REAL TIME COMMUNICATION SYSTEM POWERED BY AI FOR SPECIALLY ABLED

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certificate that the project work entitled as **“REAL TIME COMMUNICATION SYSTEM POWERED BY AI FOR SPECIALLY ABLED”** is being Submitted by **“SHIFANA M, RITHIKA S, LIJI POORANI D** and **AMIRTHA P”** in the partial fulfilment for the award of the **Degree of Bachelor of Technology** in **“INFORMATION TECHNOLOGY”** during the academic year 2022-2023, under my Supervision

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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INTRODUCTION

In our society, we have people with disabilities. The technology is developing day by day but no significant developments are undertaken for the betterment of these people. Communications between deaf-mute and a normal person has always been a challenging task. It is very difficult for mute people to convey their message to normal people. Since normal people are not trained on hand sign language. In emergency times conveying their message is very difficult. The human hand has remained a popular choice to convey information in situations where other forms like speech cannot be used. Voice Conversion System with Hand Gesture Recognition and translation will be very useful to have a proper conversation between a normal person and an impaired person in any language.The project aims to develop a system that converts the sign language into a human hearing voice in the desired language to convey a message to normal people, as well as convert speech into understandable sign language for the deaf and dumb. We are making use of a convolution neural network to create a model that is trained on different hand gestures. An app is built which uses this model. This app enables deaf and dumb people to convey their information using signs which get converted to human-understandable language and speech is given as output.

1.1.PROJECT OVERVIEW

The project developed is a system that converts hand gestures of a Deaf-Mute individual into its respective ASL (American Sign Language) alphabets for a normal individual for communication. The main customer for our project are: People who want to communicate with deaf-mute individual who desire to communicate with others, and deaf-mute individual who desire to communicate with others. This project tries to solve thecommunication during the time of emergencies. The project is developed on Python Platform using CNN (Convolutional Neural Network) model from TensorFlowpackage.

1.2.PURPOSE

Everybody cannot afford to have a human translators of sign language, they may not be available all the time and they are quite expensive. People who engage in conversation with deaf-mute individual will find it hard and tedious. Deaf-mute individual may lose a lot of opportunities because they cannot speak or express their thoughts verbally in situationslike an interview. This projectaims to overcome the said challenges

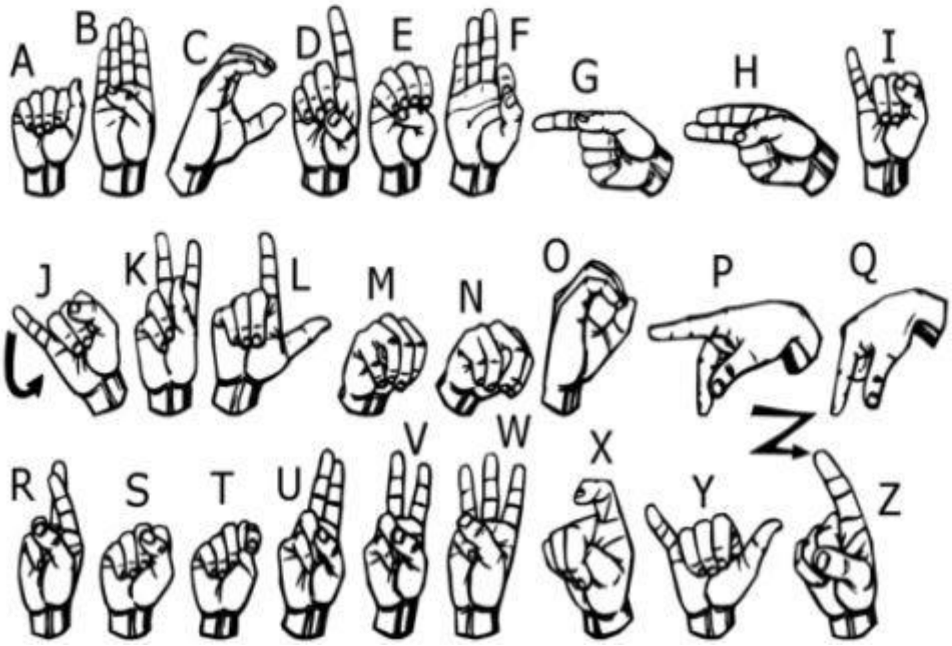


Figure 1: Sign language symbols

2. Literature Survey:

In the recent years there has been tremendous research done on the hand gesture recognition.

With the help of literature survey, we realized that the basic steps in hand gesture recognition are: -

- Data acquisition
- Data pre-processing
- Feature extraction
- Gesture classification

2.1 Data acquisition:

The different approaches to acquire data about the hand gesture can be done in the following ways:

1.Use of sensory devices:

It uses electromechanical devices to provide exact hand configuration, and position. Different glove-based approaches can be used to extract information. But it is expensive and not user friendly.

2.Vision based approach:

In vision-based methods, the computer webcam is the input device for observing the information of hands and/or fingers. The Vision Based methods require only a camera, thus realizing a natural interaction between humans and computers without the use of any extra devices, thereby reducing cost. These systems tend to complement biological vision by describing artificial vision systems that are implemented in software and/or hardware. The main challenge of vision-based hand detection ranges from coping with the large variability of the human hand's appearance due to a huge number of hand movements, to different skin-color possibilities as well as to the variations in viewpoints, scales, and speed of the camera capturing the scene.

2.2 Data Pre-Processing and 2.3 Feature extraction for vision-based approach:

- In [1] the approach for hand detection combines threshold-based colour detection with background subtraction. We can use AdaBoost face detector to differentiate between facesand hands as they both involve similar skin-color.

- We can also extract necessary image which is to be trained by applying a filter called Gaussian Blur (also known as Gaussian smoothing). The filter can be easily appliedusing open computer vision (also known as OpenCV) and is described in [3].

- For extracting necessary image which is to be trained we can use instrumented gloves as mentioned in [4]. This helps reduce computation time for Pre-Processing and gives us more concise and accurate data compared to applying filters on data received from video extraction.

- We tried doing the hand segmentation of an image using color segmentation techniques but skin colorur and tone is highly dependent on the lighting conditions due to which output, we got for the segmentation we tried to do were no so great. Moreover, we have a huge number of symbols to be trained for our project many of which look similar to each other like the gesture for symbol ‘V’ and digit ‘2’, hence we decided that in order to produce better accuracies for our large number of symbols, rather than segmenting the hand out of a random background we keep background of hand a stable single colour so that we don’t need to segment it on the basis of skin colour. This would help us to get better results.

2.4 Gesture Classification:

- In [1] Hidden Markov Models (HMM) is used for the classification of the gestures. This model deals with dynamic aspects of gestures. Gestures are extracted from a sequence of video images by tracking the skin-color blobs corresponding to the hand into a body– face space centred on the face of the user.

- The goal is to recognize two classes of gestures: deictic and symbolic. The image is filtered using a fast look–up indexing table. After filtering, skin colour pixels are gathered into blobs. Blobs are statistical objects based on the location (x, y) and the colorimetry (Y, U, V) of the skin color pixels in order to determine homogeneous areas.

- In [2] Naïve Bayes Classifier is used which is an effective and fast method for static hand gesture recognition. It is based on classifying the different gestures according to geometric based invariants which are obtained from image data after segmentation.

- Thus, unlike many other recognition methods, this method is not dependent on skin colour. The gestures are extracted from each frame of the video, with a static background. The first step is to segment and label the objects of interest and to extract geometric invariants from them. Next step is the classification of gestures by using a K nearest neighbor algorithm aided with distance weighting algorithm (KNNDW) to provide suitable data for a locally weighted Naïve Bayes‟ classifier.

- According to the paper on "Human Hand Gesture Recognition Using a Convolution Neural Network" by Hsien-I Lin, Ming-Hsiang Hsu, and Wei-Kai Chen (graduates of Institute of Automation Technology National Taipei University of Technology Taipei, Taiwan), they have constructed a skin model to extract the hands out of an image and then apply binary threshold to the whole image. After obtaining the threshold image they calibrate it about the principal axis in order to centre the image about the axis. They input this image to a convolutional neural network model in order to train and predict the outputs. They have trained their model over 7 hand gestures and using this model they produced an accuracy of around 95% for those 7 gestures.

3. Key words and Definitions:

3.1 Feature Extraction and Representation:

The representation of an image as a 3D matrix having dimension as of height and width of the image and the value of each pixel as depth (1 in case of Grayscale and 3 in case of RGB). Further, these pixel values are used for extracting useful features using CNN.

3.2 Artificial Neural Network (ANN):

Artificial Neural Network is a connection of neurons, replicating the structure of human brain. Each connection of neuron transfers information to another neuron. Inputs are fed into first layer of neurons which processes it and transfers to another layer of neurons called as hidden layers. After processing of information through multiple layers of hidden layers, information is passed to final output layer.

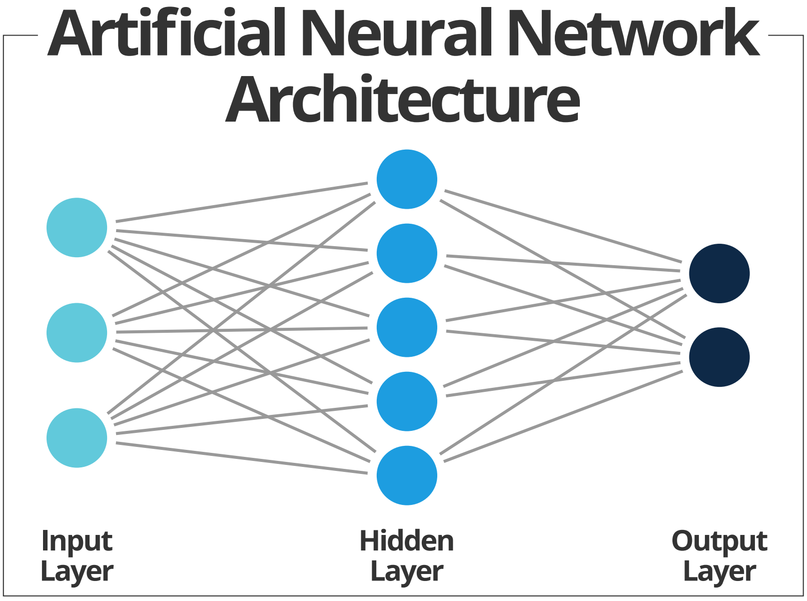


Figure 2 : Artificial Neural Network

These are capable of learning and have to be trained. There are different learning strategies:

1. Unsupervised Learning
2. Supervised Learning
3. Reinforcement Learning

3.3 Convolutional Neural Network (CNN):

Unlike regular Neural Networks, in the layers of CNN, the neurons are arranged in 3 dimensions: width, height, depth. The neurons in a layer will only be connected to a small region of the layer (window size) before it, instead of all of the neurons in a fully-connected manner. Moreover, the final output layer would have dimensions (number of classes), because by the end of the CNN architecture we will reduce the full image into a single vector of class scores.

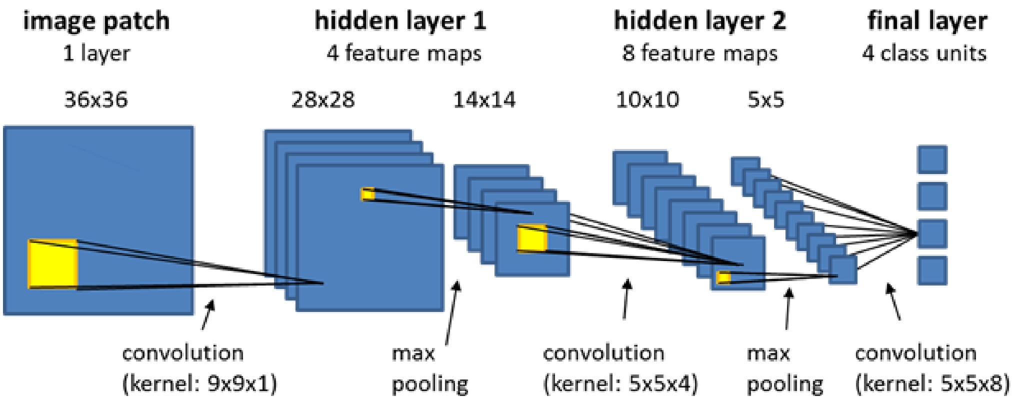


Figure 3 : Convolution Neural Network

1. Convolution Layer:

In convolution layer we take a small window size [typically of length 5*5] that extends to the depth of the input matrix. The layer consists of learnable filters of window size. During every iteration we slid the window by stride size [typically 1], and compute the dot product of filter entries and input values at a given position.

As we continue this process we will create a 2-Dimensional activation matrix that gives the response of that matrix at every spatial position. That is, the network will learn filters that activate when they see some type of visual feature such as an edge of some orientation or a blotch of some colour.

2. **Pooling Layer:**

We use pooling layer to decrease the size of activation matrix and ultimately reduce the learnable parameters. There are two types of pooling:

a. Max Pooling: In max pooling we take a window size [for example window of size 2*2], and only take the maximum of 4 values. Well lid this window and continue this process, so well finally get an activation matrix half of its original Size.

b.Average Pooling: In average pooling, we take advantage of of all Values in a window

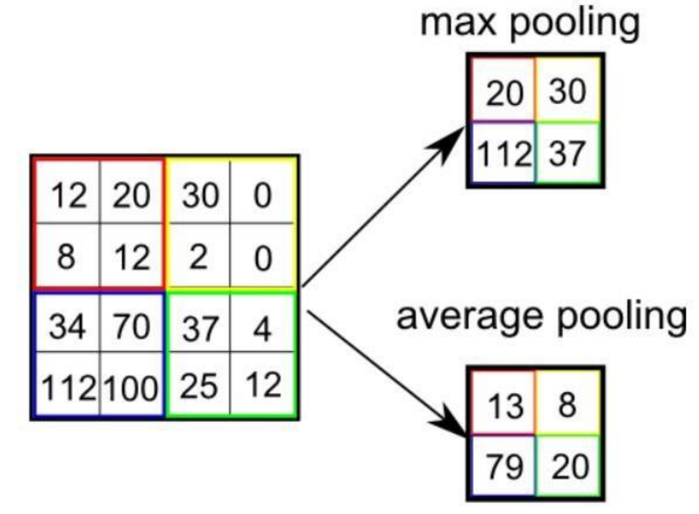
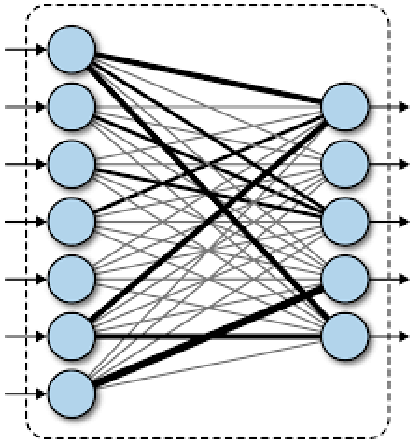


Figure 4 : Max Pooling & Average Pooling

3. Fully Connected Layer:

In convolution layer, neurons are connected only to a local region, while in a fully connected region, we will connect all the inputs to neurons .



4. Final Output Layer:

After getting values from fully connected layer, we will connect them to the final layer of neurons [having count equal to total number of classes], that will predict the probability of each image to be in different classes.

3.4 TensorFlow:

TensorFlow is an end-to-end open-source platform for Machine Learning. It has a comprehensive, flexible ecosystem of tools, libraries and community resources that lets researchers push the state-of-the-art in Machine Learning and developers easily build and deploy Machine Learning powered applications.

TensorFlow offers multiple levels of abstraction so you can choose the right one for your needs. Build and train models by using the high-level Keras API, which makes getting started with TensorFlow and machine learning easy.

If you need more flexibility, eager execution allows for immediate iteration and intuitive debugging. For large ML training tasks, use the Distribution Strategy API for distributed training on different hardware configurations without changing the model definition.

3.5 Keras:

Keras is a high-level neural networks library written in python that works as a wrapper to TensorFlow. It is used in cases where we want to quickly build and test the neural network with minimal lines of code. It contains implementations of commonly used neural network elements like layers, objective, activation functions, optimizers, and tools to make working with images and text data easier.

3.6 OpenCV:

OpenCV (Open-Source Computer Vision) is an open-source library of programming functions used for real-time computer-vision.

It is mainly used for image processing, video capture and analysis for features like face and object recognition. It is written in C++ which is its primary interface, however bindings are available for Python, Java, MATLAB/OCTAVE.

4 PROBLEM STATEMENT DEFINITION

The study of human-computer interaction has shown a great deal of interest in hand gesture recognition. In many areas of human-computer interaction, including virtual reality, gaming, automobile system control, and robotic control, quick and precise hand gesture recognition is crucial. As more sensors are added, there are numerous different ways to categorise hand motions. Since gesture identification is a problem of image classification and 2D CNNs are effective in image classification, we have chosen to employ a convolutional neural network for this task. A system that converts the sign language into the respective ASL (American Sign Language)alphabet to convey a message to normal people is developed in this project

5.IDEATION & PROPOSED SOLUTION

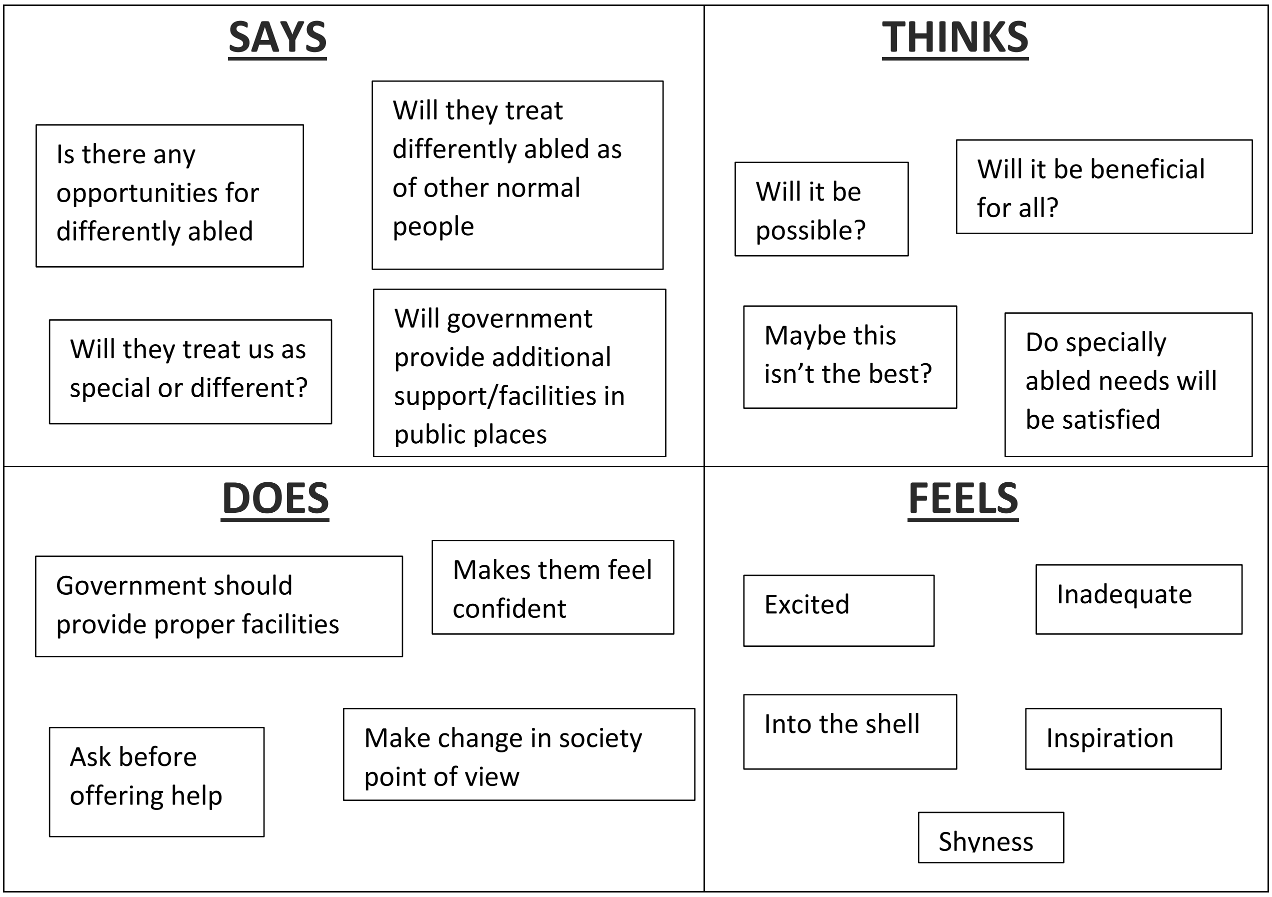
5.1.EMPATHY MAP CANVAS

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.

It is a useful tool to helps teams better understand their users.

Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

Example:



SAYS

Is there any opportunities for differently abled

Will they treat differently abled as of other normal people

Will they treat us as special or different?

Will government provide additional support/facilities in public places

THINKS

Will it be possible?

Will it be beneficial for all?

Maybe this isn't the best?

Do specially abled needs will be satisfied

DOES

Government should provide proper facilities

Makes them feel confident

Ask before offering help

Make change in society point of view

FEELS

Excited

Inadequate

Into the shell

Inspiration

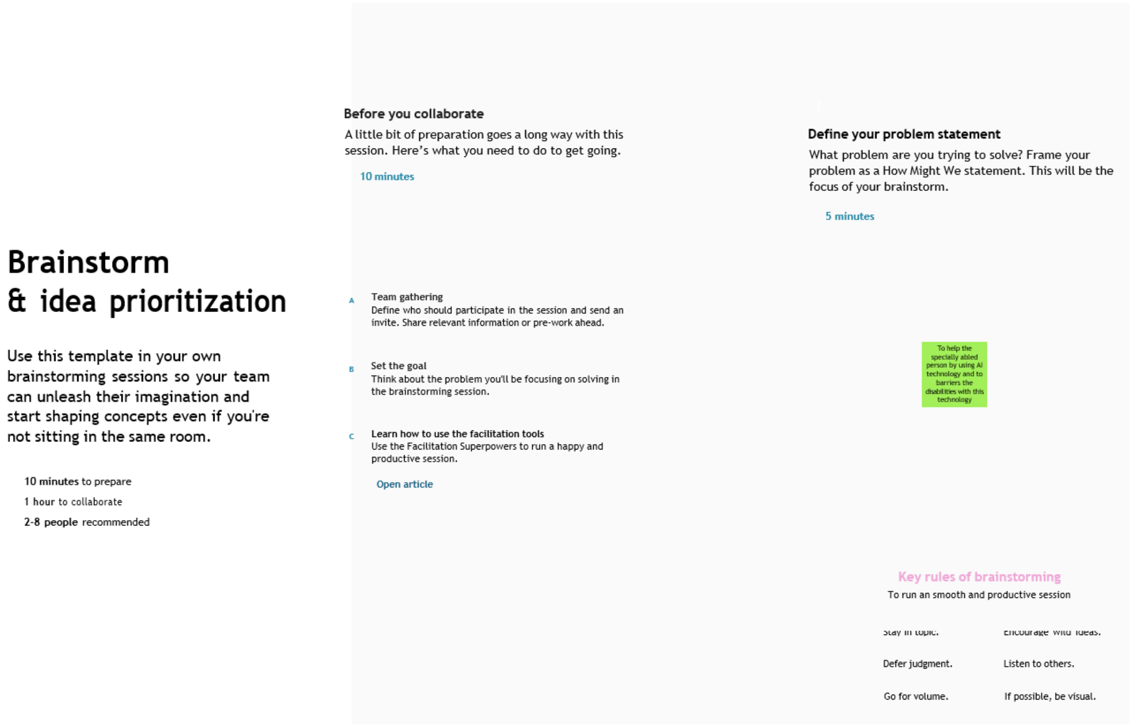
Shyness

5.2.IDEATION & BRAINSTORMING

Step-1: Team Gathering, Collaboration and Select the ProblemStatement

Step-2: Brainstorm, Idea Listing and Grouping

Step-3: Idea Prioritization



Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A Team gathering
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B Set the goal
Think about the problem you'll be focusing on solving in the brainstorming session.

C Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.

Open article

Define your problem statement

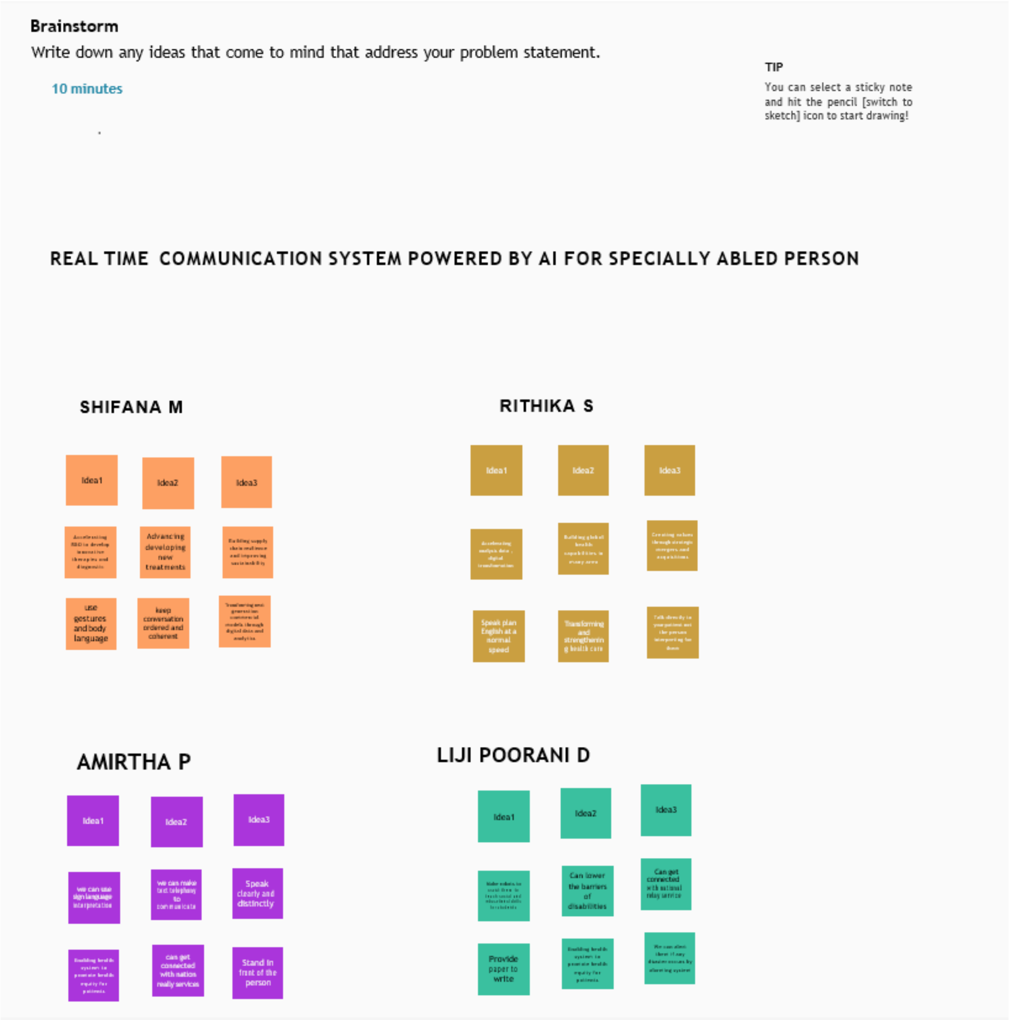
What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

To help the specially abled person by using AI technology and to barriers the disabilities with this technology

Key rules of brainstorming
To run an smooth and productive session

Stay in topic.
Encourage wild ideas.
Defer judgment.
Listen to others.
Go for volume.
If possible, be visual.



Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

REAL TIME COMMUNICATION SYSTEM POWERED BY AI FOR SPECIALLY ABLED PERSON

SHIFANA M

Idea1

Idea2

Idea3

Accelerating R&D to develop innovative therapies and diagnostics

Advancing developing new treatments

Building supply chain resilience and improving sustainability

use gestures and body language

keep conversation ordered and coherent

Transforming next-generation commercial models through digital data and analytics.

RITHIKA S

Idea1

Idea2

Idea3

Accelerating analysis data , digital transformation

Building global health capabilities in every area

Creating values through strategic mergers and acquisitions

Speak plan English at a normal speed

Transforming and strengthening health care

Talk directly to your patient not the person interpreting for them

AMIRTHA P

Idea1

Idea2

Idea3

we can use sign language interpretation

we can make text telephony to communicate

Speak clearly and distinctly

Enabling health system to promote health equity for patients.

can get connected with nation really services

Stand in front of the person

LIJI POORANI D

Idea1

Idea2

Idea3

Make robots to assist them to teach social and educational skills for students

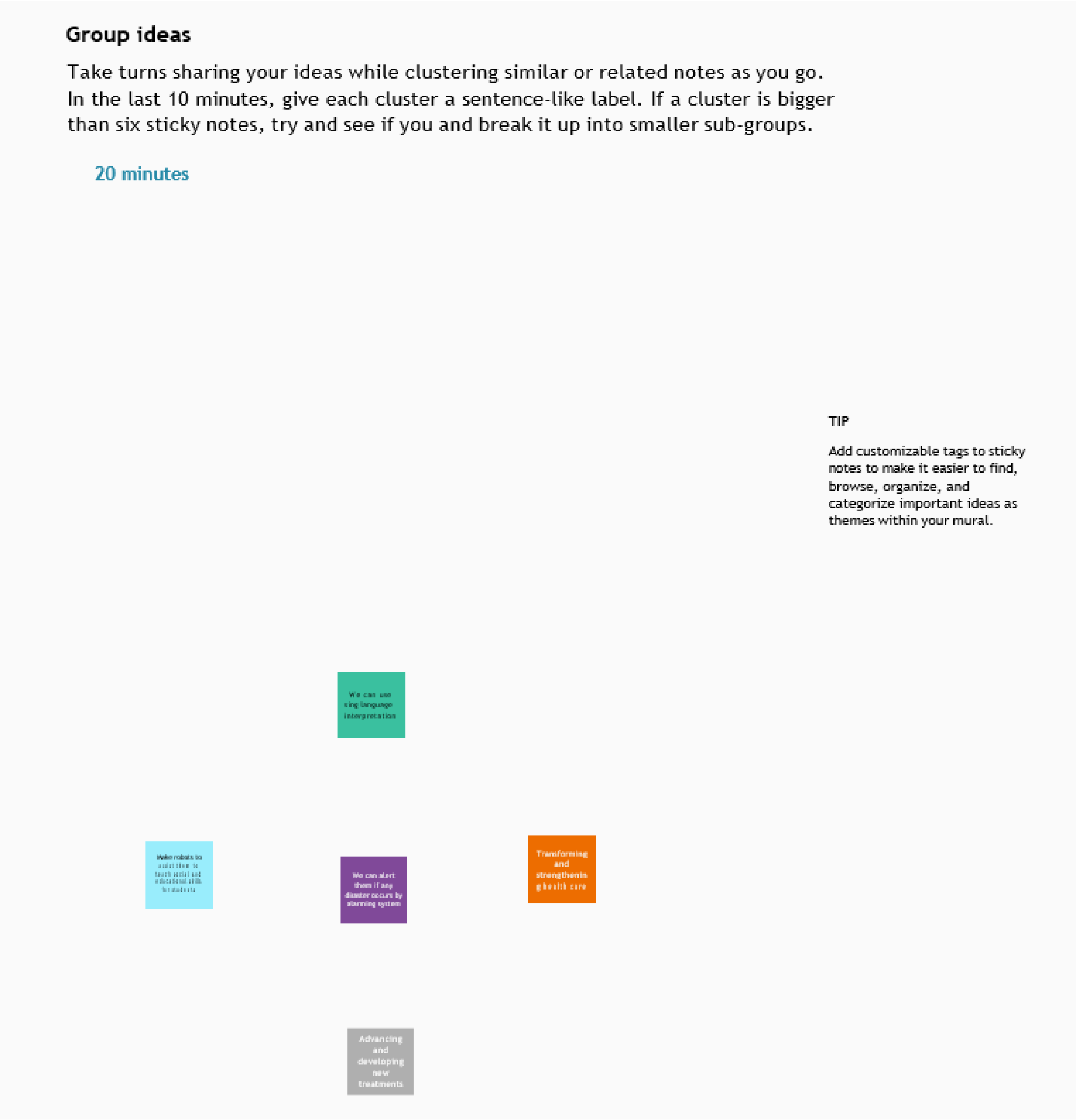
Can lower the barriers of disabilities

Can get connected with national relay service

Provide paper to write

Enabling health system to promote health equity for patients.

We can alert them if any disaster occurs by alarming system



Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. In the last 10 minutes, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

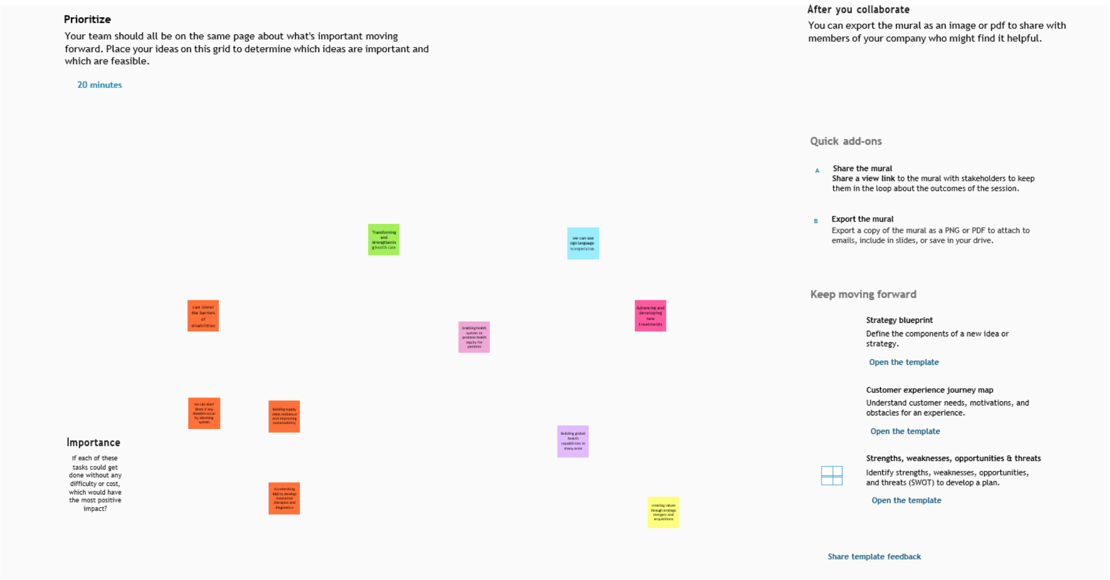
We can use sing language interpretation

Make robots to assist them to teach social and educational skills for students

We can alert them if any disaster occurs by alarming system

Transforming and strengthening health care

Advancing and developing new treatments



Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

Importance

If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

A Share the mural
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

B Export the mural
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.
Open the template

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template

Share template feedback

Transforming and strengthenin g health care
we can use sign language interpretation
can lower the barriers of disabilities
Enabling health system to promote health equity for patients
Advancing and developing new treatments
we can alert them if any disasters occur by alarming system
Building supply chain resilience and improving sustainability
Building global health capabilities in many area
Accelerating R&D to develop innovative therapies and diagnostics
creating values through strategic mergers and acquisitions

5.3 PROPOSED SOLUTION

The motive of our application is to make deaf-dumb people communicate easily with the people by the help of real-time system.

S.No	Parameter	Description
1	Statement(problem to be solved)	To solve the issues of deaf-dumb people to communicate withthe people to make them feel confident
2	Idea / Solution description	Converting sign language into voice and text in the desired language (two-way communication) using Convolutional Neural Network technology
3	Novelty / Uniqueness	Upgrading our solution by implementing an alert systemusing Big Panda algorithm for improvement
4	Impact / Customer Satisfaction	To reduce the risk of losing their lives. It increases the scope for career development. It will smash all the barriers and will help to enhance theirskills in a positive manner
5	Model (financialBenefit)	We will collaborate with multi deaf-dumb organizations tooutspread the application.

		Here we give most of the basic features at free cost but theyhave to pay if they need more advanced features
6	Scalability of Solution	It has very less complexity for the user Encoding the errors and decoding with better accuracy

5.4 PROBLEM FIT SOLUTION

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what would work and why.

Purpose:

- Solve complex problems in a way that fits the state of your customers.
- Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behavior.
- Sharpen your communication and marketing strategy with the right triggers and messaging.
- Increase touch-points with your company by finding the right problem-behavior fit and building trust by solving frequent annoyances, or urgent or costly problems.
- Understand the existing situation in order to improve it for your target group.

1.CUSTOMER SEGMENTS	**5.AVAILABLE SOLUTIONS**	**7.BEHAVIOUR**
Communication creates bonding and relations among the people, whether persona, social, or political views. Most people communicate	The process of this application can be daunting, but the value is priceless. Being able to create something to serve people in	The training phase was based on storing the images in the database. The database contained images of hands, both men and women. The

efficiently without any issues, but many cannot due to disability. They cannot hear or speak, which makes Earth a problematic place to live for them. Even simple basic tasks become difficult for them. This system provides detailed hand gestures that show the interpretation at the bottom so that everyone can understand them. This research allows the readers to learn the system and what it can do to people who are struggling with what they are not capable of and will provide the technical terms on how the system works.	need is uncountable. The focus of this research is to answer questions related to sign recognition. Artificial intelligence to make the right decisions. These trees will be based on images in the database to define our system in a more efficient and effective method to reach the optimal decision. Several questions considered as research questions, which are: What will happen when the application recognizes the image? How the image recognized by the application?	training was based on identifying all possible signs that can be made using one hand. For this purpose, 30 different images with different levels of lights and duration were captured and stored in the database. These images were used as training images that will help in making the right decision for the tasks. The database contained over 1000 images of unique hands and signs.
<u>2.JOBS-TO-DONE/PROBLEMS</u> They cannot hear or speak, which makes Earth a problematic place to live for them. Even simple basic tasks become difficult for them. Disability is an emotive human condition. It limits the individual to a	**<u>6.CUSTOMER CONSTRIANT</u>** This section provides a theoretical background for D-talk to have a better understanding of the process to be used in the application [13,30, 32]. This application can provide a helpful tool for communication between	**<u>9.PROBLEM ROOT CAUSE</u>** In a nutshell, the development of technology is essential, and its deployment in sign language is highly critical. It will serve to bring efficiency in communication, not only

certain level of performance. Being deaf and dumb pushes the subject to oblivion, highly introverted. In a world of inequality, this society needs empowerment. Harnessing technology to improve their welfare is necessary. In a tech era, no one should be limited due to his or her inability. The application of technology should create a platform or a world of equality despite the natural state of humans.	the deaf and the external world. The studies are focused on various input sensors, gesture segmentation, feature extraction, and classification methods. This paper is aimed at evaluating and comparing the methods used in the sign recognition systems, classification methods used and identifies the most promising approach for this project. This paper focuses on the classification methods used in the prior recognition scheme for sign Recognition. Based on our research, HMM-based methods, including its modifications, have been thoroughly discussed in prior studies.	to the deaf and dumb but those with the ability to hear and speak as well. In addition to creating opportunities for their career growth, it will enhance their social life through effective communication. Making an impact and changing the lives of the deaf and dump through technology will be an innovation of the year worth the time and resources. At the beginning of the D-Talk idea, the developers think to have more than one task for this application, but in the end, they narrow the task to have only one. They thought to have an open calendar, lunch Microsoft office word, and browse the website.

3.TRIGGERS	**8.CHANNELS BEHAVIOUR**	**10.YOUR SOLUTION**
This application can provide a helpful tool for communication between the deaf and the external world. The sign language recognition program, which is required to understand sign languages, has been studied extensively for years [25,27]. The studies are focused on various input sensors, gesture segmentation, feature extraction, and classification methods. This paper is aimed at evaluating and comparing the methods used in the sign recognition systems, classification methods used and identifies the most promising approach for this project. Despite recent advances in classification methods, many of the recent works proposed to apply primarily to classification methods, such as deep	We explored one way to identify simple hand gestures and implement two basic gesture controls: movement of the cursor and mouse click. The figure 6 describes the basic process of hand gesture recognition. By using vision-based recognition, the computer captures the sign to find the gesture acquisition. Hand tracking can be done by using clustering algorithms that able to treat each finger as a cluster and delete the empty spaces between them or multi-scale color feature hierarchies that provide users' hand and the different background shades of colors to identify and remove the background. Hand tracking is the computer's ability to track the user's hand and split it from the background or any other objects Feature extraction depends on the	In the implementation phase, developers change several tasks that they were planned to do. They notice that they can build the system without preparing any training and testing images as they were plan. The code is depending on skin color and contour to find the right sign. Moreover, developers narrow the tasks to only one task which is browse websites only. Moreover, the result was precise and accurate aligned with the methodology and testing that was used. This signifies that developing modern technology assists disable individuals specifically deaf-dumb on interacting among people. The measurement variables along with the supporting. evidence

learning [23, 34, 40, 42]. This paper focuses on the classification methods used in the prior recognition scheme for sign Recognition. Based our research, HMM-based methods, including its modifications, have been thoroughly discussed in prior studies.	application. On D-talk, finger status, skin color, alignments of the finger, and the palm position are taken into consideration. After features extracted, they sent to training and testing classification algorithms to reach the output.	from the methodology concluded that the measures taken to evaluate this study were supported all throughout. Meanwhile, the efficiency and effectiveness of the system provide the utmost benefit of disabled individuals by offering convenience and being able to make their lives easier and better for there are no required training or specificities for them to use the system. Thus, as a result, D-talk allows everyone to determine the hand gestures that are being projected and be able to come up with interpretations on enabled individuals. Hence, communications between deaf-dumb and enabled individuals are way easier and lacks misunderstandings are

		being prevented this time.
4.EMOTIONS Most people communicate efficiently without any issues, but many cannot due to disability. They cannot hear or speak, which makes Earth a problematic place to live for them. Even simple basic tasks become difficult for them. Disability is an emotive human condition. It limits the individual to a certain level of performance. Being deaf and dumb pushes the subject to oblivion, highly introverted. A detection algorithm is used to detect the hand of the user, and a contour-based hand tracker is developed, which combines condensation and partitioned sampling. The proposed approach can attain automated online identification of hand movements and can		

effectively reject atypical movements. The hand gesture recognition system consists of three major parts: palm detection, hand tracking, and trajectory recognition.		

6.REQUIREMENT ANALYSIS

6.1.FUNCTIONAL REQUIREMENT

FR No.	**Functional Requirement (Epic)**	**Sub Requirement (Story/ Sub-Task)**
FR-1	User Registration	Registration throughForm Registration throughGmail Registration throughLinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Uploading image	Upload image through camera Upload image through gallery
FR-4	Text to speech	Select speech icon to convert the respective text for sign language
FR-5	Whiteboard	Use whiteboard to sharethe message by drawing
FR-6	Emergency templates	Select emergency templates icon to pass the message quickly

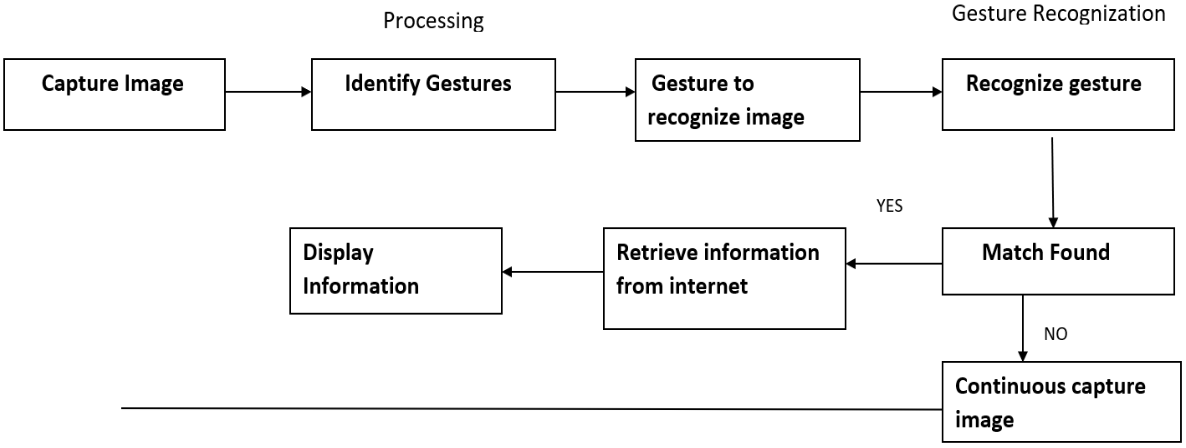
6.2.NON-FUNCTIONAL REQUIREMENT

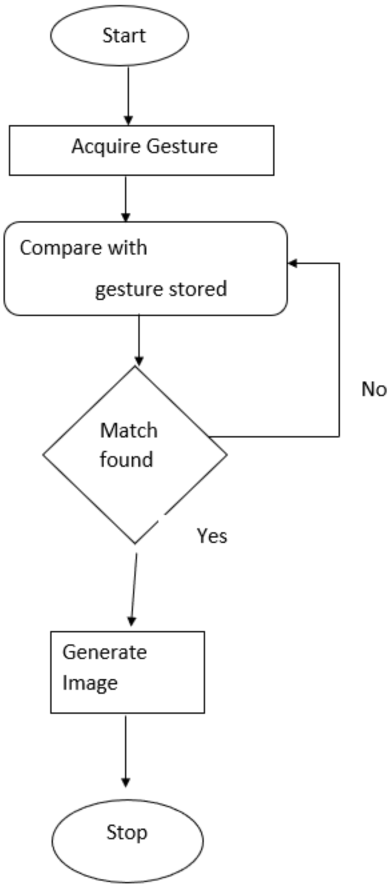
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Client can undoubtedly upload the image and this application is planned in a manner here, client can without much of a stretch discover some predefined layouts
NFR-2	Security	Client should sign in into an app only then proceed for further process.So unapproved accesswill be kept away from at max.
NFR-3	Reliability	This application has robust adaptation to noncritical failure and regardless of whether an error happens likewise it recuperates rapidly
NFR-4	Performance	This application will rapidly transfer and process the images since it predicts the gestures through signing utilizing CNN model and it gives high accuracy.
NFR-5	Availability	The predefined formats will be accessible to all clients and furthermore have whiteboard choice.This application is planned such that it is straightforward and accessible to all clients.
NFR-6	Scalability	Engineers can add new formats and it will build adaptability and this application has premium elements where client approach google maps and google duo.

7.PROJECT DESIGN

7.1.DATA FLOW DIAGRAMS

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.





User Stories

User Type	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Task**	**Acceptance criteria**	**Priority**	**Release**
Customer (Disabled People)	Web Camera	USN-1	As a user, I am focussed on various hand gestures for sign recognization	Hand gestures for sign recognization	High	Sprint-1
		USN-2	As a user, the image of the gesture gets stored	It can describe the key points from that image and it gets resized	High	Sprint-1
		USN-3	The various kinds of methods and techniques of picture demonstration with the respective algorithm	Coded with the appropriate interpretations and sent to testing phase	Low	Sprint-2
		USN-4	Use for selecting the right image for the task.	Connects the image in black and white with the brightness,vibrancy and colour.	Medium	Sprint-1
		USN-5	The gesture recognized are tested with interpretations of each individual hand gestures.	All the user need to implement this by using wifi or internet connection only	High	Sprint-1

8.SPRINT PLANNING& ESTIMATION

8.1.SPRINT PLANNING

Sprint-1	Functional Requirement (Epic)	User Story Number	User Story/ Task	Story Points	Priority	Team Members
Sprint-1	Data Collection	USN-1	Collect Dataset .	9	High	SHIFANA M
Sprint-1		USN-2	Image preprocessing	8	Medium	RITHIKA S LIJI D
Sprint-2	Model Building	USN-3	Import the required libraries, add the necessary layers and compile the model	10	High	RITHIKA S LIJI D SHIFANA M AMIRTHA P
Sprint-2		USN-4	Training the image classification modelusing CNN	7	Medium	LIJI D
Sprint-3		USN-5	Training the model and testing the model’s performance	9	High	LIJI D SHIFANA M
Sprint-4		USN-6	Converting the input sign language images into English alphabets	8	Medium	RITHIKA S

8.2.SPRINT DELIVERY SCHEDULE

Project Tracker, Velocity & Burndown Chart:

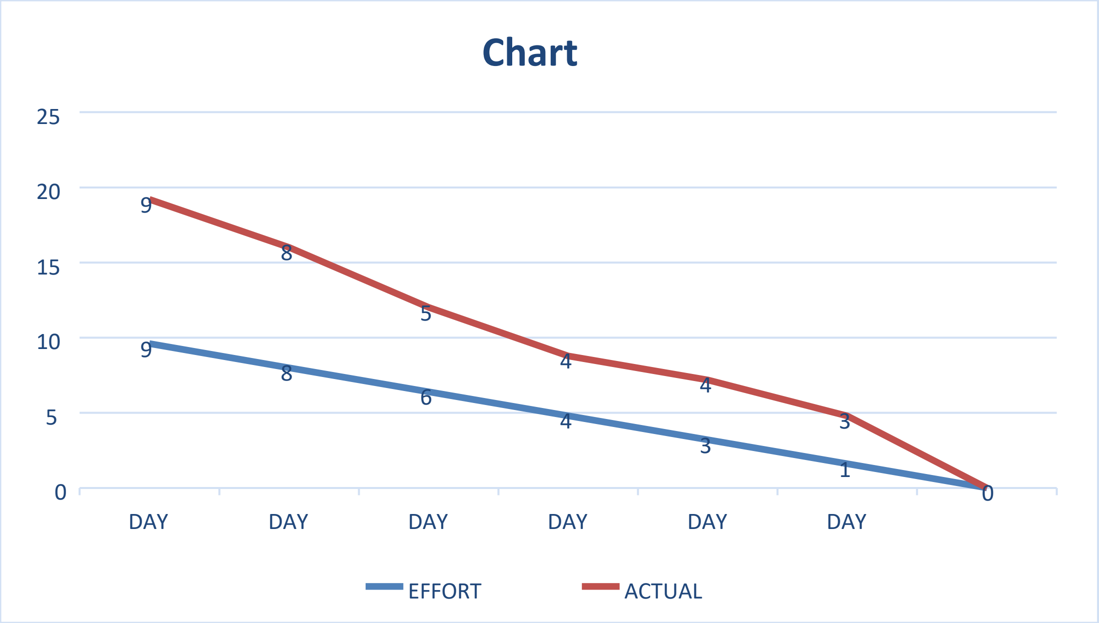
Sprint	**Total Story Points**	**Duration**	**Sprint Start Date**	**Sprint End Date (Planned)**	**Story Points Completed (as on Planned End Date)**	**Sprint Release Date (Actual)**
Sprint-1	10	6 Days	24 Oct 2022	29 Oct 2022	8	29 Oct 2022
Sprint-2	10	6 Days	31 Oct 2022	04 Nov 2022	5	04 Nov 2022
Sprint-3	10	6 Days	07 Nov 2022	11 Nov 2022	7	11 Nov 2022
Sprint-4	10	6 Days	14 Nov 2022	18 Nov 2022	5	18 Nov 2022

Velocity:

$$AV = \frac{sprint\ duration}{velocity}$$

AV= 6/10 = 0.6

Burndown chart:

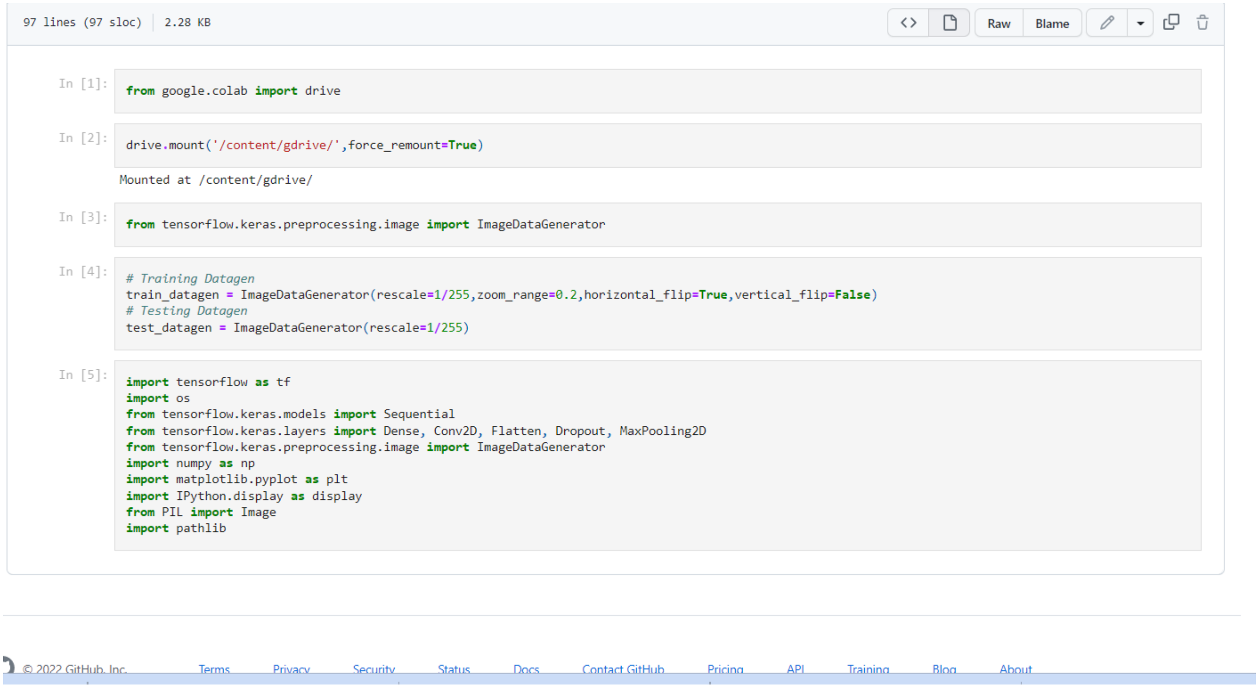


9.CODING & SOLUTIONING

9.1IMAGE PREPROCESSING

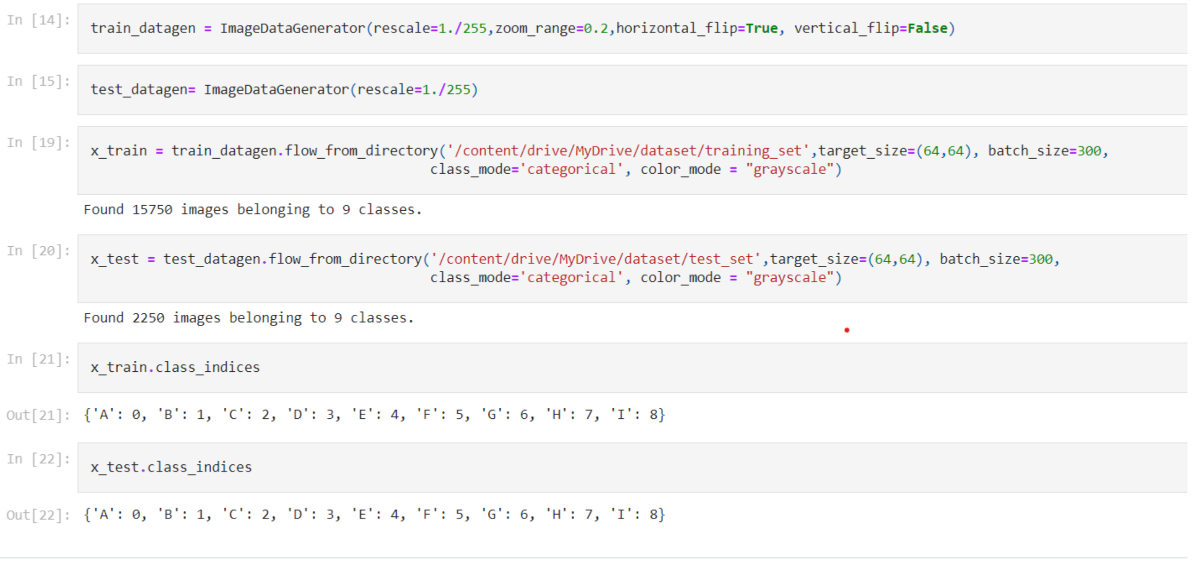
● Image pre-processing includes zooming, shearing, flipping to increase the robustness of the model after itis built. Keras package is used for pre-processing images.

● Importing ImageDataGenerator Library to create an instance for which include shearing, rescale,zooming,etc to make the model robust with different types of images.



```
In [1]: from google.colab import drive

In [2]: drive.mount('/content/gdrive/',force_remount=True)

        Mounted at /content/gdrive/

In [3]: from tensorflow.keras.preprocessing.image import ImageDataGenerator

In [4]: # Training Datagen
        train_datagen = ImageDataGenerator(rescale=1/255,zoom_range=0.2,horizontal_flip=True,vertical_flip=False)
        # Testing Datagen
        test_datagen = ImageDataGenerator(rescale=1/255)

In [5]: import tensorflow as tf
        import os
        from tensorflow.keras.models import Sequential
        from tensorflow.keras.layers import Dense, Conv2D, Flatten, Dropout, MaxPooling2D
        from tensorflow.keras.preprocessing.image import ImageDataGenerator
        import numpy as np
        import matplotlib.pyplot as plt
        import IPython.display as display
        from PIL import Image
        import pathlib
```

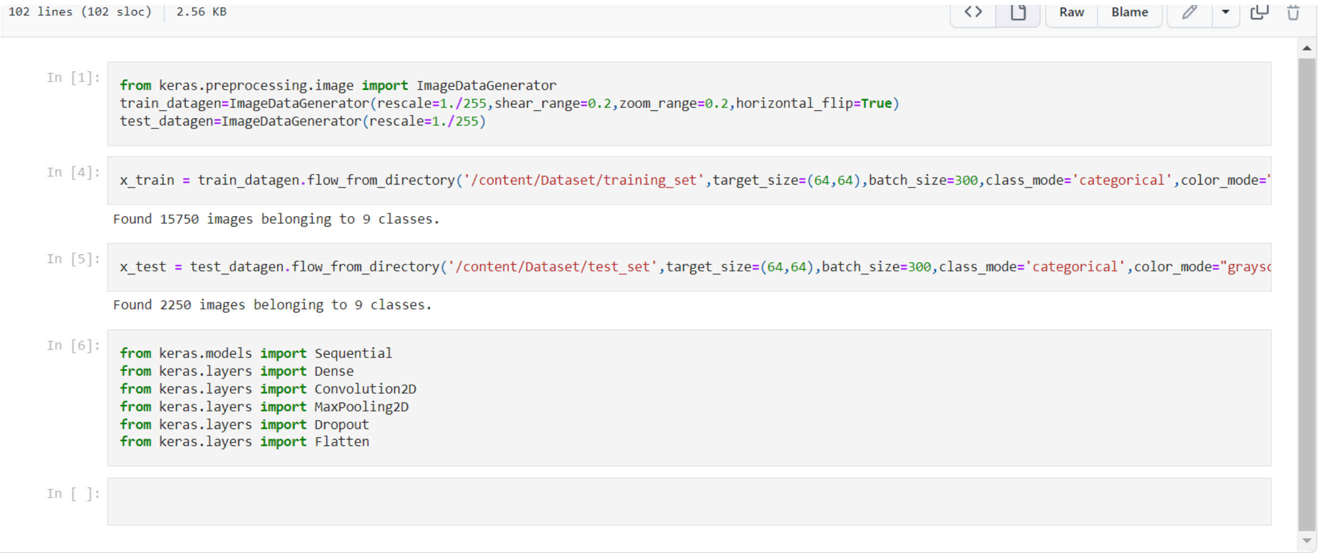
- Applying ImageDataGenerator Functionality To Train And Test Set



```
In [14]: train_datagen = ImageDataGenerator(rescale=1./255,zoom_range=0.2,horizontal_flip=True, vertical_flip=False)

In [15]: test_datagen= ImageDataGenerator(rescale=1./255)

In [19]: x_train = train_datagen.flow_from_directory('/content/drive/MyDrive/dataset/training_set',target_size=(64,64), batch_size=300,
                                                     class_mode='categorical', color_mode = "grayscale")

         Found 15750 images belonging to 9 classes.

In [20]: x_test = test_datagen.flow_from_directory('/content/drive/MyDrive/dataset/test_set',target_size=(64,64), batch_size=300,
                                                     class_mode='categorical', color_mode = "grayscale")

         Found 2250 images belonging to 9 classes.

In [21]: x_train.class_indices

Out[21]: {'A': 0, 'B': 1, 'C': 2, 'D': 3, 'E': 4, 'F': 5, 'G': 6, 'H': 7, 'I': 8}

In [22]: x_test.class_indices

Out[22]: {'A': 0, 'B': 1, 'C': 2, 'D': 3, 'E': 4, 'F': 5, 'G': 6, 'H': 7, 'I': 8}
```

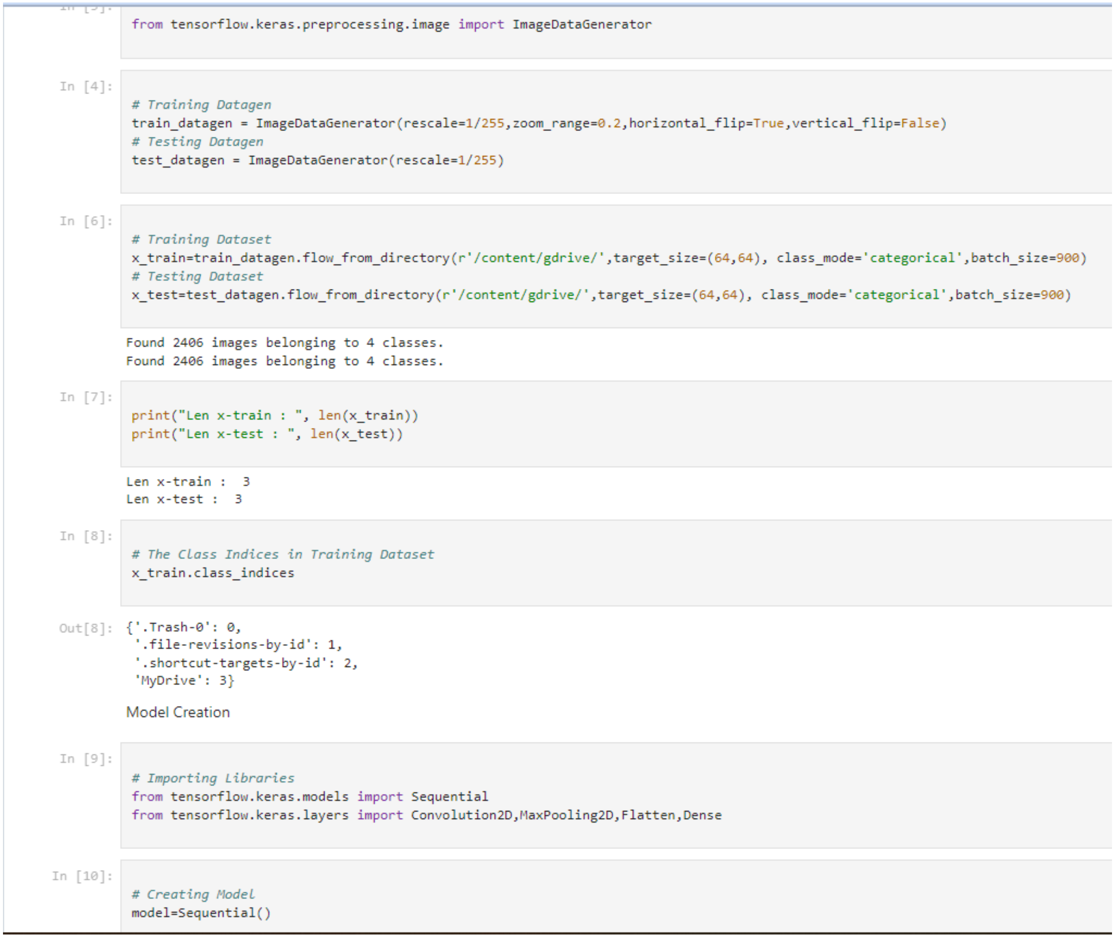
9.2.MODEL BUILDING

- Importing The Required Model Building Libraries



```
In [1]: from keras.preprocessing.image import ImageDataGenerator
        train_datagen=ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2,horizontal_flip=True)
        test_datagen=ImageDataGenerator(rescale=1./255)

In [4]: x_train = train_datagen.flow_from_directory('/content/Dataset/training_set',target_size=(64,64),batch_size=300,class_mode='categorical',color_mode='

        Found 15750 images belonging to 9 classes.

In [5]: x_test = test_datagen.flow_from_directory('/content/Dataset/test_set',target_size=(64,64),batch_size=300,class_mode='categorical',color_mode="grays

        Found 2250 images belonging to 9 classes.

In [6]: from keras.models import Sequential
        from keras.layers import Dense
        from keras.layers import Convolution2D
        from keras.layers import MaxPooling2D
        from keras.layers import Dropout
        from keras.layers import Flatten

In [ ]:
```

- Initializing The Model



```
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

```
In [4]:
# Training Datagen
train_datagen = ImageDataGenerator(rescale=1/255,zoom_range=0.2,horizontal_flip=True,vertical_flip=False)
# Testing Datagen
test_datagen = ImageDataGenerator(rescale=1/255)
```

```
In [6]:
# Training Dataset
x_train=train_datagen.flow_from_directory(r'/content/gdrive/',target_size=(64,64), class_mode='categorical',batch_size=900)
# Testing Dataset
x_test=test_datagen.flow_from_directory(r'/content/gdrive/',target_size=(64,64), class_mode='categorical',batch_size=900)

Found 2406 images belonging to 4 classes.
Found 2406 images belonging to 4 classes.
```

```
In [7]:
print("Len x-train : ", len(x_train))
print("Len x-test : ", len(x_test))

Len x-train :  3
Len x-test :  3
```

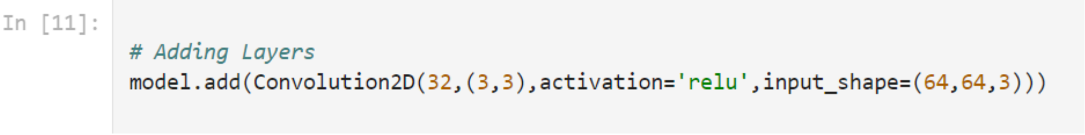
```
In [8]:
# The Class Indices in Training Dataset
x_train.class_indices

Out[8]: {'.Trash-0': 0,
         '.file-revisions-by-id': 1,
         '.shortcut-targets-by-id': 2,
         'MyDrive': 3}
```

Model Creation

```
In [9]:
# Importing Libraries
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Convolution2D,MaxPooling2D,Flatten,Dense
```

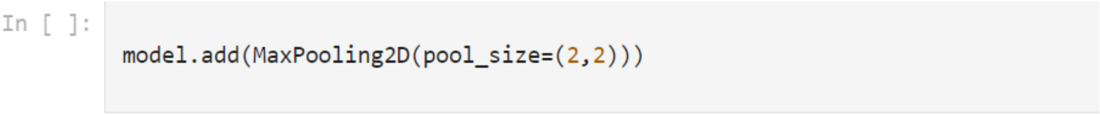
```
In [10]:
# Creating Model
model=Sequential()
```

- Adding The Convolution Layer



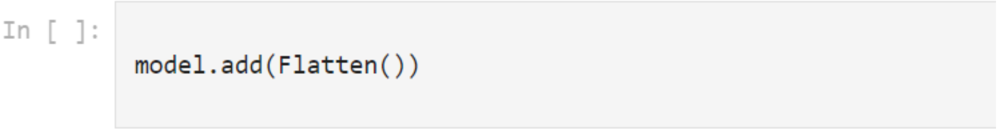
```
In [11]:
# Adding Layers
model.add(Convolution2D(32,(3,3),activation='relu',input_shape=(64,64,3)))
```

- Adding The Pooling Layer



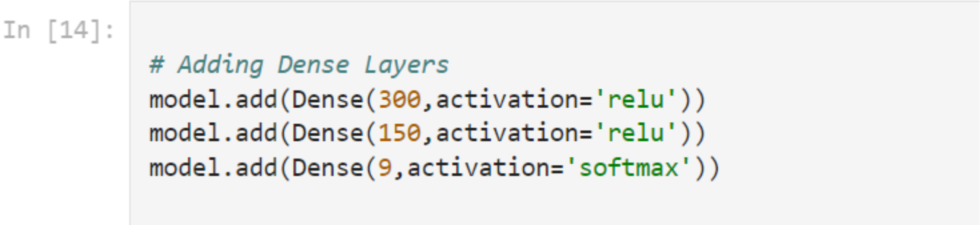
```
In [ ]:
model.add(MaxPooling2D(pool_size=(2,2)))
```

- Adding The Flatten Layer



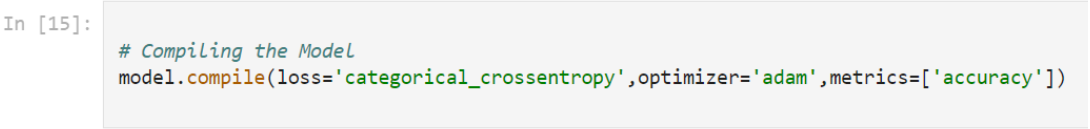
```
In [ ]:
model.add(Flatten())
```

- Add the dense layer



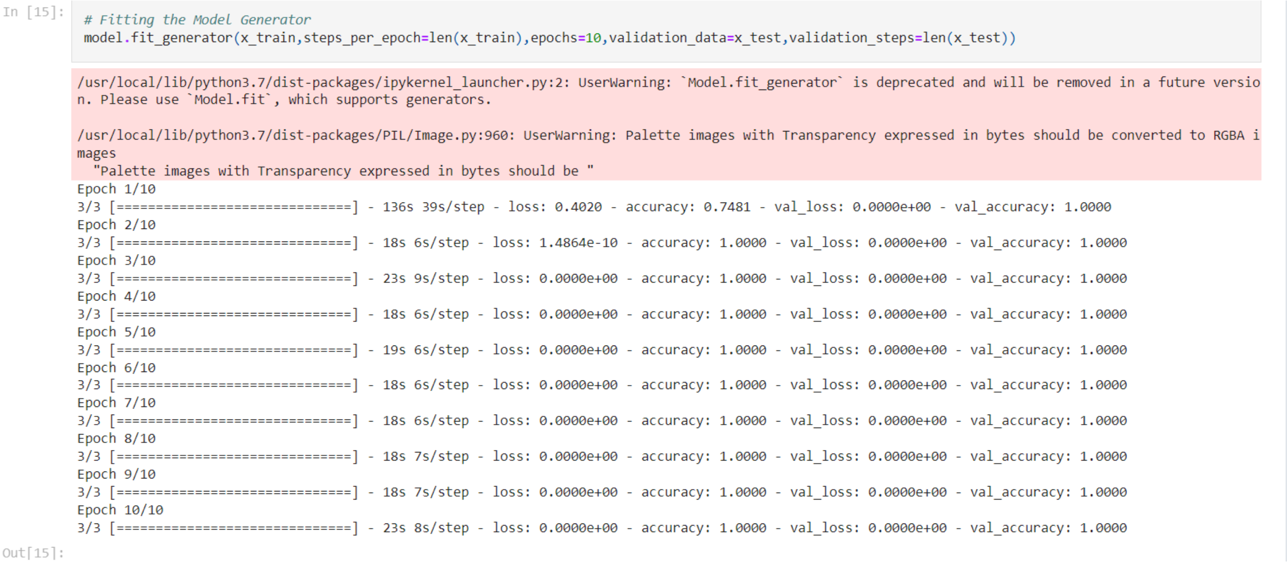
```
In [14]:
# Adding Dense Layers
model.add(Dense(300,activation='relu'))
model.add(Dense(150,activation='relu'))
model.add(Dense(9,activation='softmax'))
```

- Compiling The Model



```
In [15]:
# Compiling the Model
model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
```

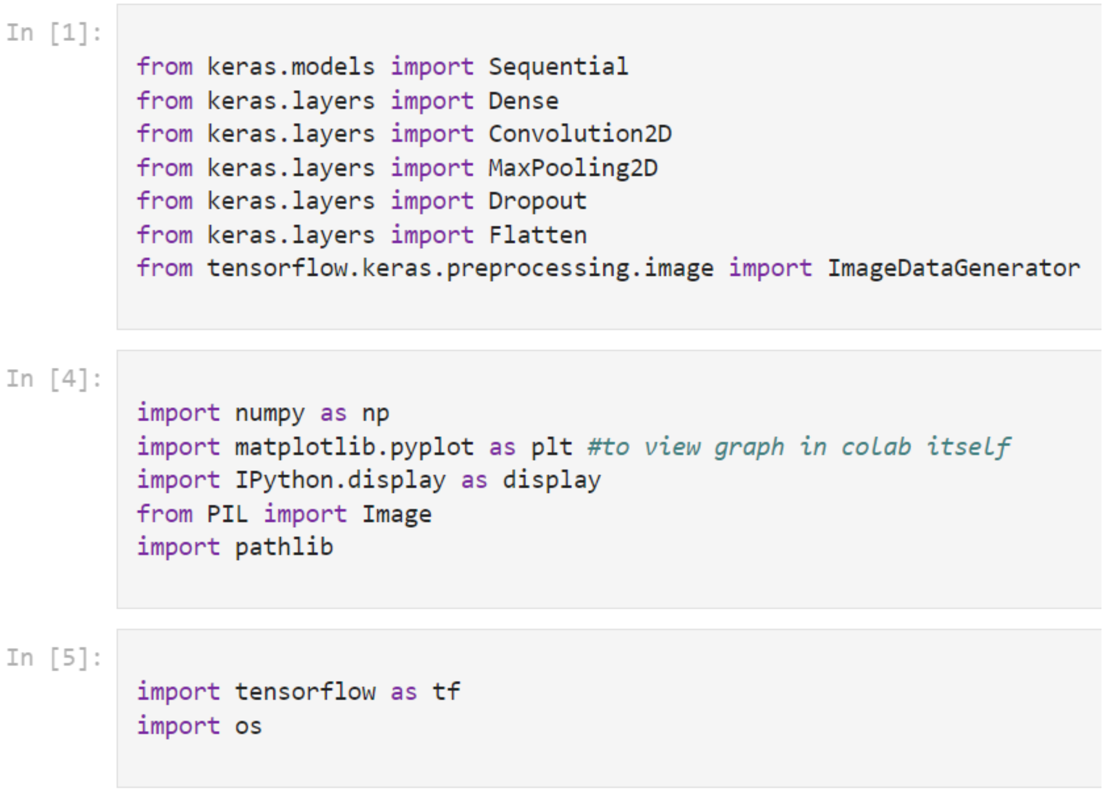
- Fit And Saving the Model



```
In [15]:
# Fitting the Model Generator
model.fit_generator(x_train,steps_per_epoch=len(x_train),epochs=10,validation_data=x_test,validation_steps=len(x_test))

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:2: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future versio
n. Please use `Model.fit`, which supports generators.

/usr/local/lib/python3.7/dist-packages/PIL/Image.py:960: UserWarning: Palette images with Transparency expressed in bytes should be converted to RGBA i
mages
  "Palette images with Transparency expressed in bytes should be "
Epoch 1/10
3/3 [==============================] - 136s 39s/step - loss: 0.4020 - accuracy: 0.7481 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 2/10
3/3 [==============================] - 18s 6s/step - loss: 1.4864e-10 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 3/10
3/3 [==============================] - 23s 9s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 4/10
3/3 [==============================] - 18s 6s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 5/10
3/3 [==============================] - 19s 6s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 6/10
3/3 [==============================] - 18s 6s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 7/10
3/3 [==============================] - 18s 6s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 8/10
3/3 [==============================] - 18s 7s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 9/10
3/3 [==============================] - 18s 7s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Epoch 10/10
3/3 [==============================] - 23s 8s/step - loss: 0.0000e+00 - accuracy: 1.0000 - val_loss: 0.0000e+00 - val_accuracy: 1.0000
Out[15]:
```

9.3.TESTING THE MODEL

- Importing The Packages and Loading the Saved Model

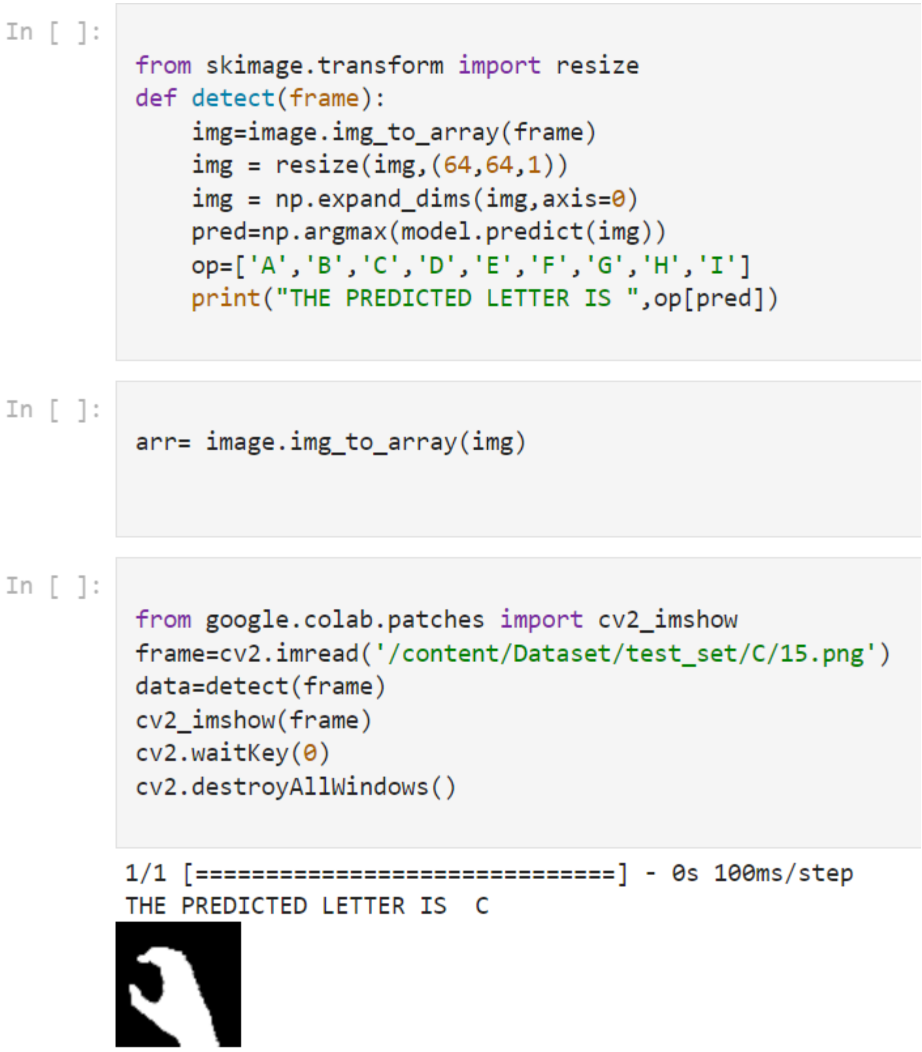


```
In [1]:
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Convolution2D
from keras.layers import MaxPooling2D
from keras.layers import Dropout
from keras.layers import Flatten
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

```
In [4]:
import numpy as np
import matplotlib.pyplot as plt #to view graph in colab itself
import IPython.display as display
from PIL import Image
import pathlib
```

```
In [5]:
import tensorflow as tf
import os
```

- Loading the Test Image, Pre-Processing it And Prediction



```
In [ ]:
from skimage.transform import resize
def detect(frame):
    img=image.img_to_array(frame)
    img = resize(img,(64,64,1))
    img = np.expand_dims(img,axis=0)
    pred=np.argmax(model.predict(img))
    op=['A','B','C','D','E','F','G','H','I']
    print("THE PREDICTED LETTER IS ",op[pred])
```

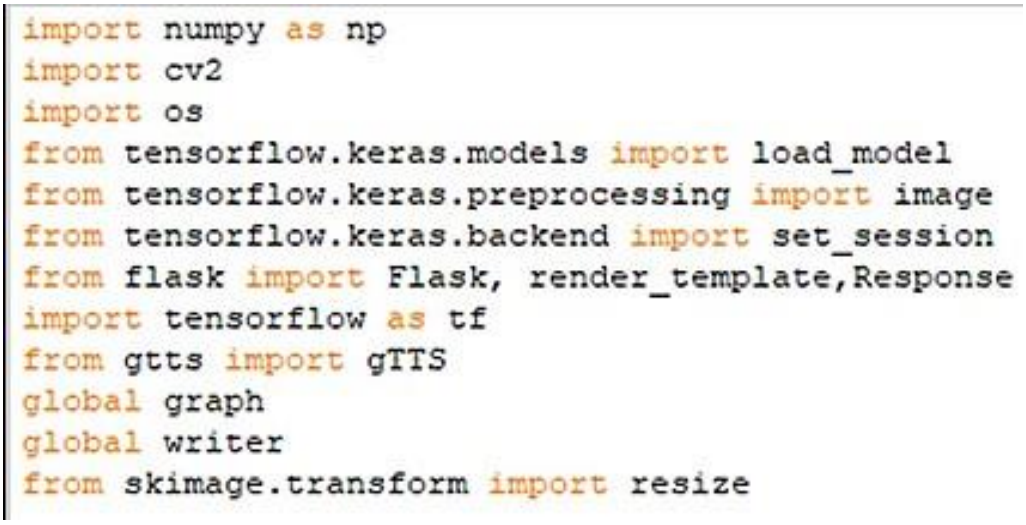
```
In [ ]:
arr= image.img_to_array(img)
```

```
In [ ]:
from google.colab.patches import cv2_imshow
frame=cv2.imread('/content/Dataset/test_set/C/15.png')
data=detect(frame)
cv2_imshow(frame)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

```
1/1 [==============================] - 0s 100ms/step
THE PREDICTED LETTER IS  C
```

9.4.FLASK APPLICATION

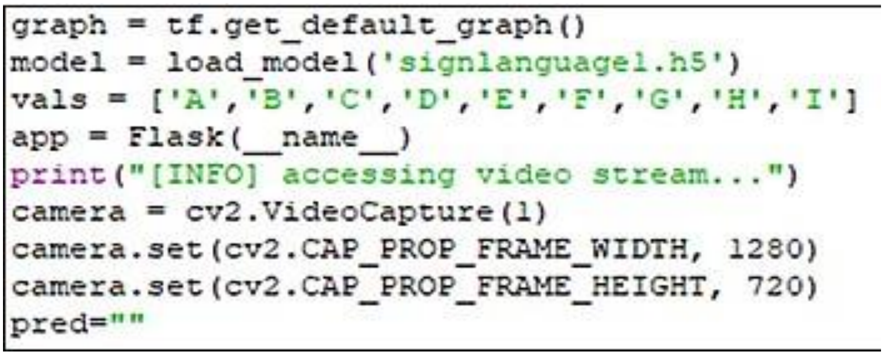
- Loading the required package



```
import numpy as np
import cv2
import os
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.backend import set_session
from flask import Flask, render_template,Response
import tensorflow as tf
from gtts import gTTS
global graph
global writer
from skimage.transform import resize
```

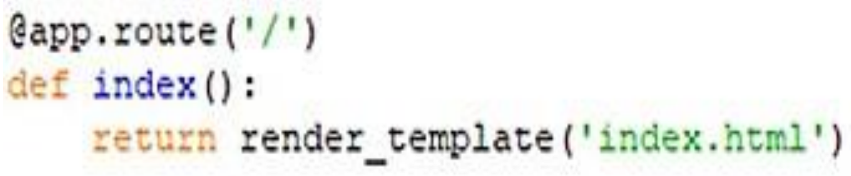
- Initializing graph, loading the model, initializing the flask app and loading the video.

- Graph element is required to work with TensorFlow. So, graph element is created explicitly.



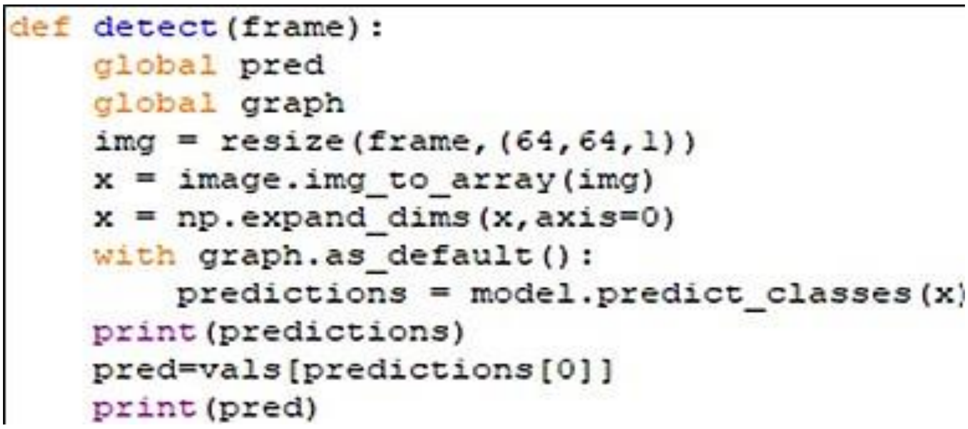
```
graph = tf.get_default_graph()
model = load_model('signlanguage1.h5')
vals = ['A','B','C','D','E','F','G','H','I']
app = Flask(__name__)
print("[INFO] accessing video stream...")
camera = cv2.VideoCapture(1)
camera.set(cv2.CAP_PROP_FRAME_WIDTH, 1280)
camera.set(cv2.CAP_PROP_FRAME_HEIGHT, 720)
pred=""
```

- Configuring the home page



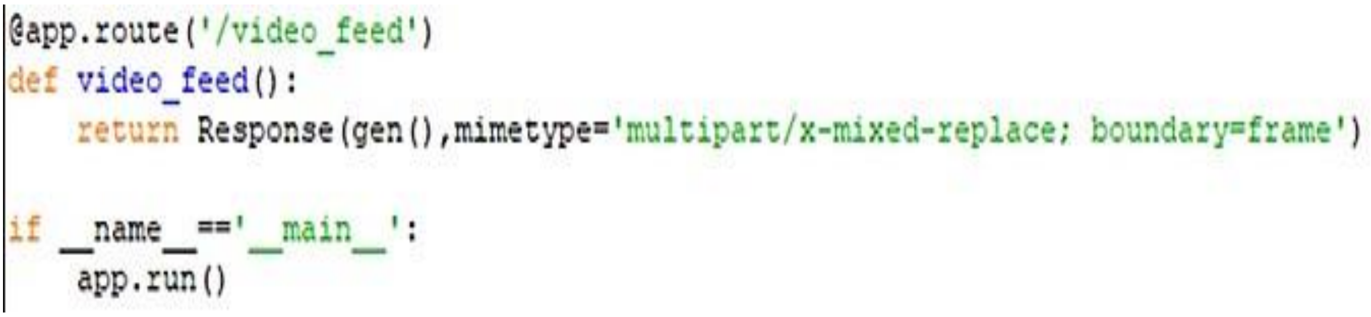
```
@app.route('/')
def index():
    return render_template('index.html')
```

- Pre-processingthe frames capturedfrom the camera



```
def detect(frame):
    global pred
    global graph
    img = resize(frame,(64,64,1))
    x = image.img_to_array(img)
    x = np.expand_dims(x,axis=0)
    with graph.as_default():
        predictions = model.predict_classes(x)
    print(predictions)
    pred=vals[predictions[0]]
    print(pred)
```

- Video Feed call from the HTML PAGE



```
@app.route('/video_feed')
def video_feed():
    return Response(gen(),mimetype='multipart/x-mixed-replace; boundary=frame')

if __name__=='__main__':
    app.run()
```

9.5.HTML PAGE

● HTML page to display the processedvideo on the screen, so that the person can show signs which can be detected

<!doctype html>

<html lang="en">

<head>

<meta charset="utf-8">

<meta name="viewport" content="width=device-width, initial-scale=1.0, shrink-to-fit=no">

<title>VHearuU</title>

```
    <link rel="stylesheet"
href="https://cdn.jsdelivr.net/npm/bootstrap@5.1.3/dist/css/bootstrap.min.css">
    <link rel="stylesheet" href="https://use.fontawesome.com/releases/v5.12.0/css/all.css">
    <link rel="stylesheet" href="static/css/Banner-Heading-Image.css">
    <link rel="stylesheet" href="static/css/Navbar-Centered-Brand.css">
    <link rel="stylesheet" href="static/css/styles.css">
</head>
<body>
<nav class="navbar navbar-light navbar-expand-md py-3" style="background: #429691;">
        <div class="container">
            <div></div><a class="navbar-brand d-flex align-items-center" href="#"><h4
style="color: #ffffff; font-style: oblique; text-align: center;font-family: Arial
Black"><strong> Real-Time Communication
                    System Powered By AI&nbsp;For Specially Abled - Team ID: IBM-Project-
PNT2022TMID43796</strong></h4></a>
            <div></div>
        </div>
    </nav>
    <section>
        <div class="d-flex flex-column justify-content-center align-items-center">
            <div class="d-flex flex-column justify-content-center align-items-center" id="div-
video-feed"
                style="width: 800px;height: 600px;margin: 10px;min-height: 480px;min-width:
640px;border-radius: 10px;border: 5px groove #000000 ;">
```

```
                <img src="{{ url_for('video_feed') }}" style="width: 100%;height: 100%;color: rgb(255,255,255);text-align: center;font-size: 20px;"
                    alt="Camera Access Not Provided!">
            </div>
        </div>
    </section>
<section>
        <div class="container">
            <div class="accordion text-white" role="tablist" id="accordion-1">

                <div class="accordion-item" style="font-style: oblique; background: #429691;">
                    <h2 class="accordion-header" role="tab"><button class="accordion-button collapsed"
                            data-bs-toggle="collapse" data-bs-target="#accordion-1 .item-2" aria-expanded="false"
                            aria-controls="accordion-1 .item-2"
                            style="font-style: oblique; background: #cc7931;color: #ffffff;">Project: Real-Time Communication System Powered by AI for Specially Abled</button></h2>
                    <div class="accordion-collapse collapse item-2" role="tabpanel" data-bs-parent="#accordion-1">
                        <div class="accordion-body">
                            <p class="mb-0">Team ID: IBM-Project-PNT2022TMID43796<br><br>VHearU Developed By,<br><br>1. <strong>SHIFANA M</strong> 9361616429<br>2.
                        <strong>RITHIKA S</strong> 9876543210<br>3. <strong>LIJI
POORANI D</strong> 9654382912<br>4. <strong></strong> 911719104024<br>5.
<strong> AMIRTHA P</strong> 9645398612

                    </p>

                </div>

            </div>

        </div>

    </div>

  </div>

 </section>

 <div class="modal fade" role="dialog" tabindex="-1" id="modal-1">

    <div class="modal-dialog" role="document">

        <div class="modal-content">

            <div class="modal-header">

                <h4 class="modal-title">American Sign Language - Alphabets</h4><button
type="button"

                    class="btn-close" data-bs-dismiss="modal" aria-label="Close"></button>

            </div>

            <div class="modal-body"><img src="{{ url_for('static',
filename='img/ASL_Alphabets.png') }}" width="100%"></div>

            <div class="modal-footer"><button class="btn btn-secondary" type="button"

                    data-bs-dismiss="modal">Close</button></div>

        </div>

    </div>
    </div>

    <script
src="https://cdn.jsdelivr.net/npm/bootstrap@5.1.3/dist/js/bootstrap.bundle.min.js"></script>

</body>

</html>
```

10.TESTING

10.1.TEST CASES

Test Case ID	**Test Scenario**	**Steps to Execute**	**Expected Result**	**Actual Result**
1	Verify if user is able to provide camera access.	1. Enter URL and click go. 2. Give Camera Access.	Camera is On.	Working as expected.
2	Verify if user is able to get the desirable prediction for the gesture.	1. Enter URL and click go. 2. Give Camera Access. 3. Make Gesture in front of camera.	Alphabet is predicted for the gesture.	Working as expected.

10.2.USER ACCEPTANCE TESTING

Defect Analysis

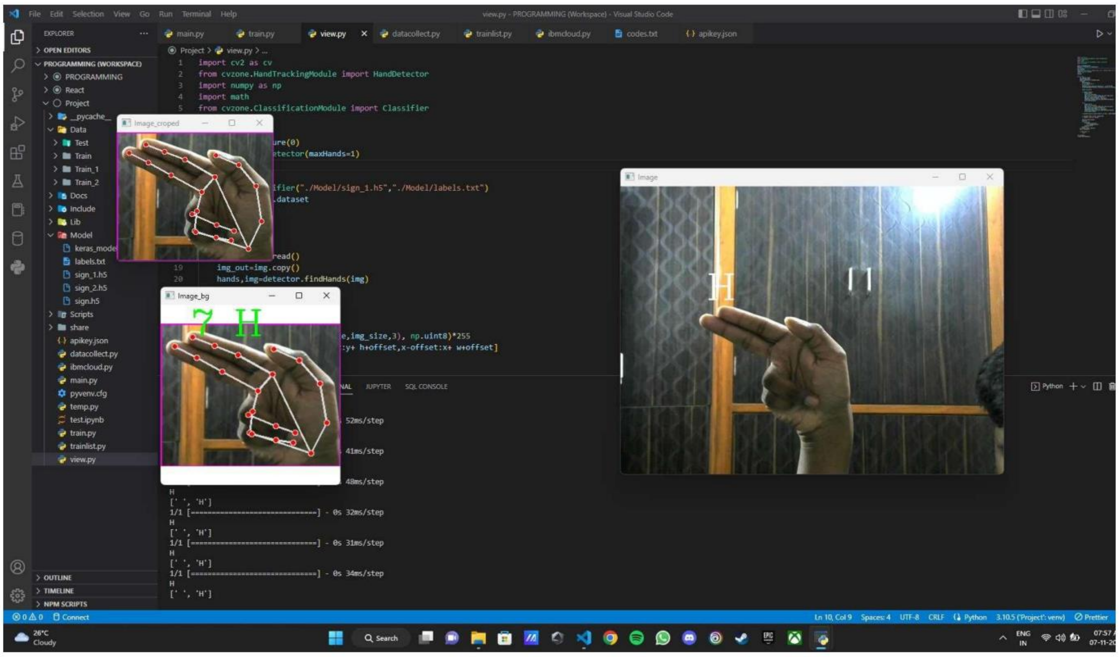
Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	0	12	1	1	14
External	5	0	0	0	5
Fixed	11	3	2	2	18

Skipped	0	0	2	0	2
Won’t Fix	4	0	0	0	4
Totals	20	15	5	3	43

- Test Case Analysis

Section	**Total Cases**	**Not Tested**	**Fail**	**Pass**
Client Application	5	1	0	5
Security	2	0	0	2
Exception Reporting	2	0	0	2
Final Report Output	9	0	0	9

- The project developed was tested by an end user and the application converts the gestures to its respective alphabet accurately



```
import cv2 as cv
from cvzone.HandTrackingModule import HandDetector
import numpy as np
import math
from cvzone.ClassificationModule import Classifier
```

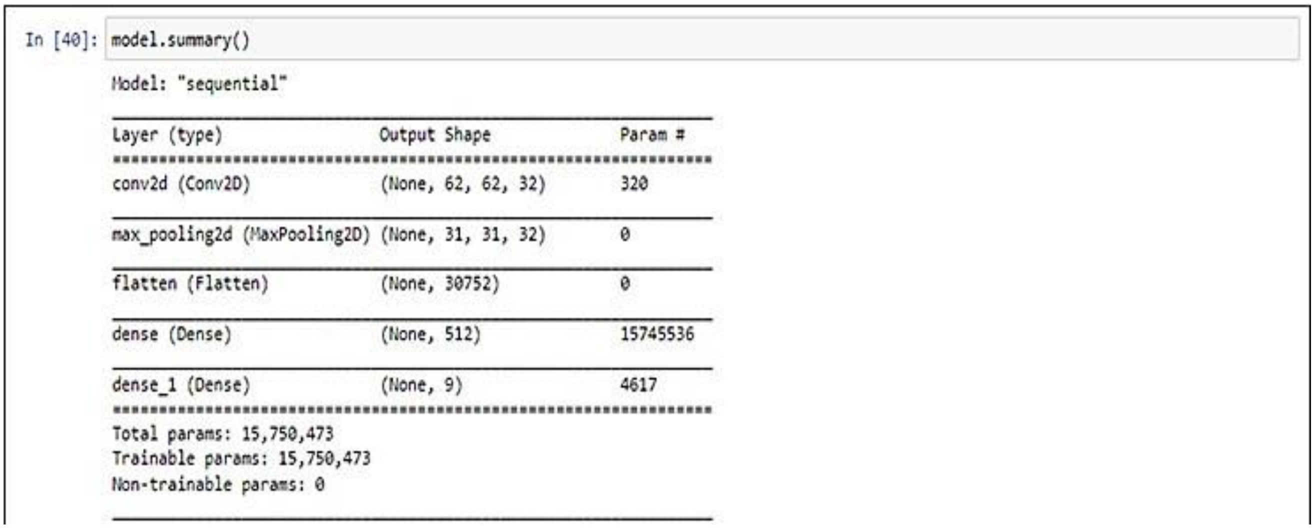
```
ure(0)
etector(maxHands=1)
ifier("./Model/sign_1.h5","./Model/labels.txt")
.dataset
read()
    img_out=img.copy()
    hands,img=detector.findHands(img)
e,img_size,3), np.uint8)*255
:y+ h+offset,x-offset:x+ w+offset]
```

```
52ms/step
41ms/step
48ms/step
H
[' ', 'H']
1/1 [==============================] - 0s 32ms/step
H
[' ', 'H']
1/1 [==============================] - 0s 31ms/step
H
[' ', 'H']
1/1 [==============================] - 0s 34ms/step
H
[' ', 'H']
```

11.RESULTS

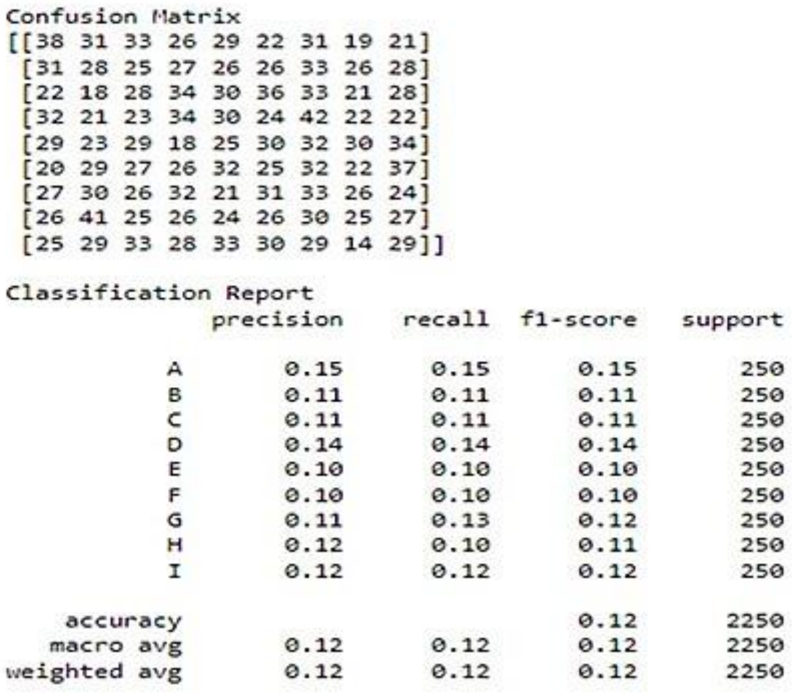
11.1.PERFORMANCE METRICS

- Model Summary



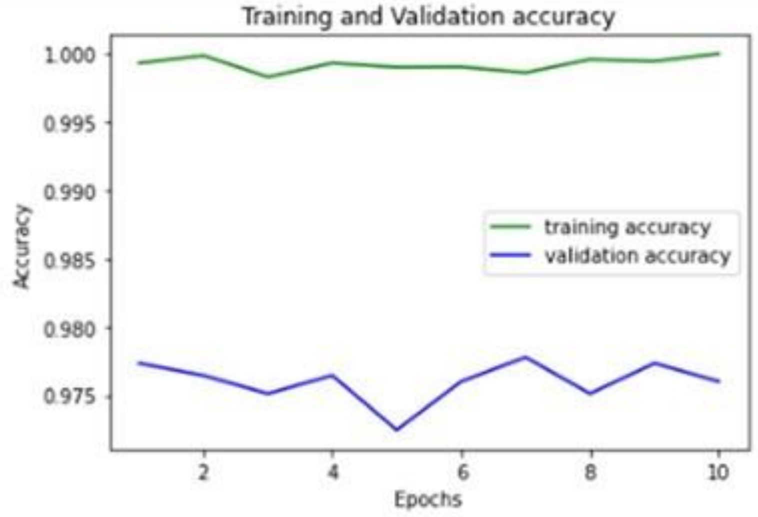
```
In [40]: model.summary()

Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 62, 62, 32)        320
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 31, 31, 32)        0
_________________________________________________________________
flatten (Flatten)            (None, 30752)             0
_________________________________________________________________
dense (Dense)                (None, 512)               15745536
_________________________________________________________________
dense_1 (Dense)              (None, 9)                 4617
=================================================================
Total params: 15,750,473
Trainable params: 15,750,473
Non-trainable params: 0
_________________________________________________________________
```

- Confusion Matrix and Classification Report



```
Confusion Matrix
[[38 31 33 26 29 22 31 19 21]
 [31 28 25 27 26 26 33 26 28]
 [22 18 28 34 30 36 33 21 28]
 [32 21 23 34 30 24 42 22 22]
 [29 23 29 18 25 30 32 30 34]
 [20 29 27 26 32 25 32 22 37]
 [27 30 26 32 21 31 33 26 24]
 [26 41 25 26 24 26 30 25 27]
 [25 29 33 28 33 30 29 14 29]]

Classification Report
             precision    recall  f1-score   support

           A       0.15      0.15      0.15       250
           B       0.11      0.11      0.11       250
           C       0.11      0.11      0.11       250
           D       0.14      0.14      0.14       250
           E       0.10      0.10      0.10       250
           F       0.10      0.10      0.10       250
           G       0.11      0.13      0.12       250
           H       0.12      0.10      0.11       250
           I       0.12      0.12      0.12       250

    accuracy                           0.12      2250
   macro avg       0.12      0.12      0.12      2250
weighted avg       0.12      0.12      0.12      2250
```

- Accuracy



12.ADVANTAGES & DISADVANTAGES

Advantages

- The application is conveniently simple for the end user.
- The user interfaceis not complex.

Disadvantages

- The dataset in limited. The alphabets only range from 'A' to 'J'.
- As of now, only static gestures are converted.

13.CONCLUSION

The main objective of this project is to develop gesture recognition so that the deaf can communicate with normal individuals. One of the crucial tasks is the extraction of features, and various gestures should yield various, effectively distinguishable characteristics. To identify the character from the gestureimages, we used a traineddataset for the CNN algorithm. These features combinedwith a labelled data enable accurate real- time ASL alphabet recognition. Our analysis found that accuracy is influenced by a variety of elements, including the camera, dataset,and approach. The accuracy drastically declines in low light and noisy backgrounds.

14.FUTURE SCOPE

The proposed system can be translated into multiple languages, enhancing its dependability and effectiveness. In the near future, it might only be accessible through mobile devices, makingthe system more convenient and portable. This system is unable to detect gestures made with both hands. Therefore, detecting gesturesdone with both hands could be a future project.

15.APPENDIX

15.1.SOURCE CODE

●Source Code is available in the GitHub link provided in Section 16.2

15.2.GITHUB

- GitHub: https://github.com/IBM-EPBL/IBM-Project-46466-1660747551