Real-Time CommunicationSystem Powered by AI for Specially Abled

Submitted By

Team ID : PNT2022TMID19999
Aarthi P
Anooshri CS
Jenifer C
Joshitha BM

ABSTRACT

Communication plays a significant role in making the world a better place. Communication creates bonding and relations among the people, whether persona, social, or political views. 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. 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.

On the other hand, technology is the most innovative thing on Earth for every time the clock ticks, researchers, software engineers, programmers, and information technology specialists are always coming up with bright ideas to provide convenience to everyone. This paper shows how artificial intelligenceis being used to help people who are unable to do what most people do in their everyday lives. Aligned with communication, D-talk is a system that allows people who are unable to talk and hear be fully understood and for them to learn their language easier and also for the people that would interact and communicatewith them

INTRODUCTION

1.1 Overview

People get to know one another by sharing their ideas, thoughts, and experiences with those around them. There are numerous ways to accomplish this, the best of which is the gift of "Speech." Everyone can very convincingly transfer their thoughts and understand each other through speech. It will be unjust if we overlook those who are denied this priceless gift: the deaf and dumb. In such cases, the human hand has remained the preferred method of communication.

1.2 Purpose

The project's purpose is to create a system that translates sign language into a human-understandable language so that ordinary people may understand it.

2. LITERATURE SURVEY

2.1 Existing problem

Some of the existing solutions for solving this problem are:

Technology

One of the easiest ways to communicate is through technology such as a smart phone or laptop. A deaf person can type out what they want to say and a person who is blind or has low vision can use a screen reader to read the text out loud. A blind person can also use voice recognition software to convert what they are saying in to text so that a person who is Deaf can then read it.

Interpreter

If a sign language interpreter is available, this facilitates easy communication if the person who is deaf is fluent in sign language. The deaf person and person who is blind can communicate with each other via the interpreter. The deaf person can use sign language and the interpreter can speak what has been said to the person who is blind and then translate anything spoken by the blind person into sign language for the deaf person.

Just Speaking

Depending on the deaf person's level of hearing loss, they may be able to communicate with a blind person who is using speech. For example, a deaf person may have enough residual hearing (with or without the use of an assistive hearing device such as a hearing aid) to be able to decipher the speech of the person who is blind or has low vision. However, this is often not the most effective form of communication, as it is very dependent on the individual circumstances of both people and their environment (for example, some places may have too much background noise).

2.2 Proposed solution

This paper describes the system that overcomes the problem faced by the speech and hearing impaired. The objectives of the research are as follow:

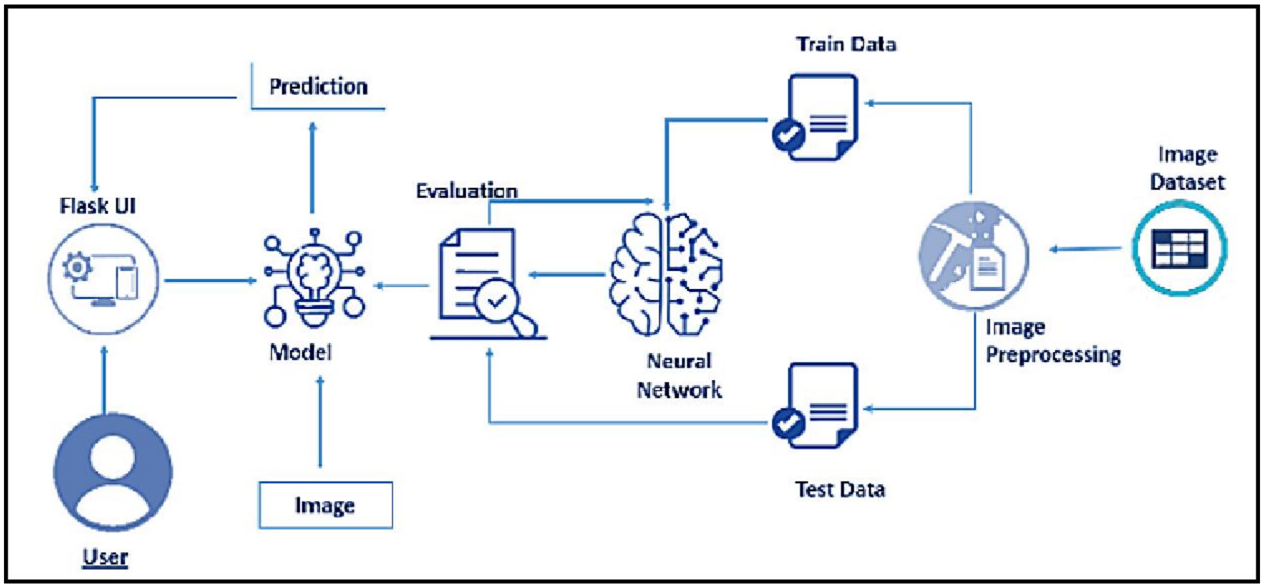
1. To design and develop a system which lowers the communication gap between speech-hearing impaired and normal world.

2. To build a communication system that enables communications between deaf-dumb person and a normal person.
3. A convolution neural network is being used to develop a model that is trained on various hand movements. This model is used to create an app. This programme allows deaf and hard of hearing persons to communicate using signs that are then translated into human-readable text.

3. THEORITICAL ANALYSIS

3.1 Block diagram

Architecture:



3.2 Hardware / Software designing

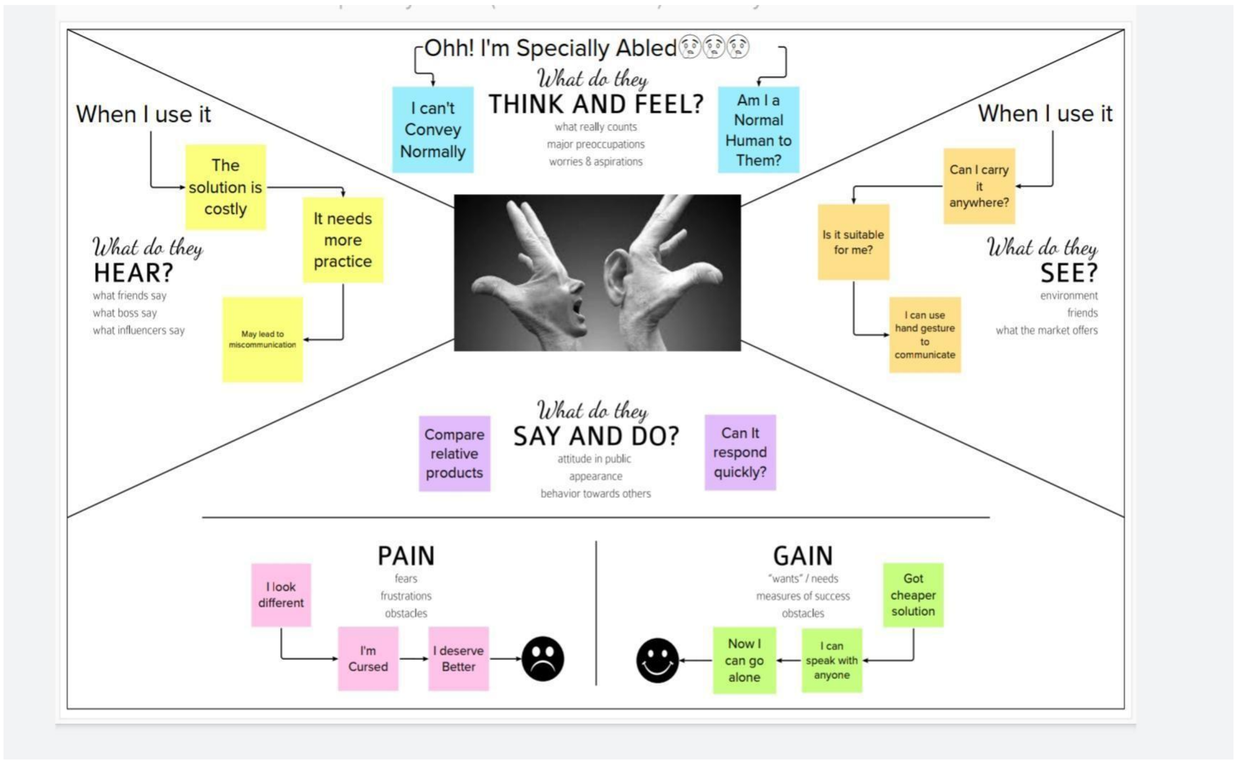
Hardware Requirements:

Operating System	Windows, Mac, Linux
CPU (for training)	Multi Core Processors (i3 or above/equivalent)
GPU (for training)	NVIDIA AI Capable / Google's TPU
WebCam	Integrated or External with FullHD Support

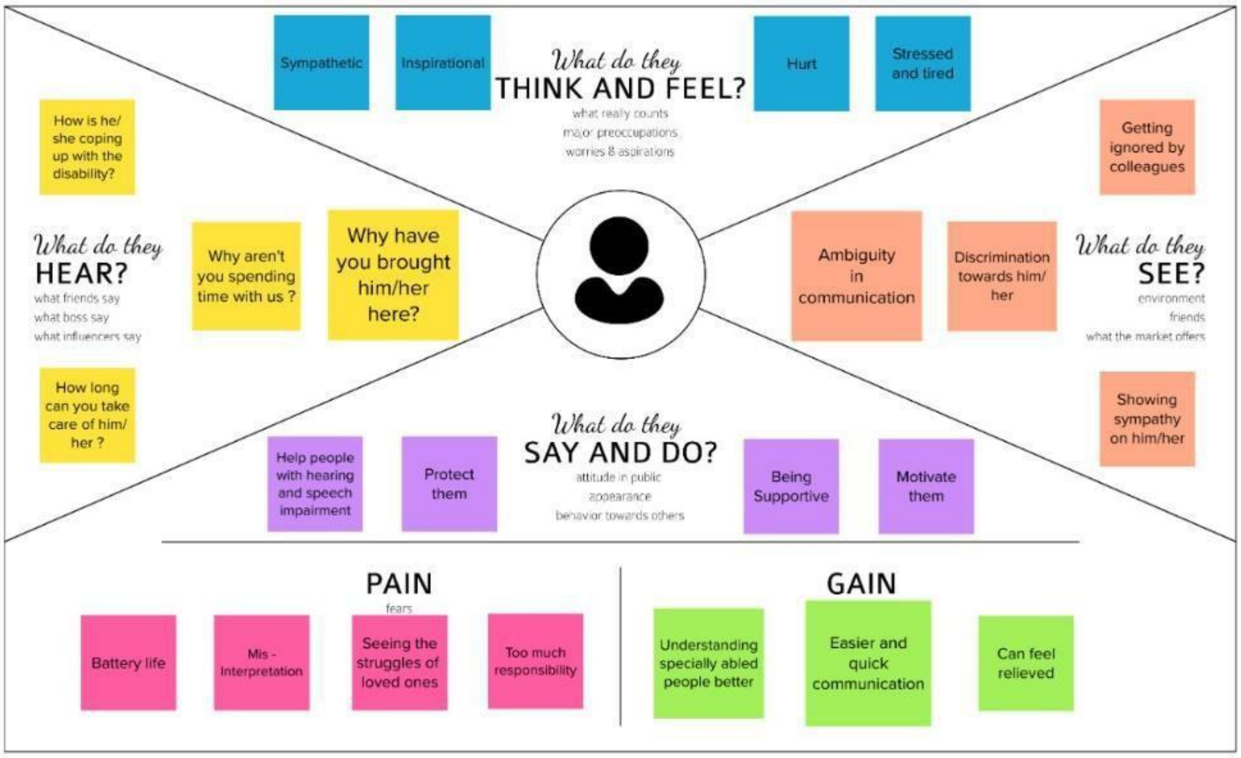
Software Requirements:

Python	v3.9.0 or Above
Python Packages	flask, tensorflow, opencv-python, keras, numpy, pandas, virtualenv, pillow
Web Browser	Mozilla Firefox, Google Chrome or any modern web browser
IBM Cloud (for training)	Watson Studio - Model Training & Deployment as Machine Learning Instance

3.3Empathy Canvas Map



User1 (someone with a speech and hearing disability)


Sympathetic
Inspirational
What do they THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations
Hurt
Stressed and tired
How is he/ she coping up with the disability?
Getting ignored by colleagues
What do they HEAR?
what friends say
what boss say
what influencers say
Why aren't you spending time with us ?
Why have you brought him/her here?
Ambiguity in communication
Discrimination towards him/ her
What do they SEE?
environment
friends
what the market offers
How long can you take care of him/ her ?
Showing sympathy on him/her
What do they SAY AND DO?
attitude in public
appearance
behavior towards others
Help people with hearing and speech impairment
Protect them
Being Supportive
Motivate them
PAIN
fears
Battery life
Mis - Interpretation
Seeing the struggles of loved ones
Too much responsibility
GAIN
Understanding specially abled people better
Easier and quick communication
Can feel relieved

User2 Person without any impairments (parent/friend/relative/colleague)

3.4 Milestone and Activity List:

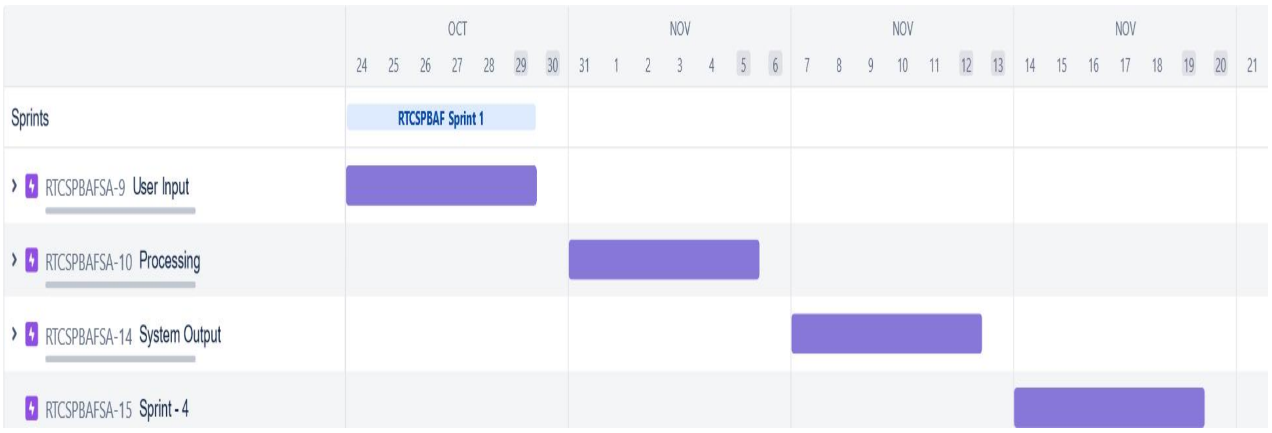
Title	**Description**	**Date**
Literature Survey & Information Gathering	Literature survey on the selected project & gatheringinformation by referring the, technical papers, research publications etc.	28 September 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problemstatements	24 September 2022
Ideation	List the by organizing the brainstorming session andprioritizethe top 3 ideas based on the feasibility &importance.	25 September 2022

Proposed Solution	Prepare the proposed solutiondocument, which includes thenovelty, feasibility of idea, business model, social impact, scalability of solution, etc.	23 September 2022
Problem Solution Fit	Prepare problem - solution fitdocument.	30 September 2022
Solution Architecture	Prepare solution architecturedocument.	28 September 2022
Customer Journey	Prepare the customer journeymaps to understand the user interactions & experiences with the application (entryto exit).	20 October 2022
Functional Requirement	Prepare the functional requirement document.	8 October 2022
Data Flow Diagrams	Draw the data flow diagrams and submit forreview.	9 October 2022
Technology Architecture	Prepare thetechnology architecture diagram.	10 October 2022
Prepare Milestone& ActivityList	Prepare the milestones &activity listof the project.	22 October 2022
Project Development - Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed codeby testing it.	16 November 2022

3.5 Product Backlog, Sprint Schedule, and Estimation (4 Marks)

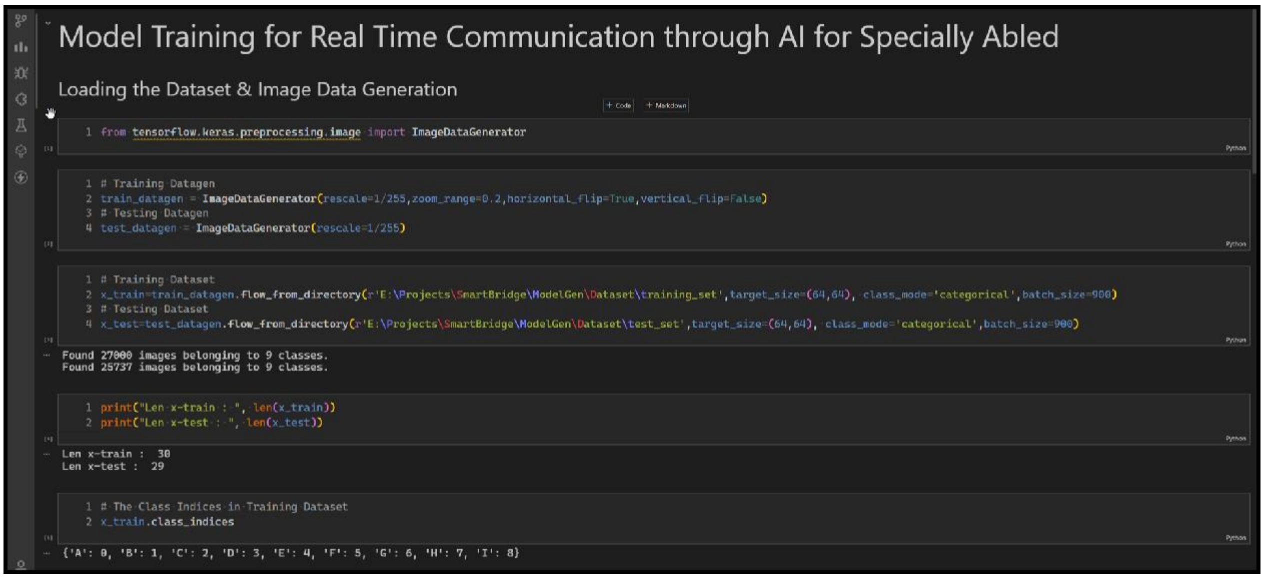
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	User Input	USN-1	As a user, I can input my sign-language to thesystem for processing.	10	Low	Jenifer, Aarthi
Sprint-1	User Input	USN-2	As a user, I can input sign-language images tothe system for processing.	10	High	Joshitha, Anooshri
Sprint-2	User Input	USN-3	As a user, I can make sure the input is captured correctly by the system.	5	Medium	Aarthi, Anooshri
Sprint-2	Processing	USN-4	As a user, I can ensure that the sign-language input is correctly getting translated into normalmessage and voice.	10	Medium	Anooshri, Jenifer
Sprint-1	Processing	USN-5	As a user, I can get acknowledgement from the system about the processing of the input.	5	High	Jenifer, Aarthi
Sprint-3	Processing	USN-6	As a user, I will get feedback about the processing of the system.	10	Low	Joshitha, Anooshri
Sprint-1	System Output	USN-7	As a user, I can acknowledge the output of thesystem by ensuring messages are displayed.	5	High	Joshitha, Jenifer
Sprint-2	System Output	USN-8	As a user, I can get feedback about the systemfrom its output.	5	Medium	Aarthi, Joshitha

3.6.Burndown Chart



4. EXPERIMENTAL INVESTIGATIONS

Training and Testing using Dataset Provided:



Model Training for Real Time Communication through AI for Specially Abled

Loading the Dataset & Image Data Generation

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

```
# 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)
```

```
# Training Dataset
x_train=train_datagen.flow_from_directory(r'E:\Projects\SmartBridge\ModelGen\Dataset\training_set',target_size=(64,64), class_mode='categorical',batch_size=900)
# Testing Dataset
x_test=test_datagen.flow_from_directory(r'E:\Projects\SmartBridge\ModelGen\Dataset\test_set',target_size=(64,64), class_mode='categorical',batch_size=900)
```

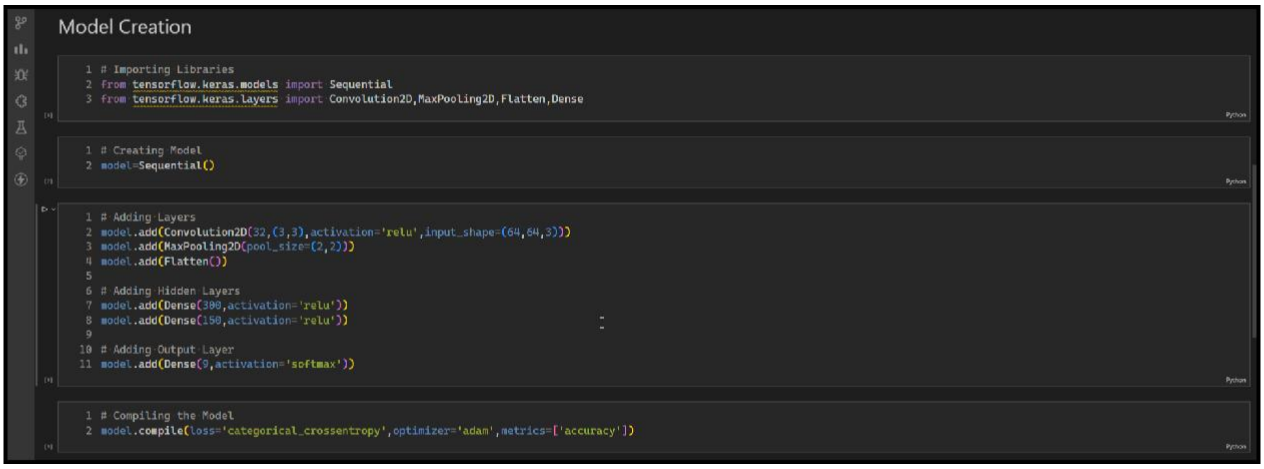
```
Found 27000 images belonging to 9 classes.
Found 25737 images belonging to 9 classes.
```

```
print("Len x-train : ", len(x_train))
print("Len x-test : ", len(x_test))
```

```
Len x-train :  30
Len x-test :  29
```

```
# The Class Indices in Training Dataset
x_train.class_indices
```

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



Model Creation

```
# Importing Libraries
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Convolution2D,MaxPooling2D,Flatten,Dense
```

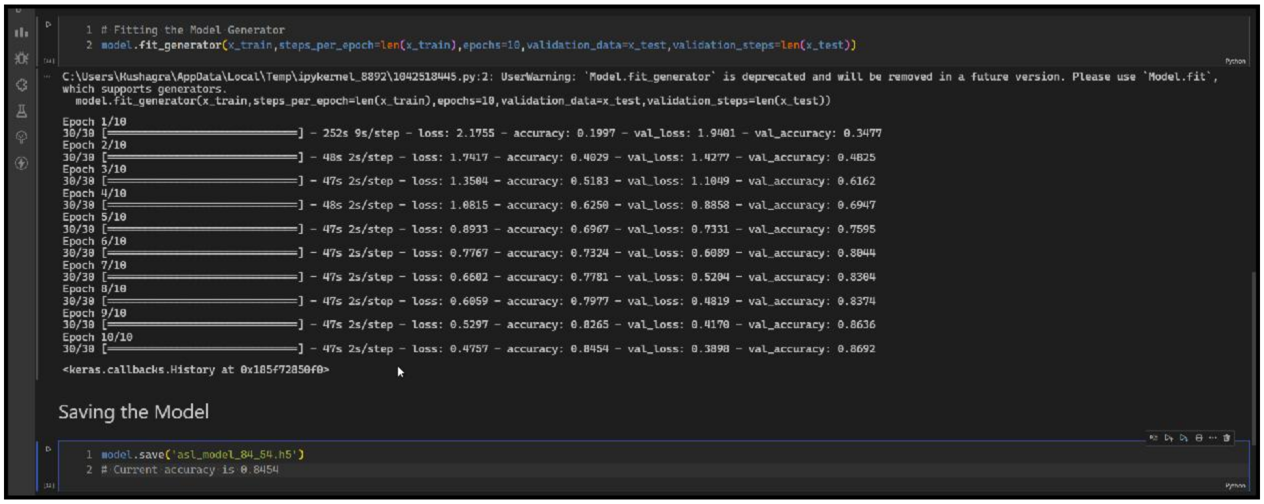
```
# Creating Model
model=Sequential()
```

```
# Adding Layers
model.add(Convolution2D(32,(3,3),activation='relu',input_shape=(64,64,3)))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())

# Adding Hidden Layers
model.add(Dense(300,activation='relu'))
model.add(Dense(150,activation='relu'))

# Adding Output Layer
model.add(Dense(9,activation='softmax'))
```

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



```
# 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))
```

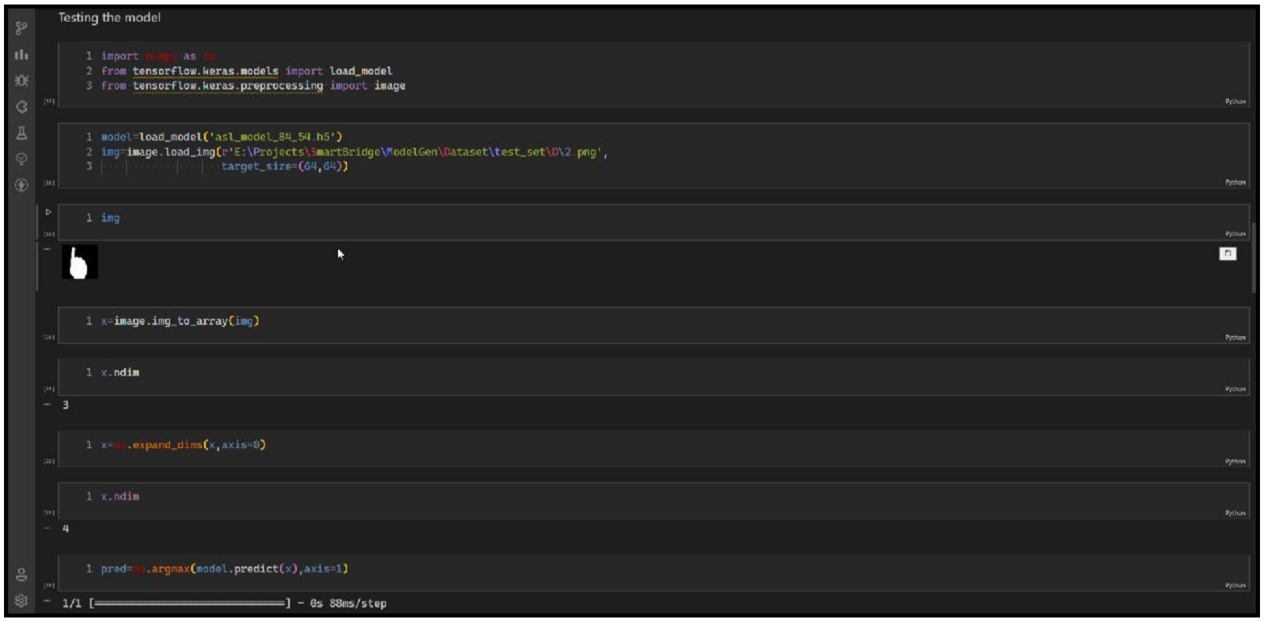
```
C:\Users\Kushagra\AppData\Local\Temp\ipykernel_8892\1042518445.py:2: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.
  model.fit_generator(x_train,steps_per_epoch=len(x_train),epochs=10,validation_data=x_test,validation_steps=len(x_test))

Epoch 1/10
30/30 [==============================] - 252s 9s/step - loss: 2.1755 - accuracy: 0.1997 - val_loss: 1.9401 - val_accuracy: 0.3477
Epoch 2/10
30/30 [==============================] - 48s 2s/step - loss: 1.7417 - accuracy: 0.4029 - val_loss: 1.4277 - val_accuracy: 0.4825
Epoch 3/10
30/30 [==============================] - 47s 2s/step - loss: 1.3504 - accuracy: 0.5183 - val_loss: 1.1049 - val_accuracy: 0.6162
Epoch 4/10
30/30 [==============================] - 48s 2s/step - loss: 1.0815 - accuracy: 0.6250 - val_loss: 0.8858 - val_accuracy: 0.6947
Epoch 5/10
30/30 [==============================] - 47s 2s/step - loss: 0.8933 - accuracy: 0.6967 - val_loss: 0.7331 - val_accuracy: 0.7595
Epoch 6/10
30/30 [==============================] - 47s 2s/step - loss: 0.7767 - accuracy: 0.7324 - val_loss: 0.6089 - val_accuracy: 0.8044
Epoch 7/10
30/30 [==============================] - 47s 2s/step - loss: 0.6602 - accuracy: 0.7781 - val_loss: 0.5204 - val_accuracy: 0.8304
Epoch 8/10
30/30 [==============================] - 47s 2s/step - loss: 0.6059 - accuracy: 0.7977 - val_loss: 0.4819 - val_accuracy: 0.8374
Epoch 9/10
30/30 [==============================] - 47s 2s/step - loss: 0.5297 - accuracy: 0.8265 - val_loss: 0.4170 - val_accuracy: 0.8636
Epoch 10/10
30/30 [==============================] - 47s 2s/step - loss: 0.4757 - accuracy: 0.8454 - val_loss: 0.3898 - val_accuracy: 0.8692

<keras.callbacks.History at 0x185f72850f0>
```

Saving the Model

```
model.save('asl_model_84_54.h5')
# Current accuracy is 0.8454
```



Testing the model

```
import numpy as np
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
```

```
model=load_model('asl_model_84_54.h5')
img=image.load_img(r'E:\Projects\SmartBridge\ModelGen\Dataset\test_set\D\2.png',
                   target_size=(64,64))
```

```
img
```

```
x=image.img_to_array(img)
```

```
x.ndim
```

```
3
```

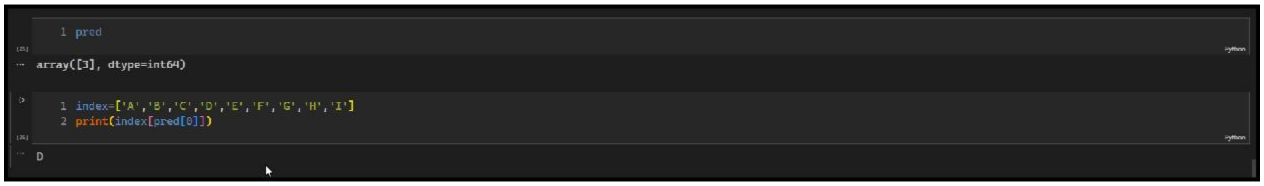
```
x=np.expand_dims(x,axis=0)
```

```
x.ndim
```

```
4
```

```
pred=np.argmax(model.predict(x),axis=1)
```

```
1/1 [==============================] - 0s 88ms/step
```



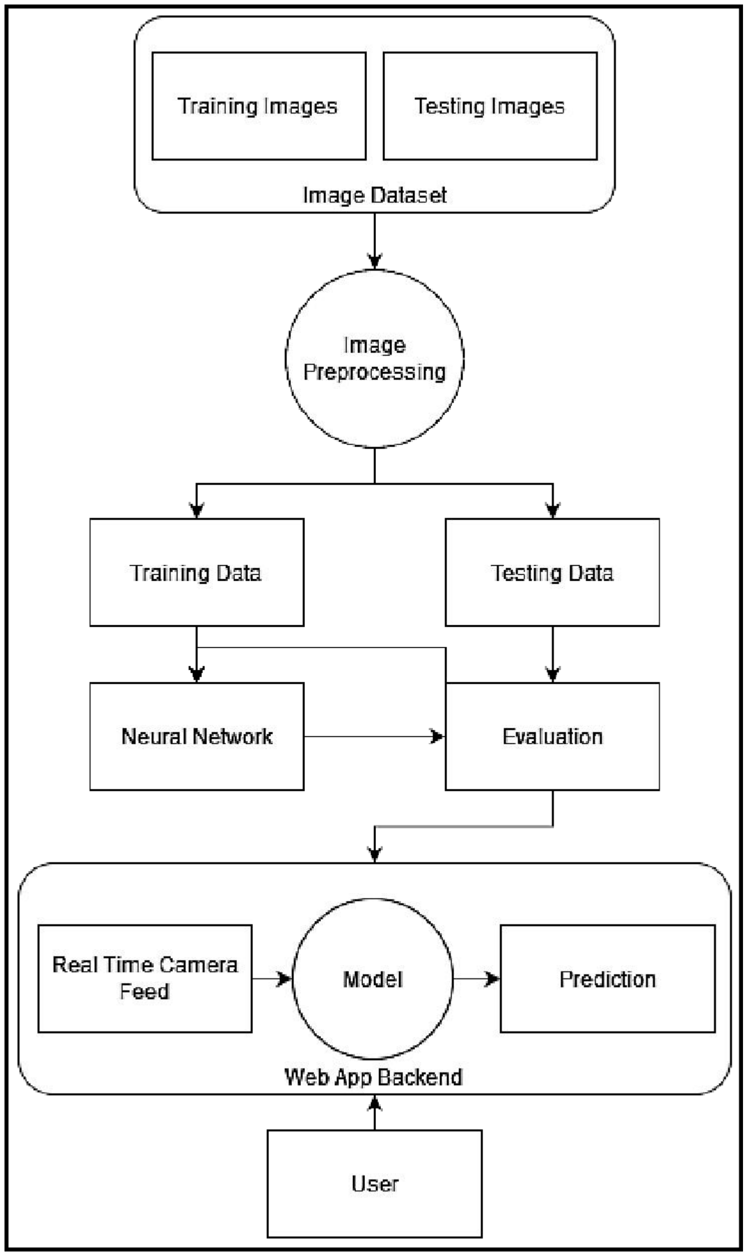
```
pred
```

```
array([3], dtype=int64)
```

```
index=['A','B','C','D','E','F','G','H','I']
print(index[pred[0]])
```

```
D
```

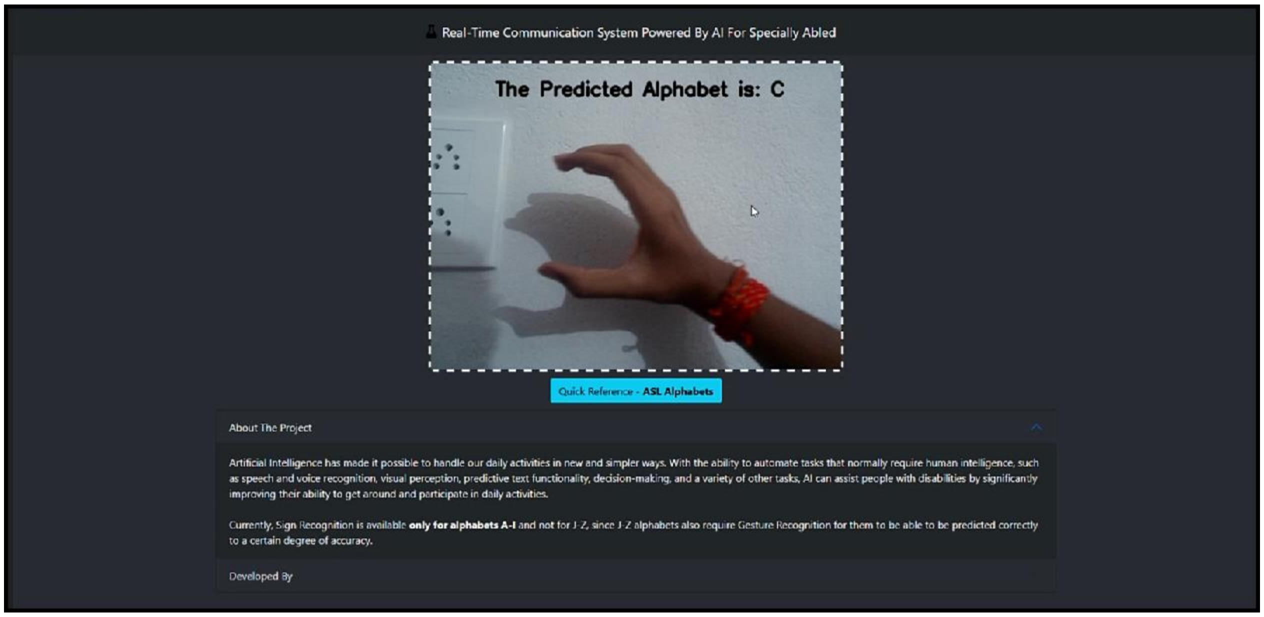
5. FLOWCHART



6. RESULT

The proposed procedure was implemented and tested with set of images. The set of 15750 images of Alphabets from “A” to “I” are used for training database and a set of 2250 images of Alphabets from “A” to “I” are used for testing database. Once the gesture is recognise the equivalent Alphabet is shown on the screen.

Some sample images of the output are provided below:


Real-Time Communication System Powered By AI For Specially Abled

The Predicted Alphabet is: C

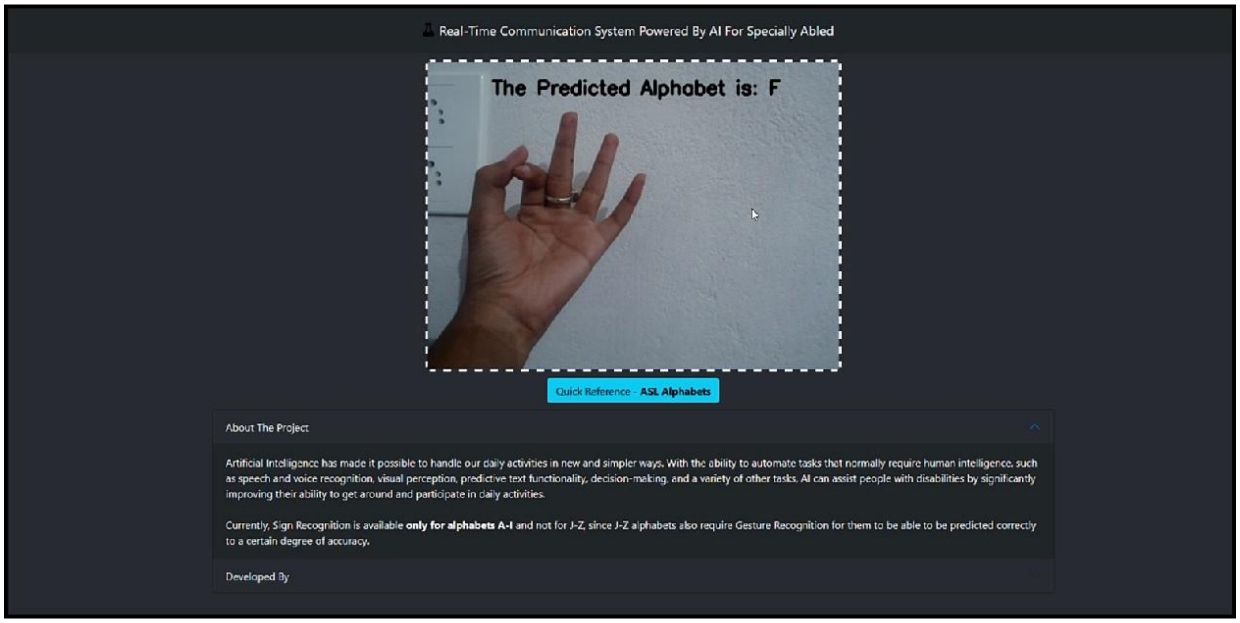
Quick Reference - **ASL Alphabets**

About The Project

Artificial Intelligence has made it possible to handle our daily activities in new and simpler ways. With the ability to automate tasks that normally require human intelligence, such as speech and voice recognition, visual perception, predictive text functionality, decision-making, and a variety of other tasks, AI can assist people with disabilities by significantly improving their ability to get around and participate in daily activities.

Currently, Sign Recognition is available **only for alphabets A-I** and not for J-Z, since J-Z alphabets also require Gesture Recognition for them to be able to be predicted correctly to a certain degree of accuracy.

Developed By


Real-Time Communication System Powered By AI For Specially Abled

The Predicted Alphabet is: F

Quick Reference - **ASL Alphabets**

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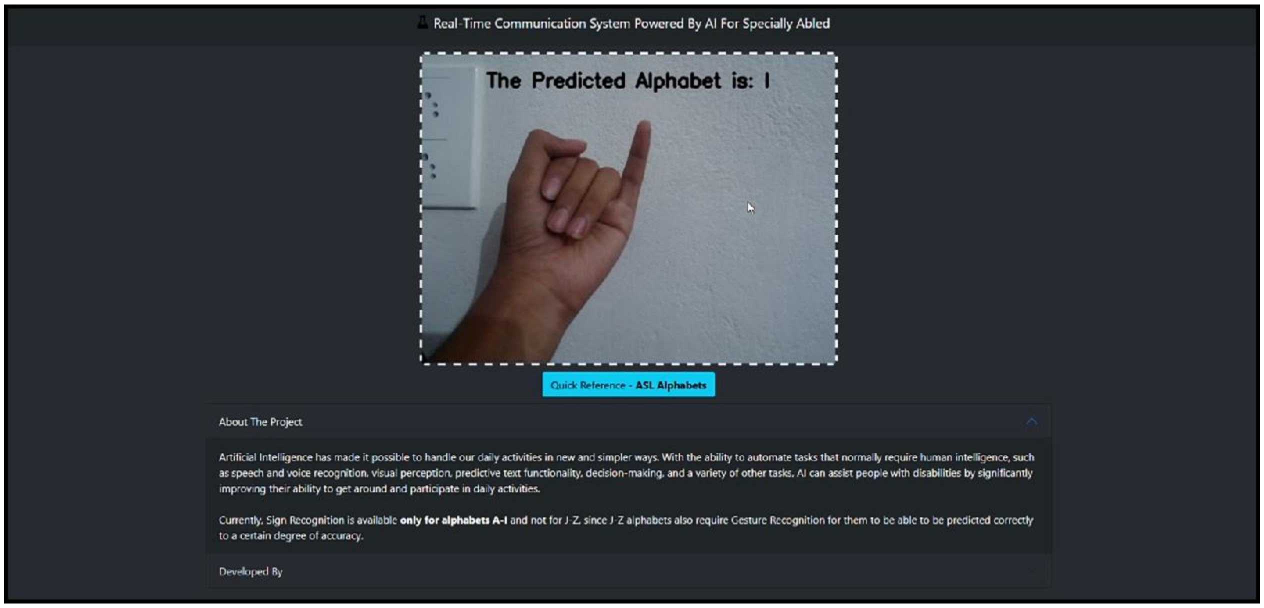
Developed By


Real-Time Communication System Powered By AI For Specially Abled
The Predicted Alphabet is: I
Quick Reference - ASL Alphabets
About The Project

Artificial Intelligence has made it possible to handle our daily activities in new and simpler ways. With the ability to automate tasks that normally require human intelligence, such as speech and voice recognition, visual perception, predictive text functionality, decision-making, and a variety of other tasks. AI can assist people with disabilities by significantly improving their ability to get around and participate in daily activities.

Currently, Sign Recognition is available **only for alphabets A-I** and not for J-Z, since J-Z alphabets also require Gesture Recognition for them to be able to be predicted correctly to a certain degree of accuracy.

7. ADVANTAGES & DISADVANTAGES

Advantages:

1. It is possible to create a mobile application to bridge the communication gap between deaf and dumb persons and the general public.

2. As different sign language standards exist, their dataset can be added, and the user can choose which sign language to read.

Disadvantages:

1. The current model only works from alphabets A to I.

2. In absence of gesture recognition, alphabets from J cannot be identified as they require some kind of gesture input from the user.

3. As the quantity/quality of images in the dataset is low, the accuracy is not great, but that can easily be improved by change in dataset.

8. APPLICATIONS

1. It will contribute to the development of improved communication for the deafened. The majority of people are unable to communicate via sign language, which creates a barrier to communication.

2. As a result, others will be able to learn and comprehend sign language and communicate with the deaf and dumb via the web app.

3. According to scientific research, learning sign language improves cognitive abilities, attention span, and creativity.

9. CONCLUSION

Sign language is a useful tool for facilitating communication between deaf and hearing people. Because it allows for two-way communication, the system aims to bridge the communication gap between deaf people and the rest of society. The proposed methodology translates language into English alphabets that are understandable to humans.

This system sends hand gestures to the model, who recognises them and displays the equivalent Alphabet on the screen. Deaf-mute people can use their hands to perform sign language, which will then be converted into alphabets, thanks to this project.

10. FUTURE SCOPE

Having a technology that can translate hand sign language to its corresponding alphabet is a game changer in the field of communication and Ai for the specially abled people such as deaf and dumb. With introduction of gesture recognition, the web app can easily be expanded to recognize letters beyond 'I', digits and other symbols plus gesture recognition can also allow controlling of software/hardware interfaces.

11. BIBILOGRAPHY

1. Environment Setup: https://www.youtube.com/watch?v=5mDYijMfSzs

2. Sign Languages Dataset: https://drive.google.com/file/d/1ITbDvhLwyTTkuUYfNjOKhcIZh7hDgi64/view?usp=sharing

3. Keras Image Processing Doc: https://keras.io/api/preprocessing/image/

4. Keras ImageDataset From Directory Doc: https://keras.io/api/preprocessing/image/#imagedatasetfromdirectory-function

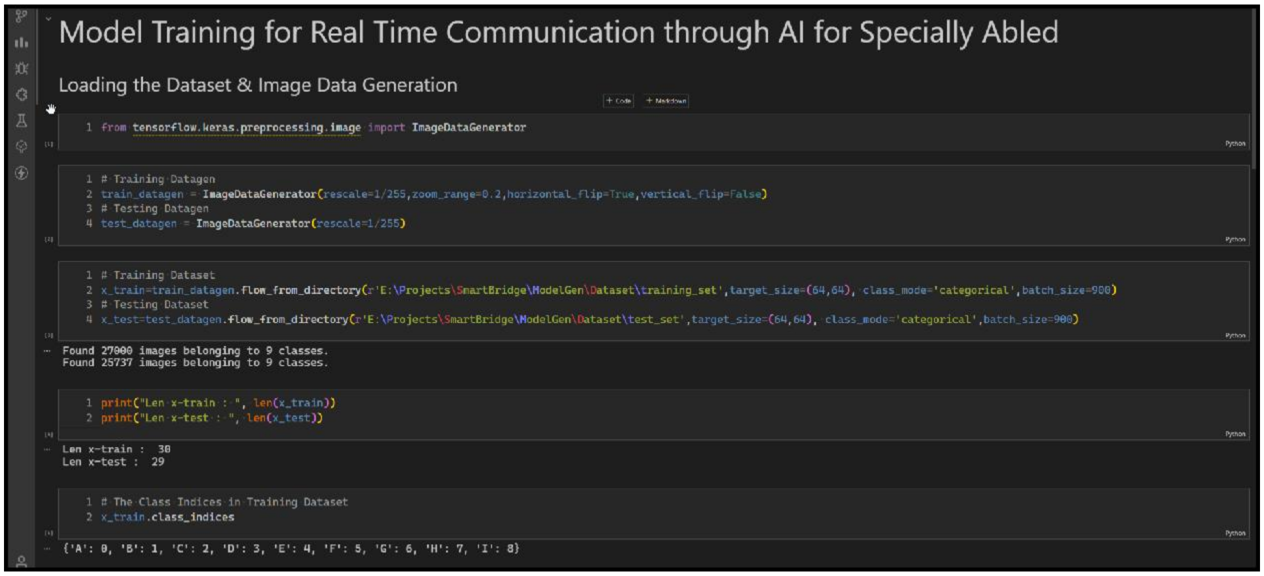
5. CNN using Tensorflow: https://www.youtube.com/watch?v=umGJ30-15_A

6. OpenCV Basics of Processing Image: https://www.youtube.com/watch?v=mjKd1Tzl70I

7. Flask Basics: https://www.youtube.com/watch?v=lj4I_CvBnt0
8. IBM Academic Partner Account Creation: https://www.youtube.com/watch?v=x6i43M7BAqE
9. CNN Deployment and Download through IBM Cloud: https://www.youtube.com/watch?v=BzouqMGJ41k

12. APPENDIX

Source Code for Model Training and Saving:



Model Training for Real Time Communication through AI for Specially Abled

Loading the Dataset & Image Data Generation

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```python
# Training Datagen
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```

```python
# Training Dataset
x_train=train_datagen.flow_from_directory(r'E:\Projects\SmartBridge\ModelGen\Dataset\training_set',target_size=(64,64), class_mode='categorical',batch_size=900)
# Testing Dataset
x_test=test_datagen.flow_from_directory(r'E:\Projects\SmartBridge\ModelGen\Dataset\test_set',target_size=(64,64), class_mode='categorical',batch_size=900)
```

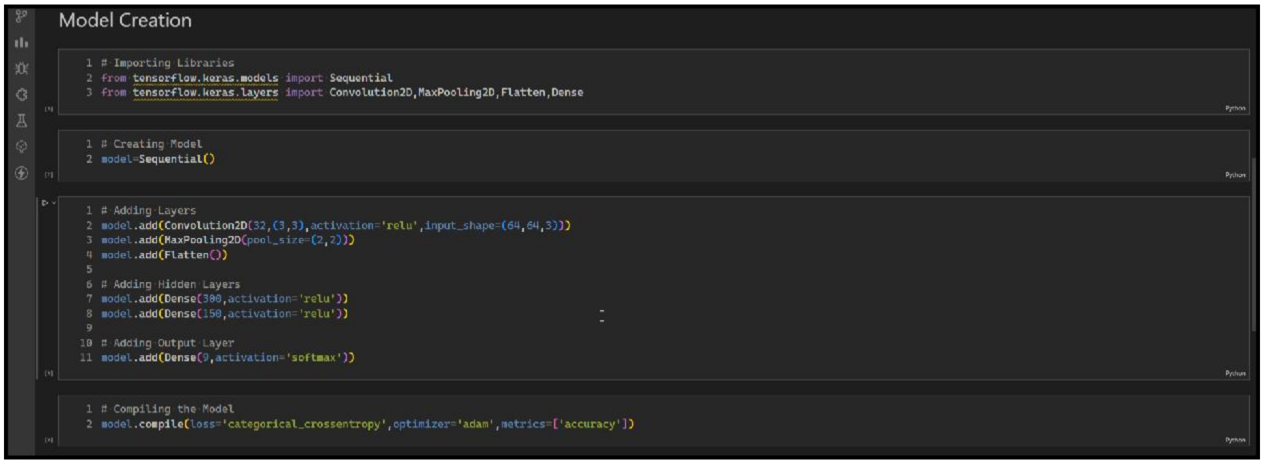
```
Found 27000 images belonging to 9 classes.
Found 25737 images belonging to 9 classes.
```

```python
print("Len x-train : ", len(x_train))
print("Len x-test : ", len(x_test))
```

```
Len x-train :  30
Len x-test :  29
```

```python
# The Class Indices in Training Dataset
x_train.class_indices
```

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



Model Creation

```python
# Importing Libraries
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Convolution2D,MaxPooling2D,Flatten,Dense
```

```python
# Creating Model
model=Sequential()
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# Adding Layers
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model.add(Flatten())

# Adding Hidden Layers
model.add(Dense(300,activation='relu'))
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# Adding Output Layer
model.add(Dense(9,activation='softmax'))
```
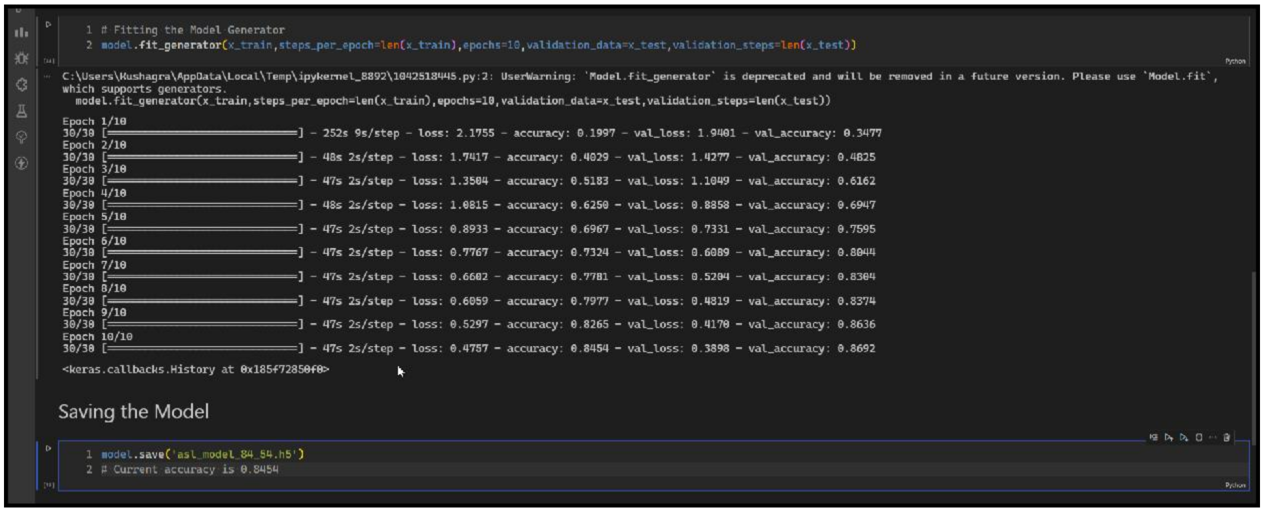

```python
# Compiling the Model
model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
```



```
# 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))
```

```
C:\Users\Kushagra\AppData\Local\Temp\ipykernel_8892\1042518445.py:2: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`,
which supports generators.
  model.fit_generator(x_train,steps_per_epoch=len(x_train),epochs=10,validation_data=x_test,validation_steps=len(x_test))
Epoch 1/10
30/30 [==============================] - 252s 9s/step - loss: 2.1755 - accuracy: 0.1997 - val_loss: 1.9401 - val_accuracy: 0.3477
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30/30 [==============================] - 47s 2s/step - loss: 1.3504 - accuracy: 0.5183 - val_loss: 1.1049 - val_accuracy: 0.6162
Epoch 4/10
30/30 [==============================] - 48s 2s/step - loss: 1.0815 - accuracy: 0.6250 - val_loss: 0.8858 - val_accuracy: 0.6947
Epoch 5/10
30/30 [==============================] - 47s 2s/step - loss: 0.8933 - accuracy: 0.6967 - val_loss: 0.7331 - val_accuracy: 0.7595
Epoch 6/10
30/30 [==============================] - 47s 2s/step - loss: 0.7767 - accuracy: 0.7324 - val_loss: 0.6089 - val_accuracy: 0.8044
Epoch 7/10
30/30 [==============================] - 47s 2s/step - loss: 0.6602 - accuracy: 0.7781 - val_loss: 0.5204 - val_accuracy: 0.8304
Epoch 8/10
30/30 [==============================] - 47s 2s/step - loss: 0.6059 - accuracy: 0.7977 - val_loss: 0.4819 - val_accuracy: 0.8374
Epoch 9/10
30/30 [==============================] - 47s 2s/step - loss: 0.5297 - accuracy: 0.8265 - val_loss: 0.4170 - val_accuracy: 0.8636
Epoch 10/10
30/30 [==============================] - 47s 2s/step - loss: 0.4757 - accuracy: 0.8454 - val_loss: 0.3898 - val_accuracy: 0.8692

<keras.callbacks.History at 0x185f72850f0>
```
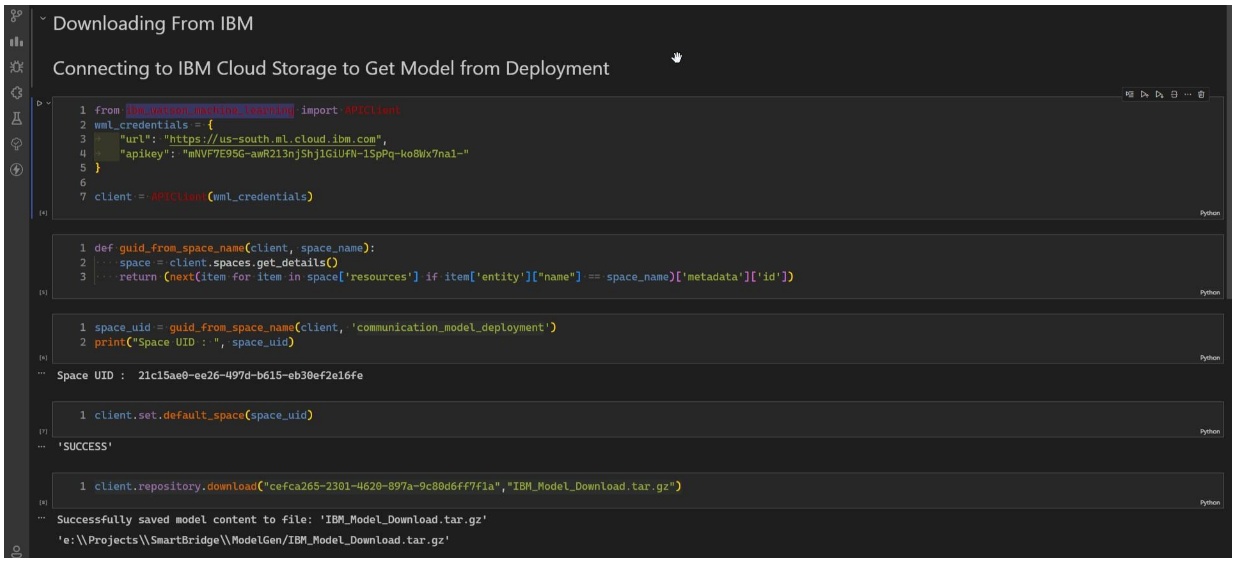

Saving the Model

```
model.save('asl_model_84_54.h5')
# Current accuracy is 0.8454
```

__IBM Model Training & Download Code:__



Downloading From IBM

Connecting to IBM Cloud Storage to Get Model from Deployment

```
from ibm_watson_machine_learning import APIClient
wml_credentials = {
    "url": "https://us-south.ml.cloud.ibm.com",
    "apikey": "mNVF7E95G-awR213njShj1GiUfN-1SpPq-ko8Wx7na1-"
}

client = APIClient(wml_credentials)
```

```
def guid_from_space_name(client, space_name):
    space = client.spaces.get_details()
    return (next(item for item in space['resources'] if item['entity']["name"] == space_name)['metadata']['id'])
```

```
space_uid = guid_from_space_name(client, 'communication_model_deployment')
print("Space UID : ", space_uid)
```

```
Space UID :  21c15ae0-ee26-497d-b615-eb30ef2e16fe
```

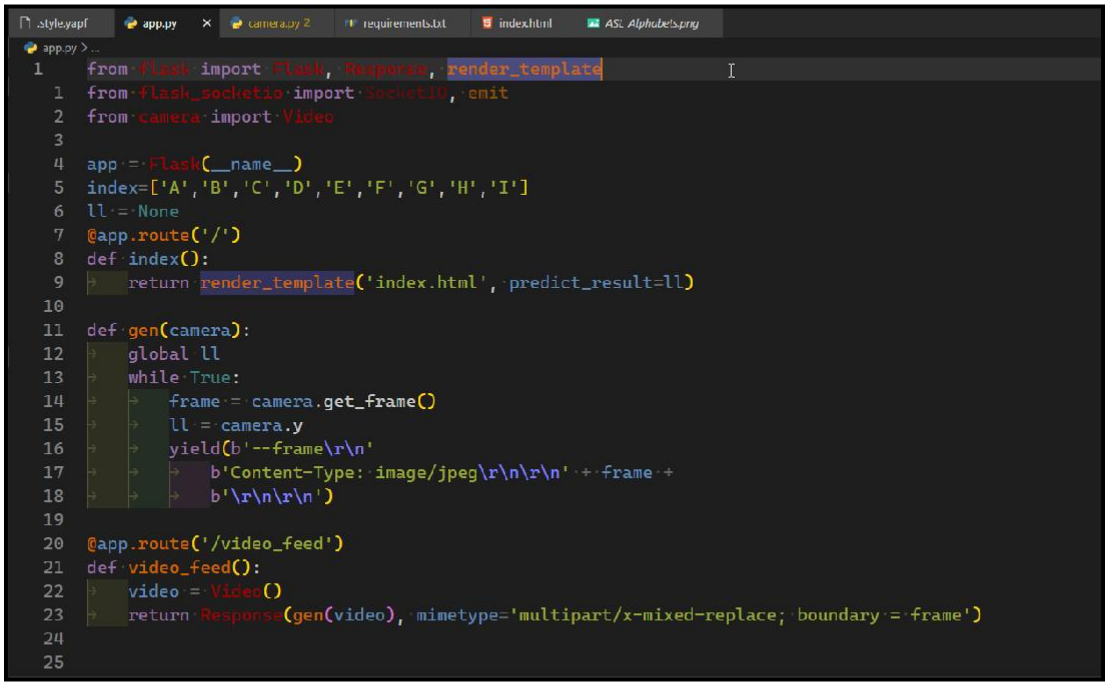
```
client.set.default_space(space_uid)
```

```
'SUCCESS'
```

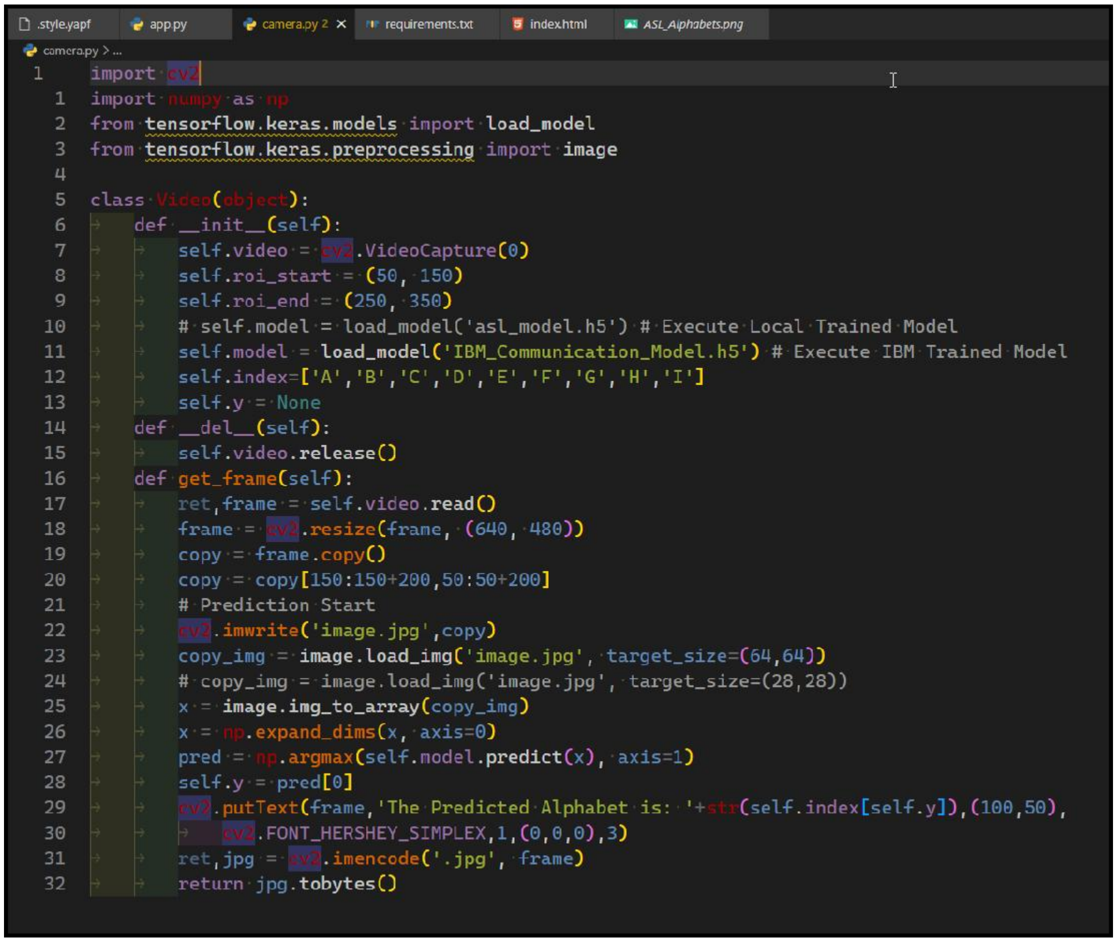
```
client.repository.download("cefca265-2301-4620-897a-9c80d6ff7f1a","IBM_Model_Download.tar.gz")
```

```
Successfully saved model content to file: 'IBM_Model_Download.tar.gz'
'e:\\Projects\\SmartBridge\\ModelGen/IBM_Model_Download.tar.gz'
```

Web app code:

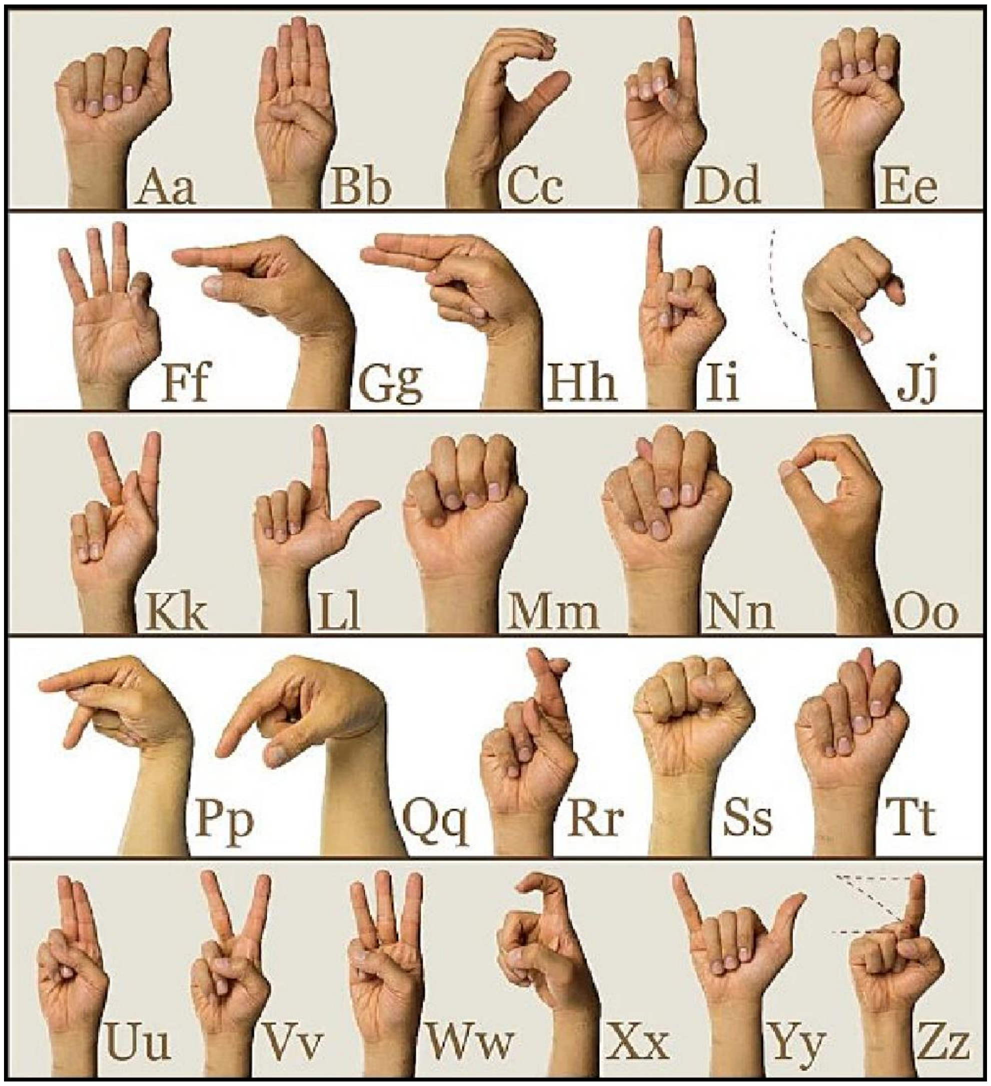


```python
from flask import Flask, Response, render_template
from flask_socketio import SocketIO, emit
from camera import Video

app = Flask(__name__)
index=['A','B','C','D','E','F','G','H','I']
ll = None
@app.route('/')
def index():
    return render_template('index.html', predict_result=ll)

def gen(camera):
    global ll
    while True:
        frame = camera.get_frame()
        ll = camera.y
        yield(b'--frame\r\n'
            b'Content-Type: image/jpeg\r\n\r\n' + frame +
            b'\r\n\r\n')

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



```python
import cv2
import numpy as np
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image

class Video(object):
    def __init__(self):
        self.video = cv2.VideoCapture(0)
        self.roi_start = (50, 150)
        self.roi_end = (250, 350)
        # self.model = load_model('asl_model.h5') # Execute Local Trained Model
        self.model = load_model('IBM_Communication_Model.h5') # Execute IBM Trained Model
        self.index=['A','B','C','D','E','F','G','H','I']
        self.y = None
    def __del__(self):
        self.video.release()
    def get_frame(self):
        ret,frame = self.video.read()
        frame = cv2.resize(frame, (640, 480))
        copy = frame.copy()
        copy = copy[150:150+200,50:50+200]
        # Prediction Start
        cv2.imwrite('image.jpg',copy)
        copy_img = image.load_img('image.jpg', target_size=(64,64))
        # copy_img = image.load_img('image.jpg', target_size=(28,28))
        x = image.img_to_array(copy_img)
        x = np.expand_dims(x, axis=0)
        pred = np.argmax(self.model.predict(x), axis=1)
        self.y = pred[0]
        cv2.putText(frame,'The Predicted Alphabet is: '+str(self.index[self.y]),(100,50),
            cv2.FONT_HERSHEY_SIMPLEX,1,(0,0,0),3)
        ret,jpg = cv2.imencode('.jpg', frame)
        return jpg.tobytes()
```

American Sign Language Standard Reference:



Demo Link:

https://drive.google.com/drive/folders/14mhdpWT-6zHocyJ-qjX1z7oKP66dpgt-