Vel Tech High Tech

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An Autonomous Institution

Project Name:

Real-Time Communication System Powered by AI for Specially Abled

Submitted by

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ABSTRACT

Speech impairment is a disability which affects an individual’s ability to communicate using speech and hearing. People who are affected by this use other media of communication such as sign language. In the recent past, research in the field of automatic sign language recognition using machine learning methods have demonstrated remarkable success and made momentous progression. A system was developed that will serve as a learning tool for starters in sign language that involves hand detection. Sign language is intentionally designed to allow deaf and dumb communities to convey messages and to connect with society. Unfortunately, learning and practicing sign language is not common among society; hence, this study developed a sign language recognition prototype using the Machine Learning. The images were fed into the model called the Convolutional Neural Network (CNN) for classification of images. Keras was used for training of images. Provided with a proper lighting condition and a uniform background. Many existing studies have proposed methods for incomplete sign language recognition, whereas this study aimed for full American Sign Language (ASL) recognition, which consists of 26 letters. Most of the ASL letters are static (no movement), but certain ASL letters are dynamic (they require certain movements). The approach is used for fast computation and is done in real time. As a result, the sign language recognition system has great potential for reducing the gap between deaf and dumb communities and others. The proposed prototype could also serve as an interpreter for the deaf and dumb in everyday life in service sectors, such as at the bank or post office. Based on the inferences from these approaches, this article discussed how machine learning methods could benefit the field of automatic sign language recognition and the potential gaps that machine learning approaches need to address for the real-time sign language recognition.

1. INTRODUCTION

1.1. PROJECT OVERVIEW

The innovation made by the task changes a Hard of hearing Quiet individual's hand developments into the proper American Communication through signing (ASL) letter sets for a meeting individual to impart. Individuals who need to speak with hard of hearing quiet individuals who need to speak with others, as well as hard of hearing quiet individuals who need to speak with others, are our venture's essential clients. The objective of this drive is to further develop correspondence in crisis circumstances. The CNN (Convolutional Brain Organization) model from the Tensor-Stream bundle is utilized to develop the venture on the Python stage.

1.2. PURPOSE

Everyone can't stand to have a human interpreter of communication through signing, they may not be accessible constantly and they are very costly. Individuals who take part in discussion with hard of hearing quiet individual will think that it is hard and dreary. Hard of hearing quiet individual might lose a ton of chances since they can't talk or offer their viewpoints verbally in circumstances like a meeting. This undertaking means to defeat the said difficulties.

2. LITERATURE SURVEY

2.1. EXISTING PROBLEMS

- This dataset was benchmarked on six different classification models of machine learning by changing the parameters. Classification models are evaluated based on the HOG features extracted from the skin filtered image. An overall accuracy of 91.72% was achieved comprising of all machine learning models.
- The system is trained with double handed sign language by using a minimum eigenvalue algorithm. Here Logitech web camera is used for image acquisition and processing is performed in MATLAB.
- Development of an artificial intelligence voice-based smart device that include the Flex sensors, LCD module, microcontroller, SD card memory, hearing phones, etc. Improves the quality of life without the assistance of some artificial means.
- The human hand comprises of numerous associated parts and joints, making it a complex object for input. The majority of the sign make utilization of both the hands together. Using webcam, capture the image of the hand to be tested. And convert the captured RGB image into HSV image and then into binary image. The edges are detected using canny edge detection.
- Over the years, communication has played a vital role in exchange of information and feelings in one's life. Sign language is the only medium through which specially abled people can connect to rest of the world through different hand gestures. With the advances in machine learning techniques, Hand gesture recognition (HGR) became a very important research topic.
- Processed image, next step is feature extraction & followed by classifier, recognized gestures are displayed as Hindi & English text & played as Hindi & English audio.

2.2 REFERENCE

[1] Leela Surya Teja Mangamuri; Lakshay Jain; Abhishek Sharmay, “Two Hand Indian Sign Language dataset for benchmarking classification models of Machine Learning”, 2019 International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT).

[2] Kusumika Krori Dutta; Satheesh Kumar Raju K.; Anil Kumar G.S.; Sunny Arokia Swamy B., “Double handed Indian Sign Language to speech and text”, 2015 Third International Conference on Image Information Processing (ICIIP).

[3] Dhaya Sindhu Battina, “Innovative study of an AI voice based smart device to assist deaf people”, International Journal of Creative Research Thoughts (IJCRT), Volume 9, Issue 10 October 2021

[4] Shraddha R. Ghorpade, Prof. Surendra K. Waghmare,"Communication system for deaf and dumb people”, International Journal of Science and Research (IJSR)2013, ISSN (Online): 2319-7064.

[5] Kusumika Krori Dutta, Sunny Arokia Swamy Bellary, “Machine Learning Techniques for Indian Sign Language Recognition",2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC).

[6] Umang Patel, Aarti G. Ambekar,"Moment Based Sign Language Recognition for Indian Languages",2017 International Conference on Computing, Communication, Control and Automation (ICCUBEA).

2.3. PROBLEM STATEMENT DEFINITION

The investigation of human-PC communication has shown a lot of revenue close by motion acknowledgment. In numerous areas of human-PC communication, including augmented reality, gaming, vehicle framework control, and automated control, fast and exact hand motion acknowledgment is essential. As additional sensors are added, there are various ways of arranging hand movements. Since signal ID is an issue of picture characterization and 2D CNNs are viable in picture order, we have decided to utilize a Convolutional Brain Organization for this undertaking. A framework that changes over the gesture-based communication into the particular ASL (American Communication through signing) letter set to pass a message on to ordinary individuals is created in this task.

3. IDEATION & PROPOSED SOLUTION

3.1. EMPATHY MAP CANVAS

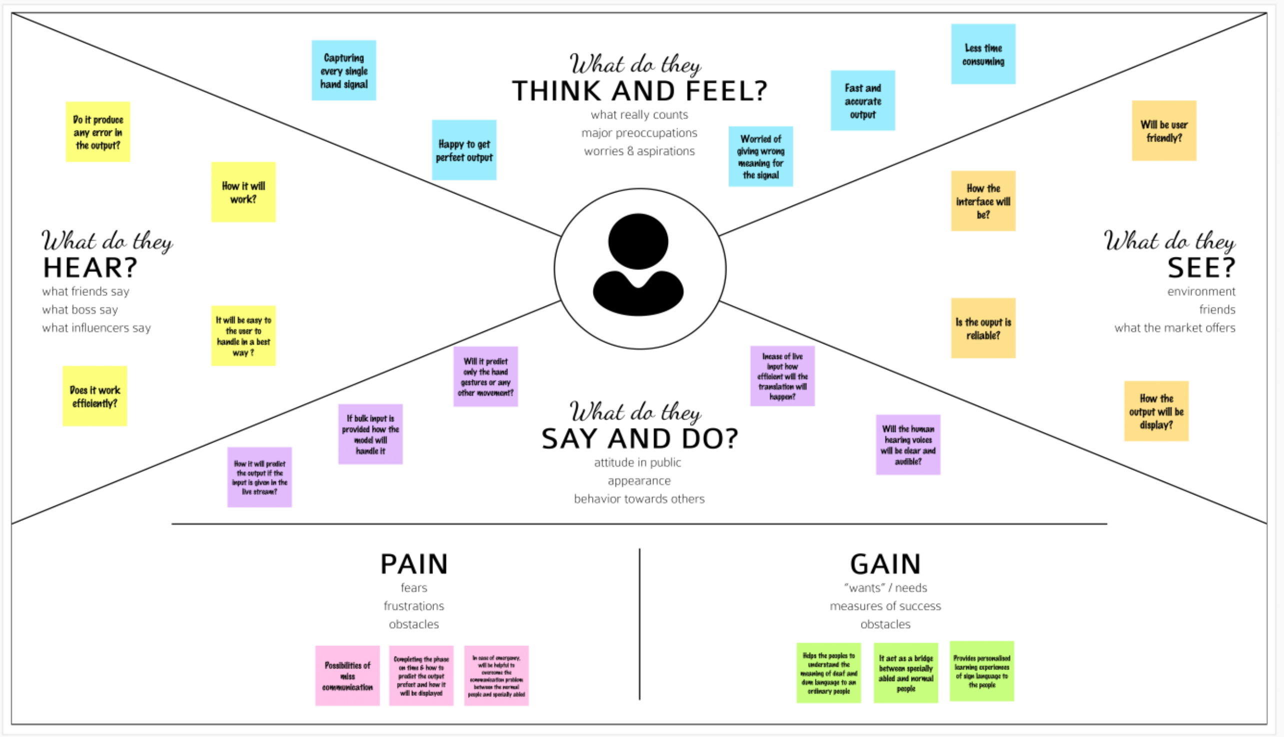
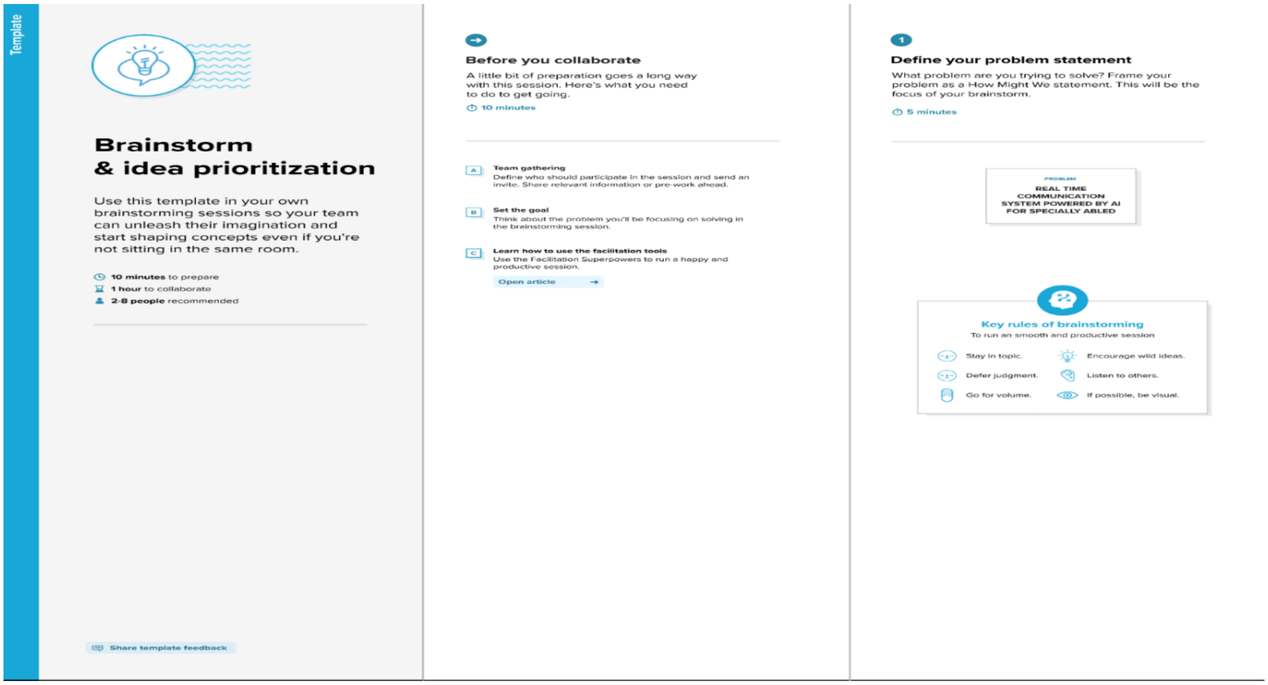

Capturing every single hand signal
What do they
THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations
Less time consuming
Fast and accurate output
Do it produce any error in the output?
Happy to get perfect output
Worried of giving wrong meaning for the signal
Will be user friendly?
How it will work?
How the interface will be?
What do they
HEAR?
what friends say
what boss say
what influencers say
What do they
SEE?
environment
friends
what the market offers
It will be easy to the user to handle in a best way ?
Is the ouput is reliable?
Does it work efficiently?
Will it prediet only the hand gestures or any other movement?
Incase of live input how efficient will the translation will happen?
How the output will be display?
If bulk input is provided how the model will handle it
What do they
SAY AND DO?
attitude in public
appearance
behavior towards others
Will the human hearing voices will be clear and audible?
How it will prediet the output if the input is given in the live stream?
PAIN
fears
frustrations
obstacles
Possibilities of miss communication
Completing the phase on time & how to prediet the output prefect and how it will be displayed
In case of emergency, will be helpful to overcome the communication problem between the normal people and specially abled
GAIN
"wants" / needs
measures of success
obstacles
Helps the peoples to understand the meaning of deaf and dum language to an ordinary people
It act as a bridge between specially abled and normal people
Provides personalised learning experiences of sign language to the people

Fig 3.1.1 Empathy Map

3.2. IDEATION & BRAINSTORMING

Step-1: Team Gathering, Collaboration and Select the Problem Statement



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.

1 **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

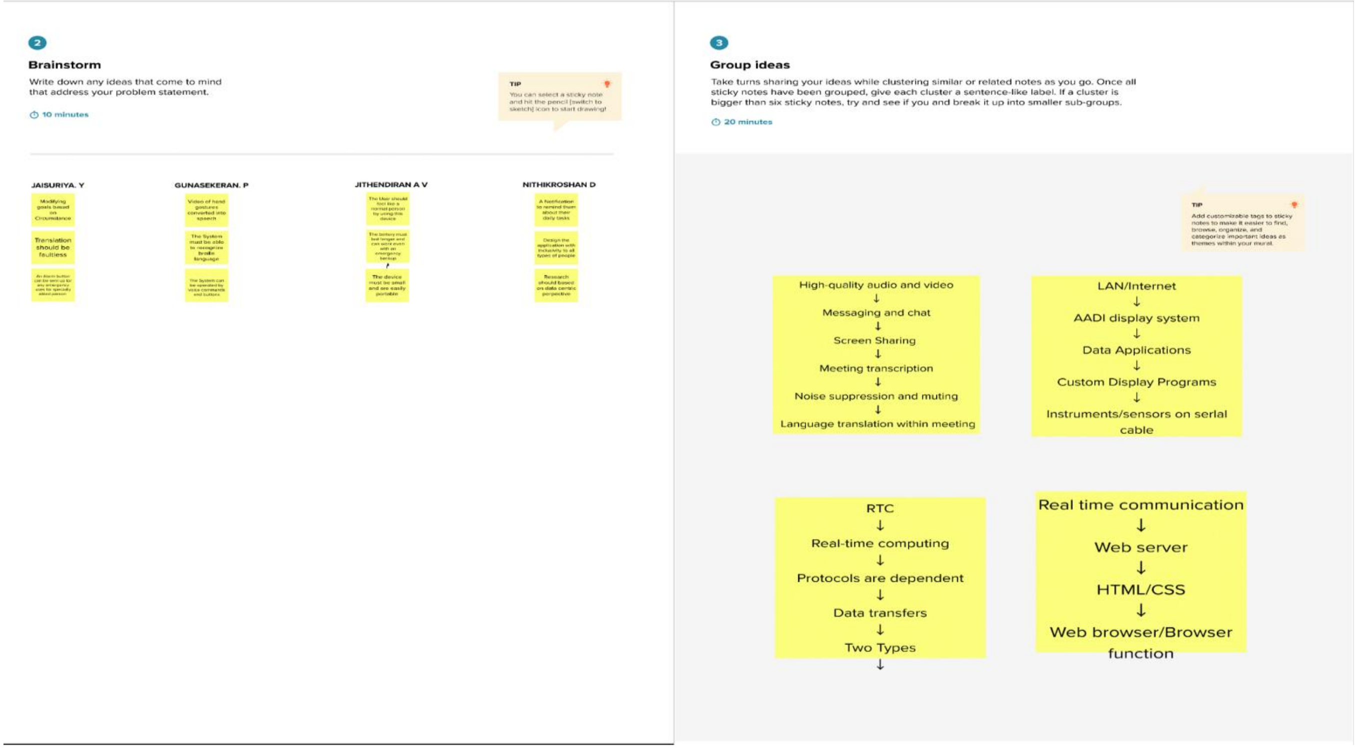
PROBLEM
REAL TIME COMMUNICATION SYSTEM POWERED BY AI FOR SPECIALLY ABLED

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.

Fig 3.2.1 Problem Statement Collection

Step-2: Brainstorm, Idea Listing and Grouping



2

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!

JAISURIYA. Y

- Modifying goals based on Circumstance
- Translation should be faultless
- An Alarm button can be set up for any emergency uses for specially abled person

GUNASEKERAN. P

- Video of hand gestures converted into speech
- The System must be able to recognize braille language
- The System can be operated by voice commands and buttons

JITHENDIRAN A V

- The User should feel like a normal person by using this device
- The battery must last longer and can work even with an emergency backup
- The device must be small and are easily portable

NITHIKROSHAN D

- A Notification to remind them about their daily tasks
- Design the application with inclusivity to all types of people
- Research should based on data centric perpective

3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, 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.

High-quality audio and video
↓
Messaging and chat
↓
Screen Sharing
↓
Meeting transcription
↓
Noise suppression and muting
↓
Language translation within meeting

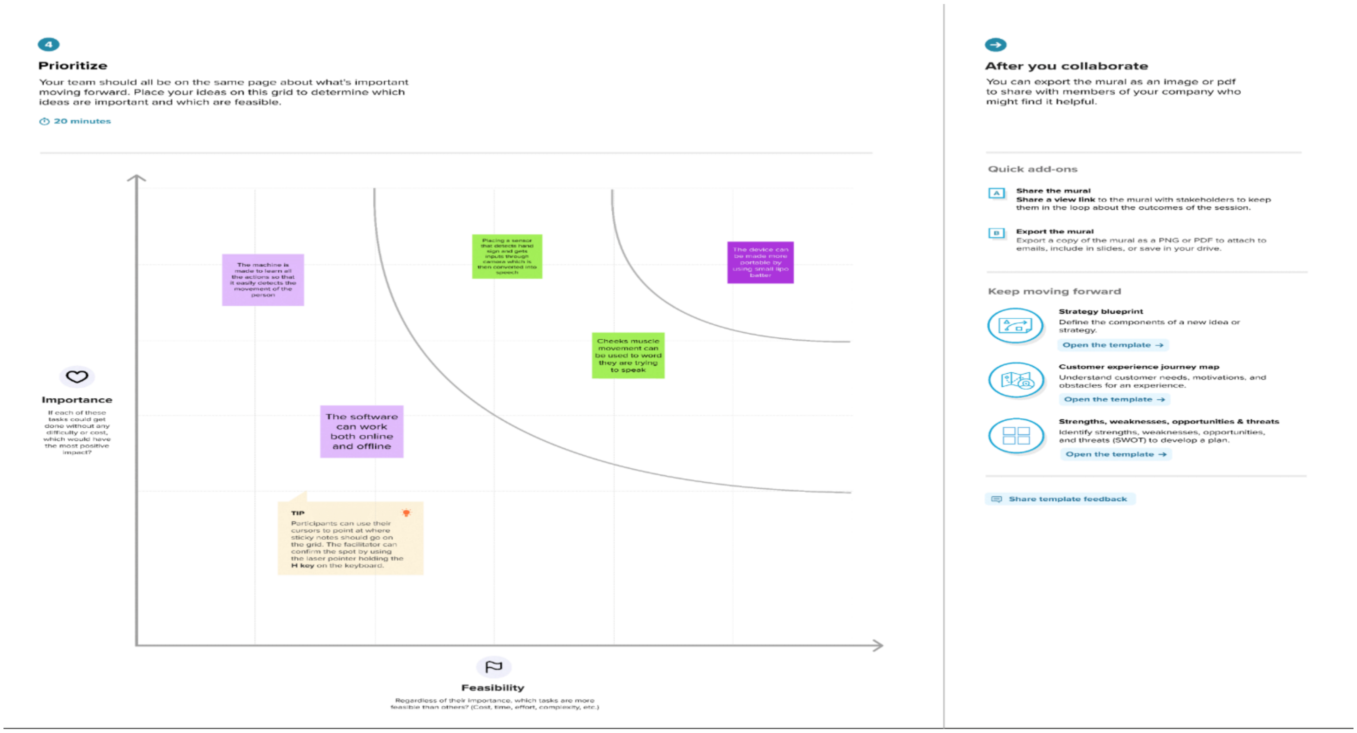
LAN/Internet
↓
AADI display system
↓
Data Applications
↓
Custom Display Programs
↓
Instruments/sensors on serial cable

RTC
↓
Real-time computing
↓
Protocols are dependent
↓
Data transfers
↓
Two Types
↓

Real time communication
↓
Web server
↓
HTML/CSS
↓
Web browser/Browser function

Fig 3.2.2 Listing of Idea

Step-3: Idea Prioritization



4

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

- The machine is made to learn all the actions so that it easily detects the movement of the person
- Placing a sensor that detects hand sign and gets inputs through camera which is then converted into speech
- The device can be made more portable by using small lipo batter
- Cheeks muscle movement can be used to word they are trying to speak
- The software can work both online and offline

TIP

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the **H key** on the keyboard.

Importance

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

Feasibility

Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

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 →

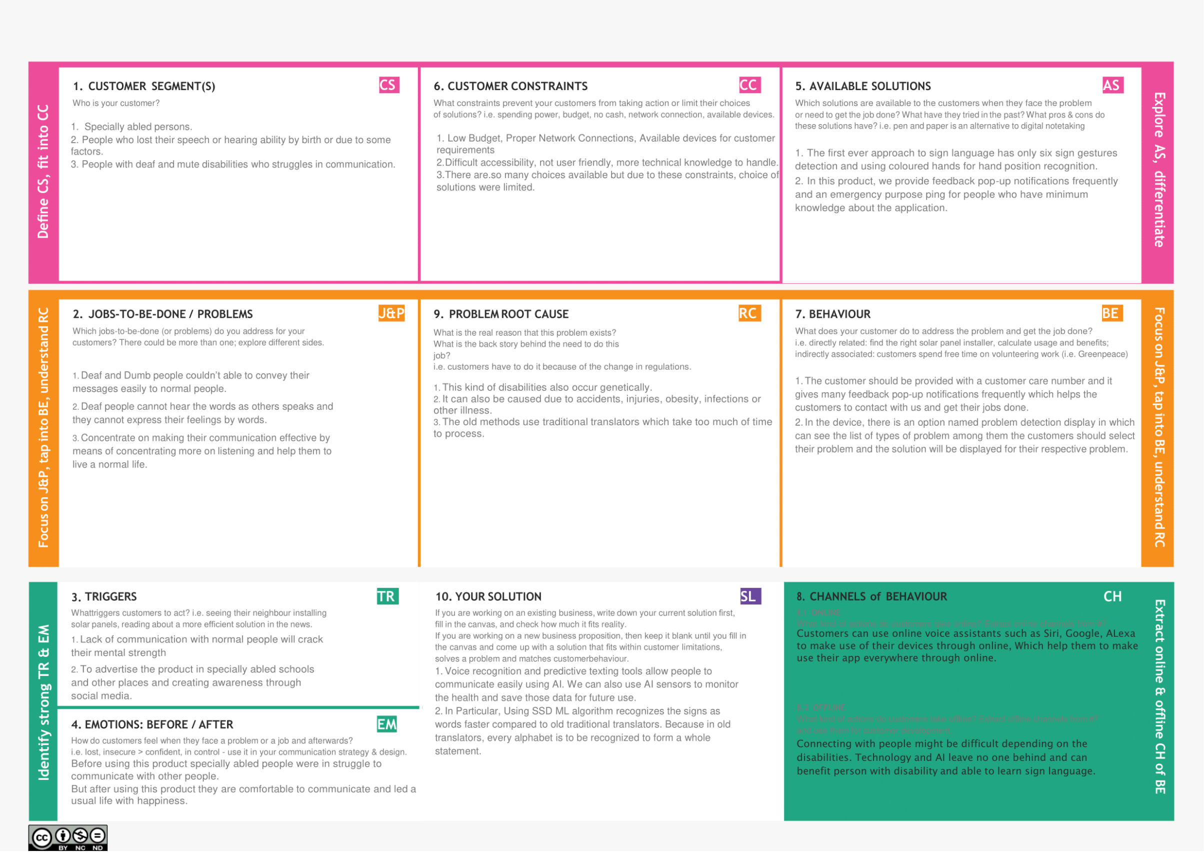
Share template feedback

Fig 3.2.3 Idea Prioritization

3.3. PROPOSED SOLUTION

S.No.	Parameter	Description
1.	Problem Statement (Problem to be resolved)	Communication between deaf-mute and anormal person has always been a challenging task. It is very difficult for mute people to convey their message to normal people in emergency times as wellas in normal times.
2.	Idea / Solution description	**1.** Voice Conversion System with Hand Gesture Recognition and translationwill be very useful to have a proper conversation between a normal person and an impaired person in any language. **2.** To design and implement a system using artificial intelligence, image processing and data mining concepts to take input as hand gestures.
3.	Novelty / Uniqueness	We are using a convolution neural network to create a model that is trained on different hand gestures and an app is built for the use of this mode. **1.** Artificial Intelligence developed the app called GnoSys that uses neuralnetworks and computer vision. **2.** It recognizes the video of sign language speaker and then smart algorithms translate it into speech.
4.	Social Impact / CustomerSatisfaction	**1.** The main purpose of this application isto make deaf-mute people feel independent and more confident. **2.** About two thirds of people with a mobility and dexterity disability are mostlikely to experience a great deal of difficulty with everyday activities.
5.	Business Model (Revenue Model)	1. AI can generate revenue throughdirect customers and collaborate withhealth care sector and generate revenue from their customers. 2. B2B setting uses to employ deaf and mute employees can use to convey messages according to the company.
6.	Scalability of the Solution	1. Enhance people with disabilities to step into a world where there are facing difficulties in communication. 2. AI technology helps disabled people to open up new opportunities for accessibility inclusion in society and independent living. 3. It might open the door to more cutting edge and creative approaches to the most difficult problems facing disadvantaged People.

3.4. PROBLEM SOLUTION FIT



Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Who is your customer?

1. Specially abled persons.
2. People who lost their speech or hearing ability by birth or due to some factors.
3. People with deaf and mute disabilities who struggles in communication.

6. CUSTOMER CONSTRAINTS CC

What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.

1. Low Budget, Proper Network Connections, Available devices for customer requirements
2.Difficult accessibility, not user friendly, more technical knowledge to handle.
3.There are.so many choices available but due to these constraints, choice of solutions were limited.

5. AVAILABLE SOLUTIONS AS

Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking

1. The first ever approach to sign language has only six sign gestures detection and using coloured hands for hand position recognition.
2. In this product, we provide feedback pop-up notifications frequently and an emergency purpose ping for people who have minimum knowledge about the application.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.

1. Deaf and Dumb people couldn't able to convey their messages easily to normal people.
2. Deaf people cannot hear the words as others speaks and they cannot express their feelings by words.
3. Concentrate on making their communication effective by means of concentrating more on listening and help them to live a normal life.

9. PROBLEM ROOT CAUSE RC

What is the real reason that this problem exists?
What is the back story behind the need to do this job?
i.e. customers have to do it because of the change in regulations.

1. This kind of disabilities also occur genetically.
2. It can also be caused due to accidents, injuries, obesity, infections or other illness.
3. The old methods use traditional translators which take too much of time to process.

7. BEHAVIOUR BE

What does your customer do to address the problem and get the job done?
i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)

1. The customer should be provided with a customer care number and it gives many feedback pop-up notifications frequently which helps the customers to contact with us and get their jobs done.
2. In the device, there is an option named problem detection display in which can see the list of types of problem among them the customers should select their problem and the solution will be displayed for their respective problem.

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

Whattriggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.

1. Lack of communication with normal people will crack their mental strength
2. To advertise the product in specially abled schools and other places and creating awareness through social media.

4. EMOTIONS: BEFORE / AFTER EM

How do customers feel when they face a problem or a job and afterwards?
i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

Before using this product specially abled people were in struggle to communicate with other people.
But after using this product they are comfortable to communicate and led a usual life with happiness.

10. YOUR SOLUTION SL

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customerbehaviour.

1. Voice recognition and predictive texting tools allow people to communicate easily using AI. We can also use AI sensors to monitor the health and save those data for future use.
2. In Particular, Using SSD ML algorithm recognizes the signs as words faster compared to old traditional translators. Because in old translators, every alphabet is to be recognized to form a whole statement.

8. CHANNELS of BEHAVIOUR CH

8.1 ONLINE

What kind of actions do customers take online? Extract online channels from #7

Customers can use online voice assistants such as Siri, Google, ALexa to make use of their devices through online, Which help them to make use their app everywhere through online.

8.2 OFFLINE

What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.

Connecting with people might be difficult depending on the disabilities. Technology and AI leave no one behind and can benefit person with disability and able to learn sign language.

Extract online & offline CH of BE

Fig 3.4.1 Problem Solution Fit

4. REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIn
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 share the message by drawing
FR-6	Emergency templates	Select emergency templates icon to pass the message quickly

4.2. 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 access will be kept away from at max.
NFR-3	Reliability	This application has robust adaptation to non-critical 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.

5. PROJECT DESIGN

5.1. DATA FLOW DIAGRAMS

❖ Level 0 – DFD

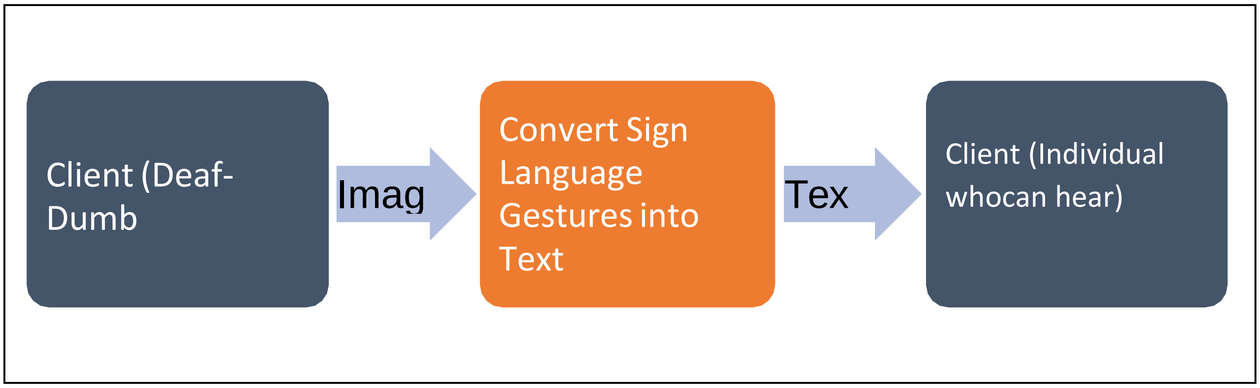

Client (Deaf-Dumb
Imag
Convert Sign Language Gestures into Text
Tex
Client (Individual whocan hear)

Fig 5.1.1 Data Flow Diagram – Level 0

❖ Level 1 – DFD

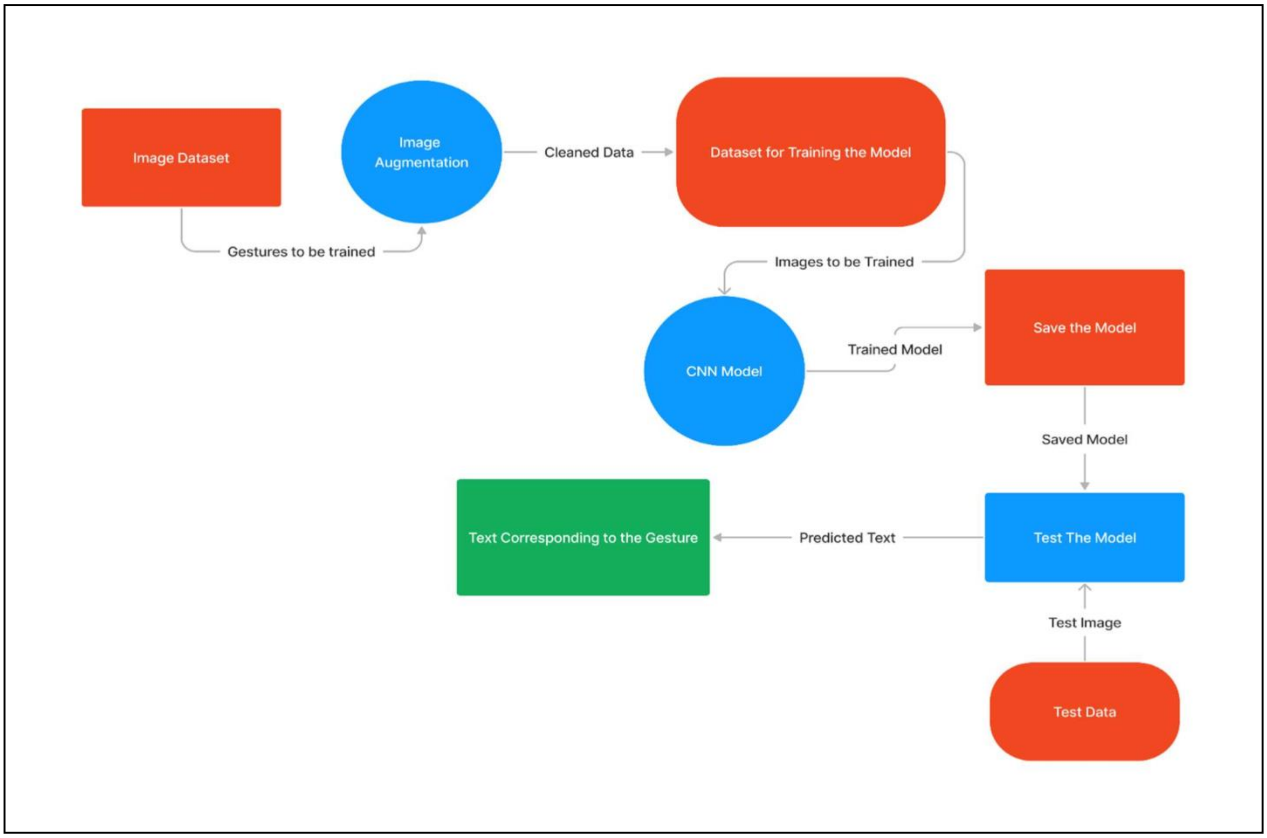


Fig 5.1.2 Data Flow Diagram – Level 1

- Simplified Flow Diagram

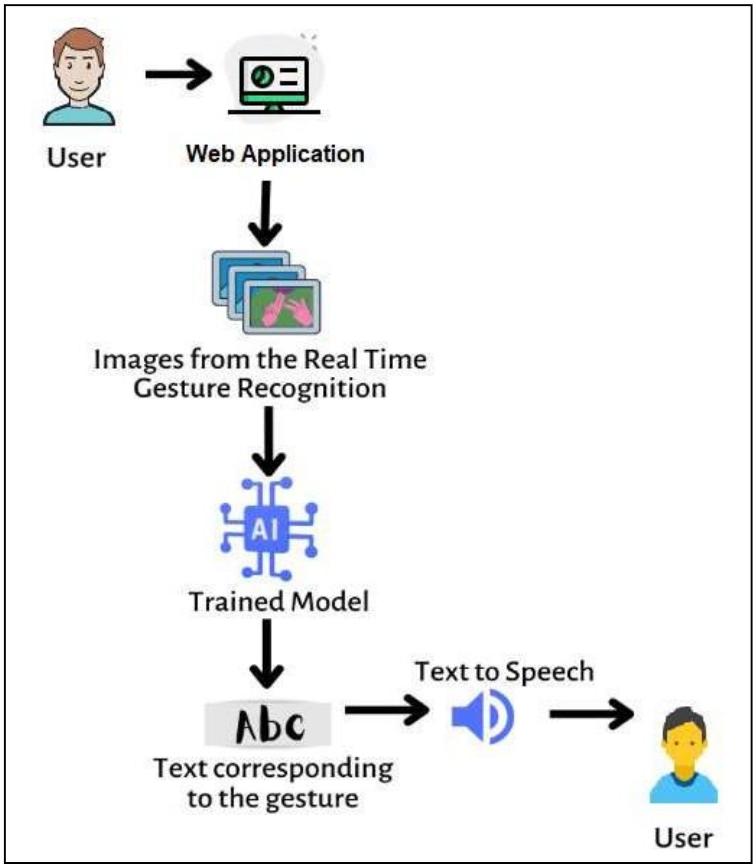

User
Web Application
Images from the Real Time Gesture Recognition
AI
Trained Model
Abc
Text corresponding to the gesture
Text to Speech
User

Fig 5.1.3 Simplified flow Diagram

5.2. SOLUTION & TECHNICAL ARCHITECTURE

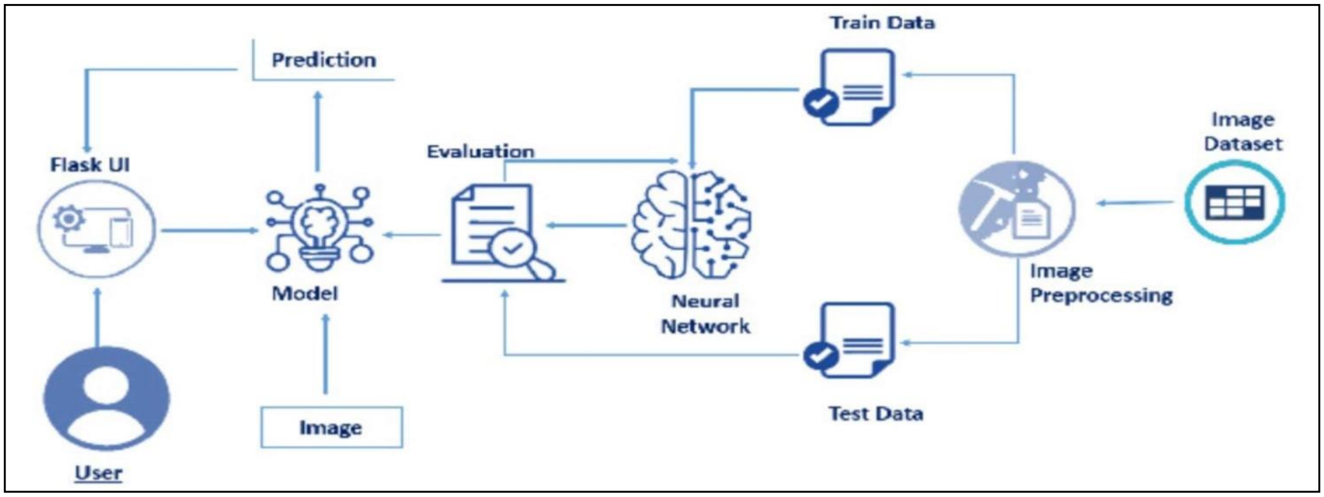


Fig 5.2.1 Technical Architecture

5.3. USER STORIES

User Type	Functional Requirement (Epic)	User StoryNumber	User Story / Task	Acceptancecriteria
Customer (People who cannot hear)	Convert sign language into text	USN - 1	As a user, I can open camera in the app and record my signs to be converted into text	I can communicate with normal people effectively
		USN - 2	As a user, I can upload my previous sign gestures to communicate faster	I can have a list of frequently used signs to make for fast reference
	Dashboard	USN – 3	Buttons to record the signs, to convert in real-time and other buttons should be available in the right places	All features must be easily accessible
		USN – 4	Emergency calls must be available so that I can press a button in times of emergency to get the attention of others	I can feel safe because of the Emergency Button which can get me help.
Customer (People who can hear and talk)	Convert sign language into text	USN - 5	As a user, I can open back camera in the app and record the specially abled people’s signs to be converted into text	I can understand the mode of communication of specially-abled people effectively
	Show the message to convey in the form of text	USN - 6	As a user, I can open a Text-pad that is available in the app, so that the deaf people can see the message I need to convey	I can convey my message to them effectively
Administrator	Integrate application with trained model	USN - 7	As an admin, I should be able to integrate the AI model into the application and maintain the application	I can give best experience to app users

6. PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint	Functional Requirement(Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data Collection	USN-1	Collect Dataset.	9	High	Jaisuriya. Y Jithendiran. A. V
Sprint-1		USN-2	Image preprocessing	8	Medium	Gunasekeran. P Nithikroshan.D
Sprint-2	Model Building	USN-3	Import the required libraries, add the necessary layers and compile the model	10	High	Jaisuriya. Y Jithendiran. A. V
Sprint-2		USN-4	Training the image classification model using CNN	7	Medium	Jaisuriya. Y Jithendiran. A. V
Sprint-3	Training and Testing	USN-5	Training the model and testing the model's performance	9	High	Gunasekeran. P Nithikroshan.D
Sprint-4	Implementation ofthe application	USN-6	Converting the input sign languageimages into English alphabets	8	Medium	Jaisuriya. Y Jithendiran. A. V

6.2 SPRINT DELIVERY SCHEDULE

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

- Burn down Chart

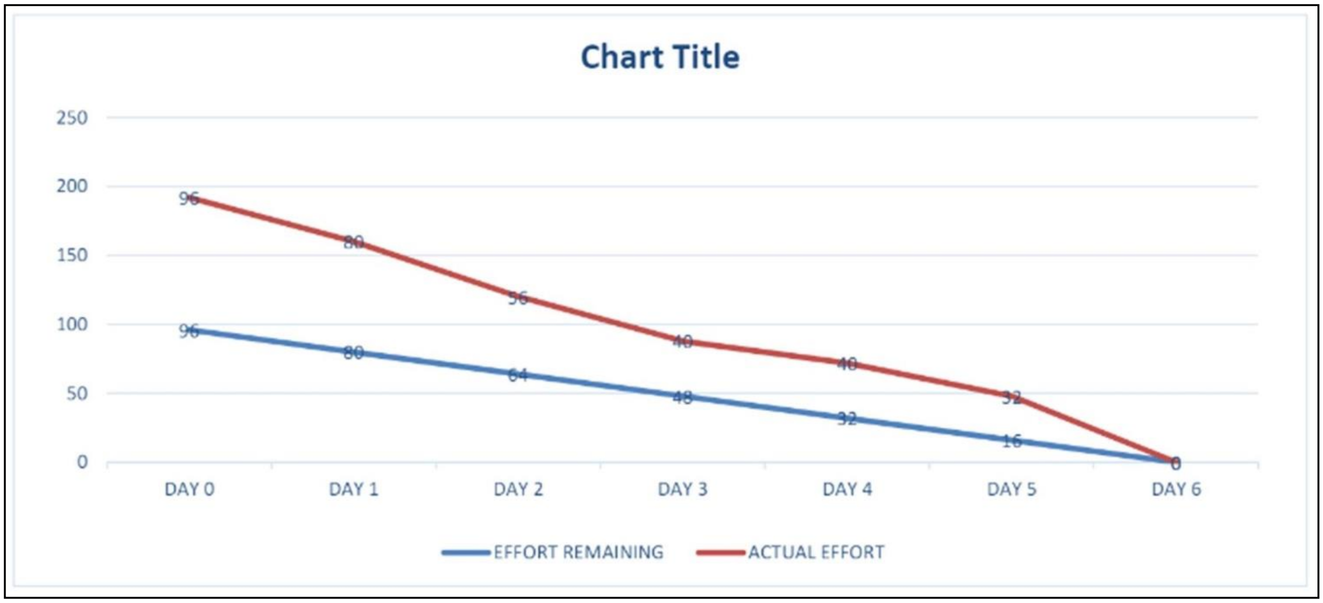
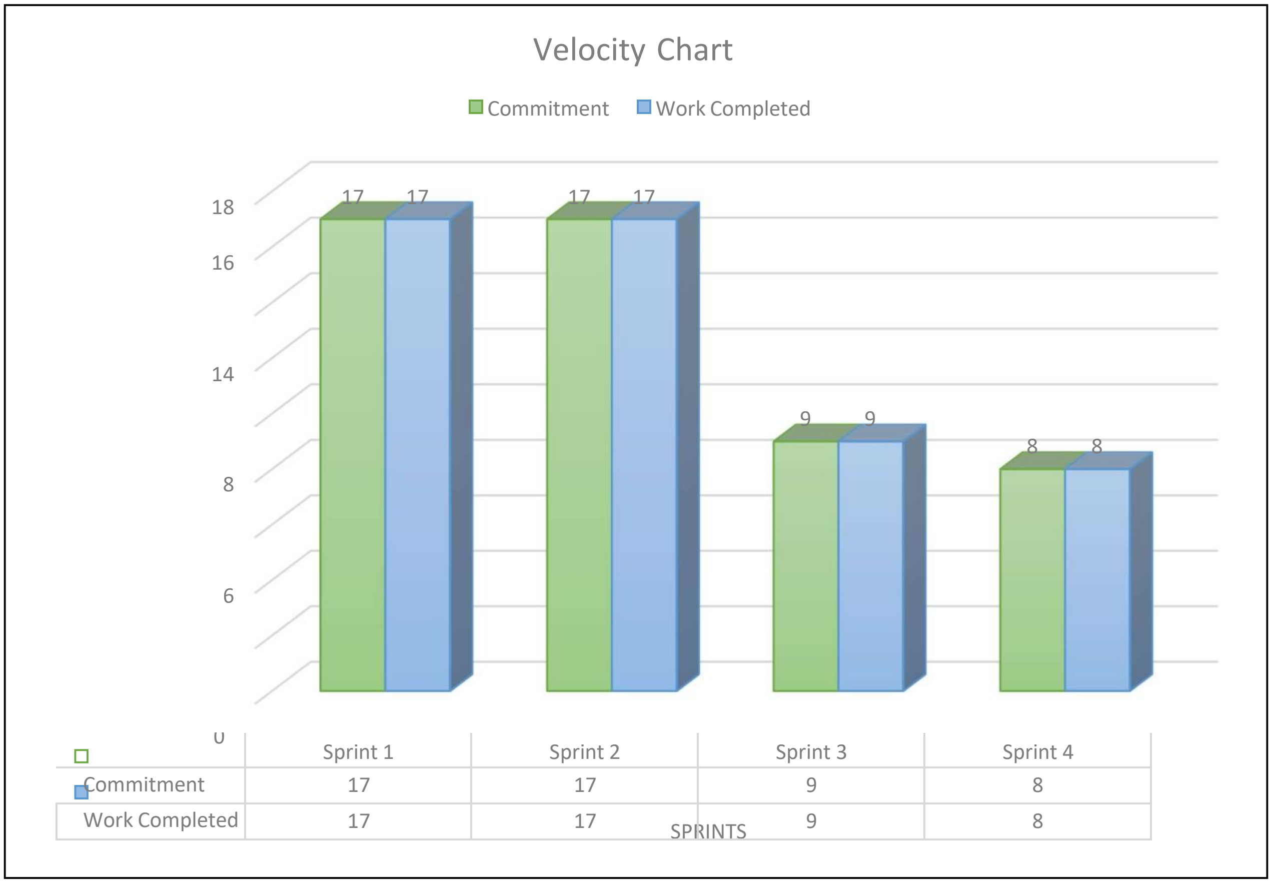


Fig 6.2.1 Burn down chart

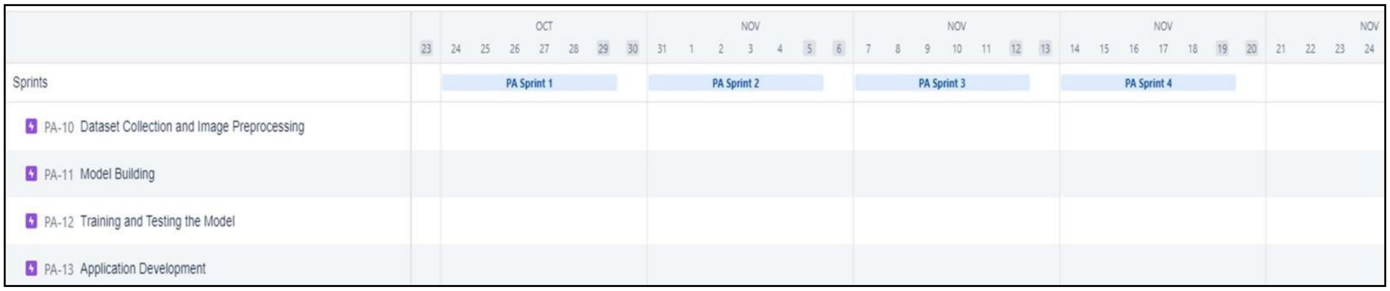
- Velocity Chart



	Sprint 1	Sprint 2	Sprint 3	Sprint 4
🟩 Commitment	17	17	9	8
🟦 Work Completed	17	17	9	8

Fig 6.2.2 Velocity Chart

6.3. REPORTS FROM JIRA



Sprints

PA Sprint 1 PA Sprint 2 PA Sprint 3 PA Sprint 4

PA-10 Dataset Collection and Image Preprocessing

PA-11 Model Building

PA-12 Training and Testing the Model

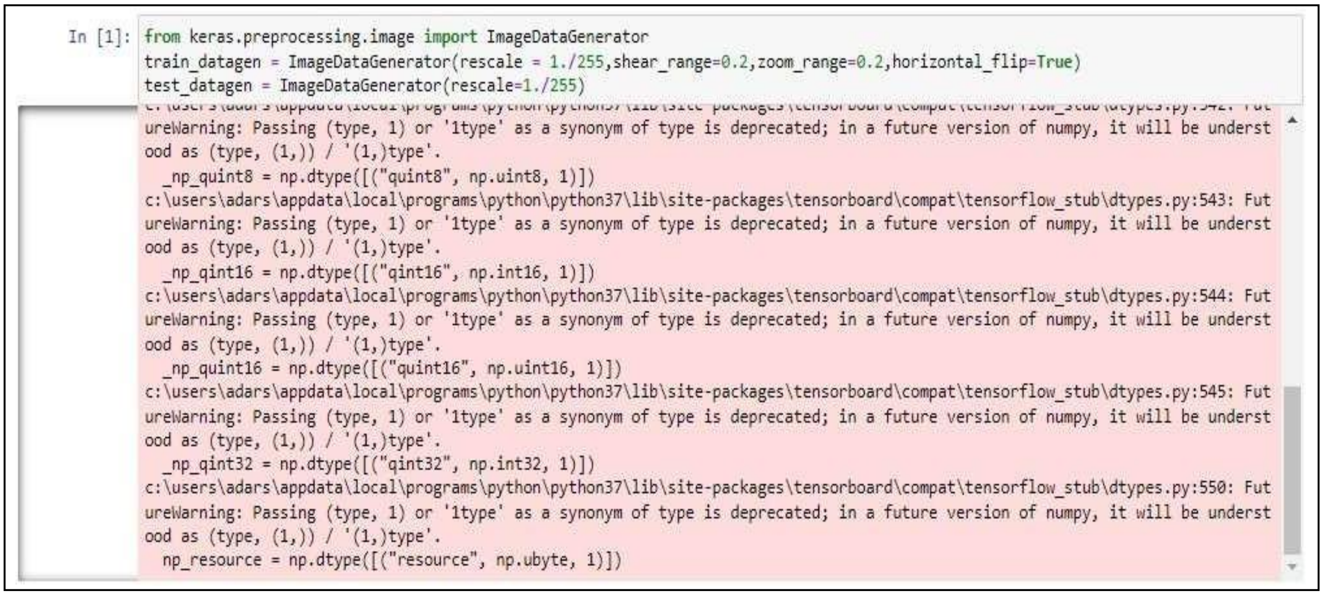
PA-13 Application Development

Fig 6.3.1 Jira Report

7. CODING & SOLUTIONING

7.1. IMAGE PREPROCESSING

- Image pre-processing includes zooming, shearing, flipping to increase the robustness of the model after it is built. Keras package is used for pre-processing images.
- Importing Image Data Generator Library to create an instance for which include shearing, rescale, zooming, etc., to make the model robust with different types of images.

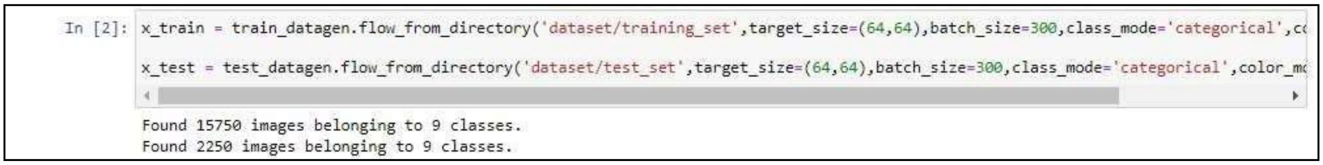


```
In [1]: from keras.preprocessing.image import ImageDataGenerator
        train_datagen = ImageDataGenerator(rescale = 1./255,shear_range=0.2,zoom_range=0.2,horizontal_flip=True)
        test_datagen = ImageDataGenerator(rescale=1./255)

        c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:542: Fut
        ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
        ood as (type, (1,)) / '(1,)type'.
          _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
        c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:543: Fut
        ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
        ood as (type, (1,)) / '(1,)type'.
          _np_qint16 = np.dtype([("qint16", np.int16, 1)])
        c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:544: Fut
        ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
        ood as (type, (1,)) / '(1,)type'.
          _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
        c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:545: Fut
        ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
        ood as (type, (1,)) / '(1,)type'.
          _np_qint32 = np.dtype([("qint32", np.int32, 1)])
        c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:550: Fut
        ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
        ood as (type, (1,)) / '(1,)type'.
          np_resource = np.dtype([("resource", np.ubyte, 1)])
```

Fig 7.1.1 Image Processing

- Applying Image Data Generator Functionality to Train and Test Set

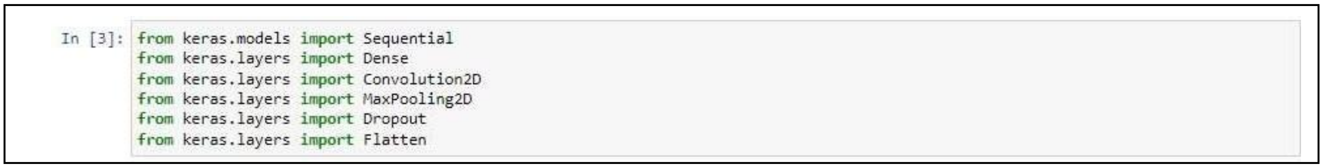
Fig 7.1.2 Train and Test Data Set



```
In [2]: x_train = train_datagen.flow_from_directory('dataset/training_set',target_size=(64,64),batch_size=300,class_mode='categorical',co

        x_test = test_datagen.flow_from_directory('dataset/test_set',target_size=(64,64),batch_size=300,class_mode='categorical',color_mo

        Found 15750 images belonging to 9 classes.
        Found 2250 images belonging to 9 classes.
```

7.2. MODEL BUILDING

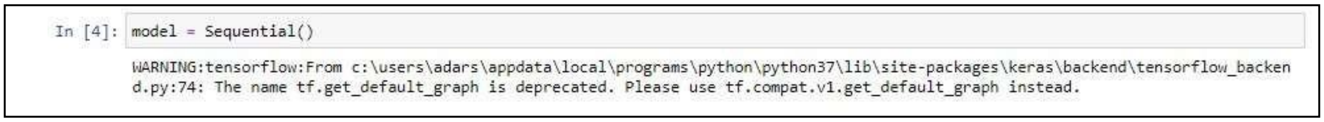
- Importing the Required Model Building Libraries



```
In [3]: 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
```

Fig 7.2.1 Importing Libraries

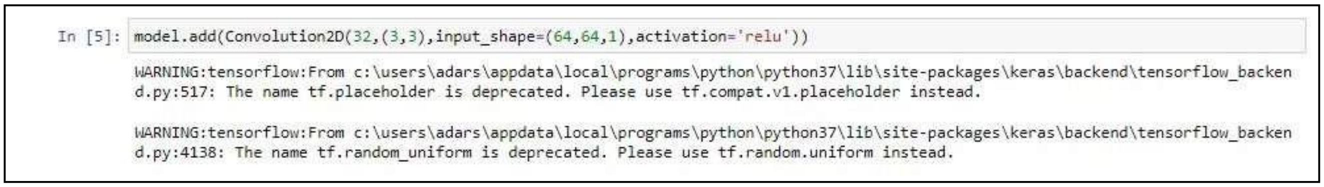
- Initializing the Mode



```
In [4]: model = Sequential()

        WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_backen
        d.py:74: The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.
```

Fig 7.2.2 Initializing the Mode

- Adding the Convolution Layer

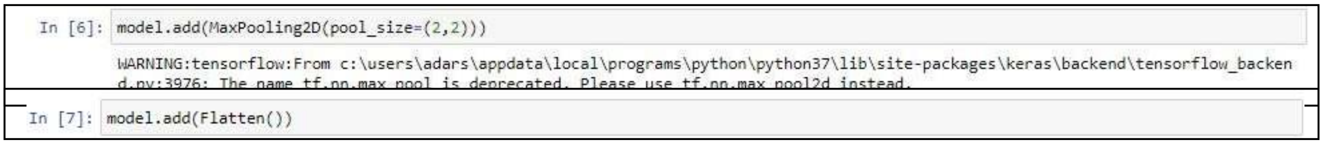


```
In [5]: model.add(Convolution2D(32,(3,3),input_shape=(64,64,1),activation='relu'))

        WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_backen
        d.py:517: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

        WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_backen
        d.py:4138: The name tf.random_uniform is deprecated. Please use tf.random.uniform instead.
```

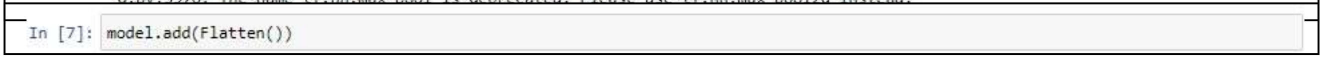
Fig 7.2.3 Adding the Convolution Layer

- Adding the Pooling Layer

Fig 7.2.4 Aadding The Pooling Layer



```
In [6]: model.add(MaxPooling2D(pool_size=(2,2)))

        WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_backen
        d.py:3976: The name tf.nn.max_pool is deprecated. Please use tf.nn.max_pool2d instead.
```

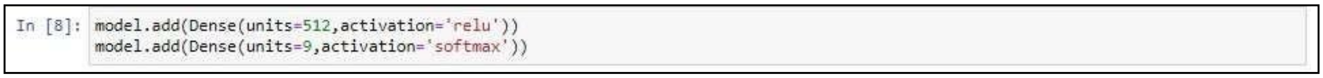


```
In [7]: model.add(Flatten())
```

- Adding the Flatten Layer

Fig 7.2.5 Aadding Flatten Layer

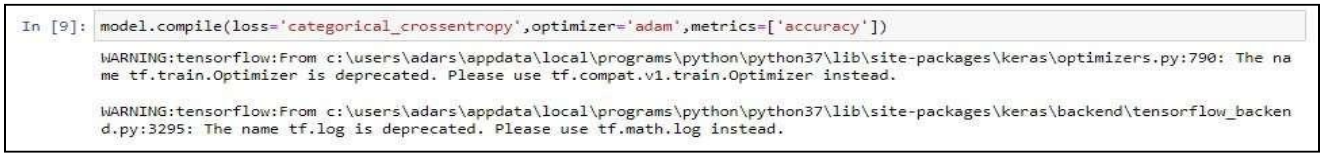
- Adding the Dense Layers



```
In [8]: model.add(Dense(units=512,activation='relu'))
        model.add(Dense(units=9,activation='softmax'))
```

Fig 7.2.6 Aadding Dense Layer

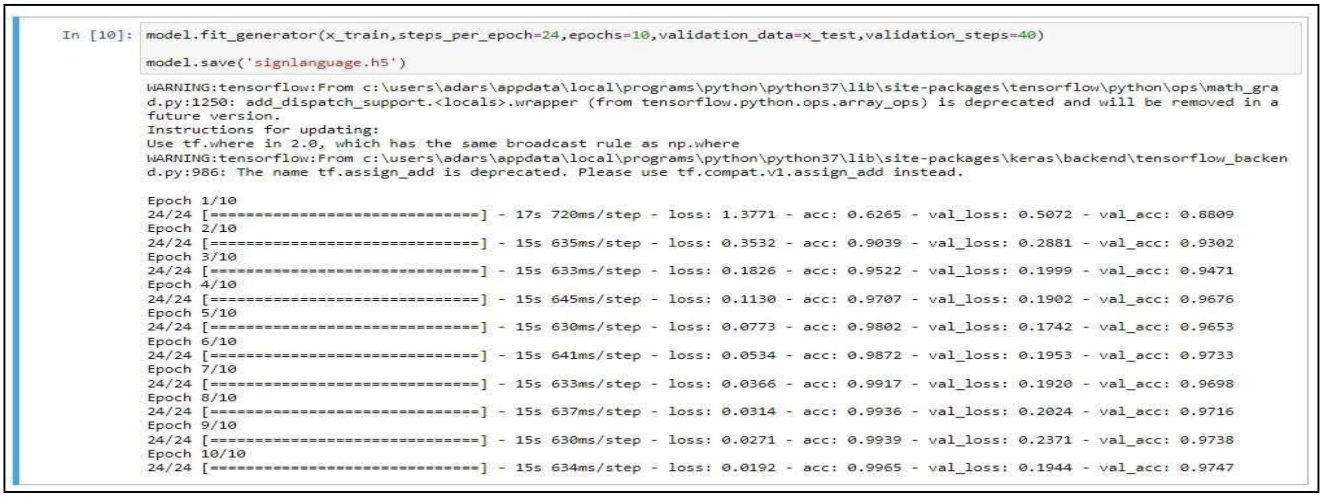
- Compiling the Model



```
In [9]: model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])

        WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\optimizers.py:790: The na
        me tf.train.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.

        WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_backen
        d.py:3295: The name tf.log is deprecated. Please use tf.math.log instead.
```

Fig 7.2.7 Compiling the Model

- Fit and Saving the Model

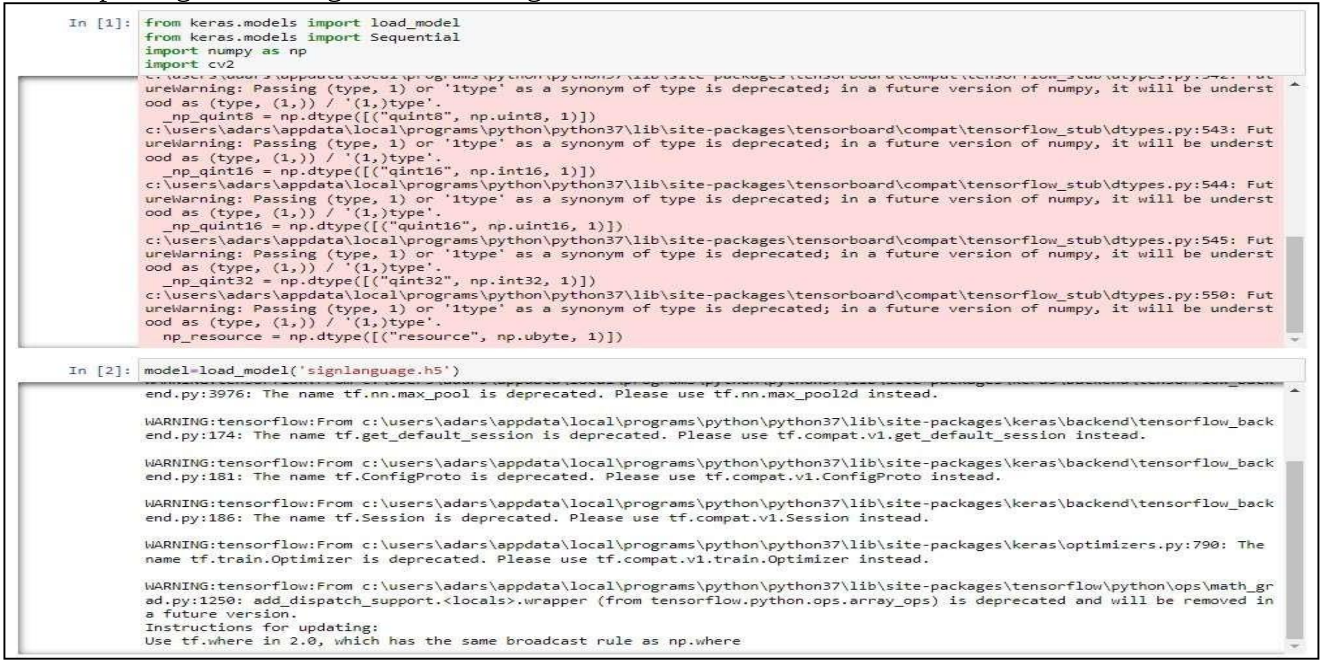


```
In [10]: model.fit_generator(x_train,steps_per_epoch=24,epochs=10,validation_data=x_test,validation_steps=40)

         model.save('signlanguage.h5')

         WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorflow\python\ops\math_gra
         d.py:1250: add_dispatch_support.<locals>.wrapper (from tensorflow.python.ops.array_ops) is deprecated and will be removed in a
         future version.
         Instructions for updating:
         Use tf.where in 2.0, which has the same broadcast rule as np.where
         WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_backen
         d.py:986: The name tf.assign_add is deprecated. Please use tf.compat.v1.assign_add instead.

         Epoch 1/10
         24/24 [==============================] - 17s 720ms/step - loss: 1.3771 - acc: 0.6265 - val_loss: 0.5072 - val_acc: 0.8809
         Epoch 2/10
         24/24 [==============================] - 15s 635ms/step - loss: 0.3532 - acc: 0.9039 - val_loss: 0.2881 - val_acc: 0.9302
         Epoch 3/10
         24/24 [==============================] - 15s 633ms/step - loss: 0.1826 - acc: 0.9522 - val_loss: 0.1999 - val_acc: 0.9471
         Epoch 4/10
         24/24 [==============================] - 15s 645ms/step - loss: 0.1130 - acc: 0.9707 - val_loss: 0.1902 - val_acc: 0.9676
         Epoch 5/10
         24/24 [==============================] - 15s 630ms/step - loss: 0.0773 - acc: 0.9802 - val_loss: 0.1742 - val_acc: 0.9653
         Epoch 6/10
         24/24 [==============================] - 15s 641ms/step - loss: 0.0534 - acc: 0.9872 - val_loss: 0.1953 - val_acc: 0.9733
         Epoch 7/10
         24/24 [==============================] - 15s 633ms/step - loss: 0.0366 - acc: 0.9917 - val_loss: 0.1920 - val_acc: 0.9698
         Epoch 8/10
         24/24 [==============================] - 15s 637ms/step - loss: 0.0314 - acc: 0.9936 - val_loss: 0.2024 - val_acc: 0.9716
         Epoch 9/10
         24/24 [==============================] - 15s 630ms/step - loss: 0.0271 - acc: 0.9939 - val_loss: 0.2371 - val_acc: 0.9738
         Epoch 10/10
         24/24 [==============================] - 15s 634ms/step - loss: 0.0192 - acc: 0.9965 - val_loss: 0.1944 - val_acc: 0.9747
```

Fig 7.2.8 Fit and Saving the Model

7.3. TESTING THE MODEL

- Importing the Packages and Loading the Saved Model



```
In [1]: from keras.models import load_model
        from keras.models import Sequential
        import numpy as np
        import cv2
```

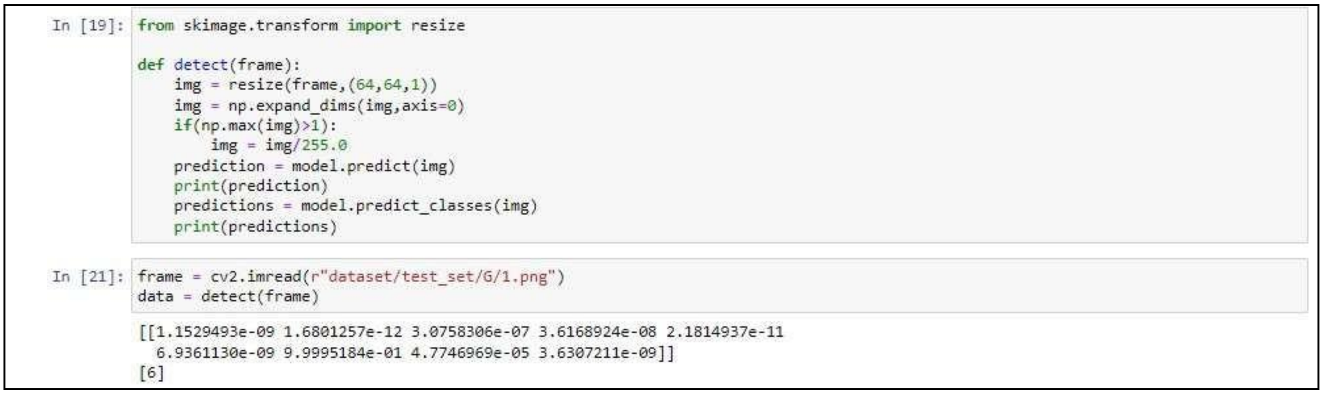
```
ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
ood as (type, (1,)) / '(1,)type'.
  _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:543: Fut
ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
ood as (type, (1,)) / '(1,)type'.
  _np_qint16 = np.dtype([("qint16", np.int16, 1)])
c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:544: Fut
ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
ood as (type, (1,)) / '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:545: Fut
ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
ood as (type, (1,)) / '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:550: Fut
ureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be underst
ood as (type, (1,)) / '(1,)type'.
  np_resource = np.dtype([("resource", np.ubyte, 1)])
```

```
In [2]: model=load_model('signlanguage.h5')
```

```
end.py:3976: The name tf.nn.max_pool is deprecated. Please use tf.nn.max_pool2d instead.

WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_back
end.py:174: The name tf.get_default_session is deprecated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_back
end.py:181: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\backend\tensorflow_back
end.py:186: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\keras\optimizers.py:790: The
name tf.train.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From c:\users\adars\appdata\local\programs\python\python37\lib\site-packages\tensorflow\python\ops\math_gr
ad.py:1250: add_dispatch_support.<locals>.wrapper (from tensorflow.python.ops.array_ops) is deprecated and will be removed in
a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
```

Fig 7.3.1 Load the Model

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



```
In [19]: from skimage.transform import resize

         def detect(frame):
             img = resize(frame,(64,64,1))
             img = np.expand_dims(img,axis=0)
             if(np.max(img)>1):
                 img = img/255.0
             prediction = model.predict(img)
             print(prediction)
             predictions = model.predict_classes(img)
             print(predictions)
```

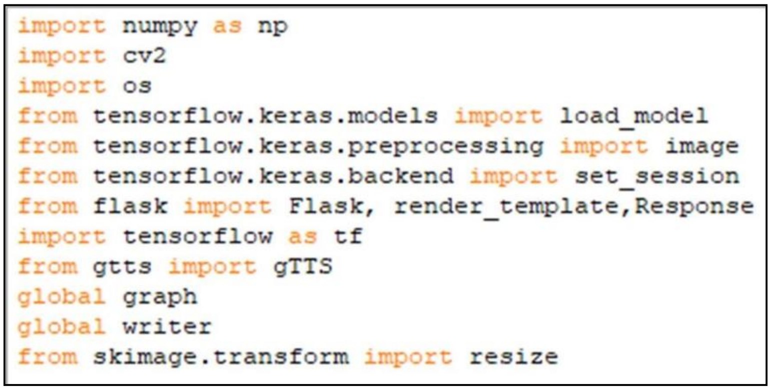
```
In [21]: frame = cv2.imread(r"dataset/test_set/G/1.png")
         data = detect(frame)

         [[1.1529493e-09 1.6801257e-12 3.0758306e-07 3.6168924e-08 2.1814937e-11
           6.9361130e-09 9.9995184e-01 4.7746969e-05 3.6307211e-09]]
         [6]
```

Fig 7.3.2 Test Image, Pre-Processing it And Prediction

- ➢ The output [6] in the above image represents the index value in the array[‘A’,’B’,’C’,’D’,’E’,’F’,’G’,’H’,’I’].
- ➢ Thus, the predicted alphabet is G.

7.4. FLASK APPLICATION

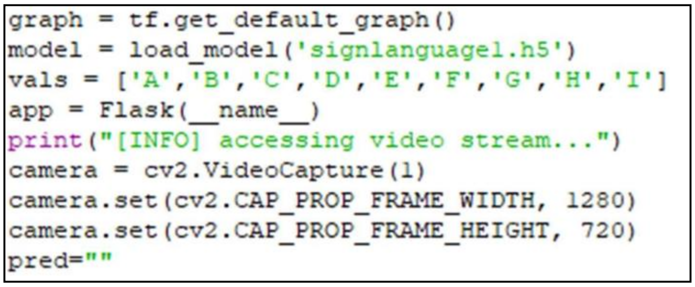
- Loading the required packages (Fig 7.4.1)
- Initializing graph, loading the model, initializing the flask app and loading the video.



```python
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
```

Fig 7.4.1 Loading the required packages

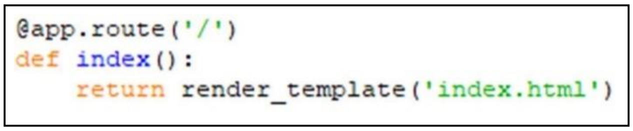
- Graph element is required to work with TensorFlow. So, graph element is created explicitly.



```python
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=""
```

Fig 7.4.2 Initializing graph

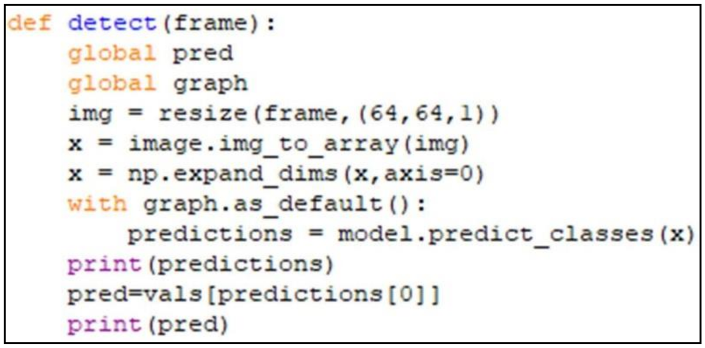
- Configuring the home page



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

Fig 7.4.3 Configure the home page

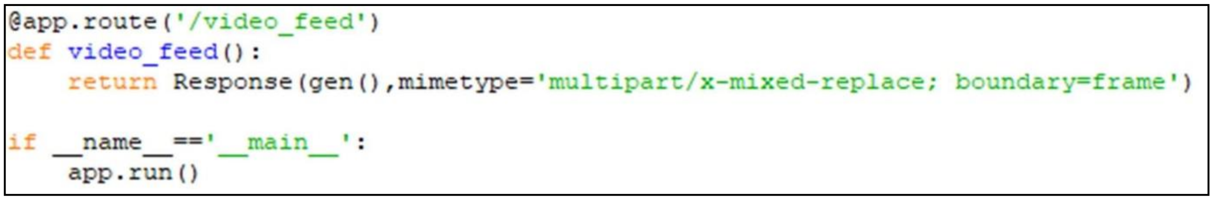
- Pre-processing the frames captured from the camera



```python
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)
```

Fig 7.4.4 Pre-processing the frames

- Video Feed call from the HTML PAGE

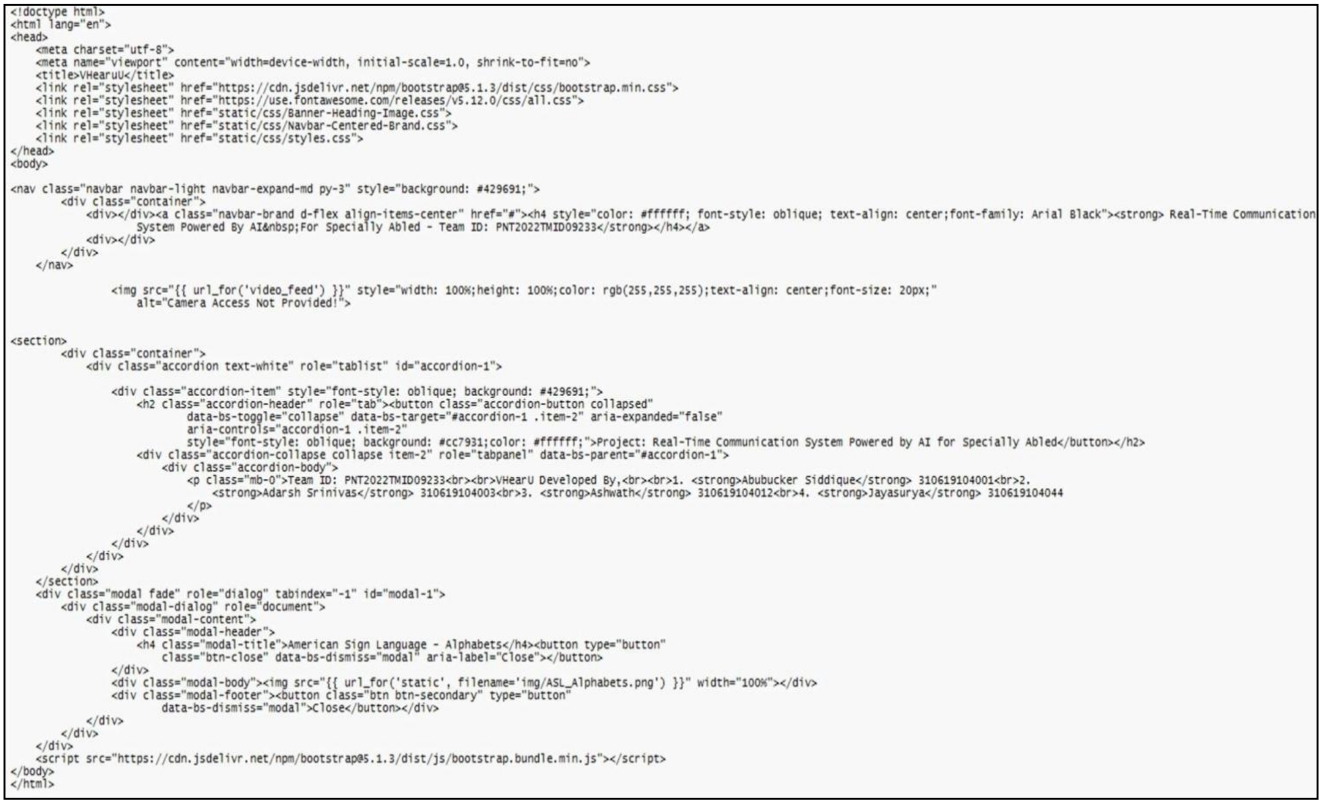


```
@app.route('/video_feed')
def video_feed():
    return Response(gen(),mimetype='multipart/x-mixed-replace; boundary=frame')

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

Fig 7.4.5 Video Feed call

7.5. HTML PAGE

- HTML page to display the processed video on the screen, so that the person can show signs which canbe 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: PNT2022TMID09233</strong></h4></a>
            <div></div>
        </div>
    </nav>

                <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!">


<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: PNT2022TMID09233<br><br>VHearU Developed By,<br><br>1. <strong>Abubucker Siddique</strong> 310619104001<br>2.
                                <strong>Adarsh Srinivas</strong> 310619104003<br>3. <strong>Ashwath</strong> 310619104012<br>4. <strong>Jayasurya</strong> 310619104044
                            </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>
```

Fig 7.5.1 HTML Page

8. TESTING

8.1. 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.

8.2. 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

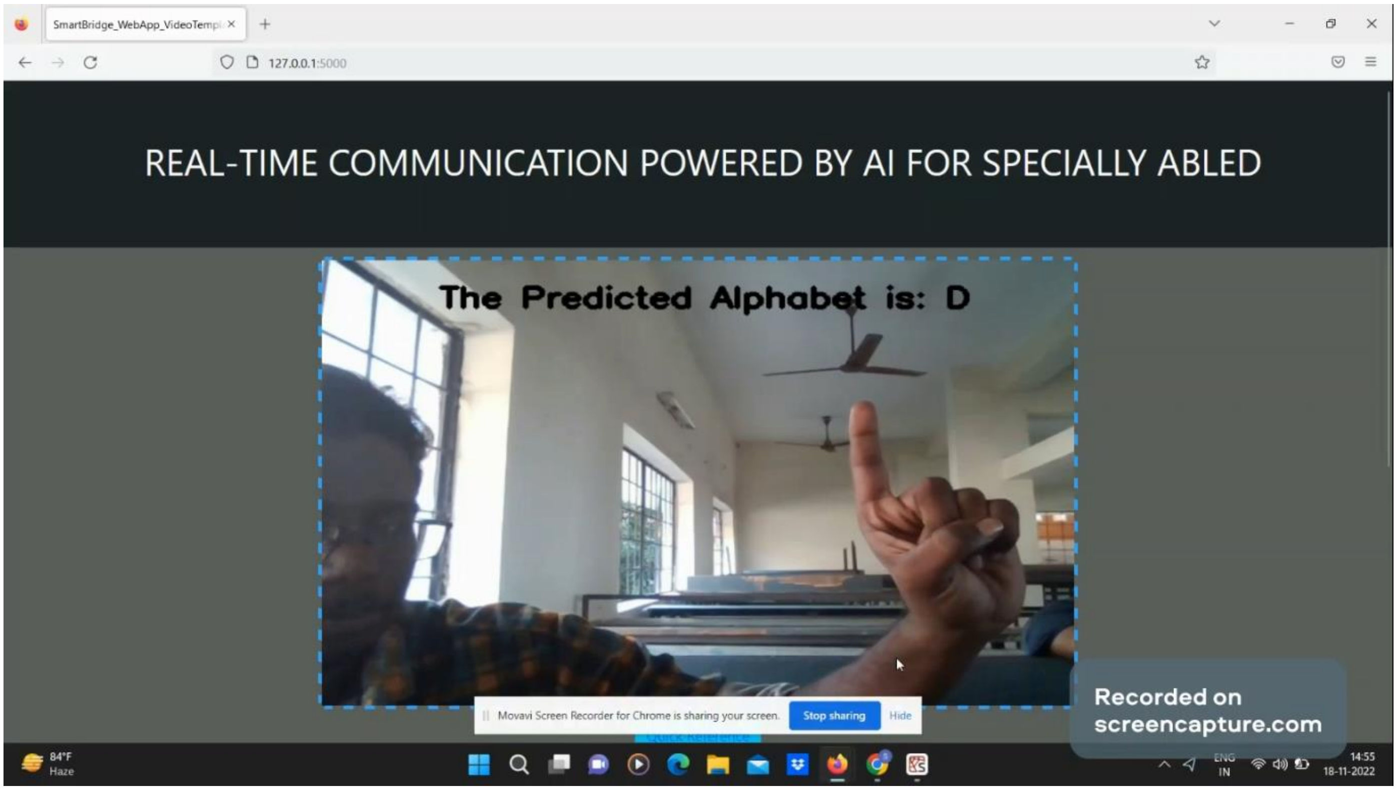
- **Test Case Analysis**

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 itsrespective alphabet accurately.

9. RESULT

9.1 SAMPLE OUTPUT

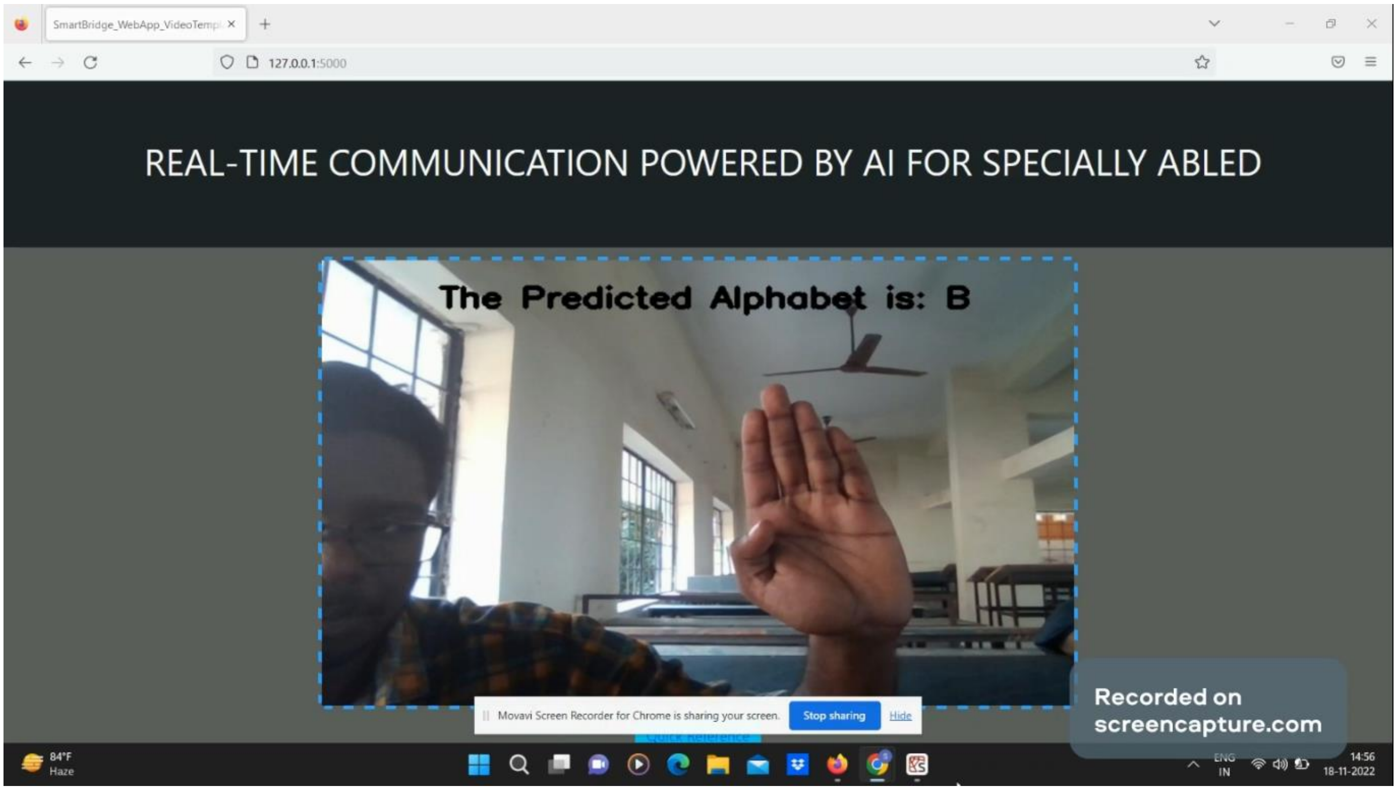


REAL-TIME COMMUNICATION POWERED BY AI FOR SPECIALLY ABLED

The Predicted Alphabet is: D

Movavi Screen Recorder for Chrome is sharing your screen.

Fig 9.1 Predicated Letter "D"



REAL-TIME COMMUNICATION POWERED BY AI FOR SPECIALLY ABLED

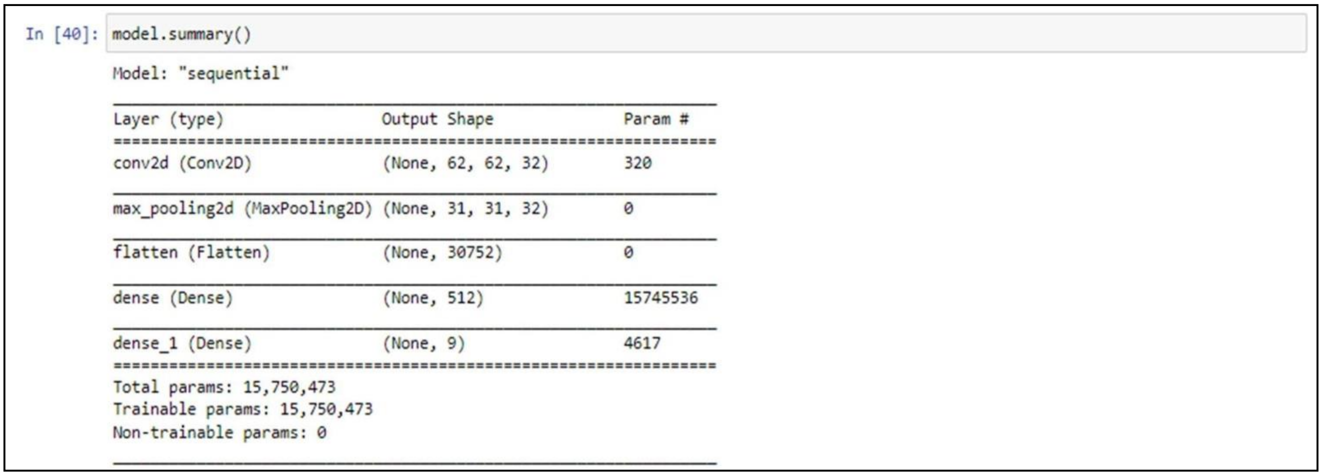
The Predicted Alphabet is: B

Movavi Screen Recorder for Chrome is sharing your screen.

Fig 9.2 Predicated Letter "B"

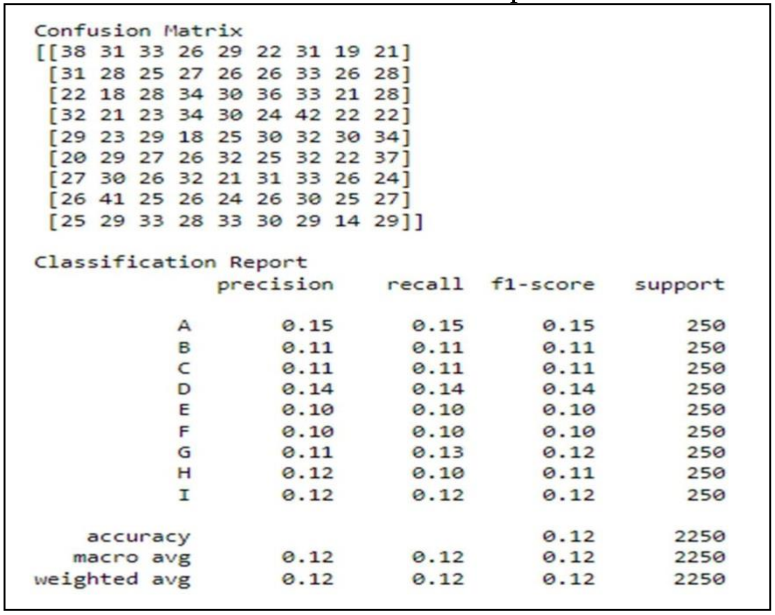
9.2. PERFORMANCE METRICS

- Model Summary



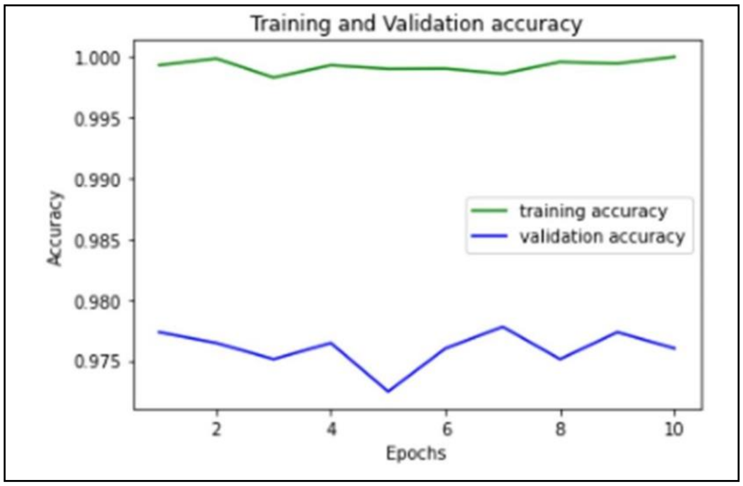
```
In [40]: model.summary()

         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



10. ADVANTAGES & DISADVANTAGES

Advantages

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

Disadvantages

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

11. 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 gesture images, we useda trained dataset for the CNN algorithm. These features combined with 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

12. 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, making the system more convenient and portable. This system is unable to detect gestures made with both hands. Therefore, detecting gestures done with both hands could be a future project.

13. APPENDIX

13.1 SOURCE CODE

- ➢ Source Code is available in the GitHub link provided in Section 13.2.

13.2. GITHUB & PROJECT DEMO LINK

- ➢ GitHub Link: https://github.com/IBM-EPBL/IBM-Project-17580-1659673617
- ➢ Project Demo Link: https://youtu.be/zV0nUu1EURA