Real-Time Communication System Powered by AI

For Specially Abled

A Project Report

Submitted by

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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

Our goal is to design a human computer interface system that can accurately identify the language of the deaf and dumb. With the use of image processing and artificial intelligence, many techniques and algorithms have been developed in this area. Each character speech recognition system is trained to recognize the characters and convert them into the required pattern. The proposed system aims to give speech speechless, a real-time character language is captured as a series of images, and it is processed and then converted into speech and text.

Key Words: Sign Language, Communication aid, Sign Recognition, Image Processing, Text Language.

1.2. PURPOSE

- Proposed systems scope is related with education of dumb peoples. Dumb people face many problems when normal person could not understand their language. They were facing communication gap with normal peoples
- For communication between deaf person and a second person, a mediator is required to translate sign language of deaf person. But a mediator is required to know the sign language used by deaf person. But this is not always possible since there are a multiple sign languages for multiple languages.
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2. LITERATURE SURVEY

2.1. EXISTING PROBLEM

Dumb people are usually face some problems on normal communication with other people in society. It has been observed that they sometimes find it difficult to interact with normal people with their gestures. Because people with hearing problems or deaf people cannot speak like normal people, they have to depend on a kind of visual communication in most cases. To overcome these problems, we have proposed a system that uses cameras to capture and convert videos of hand gestures from dumb people who turn into speech for understanding normal people.

2.2. REFERENCES AND PROBLEM STATEMENT DEFINITIONS

A. Two Way Communicator between Deaf and Dumb People and Normal People.

[1] This system consists mainly of two module the first module is Indian Sign Language (ISL) gestures from real- time video and mapping it with human-Understandable speech. Accordingly, the second module is the natural language as Input and card with equivalent Indian Sign Language animated gestures.

B. Sign Language Recognition System to aid Deaf-dumb People Using PCA.

[2] This paper presents design and implementation of real-time sign language recognition system, to 26 gestures from the Indian sign language with MATLAB.

C. Sign Language to Text and Vice Versa Recognition using Computer Vision in Marathi.

[3] In this system edge detection algorithm is used to recognize the input character image gray scale and recognition of the edges of the hand gesture. The system is able to handle the different input records images of alphabets, words, sentences, and translates them in text and vice versa. The system is designed to translate the Marathi sign language to text

.

D. Sign Language Learning based on Android for Deaf and Speech Impaired People.

[4] This research makes an Android-based application that can directly interpret Sign language presented by deaf people in written language. Translation process Starts with the detection of hands with OpenCV and translation of and signals. The K-NN classification. Tutorial features added in this application with the goal to train intensively to guide the user when using the sign language.

E. Real-time Communication System for the Deaf and Dumb

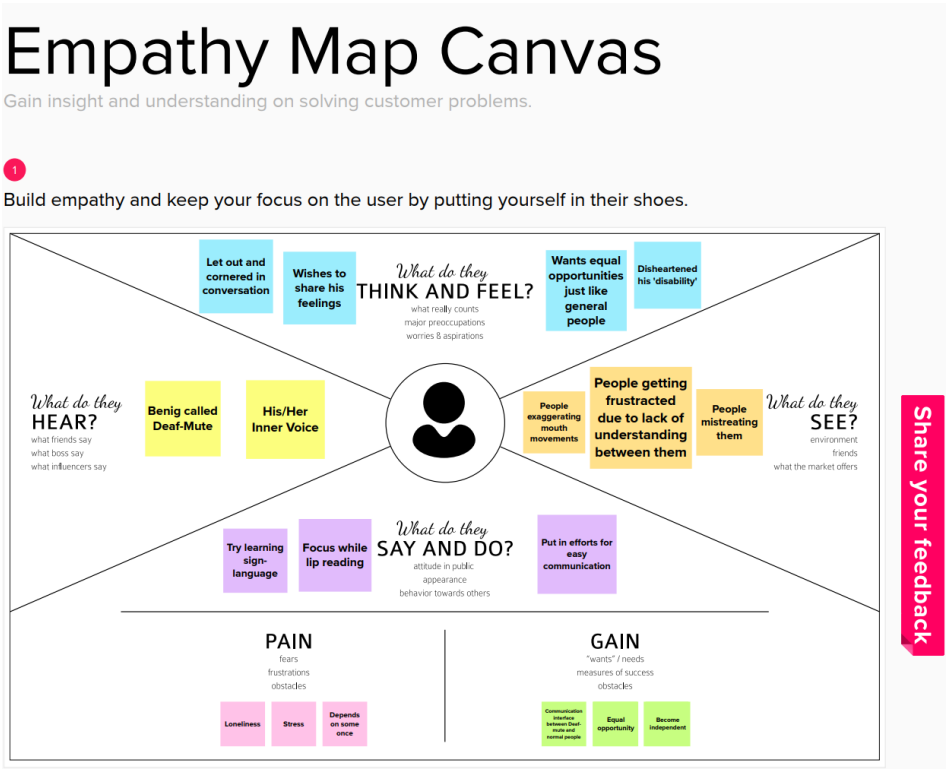
[5] This project aims to aid the deaf-mute by creation of a new system that he`lps convert sign languageto text and speech for easier communication with audience. The system consists of a gesturerecognizer hand-glove which converts gestures into electrical signals using flex sensors. These electrical signals are then processed using an Arduino microcontroller and a Python-based backendfor text-to speech conversion. The glove includes two modes of operation – phrase fetch mode and letter fetch mode. The phrase fetch mode speaks out words at once, while the letter fetch mode speaks out individual letters.

F. A communication aid application for the physically handicapped

[6]The project mainly deals on application which helps the physical challenged people to communicate between them and the common people. Communications between deafmute and a normal person have always been a challenging task. This application describes a way to reduce barrier of communication by developing an assistive application for deaf-mute persons.

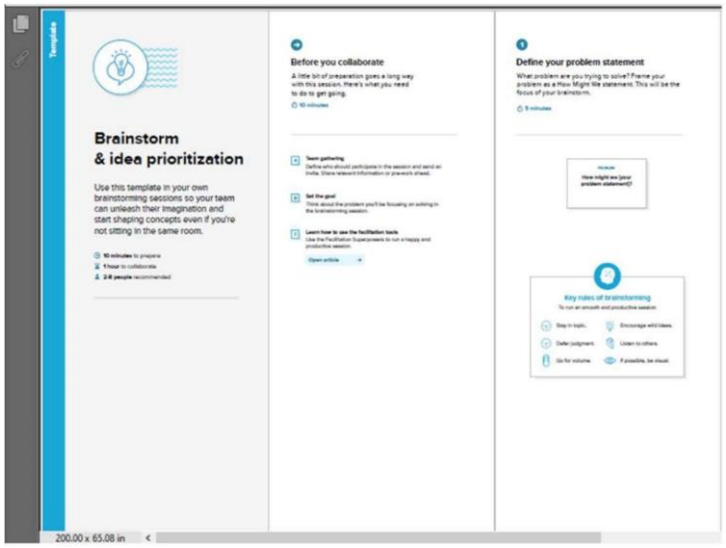
3. IDEATHON AND PROPOSED SOLUTION

3.1. EMPATHY MAP CANVAS

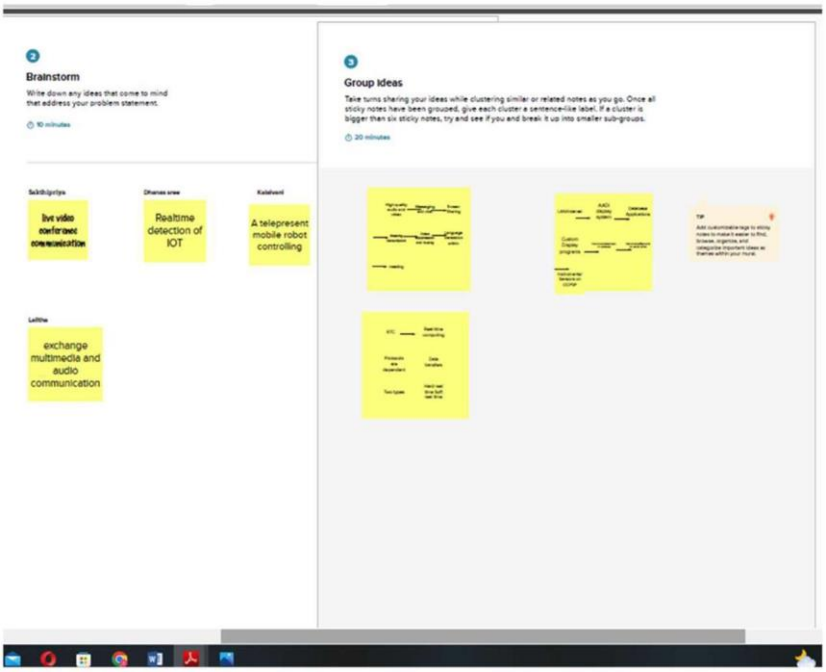


3.2. IDEATHON&PROPOSED SOLUTION

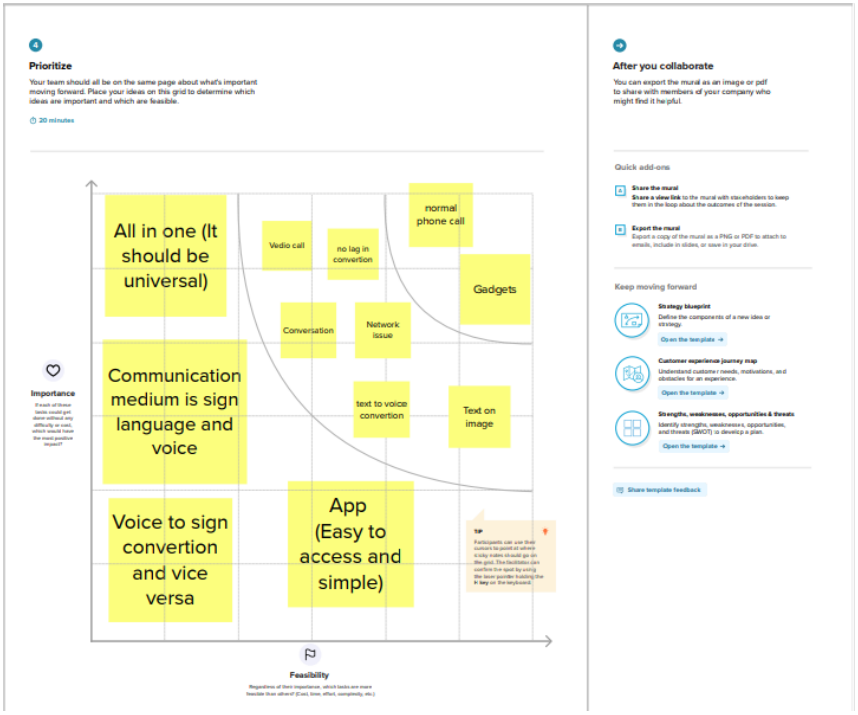
Step-1: Team Gathering, Collaboration and Select the Problem Statement


Template
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
Team gathering
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.
Set the goal
Think about the problem you'll be focusing on solving in the brainstorming session.
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
How might we [your problem statement]?
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.
200.00 x 65.08 in

Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



3.3. PROPOSED SOLUTION

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Real-Time Communication System Powered by AI for Specially Abled.
2.	Idea / Solution description	Communications between deaf-mute and a normal person.
3.	Novelty / Uniqueness	Sign Language to speech and vice-versa
4.	Social Impact / Customer Satisfaction	Even deaf-mute can be easily able to communicate with normal people without any difficulty.
5.	Business Model (Revenue Model)	In this app we can customise the avatar in it, so that we can gain revenue form this.
6.	Scalability of the Solution	Convolution neural network to create a model

3.4. PROBLEM SOLUTION FIT

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Who is your customer?

i.e. working parents of 0-5 y.o. kids

Deaf-mute and a normal person

6. CUSTOMER CONSTRAINTS CC

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

1. Network connection
2. Large amount of data is needed
3. Not so accurate
4. no offline Control
5. Limited features
6. NO proper Gadgets

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

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.

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.

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.

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.

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.

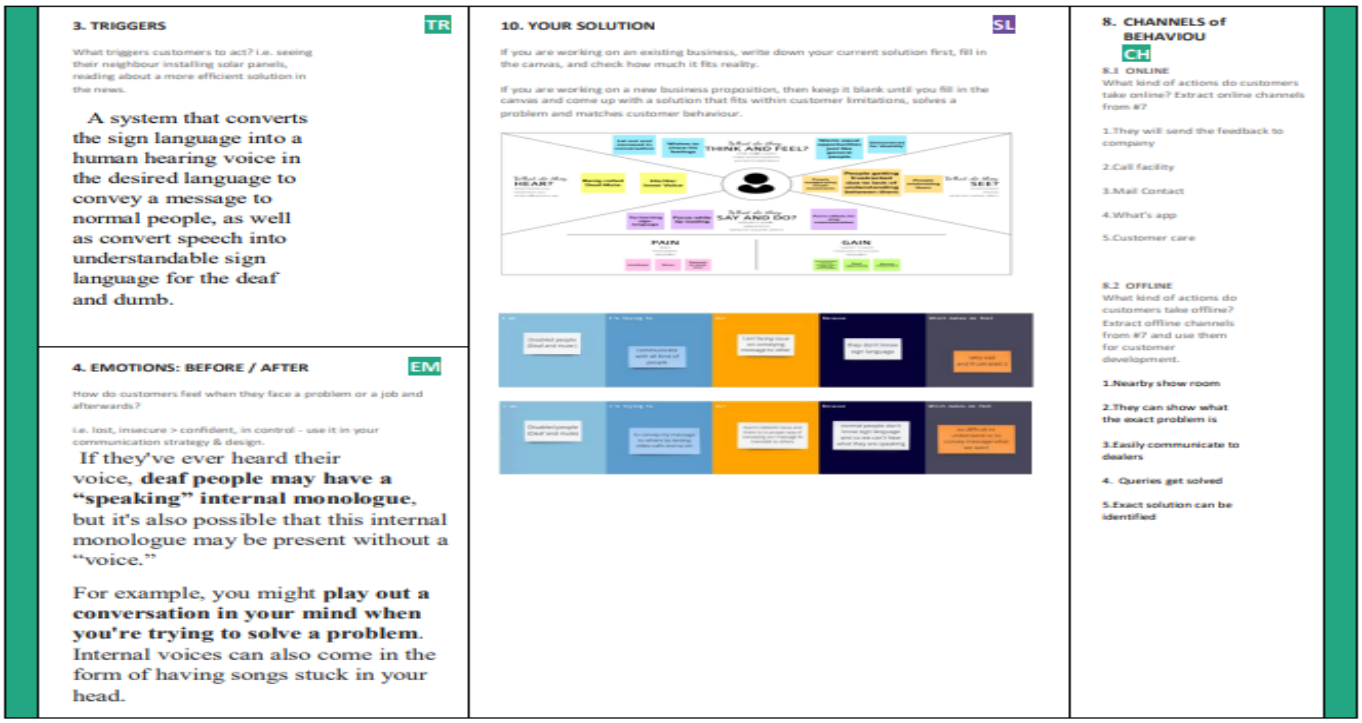
7. BEHAVIOUR BE

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. Ask, Ask and Ask.
2. Identify the Problem.
3. Formulate Solutions.
4. Deliver the Solution.
5. Follow up with Customers.

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



4. REQUIREMENT ANALYSIS

4.1. FUNCTIONAL REQUIREMENTS:

S.NO	FUNCTIONAL REQUIREMENT(EPIC)	SUB REQUIREMENT
1	User Step-in	Recognition starts
2	User feature through camera (Photo), video	Select required feature
4	Image recognition	Image recognition through webcam

4.2. NON-FUNCTIONAL REQUIREMENTS:

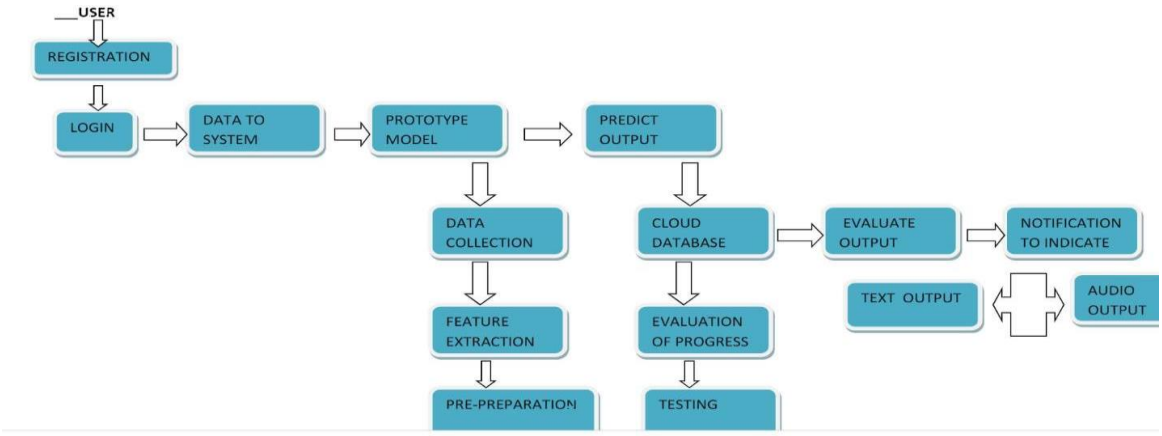
S.NO	NON-FUNCTIONAL REQUIREMENTS	DESCRIPTION
1	Usability	Interactive User Interface is easy to use.
2	Security	Personal information can access only by the own user and not by other users.
3	Reliability	The interaction between the normal people and specially aided is trustworthy.
4	Performance	The results have to be shown immediately.
5	Availability	The server will be available to users all the time.

5. PROJECT DESIGN

5.1 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.

FLOW CHART:



5.2 SOLUTION AND TECHNICAL ARCHITECTURE

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2

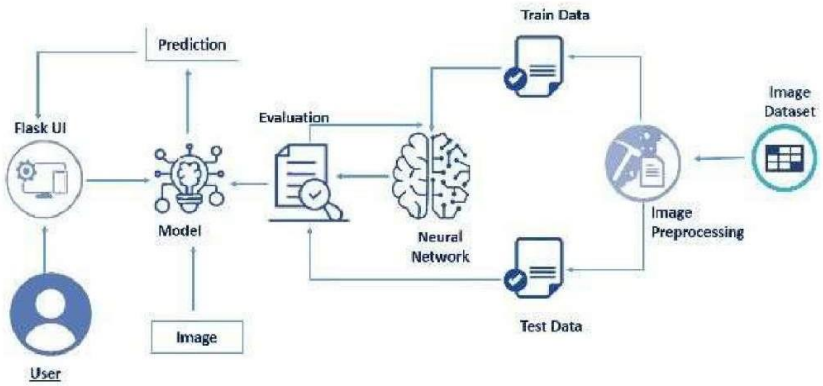


TABLE 1: COMPONENTS AND TECHNOLOGIES:

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Web UI, Mobile App, Chatbot etc.	HTML, CSS, JavaScript / Angular Js / React Js etc.
2.	Application Logic-1	It deals with variety of frameworks, libraries and supports required to develop the project	Java / Python
3.	Application Logic-2	Helps in converting human voice into written words, In simple it is used to convert speech to text.	IBM Watson STT service
4.	Application Logic-3	Provides fast ,consistent and accurate answers during the execution phase of the project	IBM Watson Assistant
5.	Database	It can be numerical, categorical or time-series data	MySQL, NoSQL, etc.
6.	Cloud Database	Enables the user to use host database without buying the additional hardware	IBM DB2, IBM Cloudant etc.
7.	File Storage	File storage should be highly flexible, scalable and effective	IBM Block Storage or Other Storage Service or Local Filesystem
8.	External API-1	Used to access the information in the cloud	IBM Weather API, etc.
9.	External API-2	Used to access the information for data driven decision making	Aadhar API, etc.
10.	Machine Learning Model	Machine Learning Model deals with various algorithms that are needed for the implementation	Real time communication using AI for specially abled
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Local Server Configuration: Install the windows version and execute the installer Select APACHE to install web server Cloud Server Configuration : This server deals with the additional storage	Local, Cloud Foundry, Kubernetes, etc.

TABLE 2:APPLICATION CHARACTERISTICS:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	The frameworks used are	Tensor flow PyTorch, OpenCV
2.	Security Implementations	the security / access controls implemented, use of firewalls etc.	Identify, Prevent aznd Respond
3.	Scalable Architecture	the scalability of architecture (3 – tier, Micro-services)	Data , models, operate at size, speed and complexity
4.	Availability	the availability of application (e.g. use of load balancers, distributed servers etc.)	Image and facial recognition, lip reading, text summarization, real time captioning
5.	Performance	Design consideration for the performance of the application (number of requests per sec, use of Cache, use of CDN's) etc.	Full and effective participation , equality of opportunity, accessibility

5.3 USER STORIES:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint - 1
	Authentication	USN-2	As a user, I will receive confirmation email once I have registered for the application.	I can receive confirmation email & click confirm	Low	Sprint - 1
	Login	USN-3	As a user, I can log into the application by entering email & password.	I am able to get into the Dashboard	High	Sprint - 2
	Dashboard	USN-4	One place to explore all available features.	I can access my dashboard	High	Sprint - 2
Customer (Web user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint - 1
	Authentication	USN-2	As a user, I will eceive confirmation email once I have registered for the application.	I can receive confirmation email & click confirm.	Low	Sprint - 1
	Login	USN-3	As a user, I can log into the application by entering email & password	I am able to get into the Dashboard	Low	Sprint - 2
	Dashboard	USN-4	One place to explore all available features	I can access my dashboard	Low	Sprint - 2
	Upload image	USN-5	As a user, I can upload the sign language image for translating into text format	I can be able to see the appropriate text for the sign language	High	Sprint - 3
Administrator	Manage	USN-6	Do-it-yourself service for delivering Everything.	Set of predefined requirements that must be met to mark a user story complete	High	Sprint - 4

6. PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING AND ESTIMATATION:

Product Backlog, Sprint Schedule, and Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data collection	USN-1	Collect and create the data set related to the objective	2	High	D.JAILAKSHMAN
Sprint-1	Image processing	USN-2	Do image processing in this step	1	high	S.Karthikeyan
Sprint-2	Adding layers	USN-3	Adding layers in the model by import layer libraries	1	high	D.Jailakshman
Sprint-2	Model building	USN-4	Build the model	1	medium	C.Ajay Murugan
Sprint-3	Test the model	USN-5	Testing the build model	1	medium	D.Jailakshman
Sprint-3	Preprocess and predict	USN-6	User can recognize the gesture , User can predict the image	1	medium	R.Dhinesh Kumar
Sprint-4	Application development	USN-7	Develop the application for user interface	1	high	D.Jailakshman

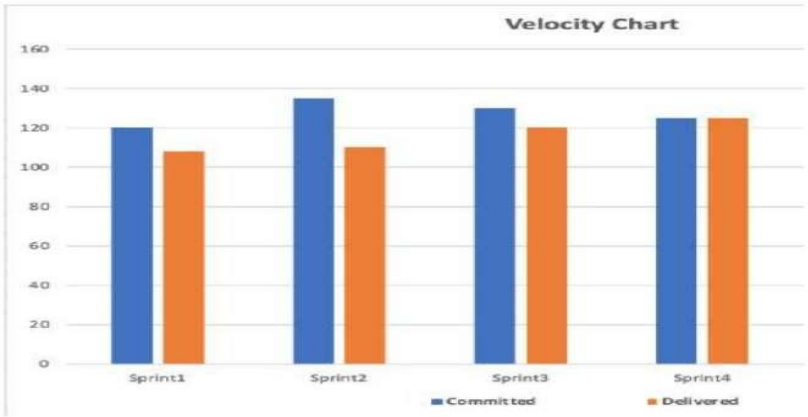
Project Tracker, Velocity & Burndown Chart:

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	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day).

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$



7. CODING AND SOLUTIONING

7.1 FEATURE 1

Easily Accessible:

Responsive website design. Modern web applications have higher user expectations and greater demands than ever before. Today' s web apps are expected to be available 24/7 from anywhere in the world, and usable from virtually any device or screensize. Web applications must be secure , flexible , and scalable to meet spikes in demand.

7.2 FEATURE 2

Image Quality:

Images matters because Studies show that people remember 80% what they see and only 20% what they read. In fact, there's research that suggests that 65% of people are visual learners. MIT also found that the human brain can process images in as little as 13 milliseconds. These and many other statistics favor idea that images are powerful means of communication.so providing a high resolution image is necessary.

7.3 DATA SCHEME:

Watson Studio **provides you with the environment and tools to solve your business problems by collaboratively working with data**. You can choose the tools you need to analyze and visualize data, to cleanse and shape data, or to create and train machine learning models.

8.TESTING

8.1 TEST CASES:

8.2 USER ACCEPTANCE TESTING:

1. Purpose of Document:

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project at the time of the release to User Acceptance Testing (UAT).

2. Defect Analysis:

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

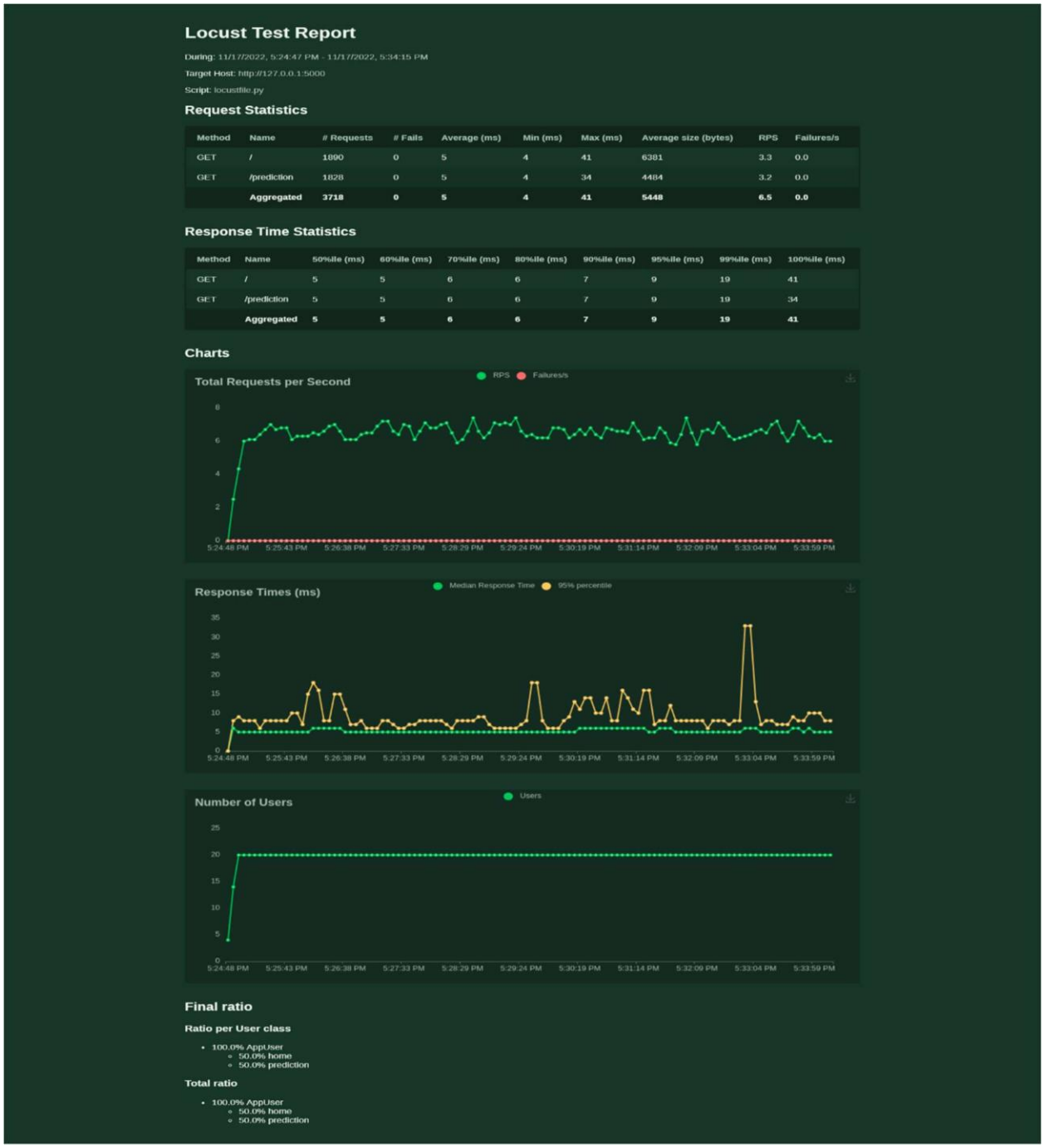
3. Test Case Analysis

This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	23	0	0	67
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	2	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

9. RESULTS

9.1 PERFORMANCE METRICES:



Locust Test Report

During: 11/17/2022, 5:24:47 PM - 11/17/2022, 5:34:15 PM

Target Host: http://127.0.0.1:5000

Script: locustfile.py

Request Statistics

Method	Name	# Requests	# Fails	Average (ms)	Min (ms)	Max (ms)	Average size (bytes)	RPS	Failures/s
GET	/	1890	0	5	4	41	6381	3.3	0.0
GET	/prediction	1828	0	5	4	34	4484	3.2	0.0
	Aggregated	**3718**	**0**	**5**	**4**	**41**	**5448**	**6.5**	**0.0**

Response Time Statistics

Method	Name	50%ile (ms)	60%ile (ms)	70%ile (ms)	80%ile (ms)	90%ile (ms)	95%ile (ms)	99%ile (ms)	100%ile (ms)
GET	/	5	5	6	6	7	9	19	41
GET	/prediction	5	5	6	6	7	9	19	34
	Aggregated	**5**	**5**	**6**	**6**	**7**	**9**	**19**	**41**

Charts

Final ratio

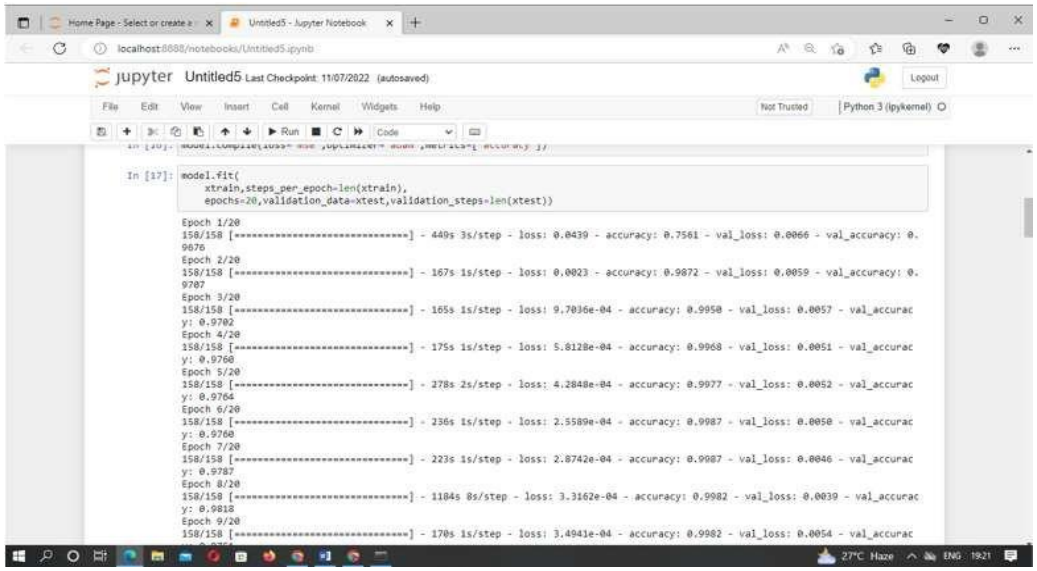
Ratio per User class

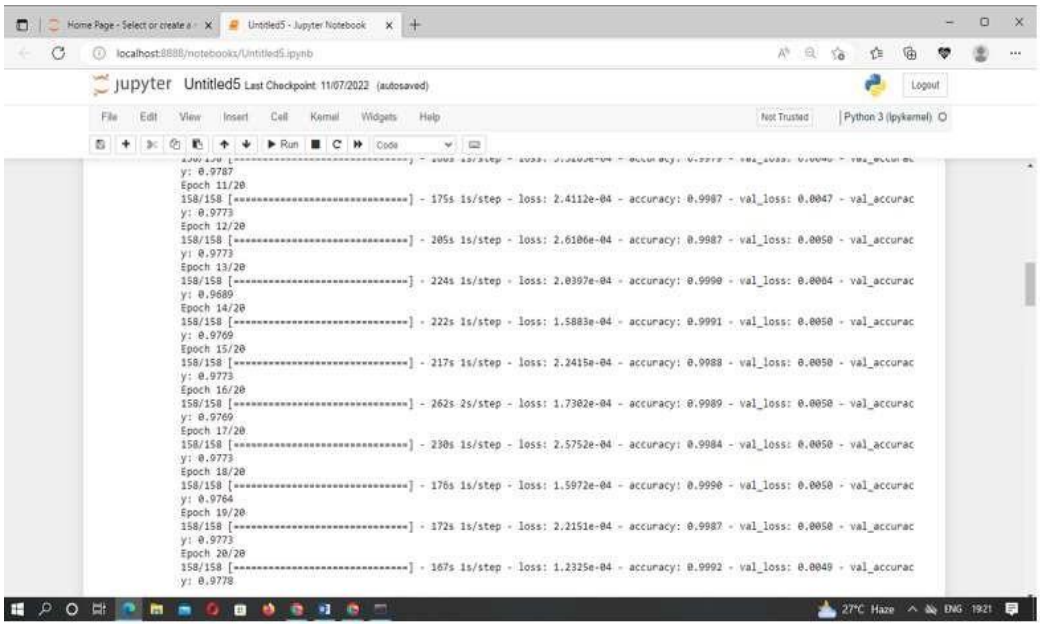
- 100.0% AppUser
  - 50.0% home
  - 50.0% prediction

Total ratio

- 100.0% AppUser
  - 50.0% home
  - 50.0% prediction

PERFORMANCE ACCURACY:





MODEL SUMMARY:

```
In [41]: model.summary()

Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_5 (Conv2D)           (None, 126, 126, 32)      896

 max_pooling2d_2 (MaxPooling  (None, 63, 63, 32)       0
 2D)

 flatten_2 (Flatten)         (None, 127008)            0

 dense_6 (Dense)             (None, 40)                5080360

 dense_7 (Dense)             (None, 70)                2870

 dense_8 (Dense)             (None, 6)                 426

=================================================================
Total params: 5,084,552
Trainable params: 5,084,552
Non-trainable params: 0
_________________________________________________________________
```

10. ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

1. Communication become feasible between normal person and specially aided person.
2. Easily accessible.
3. High bandwidth and network speed.
4. Bugs free.
5. User friendly environment.

DISADVANTAGES:

1. Image captured in dim light gives inappropriate results.
2. Limited mobile experience.
3. Loss and miscommunication of information.

11. CONCLUSION

The proposed communication system between Deaf and Dumb people and ordinary people are aiming for it when bridging the communication gap between two societies. Several works are done earlier in this area, but this paper adds in complete two - sided communication in an efficient manner because the system is implemented as one Handy mobile application. So, it really serves its needs in all aspects. The above strategies prove to be efficient In terms of time and accuracy. Further improvements can be done in the implementation of the communicator with other sign language such as American Sign Language, Accent recognition for different accents throughout Globe, recognition of emotions in sign language and language Translation.

12. FUTURE SCOPE

1. Proposed systems scope is related with education of dumb peoples. Dumb people face many problems when normal person could not understand their language. They were facing communication gap with normal peoples.

2. For communication between deaf person and a second person, a mediator is required to translate sign language of deaf person. But a mediator is required to know the sign language used by deaf person. But this is not always possible since there are multiple sign languages for multiple languages. So, to understand all sign languages, Hand gestures of deaf peoples by normal peoples this system is proposed. System gives output in the form of sound.

13.APPENDIX

SOURCE CODE:

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


cap = cv2.VideoCapture(0)
detector = HandDetector(maxHands=1)
Classifier = Classifier("Model/keras_model.h5", "Model/labels.txt")
offset = 20
imgSize = 300

folder = "Data/Z"
counter = 0

labels = ["A", "B", "C", "D", "E", "F", "G", "H", "I", "J", "K", "L", "M", "N", "O",
"P", "Q", "R", "S", "T", "U", "V", "W", "X", "Y", "Z"]
while True:
    success, img = cap.read()
    imgOutput = img.copy()
    hands, img = detector.findHands(img)
    if hands:
        hand = hands[0]
        x, y, w, h = hand['bbox']

        imgWhite = np.ones((imgSize, imgSize, 3), np.uint8) * 255
        imgCrop = img[y - offset:y + h + offset, x - offset:x + w + offset]

        imgCropShape = imgCrop.shape

        aspectRatio = h / w

        if aspectRatio > 1:
            k = imgSize / h
            wCal = math.ceil(k * w)
            imgResize = cv2.resize(imgCrop, (wCal, imgSize))
            imgResizeShape = imgResize.shape
            wGap = math.ceil((imgSize - wCal) / 2)
            imgWhite[:, wGap:wCal + wGap] = imgResize
            prediction, index = Classifier.getPrediction(imgWhite, draw=False)
            print(prediction,index)


        else:
            k = imgSize / w
            hCal = math.ceil(k * h)
            imgResize = cv2.resize(imgCrop, (imgSize, hCal))
            imgResizeShape = imgResize.shape
            hGap = math.ceil((imgSize - hCal) / 2)
            imgWhite[hGap:hCal + hGap, :] = imgResize
            prediction, index = Classifier.getPrediction(imgWhite, draw=False)

        cv2.rectangle(imgOutput, (x - offset, y - offset-90), (x - offset + 50, y -
offset + 50), (255, 0, 255), cv2.FILLED)
```

```
        cv2.putText(imgOutput, labels[index], (x, y - 25), cv2.FONT_HERSHEY_COMPLEX,
1.7, (255, 255, 255), 2)
        cv2.rectangle(imgOutput, (x-offset, y-offset), (x + w+offset, y + h+offset),
(255, 0, 255), 4)

        cv2.imshow("ImageCrop", imgCrop)
        cv2.imshow("ImageWhite", imgWhite)

    cv2.imshow("Image", imgOutput)
    cv2.waitKey(1)
```

GITHUB AND PROJECT LINK:

https://github.com/IBM-EPBL/IBM-Project-6922-1658843152

https://youtu.be/I-AOSJUh8C8