-purpose programming language, which has various applications in Machine learning, back-end development, Artificial intelligence software development, data science and writing system scripts among other things. Due to its easy and simplicity way of writing code, application development became much easier.

GUI: Tkinter helps to develop the GUI with various methods and functions provided by the Tkinter Package. The various functions which we have used to develop the interface are:

- Window = Tk() : The root window is created. The root window is a main application window in our programs. It has a title bar and borders. These are provided by the window manager.
- window.title("Title of window"):To provide the title of window.
- window.geometry('1300x800'): To provide dimensions to the main window in which it appears.
- window.configure(background='orange'): configure is used to access an windows attributes after its initialization. Ex: L = Label(root, bg="ivory",fg="dark green") here we are setting the background color to orange.
- rd2=Radiobutton(args….) : The Radio button is a standard Tkinter widget used to implement one-of-many selections. Radio buttons can contain text or images, and you can associate a Python function or method with each button. When the button is pressed, Tkinter automatically calls that function or method.
  Ex: rd2=Radiobutton(win, text='Emergency', variable=var_chk, value=2)
- l1.grid(row=0):The master widget is split into rows and columns, and each part of the table can hold a widget. It uses column, column span, ipadx, ipady, padx, pady, row, row span and sticky.



main.py - C:\Users\HP\Desktop\emnist fixed\emnis

Choose Pen

● Safron
○ red
○ Green
○ Blue

```
impo         s tf

impo
impo
impo

impo         yplot as plt

from keras.models import load_model
```

Fig 7.1 Select the color variant.

Capturing video, detecting contour and writing on frames:

OpenCV

Computer Vision is a field of study which enables computers to replicate the human visual system. OpenCV (Open Source Computer Vision Library) is an open source software library for computer vision and machine learning. OpenCV was created to provide a shared infrastructure for applications for computer vision and to speed up the use of machine perception in consumer products.

Read and Save images

Now for OpenCV to work on any image, it must be able to read it. Here we will see how to read a file and save it after we are done with it. Let’s see how to do it:

Imread function in OpenCV: We use the imread function to read images; here is the syntax of this function.

```
#python code to read image in OpenCV
cv2.imread(path, flag)
```

Imwrite function in OpenCV: We can use OpenCV’s imwrite() function to save an image in a storage device and the file extension defines the image format as shown in the example below. The syntax is the following:

```
#python code to read image in OpenCV
cv2.imwrite(filename, image)
```

Access pixel values and modify them: There are basically two ways to access a pixel value in an Image and modify them. First let us see how we can access a particular pixel value of an image.

```
#Python code to read pixel values import numpy as np
Import cv2 as cv
img=cv.imread(r'C:\Users\dk\dog.jpeg')
px=img[100,100]
print(px)
```

Drawing circle: We use the method to circle to draw a circle in an image. Here is the syntax and parameters:

```
Syntax:
cv2.circle(image, coordinates, radius, color, thickness)
```

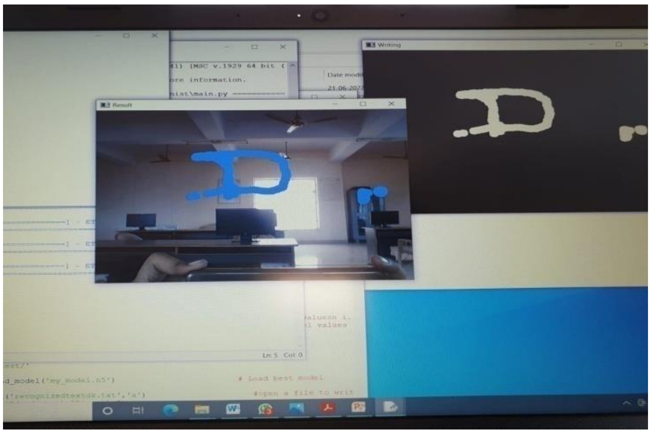


Fig 7.2: Writing detected contour on live and writing frame.

Preparing the model and predicting the written script:

TensorFlow: It is mainly used to develop model for Analysis, Prediction, Classification, etc.

In Short we use Keras to:

1. Build a neural network that classifies images.
   In this stage we build a neural network that is used to classify the image and predict the characters.
2. Train this neural network.
   In this stage we train our model with dataset and fit that model ready to test against different test sets.
3. And, finally evaluate the accuracy of the model.
   Once the model is trained and fit we can save model for further usage. Using the train and test set we need to find out the accuracy and error of our model.

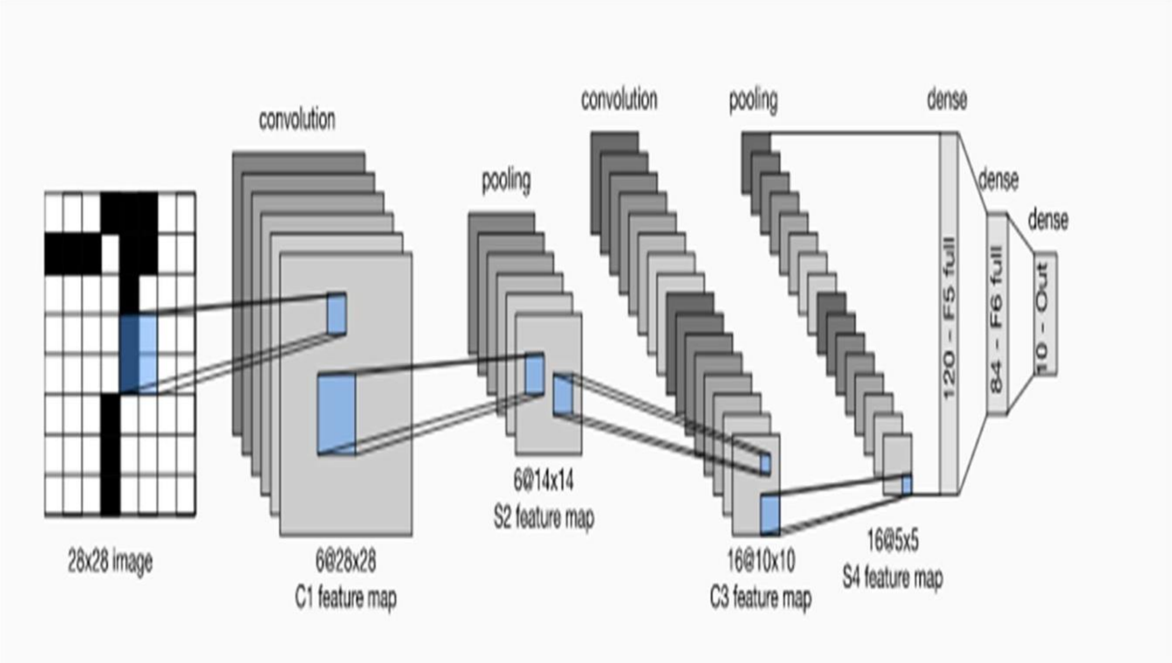


Fig 7.3: Convolution Neural Network.

Data flow in CNN. The input is a handwritten text and the output is a probability over 10 possible outcomes.

By passing a single-channel (black and white)28*28 image through the network and printing the output shape at each layer, we can inspect the model to make sure that its operations line up with what we expect from the below figure.

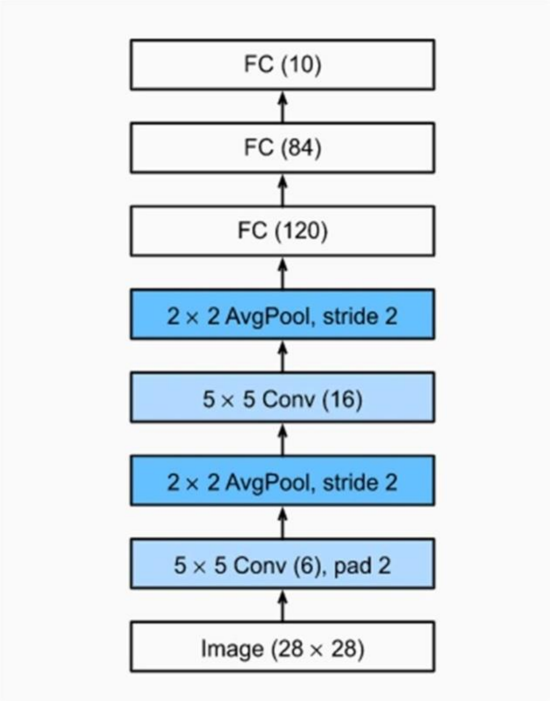


Fig 7.4: Single channel image at each layer.

The below data is the sequential model information we developed to predict our air written script.

Model:"sequential" Table.

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 28, 28, 32)	832
max_pooling2d (MaxPooling2D)	(None, 14, 14, 32)	0
conv2d_1 (Conv2D)	(None, 10, 10, 48)	38448
max_pooling2d_1 (MaxPooling2)	(None, 5, 5, 48)	0
flatten (Flatten)	(None, 1200)	0
dense (Dense)	(None, 256)	307456
dense_1 (Dense)	(None, 84)	21588
dense_2 (Dense)	(None, 47)	3995

Total params: 372,319

Trainable params: 372,319

Non-trainable params: 0

We came across the design aspects and the sequential model that was developed to recognize the air written script. In next chapter we are going to see analysis and results of the model we have trained, accuracy of model.

Chapter 8

Experimentation and Result Analysis

This chapter consists of detailed information about the dataset used and analysis of the steps carried out to obtain the result of our project.

Dataset and testing the model

The dataset used in our project is EMNIST dataset. The EMNIST dataset is a set of handwritten characters. Here we have used datasets which includes digits from 0-9 and alphabets from A-Z in both uppercase and lowercase.

The original black and white images from NIST were normalized to fit in a 20x20pixel box. The resulting images contain grey levels. The images were centered in a 28x28 image.

This dataset consists of 112,800 different types of handwriting styles of all digits and alphabets. These images are used to train the model to recognize the handwritten characters and there are 18,200 samples for testing the model. Each image in the dataset is associated with corresponding label as shown below.

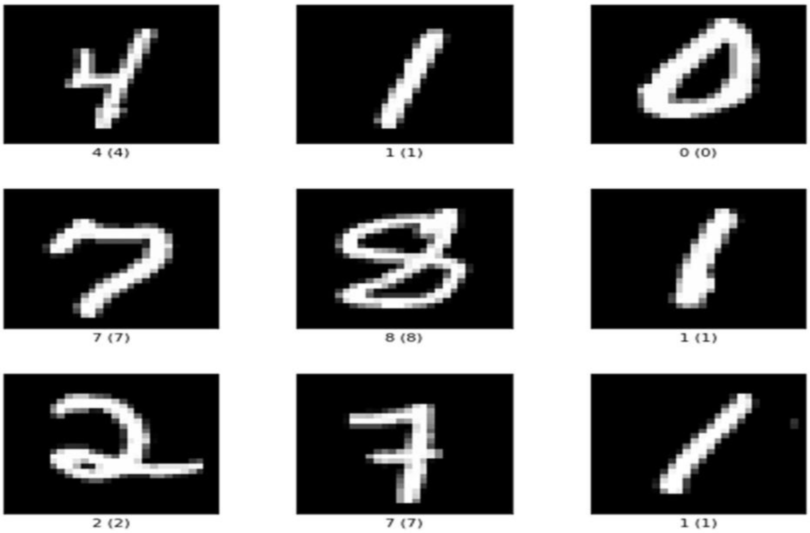
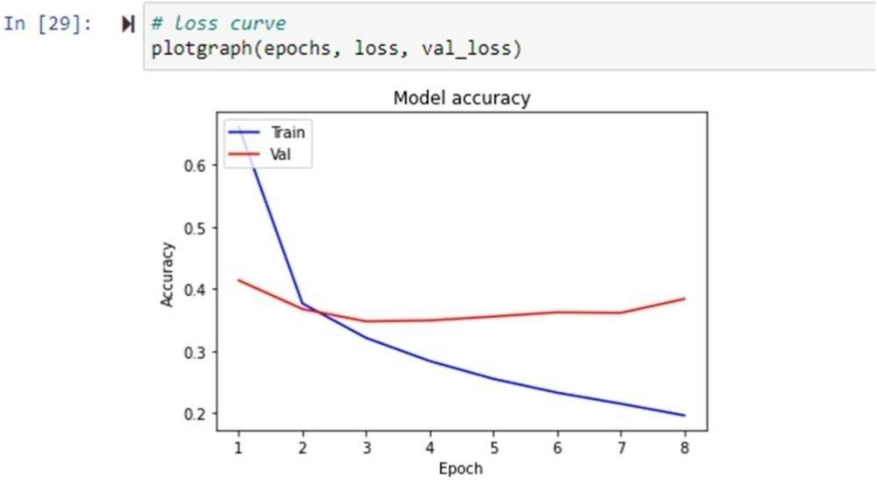


Fig 8.1: Data objects from EMNIST dataset.

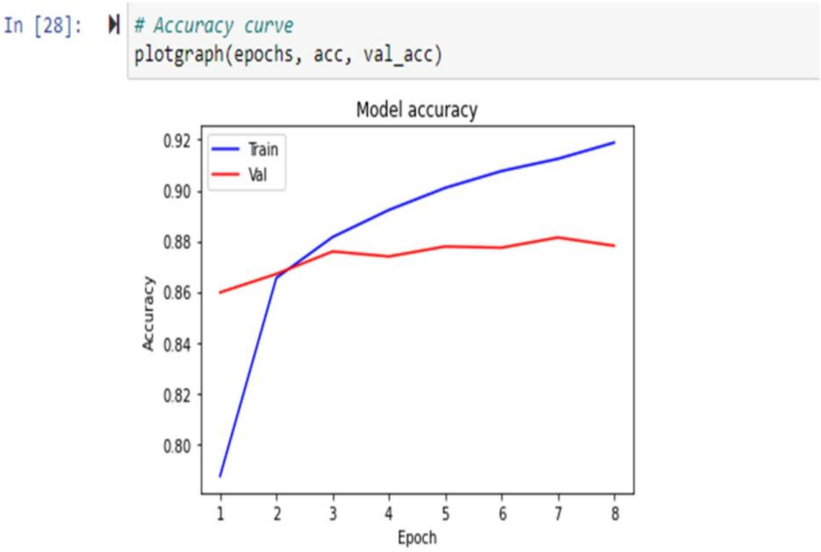
- The model has two main aspects: the feature extraction front end comprised of convolutional and pooling layers, and the classifier backend that will make a prediction.
- For the convolutional front-end, we have two convolutional layer with a small filter size (5) and number of filters (32) followed by a max pooling layer. The filter maps are then flattened to provide features to the classifier.
- There is also use of a softmax activation function between the feature extractor and the output layer.
- We have used ReLU activation function for all layers.
- Next we fit the model and calculate the accuracy and loss on the training samples. In this process we achieved the loss of 0.1876 and the accuracy of 0.9218.

- After the model is defined, we evaluate it against the test samples which are separately stored and not used during training the model.
- To evaluate the performance of model, we used separate data. Each test set will be 20% of the training dataset, or about 18200 examples, close to the size of the actual test set.
- The evaluate model () function takes the training dataset as arguments and returns a list of accuracy scores.



```
In [29]:  # loss curve
          plotgraph(epochs, loss, val_loss)
```

Fig 8.2: Accuracy vs Epoch curve representing loss of model.

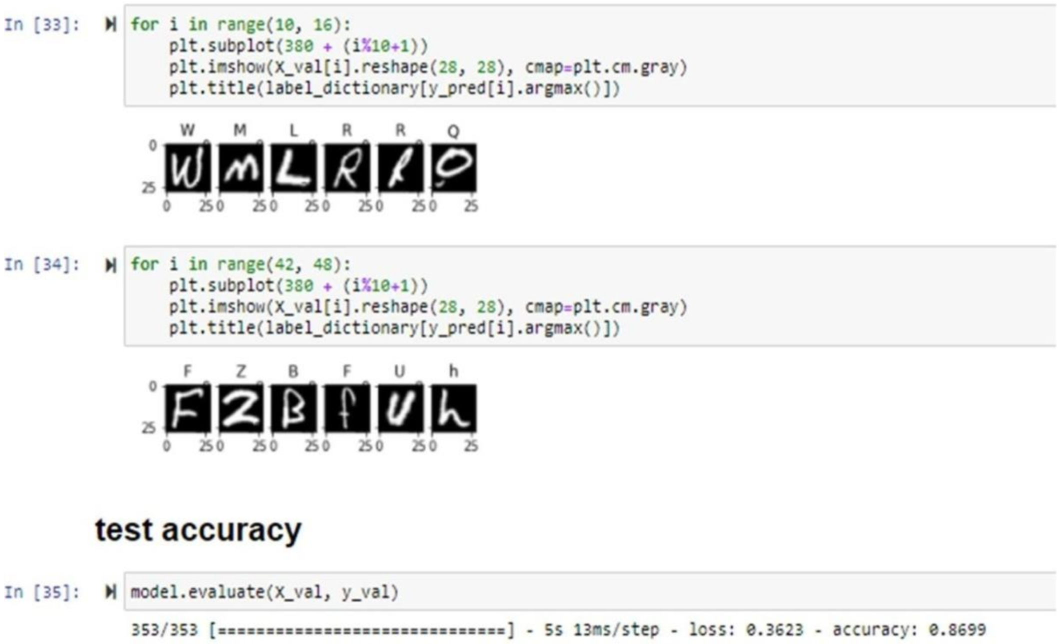


```
In [28]:  # Accuracy curve
          plotgraph(epochs, acc, val_acc)
```

Fig 8.3: Accuracy vs Epoch curve representing accuracy of model.

Predicting the characters and analyzing the results

After evaluation we have used our model to make a prediction on new images. The new images are pre-processed before inputting to the model. In preprocessing stage the image is converted to grayscale and the image is aligned so that one image contains one centered handwritten digit or character and the size of the image is square with the size 28×28 pixels.



```
In [33]:  for i in range(10, 16):
              plt.subplot(380 + (i%10+1))
              plt.imshow(X_val[i].reshape(28, 28), cmap=plt.cm.gray)
              plt.title(label_dictionary[y_pred[i].argmax()])
```

```
In [34]:  for i in range(42, 48):
              plt.subplot(380 + (i%10+1))
              plt.imshow(X_val[i].reshape(28, 28), cmap=plt.cm.gray)
              plt.title(label_dictionary[y_pred[i].argmax()])
```

test accuracy

```
In [35]:  model.evaluate(X_val, y_val)

          353/353 [==============================] - 5s 13ms/step - loss: 0.3623 - accuracy: 0.8699
```

Fig 8.4: Test results figure.

Predicting characters and writing into file or frame

After the pre-processing stage the image is predicted by the model and the result of the prediction is written to a text file or frame for reference. The below image represents text which is recognized is written into the output frame, the same output is written to file also.

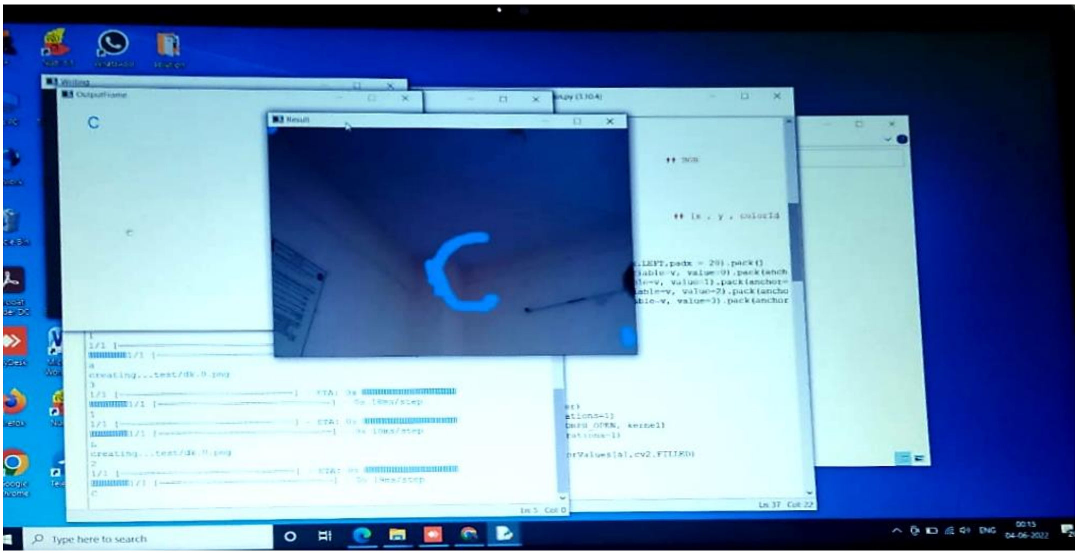
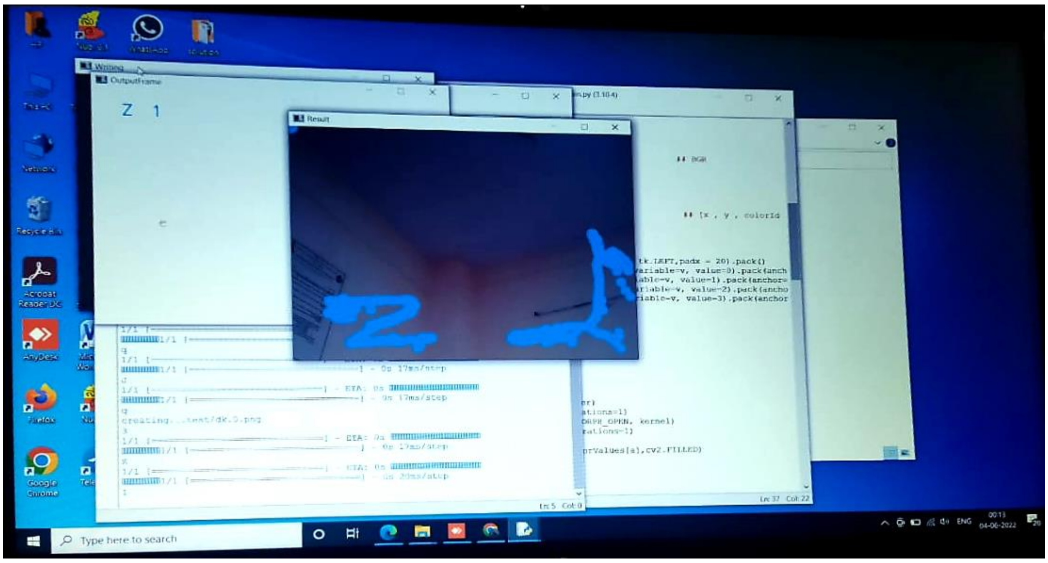


Fig 8.5: Characters predicted and written to output frame.

The model we developed can easily recognize the air written script and able to convert it into system font. We have achieved better accuracy compared to existing system.



```
1/1 [
1/1 [
q
1/1 [
1/1 [==============================] - 0s 17ms/step
d
1/1 [==============================] - ETA: 0s
1/1 [==============================] - 0s 17ms/step
q
creating...test/dk.0.png
3
1/1 [==============================] - ETA: 0s
1/1 [==============================] - 0s 17ms/step
%
1/1 [==============================] - ETA: 0s
1/1 [==============================] - 0s 20ms/step
1
```

Fig 8.6: Detecting unwanted character.

The above image shows the character which we have written in front of camera using selected colored object. The written character should be accurate. Sometimes extra dots or lines written on the screen will lead to detect extra character in the output frame. This result we include in loss accuracy.

CONCLUSION

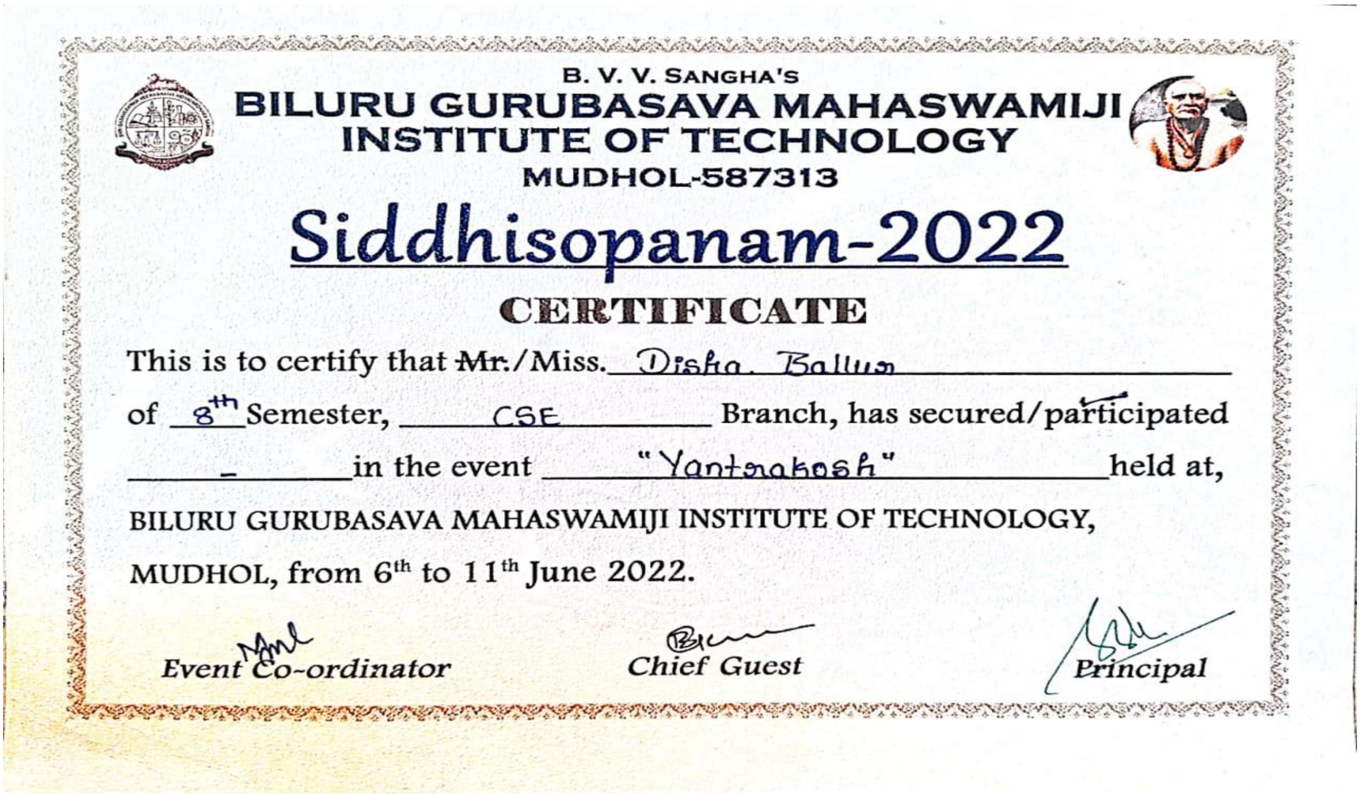
The predicted output of the model which is the computer text format of air written characters is written into a text file for user’s reference and displayed on the output device. The current paper accuracy is 63.71% using Linear discriminate analysis and our accuracy is 70% or more by using CNN and Kaggle dataset.

REFERENCES

1. HayderM. Albeahdili, Haider A. Alwzwazy, Naz E. Islam.” Robust Convolutional Neural Networks for Image Recognition”. (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 6, No.11, 2015.
2. Fabien Lauer, Ching Y. Suen, and G´erard Bloch “A trainable feature extract or for handwritten digit recognition‖”, Journal Pattern Recognition, Elsevier, 40 (6), pp.1816-1824, 2007.
3. Chen-Yu Lee, Saining Xie, Patrick Gallagher, Zhengyou Zhang, Zhuowen Tu, “ Deeply-SupervisedNets“NIPS2014.
4. M. Fischler and R. Elschlager, “The representation and matching of pictorial structures”, IEEE Transactions on Computer, vol. 22, no. 1, 1973.
5. Kevin Jarrett, Koray Kavukcuoglu, Marc’Aurelio Ranzato and Yann LeCun “What is the Best Multi-Stage Architecture for Object Recognition”CCV’09, IEEE, 2009.
6. Kaiming, He and Xiangyu, Zhang and Shaoqing, Ren and Jian Sun “ Spatial pyramid pooling in deep convolutional networks for visual recognition European”, Conference on Computer Vision, arXiv:1406.4729v4 [cs.CV] 23 Apr 2015.
7. X. Wang, M. Yang, S. Zhu, and Y. Lin.“Region lets for generic object detection”. InICCV, 2013.
8. Krizhevsky, Alex, Sutskever, Ilya, and Hinton, Geoffrey. “Image Net classification with deep convolutional neural networks”. In Advances in Neural Information Processing Systems25 (NIPS’2012). 2012.
9. C. Couprie, C. Farabet, L. Najman, and Y. LeCun. “Indoor semantic segmentation using depth information”. International Conference on Learning Representation, 2013.
10. R. Girshick, J. Donahue, T. Darrell, and J. Malik. “Rich feature hierarchies for accurate object detection and semantic segmentation”. CoRR,abs/1311.2524, 2013.
11. O.Russakovsky,J.Deng,H.Su,J.Krause,S.Satheesh,S.Ma,S.Huang,A.Karpathy,A.Khosla,M. Bernstein, A.C. Berg, and F.F. Li. “ Image net large scale DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING Recognition Of Text Written In Air 33 visual recognition challenge”. International Journal of Computer Vision” December 2015, Volume115, Issue3, pp211- 252.
12. Raia Hadsell, Sumit Chopra, Yann LeCun, “Dimensionality Reduction by Learning an Invariant Mapping” CVPR, vol. 2, pp. 1735- 1742, 2006.
13. Omkar M. Parkhi, Andrea Vedaldi, and Andrew Zisserman “Deep Face Recognition” British Machine Vision Conference, 2015.
14. Dan Claudiu Ciresan, Ueli Meier, Luca Maria Gambardella, Juergen Schmidhuber, “DeepBig Simple Neural NetsExcel on Handwritten Digit Recognition” Neural Computation, Volume22, Number 12, December 2010.
15. Sherif Abdel Azeem, Maha El Meseery, HanyAhmed ,”Online Arabic Handwritten Digits Recognition“, Frontiers in Handwriting Recognition (ICFHR),2012.

APPENDIX

Appendix-A



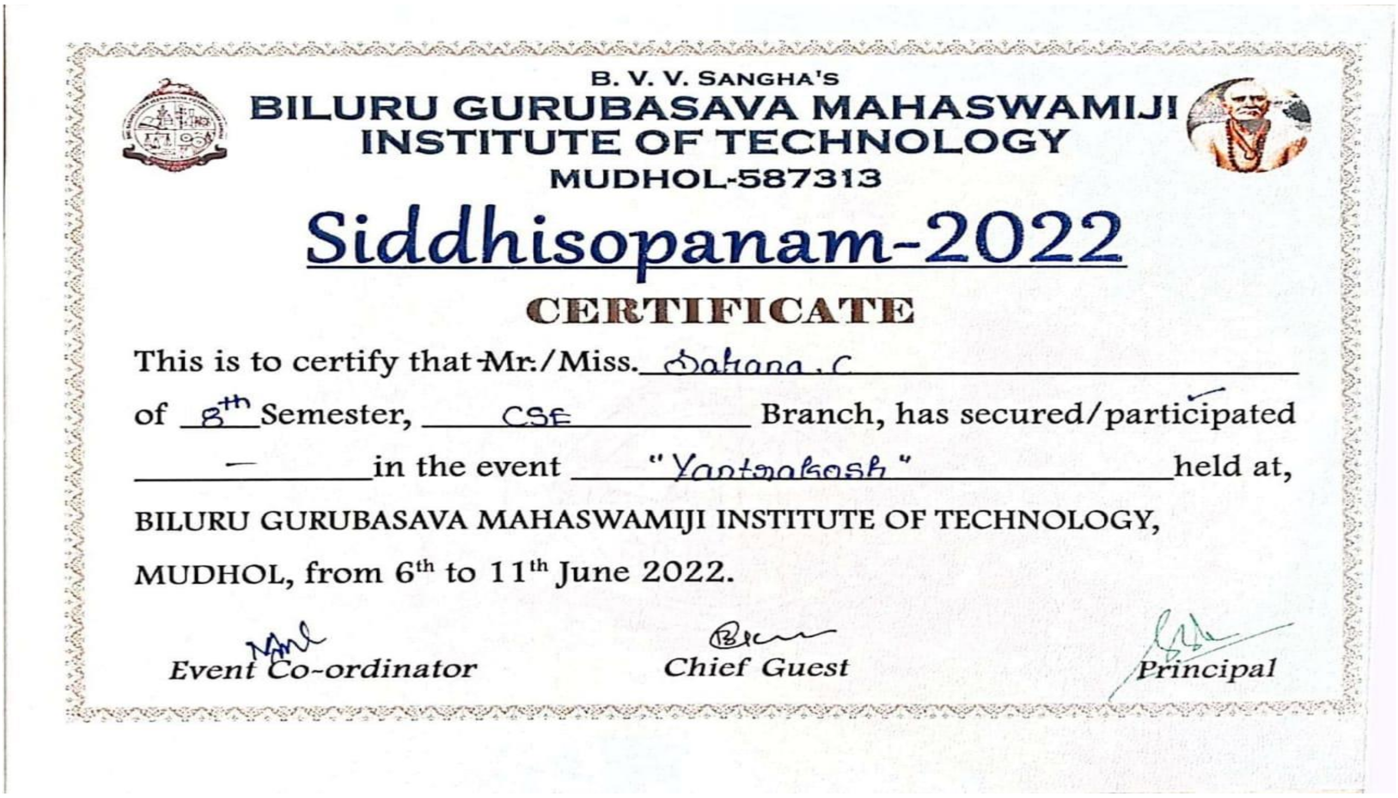
B. V. V. SANGHA'S
BILURU GURUBASAVA MAHASWAMIJI
INSTITUTE OF TECHNOLOGY
MUDHOL-587313

Siddhisopanam-2022

CERTIFICATE

This is to certify that ~~Mr.~~/Miss. Disha. Balluri of 8th Semester, CSE Branch, has secured/participated - in the event "Yantrakosh" held at, BILURU GURUBASAVA MAHASWAMIJI INSTITUTE OF TECHNOLOGY, MUDHOL, from 6th to 11th June 2022.

Event Co-ordinator   Chief Guest   Principal



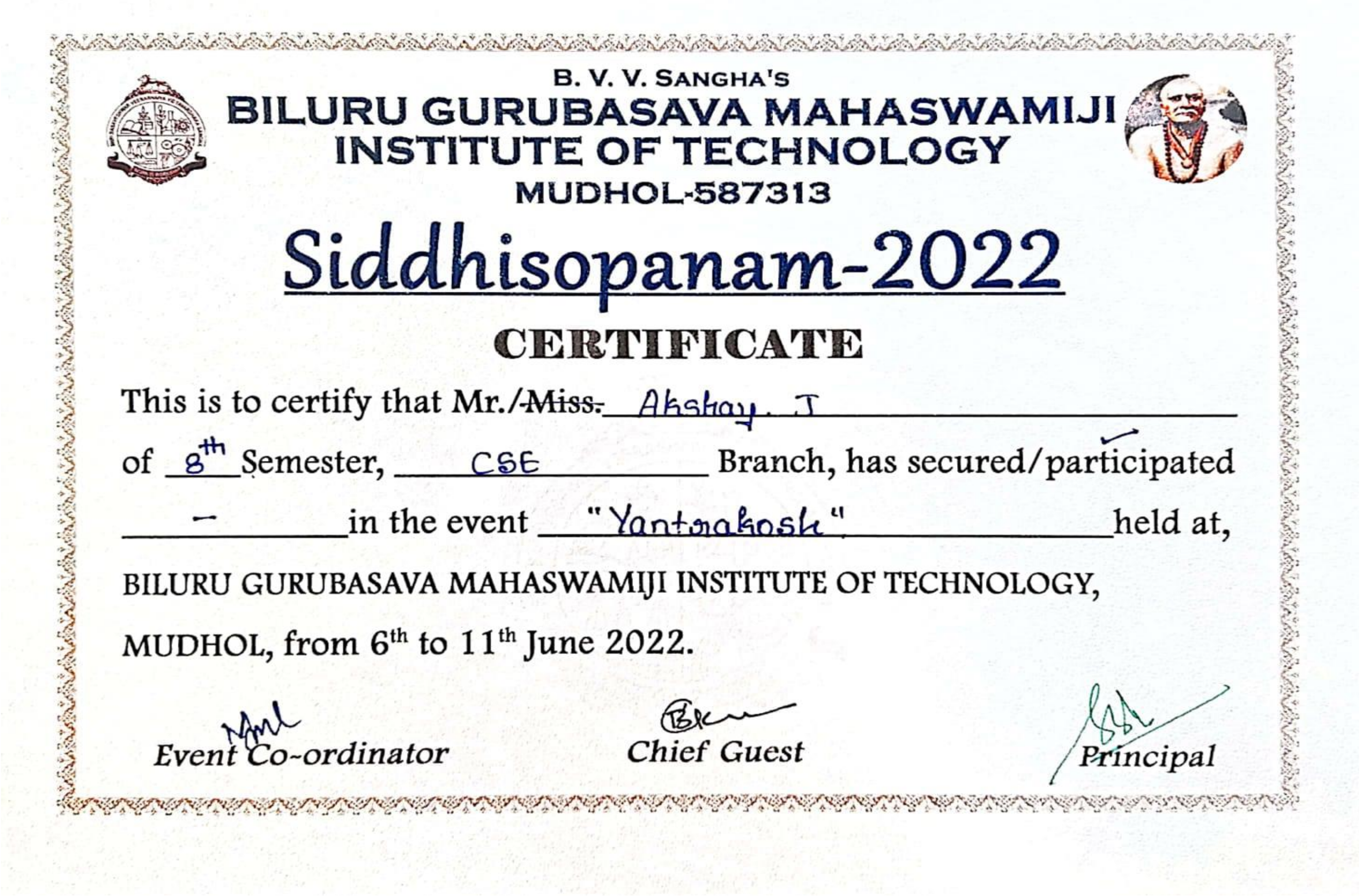
B. V. V. SANGHA'S
BILURU GURUBASAVA MAHASWAMIJI
INSTITUTE OF TECHNOLOGY
MUDHOL-587313

Siddhisopanam-2022

CERTIFICATE

This is to certify that ~~Mr.~~/Miss. Sahana. C of 8th Semester, CSE Branch, has secured/participated — in the event "Yantrakosh" held at, BILURU GURUBASAVA MAHASWAMIJI INSTITUTE OF TECHNOLOGY, MUDHOL, from 6th to 11th June 2022.

Event Co-ordinator   Chief Guest   Principal



B. V. V. SANGHA'S

BILURU GURUBASAVA MAHASWAMIJI
INSTITUTE OF TECHNOLOGY
MUDHOL-587313

Siddhisopanam-2022

CERTIFICATE

This is to certify that Mr./~~Miss.~~ Akshay. J

of 8th Semester, CSE Branch, has secured/participated

- in the event "Yantrakosh" held at,

BILURU GURUBASAVA MAHASWAMIJI INSTITUTE OF TECHNOLOGY,

MUDHOL, from 6th to 11th June 2022.

Event Co-ordinator

Chief Guest

Principal

Appendix-B

Installing **WINDOWS 10**

Step 1: Check your device meets the Windows 10 system requirements.

Step 2: Create USB installation media.

Step 3: Run the installer tool.

Step 4: Use your installation media.

Step 5: Change your computer's boot order.

Step 6: Restart your device.

Step 7: Complete the installation.

Appendix-C

Installing **PYTHON**

Step 1: Download python 3.

Step 2: Select Version of Python to Install.

Step 3: Download Python Executable Installer.

Step 4: Run Executable Installer.

Step 5: Verify Python is installed on Windows.

Step 6: Verify Pip was installed.

Appendix-D

Step 1: Visit the official website of the Visual Studio Code using any web browser like Google Chrome, Microsoft Edge, etc.

Step 2: Press the "Download for Windows" button on the website to start the download of the Visual Studio Code Application.

Step 3: When the download finishes, then the Visual Studio Code icon appears in the Downloads folder.

Step 4: Click on the installer icon to start the installation process of the Visual Studio Code.

Step 5: After the Installer opens, it will ask you for accepting the terms and conditions of the Visual Studio Code. Click on I accept the agreement and then click the Next button.

Step 6: Choose the location data for running the Visual Studio Code. It will then ask you for browsing the location. Then click on Next button.

Step 7: Then it will ask for beginning the installing setup. Click on the Install button.

Step 8: After clicking on Install, it will take about 1 minute to install the Visual Studio Code on your device.

Step 9: After the Installation setup for Visual Studio Code is finished, it will show a window like this below. Tick the "Launch Visual Studio Code" checkbox and then click Next.

Step 10: After the previous step, the Visual Studio Code window opens successfully. Now you can create a new file in the Visual Studio Code window and choose a language of yours to begin your programming journey!