HAND GESTURE MAGIC

Capstone Project Report

Mid-Semester Evaluation

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BE Third Year, COEM

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ABSTRACT

The project is introducing an application using Hand Gesture Recognition computer vision. A camera records a live stream of video from which an interface is used to take a snapshot. For each type of count hand gestures, the system is trained at least once. After that, it gives the system a test gesture and it recognizes it.

Our idea is to develop an application that would translate hand gestures and vocal inputs to texts and prevent the differently-abled community from their daily life struggles, help them communicate without any hesitation and trouble.

The application is built upon the concepts of Hand Gesture Recognition in computer vision. All that the user will have to do is, perform the desired gestures in front of the camera and the camera will record the live stream of video from which an interface is used to take a snapshot. For each type of count hand gestures, the system is trained at least once. After that, it gives the system a test gesture and it recognizes it.

Various stages in which the project will move forward includes study about various concepts of Machine Learning, Data Analytics, Deep Learning followed by rigorous study about various machine learning models related to our project and their behavior, pre-processing of data including extraction of features required to build a machine learning model and applying various testing procedures to figure out the best or the most accurate model that can deliver the desired and correct output.

DECLARATION

We hereby declare that the design principles and working prototype model of the project entitled Hand Gesture magic is an authentic record of our own work carried out in the Computer Science and Engineering Department, TIET, Patiala, under the guidance of Dr. Manju Khurana during 6th semester (2019).

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ACKNOWLEDGEMENT

We would like to express our thanks to our mentor Dr. Manju. She has been of great help in our venture, and an indispensable resource of technical knowledge. She is truly an amazing mentor to have.

We are also thankful to Dr. Maninder Singh Head, Computer Science and Engineering Department, entire faculty and staff of Computer Science and Engineering Department, and also our friends who devoted their valuable time and helped us in all possible ways towards successful completion of this project. We thank all those who have contributed either directly or indirectly towards this project.

Lastly, we would also like to thank our families for their unyielding love and encouragement. They always wanted the best for us and we admire their determination and sacrifice.

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CHAPTER 1 - INTRODUCTION

1.1. PROJECT OVERVIEW

Communication brings people together, closer to each other. It bridges the gap between individuals and groups through flow of information and understanding between them. It is the most basic requirement for a healthy life. But this is basic requirement is not too easy to fulfill, especially if you are a differently-abled person. Expressing even a single thought becomes a tough challenge for those who are deaf and mute. This is mainly because how they communicate or rather try to communicate is by using sign language, which is generally not understood by majority of the common audience. Now to be able to express themselves, they either take help of a human interpreter or carry pen-paper with them wherever they go. This, however, causes them to fell dependent and lowers their confidence.

This project is our way to help them regain their confidence. Our application will provide them with a handy, pocket friendly interpreter.

1.1.1. Technical terminology

A significant challenge with data-driven algorithmic composition is: what data to use? What parts or features to be used? This is where Machine Learning and Data Analytics approach comes into being. Data Analytics is the science of examining raw data with the purpose of finding patterns. Whereas, Machine Learning focuses on the development of computer programs that can access data and use it to learn for themselves.

1.1.2. **Problem Statement**

For a population of about 1.3 million deaf and mute people, there are only 250 trained interpreters available in our country. This poor proportion causes majority of these people to face all sorts of communication related problems. Talking to people, getting education, visiting a doctor, everything's a struggle for them. Our app would bridge the day to day hurdles faced by our audience while communicating with each other. It would be a stepping stone for the people related to this field as there are no other major sources available to them.

1.1.3. **Goal**

Our goal is to provide the differently abled, a tool with which they'll be able to communicate with everyone all by themselves. The growth in education sector when considered for deaf and mute is very low, our app aims to increase the education rate. The doctors face many problems while interacting with these people so our app will be useful for them as well.

1.1.4. **Solution**

- The solution according to our project involves numerous steps:
- To study the existing models, related projects and analyze them to deduce the feasibility and working of our own project.
- To gather and preprocess the input dataset and apply various data mining operations on them to extract the useful data.
- To optimize the chosen model to generate output with desired accuracy.
- To make the outcome available over an android application.

1.2. **NEED OF THE PRODUCT**

Most of the differently-abled people face a lot of problems in communicating with others. It is difficult for them to express what they feel and also to show what they have understood.

With our app, it would not only help these people but also for those who haven't bought mobile phones yet (we observed it doing our surveys) as for them, hearing and speaking disability have left them with no other reason to buy a phone so the electronics segment of the market would experience a certain rise too as now we are providing them with an easier and a comfortable platform to communicate through.

Our product will definitely be a source of aid for the differently-abled people as they will be provided with a new medium for communication.

There is a big need to rise in the education sector in our country as well, our app will help in providing aid to the cause and can be used a mode of education for the customer segment we have our focus on. It is observed that the doctors and government running organizations have many difficulties too when it comes on the ground level in dealing with the deaf & mute, so for them as well ,our one click away app will help them too.

These are basically where we aim to tap on. Other people willing to learn and communicate with their dear ones via our application are also most welcome.

1.3. RESEARCH GAPS

In terms of the research approach, we see at least two recurring questions. First, what kind of representations should we use for each gesture as including each and every possible with reference to American sign language is difficult to achieve.

Second, how can we achieve accuracy in displaying the corresponding text with minimal possible latency?

1.4. PROBLEM DEFINITION AND SCOPE

Problem:

Differently-abled people, particularly the ones that are deaf or/and mute, face a number of difficulties in their daily lives especially while communicating with a normal person.

Trying to express what they feel or what they want is a never ending and an exhausting process. Not everyone understands sign language so either they have to carry a pen-paper or tag along an interpreter wherever they go to express themselves.

Not just communication, getting a decent education is a difficult task because not many schools or colleges offer classrooms with interpreters or teachers capable of using sign-languages.

It's also strenuous for doctors to deal with patients that are deaf or/and mute.

Scope:

.India has approximately only **250 qualified Indian Sign Language (ISL) interpreters** for a population of over **one crore deaf and mute** people! This is a large community and there is a need for quality interpreters.

The project has a very wide future scope of further development and expansion. This disproportionality can be successfully eliminated by our app. Our app would prove to be a stepping stone and benefit our deaf and mute people in many ways!

1.5. ASSUMPTIONS AND CONSTRAINTS

Table 1.1 – Assumptions

S NO.	ASSUMPTIONS
1	We assume that the phone used is equipped with high quality camera that detects the hand gesture easily and as accurately as possible.
2	One assumption about the product is that it will always be used on mobile phones that have enough performance. If the phone does not have enough hardware resources available for the application, for example the users might have allocated them with other applications, there may be scenarios where the application does not work as intended or even at all.

Table 1.2- Constraints

S NO.	CONSTRAINTS
1	It is very important for the hand gesture to be detected precisely and understood by the system.
2	It necessary for the hand gesture made to be present in the existing database as well, then only the conversion to corresponding text can take place.

1.6. APPROVED OBJECTIVES

The objectives of our project are described below:

i. To study the existing models, related projects and analyze them to deduce the feasibility and working of our own project.

ii. To gather and preprocess the input gestures and apply various data mining operations on them to extract the useful data.

iii. To predict the gesture of the input action and then generate text of the same g using our Machine Learning model.

iv. To optimize the chosen model to generate texts corresponding to the gestures with desired accuracy.

i. To make the outcome available over an android application.

1.7 METHODOLOGY

• User opens application and provides video feed.

• Frames are taken into consideration.

• Relevant features are extracted and classified.

• Intended gesture is recognized and converted into text.

• Text is then displayed on the screen.

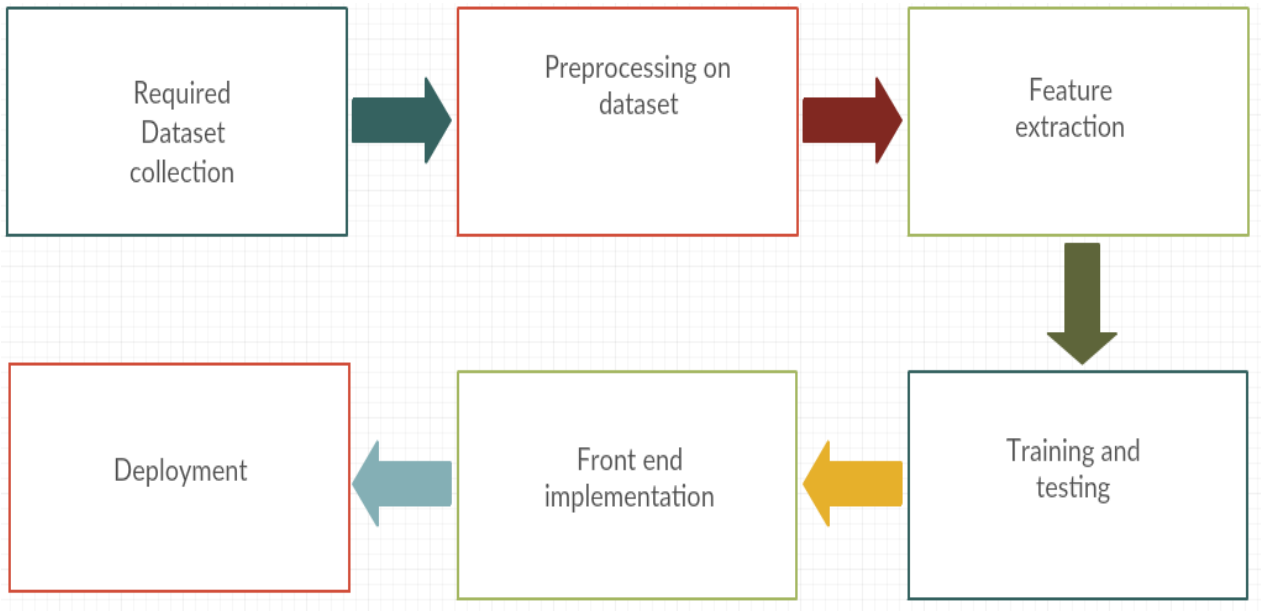


Figure 1.1: Methodolgy

1.8 PROJECT OUTCOMES & DELIVERABLES

This project aims at successfully interpreting the desired or projected hand gesture into its letter equivalent, thus eliminating the need for anyone to learn sign language and also reducing the chance of miss communications.

The app can be conveniently used by differently abled, doctors and in educational institutions dealing with differently abled students. They would no longer need to carry any card or human interpreter, just a mobile phone with our application in it!

Our goal is to create the best in class services along with the pocket friendly application on the phone itself. The project is aimed at creating a medium for communication between people who are both deaf and mute. This app would bring rescue to doctors as well and also help in increasing the education rate of our country.

1.9 NOVELTY OF WORK

The proposed solution is quite unique as none of our competitors provide services with the ease that we aim to provide them with. Bringing an application easily available on the play store which is also open to all shouts for uniqueness and increase in development itself is our key strategy.

Currently in the market, there is no other app that provides with the same solutions for the Indian masses. They still rely on paper based or human based solutions. Our application will provide them a sense of independence and confidence.

Our application is feasible, accessible, and easy to understand and use by any and every person.

CHAPTER 2 - REQUIREMENT ANALYSIS

2.1. LITERATURE SURVEY

2.1.1. Theory Associated with the Problem Area

As described above, the detection and recognition of gestures is related to the location of a hand in a still image or image sequence, i.e. moving images. The tracking of the hand in the scene that is relevant to the application such as sign language can be followed in the case of moving images. The underlying concept of hand detection is that human eyes can detect objects which machines cannot with that much accuracy as that of human.

We use a variety of factors to determine hand detection including variation in image plane and pose, skin tone and other structural components, lighting and background. The model will then be trained to recognize gestures which are imputed to it. The gestures are then looked up in the existing database and the corresponding text is then conveyed on the screen. The tracking of the hand in the scene that is relevant to the application such as sign language can be followed in the case of moving images. The underlying concept of hand detection is that human eyes can detect objects that are not possible for machines with as much precision as human.

This project's scope is to build a classification system for real-time gestures that can automatically detect gestures in natural lighting conditions. A real-time gesture-based system is developed to identify gestures to accomplish this objective.

This system will function as one of Artificial Intelligence's futuristic and user interface computer vision. Its method of creating hand gesture recognition is based on various parameters. The main priority of the system, however, is to fulfill requirements of being simple, easy and user friendly without using any specialized hardware.

2.1.2. Existing Systems & Solutions

Research has been limited to small scale systems able of recognizing a minimal subset of a full sign language. Christopher Lee and Yangsheng Xu developed a glove-based gesture recognition system that was able to recognize 14 of the letters from the hand alphabet, learn new gestures and able to update the model of each gesture in the system in online mode, with a rate of 10Hz. Over the years advanced glove devices have been designed such as the Sayre Glove, Dexterous Hand Master and PowerGlove.

Chan Wah Ng, Surendra Ranganath presented a hand gesture recognition system, they used image furrier descriptor as their prime feature and classified with the help of RBF network. Their

system's overall performance was 90.9%. Claudia Nölker and Helge Ritter presented a hand gesture recognition modal based on recognition of finger tips, in their approach they find full identification of all finger joint angles and based on that a 3D modal of hand is prepared and using neural network.

Application running on Android Platform but only in Brazilian language is also available on the Android Play Store. We aim to introduce our app for English & further languages would be introduced later.

2.1.3. Research Findings for Existing Literature

Table 2.1- Research Findings

S. No.	Project Title	Tools/ Technology	Learnings
1	A Review on Indian Sign Language Recognition	ASLR	Learnt about Neural Networks, SVM, CNN
2	Vision-Based Sign Language Translation Device	Real Time Vision Based System	Image Thresholding
3	Hand Gesture Recognition for Human-Machine Interaction	Image Comparison Techniques	Hausdorf Distance

2.1.4. The Problem That Has Been Identified

As discussed above, the problems faced by the people or the customer segment are limited but there are no optimal solutions and better options available right now.

It has been observed that the differently-abled people face difficulties and obstacles while communicating with others so our application bridges the gap between the two. The growth in education sector when considered for deaf and mute is very low, our app would prove to be a

stepping stone in increasing the education rate. The doctors face many problems while interacting with these people so our app will be useful for them as well.

2.1.5. Survey of Tools and Technologies Used

The following methods or technologies were observed during the literature survey:

i. Data Analytics - Data Analytics is the science of examining raw data with the purpose of finding patterns and drawing conclusions about that information by applying an algorithmic or mechanical process to derive insights. Since our data is in the form of hand gestures, it is the most crucial step to convert these files to machine understandable form such that finding similarities and patterning the data becomes easy.

ii. Machine Learning - Machine Learning focuses on the development of computer programs that can access data and use it to learn for themselves. Once the data is extracted from raw files, it is fed into the best suited machine learning model giving the desired accuracy. Devising methods of testing and increasing our model accuracy also remains an objective of this project. Tools Used for the same include “Jupyter-Notebook” and we may even use Google’s Cloud Computing services during model building and training.

iii. Deep Learning - Deep Learning is a part of broader family of Machine Learning methods based on learning data representations and can be supervised, semi-supervised or unsupervised. Deep learning models are used in Neural Networks and have been applied to the fields including Natural language processing, Audio recognition, speech recognition, computer vision, etc.

iv. Android Studio - Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is

available for download on Windows, macOS and Linux based operating systems. It is a replacement for the Eclipse Android Development Tools (ADT) as the primary IDE for native Android application development.

2.2 STANDARDS

IEEE 802.11 - It is a set of media access control (MAC) and physical layer (PHY) specifications for implementing wireless local area network (WLAN) computer communication, They are the world's most widely used wireless computer networking standards, used in most home and office networks to allow laptops, printers, and smart phones to talk to each other and access the Internet without connecting wires.

IEEE 610.4-1990 IEEE 610.4-1990-It is a specification IEEE Standard for Pattern Recognition Terminology which was established by IEEE.

2.3. SYSTEM REQUIREMENT SOFTWARE

2.3.1. INTRODUCTION

2.3.1.1. Purpose

This document is intended to provide a detailed overview of our software product, its parameters and its objectives. This document specifies in detail various functional and non-functional requirements and also specifies which software feature satisfies these requirements. It also describes different constraints and standards that apply to this domain's software. It includes in the development of this software description of all software / hardware and third-party dependencies.

2.3.1.2. Intended Audience and Reading Suggestions

Majority of our users and customers can be classifies as:-

- Differently-abled people.
- MHRD programs for welfare of deaf and mute.
- Schools for Deaf and Mute.
- Employers dealing with Deaf and Mute Employees.
- Hospitals and Clinics.

These are basically where we aim to tap on. Other people willing to learn and communicate with their dear ones via our application are also encouraged. Not declining the fact that still there is a big need to reach the masses and creating awareness about an all-time available app that would act as an interpreter for them, easily carried anywhere any time just in their pockets in their cell phones, would definitely help them to discover this as a great solution. On an initial note, it would be difficult to accept this but once our product is released in the market and people start to believe in us and in our vision, they won’t be disappointed.

2.3.1.3. Scope

With the launch of our application, we’ll be the trend setters in this field. It will also help in creating opportunities for growth in electronics sector and literacy rate of our nation as well. With belief in our vision, we hope that the market is affected in a positive manner only. The purpose of this document is to provide a detailed overview of our software product, its parameters and its objectives. Our app would bridge our audience's day-to-day hurdles while communicating with each other. For people related to this field, it would be a stepping stone as there are no other major sources available for them to develop and grow shoulder to shoulder

with other human beings (with no disabilities) and it will also help to increase the literacy rate and the economy.

2.3.2. Overall Description

2.3.2.1. Product Perspective

A machine learning model will act as the generating core of the system which will translate the gesture to its corresponding text. The camera will be used to input the gesture made by the user. Using feature extraction algorithms implemented by CNN, the system will detect the gesture and look into its database for the corresponding text. The text will then be displayed on the screen. The final product will be able to do the following:

1. Get gesture as input from the user.
2. Feature extraction and classification to detect the gesture.
3. Compare the gesture with existing database.
4. Generate the corresponding output.
5. Input audio from user and get the corresponding text.

2.3.2.2. Product Features

Some of the features of the product are as follows:

1. Real time conversion of visual data into text.
2. Create a user friendly phone application.
3. Real time conversion of audio into text.

2.3.3. External Interface required

2.3.3.1. User Interfaces

Android Phone/iOS Device

2.3.3.2. Hardware Interfaces

Table 2.2- Hardware Requirements

Hardware	**Minimum requirements**
Android Phone	2 GHz minimum, multi-core processor
Memory (RAM)	At least 2GB, preferably higher

disk space	At least 1 GB
Camera	8 MegaPixel or Higher

2.3.3.3 Software Interfaces

Table 2.3- Software Requirements

Software	**Minimum Requirements**
Operating System	Android 6.0 or Higher
IIS(Internet Information Services)	Version 8 or Higher
Tensor Flow Framework(v 4.6.1 or Higer)	Mobiles And Web or Higher
OpenCV(Open Computer Vision)	Version 2.10 or Higher
Google Play Services	Google Play services 14.1.94 or Higher

2.3.4 Other Non-Functional Requirements

2.3.4.1 Performance Requirements

Model selection and optimization is crucial since it will directly affect the response time. Better response time and accuracy detection will improve the efficiency of the product.

2.3.4.2 Safety Requirements

The user interface should be safe, secure, friendly and easy to use so that people not having much knowledge about sign language and technology are also able to use the product easily.

2.3.4.3 Security Requirements

Payments in case of downloading options, should me made securely.

2.4 COST ANALYSIS

(i) The first novelty of the proposed method is that the hand gesture recognition is based on the result of finger recognition. Therefore, the recognition is accomplished by a simple and efficient rule classifier instead of the sophisticated but complicated classifiers such as SVM and CRF.

(ii) Some previous works need the users to wear data glove to acquire hand gesture data. However, the special sensors of data glove are expensive and hinder its wide application in real life. In the work , the authors use TOF camera, that is, Kinect sensor, to capture the depth of the environment and a special tape worn across the wrist to detect hand region. Our approach only uses a normal camera to capture the vision information of the hand gesture meanwhile does not need the help of the special tape to detect hand regions.

(iii) The third advantage of the proposed method is that it is highly efficient and fit for real-time applications.

(iv) Hand Gesture Recognition System in form of a software that is compatible either on firstly Android and then followed by iOs.

Model (1)

An Android Application that could run a pre trained android model.

Table 2.4 –Cost Break-up

Android Developer Signup 1 time cost	$25	Rs 1734/-
Java Development Course	$20	Rs 1387/-
Android Development Course	$30	Rs 2082/-
Android Device	-/-	
AWS	Variable Cost	

2.5. RISK ANALYSIS

There are a few risk factors included in the building and completion of this project like: the device will use a large amount of processing power and a will need some noticeable amount of time to respond. Another risk factor we have considered is that the model might produce some unrequired text in some cases until it attains the desired accuracy. The fact that we will be needing a high computational system for model building and training purposes is another risk factor.

CHAPTER 3 METHODOLOGY ADOPTED

3.1. INVESTIGATION TECHNIQUES

Our project is based on Experimental investigation since we are trying to design a model which will take input a hand gesture and will detect it and match it in the existing database. Further if matched then corresponding text will be displayed on the screen. Initially android studio platform is used in formation of the application further then we use various Machine Learning algorithms and LSTM Deep Learning model to test and train our model.

3.2. PROPOSED SOLUTION

An android application that will bring aid to the cause is the appropriate solution. Explaining how the application would work.

A new user will first sign up through an email-id and set a password. After the initial sign-up the user can login into their accounts.

He/She can then allow permissions to access camera and microphone, so as allowing the application to access them. Now when the user clicks on Generate gesture, camera will be opened and then the action made would be detected.

Gesture captured will be processed and matched from the existing database, after the processing only the text corresponding to the gesture will be displayed.

If the gesture made doesn’t exist in the database, user will be asked to try again.

3.3. WORK BREAKDOWN STRUCTURE

Since we believe in teamwork, every task is performed by the group. So segregating each person's individual role is quite difficult. Still the main front end development of the application & training of the model is managed by Mansi & Kali. They are also working hard in doing literature surveys and research work required in the field. The back end development of the app including testing the model made, surveys, contacting people related to this field & researchers willing to provide us with helpful information, these tasks are seen by Devak & Deepanshu.

3.4. TOOLS AND TECHNOLOGIES USED

- Data Analytics - Data Analytics is the science of examining raw data with the purpose of finding patterns and drawing conclusions about that information by applying an algorithmic or mechanical process to derive insights. Tools Used for the same include "Jupyter-Notebook", "Pycharm" and various Python libraries like librosa, pyAudioAnalysis, etc.
- Android Studio is the official integrated Development Environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems.[9][10] It is a replacement for the Eclipse Android Development Tools (ADT) as the primary IDE for native Android application development.
- Google Camera is a camera application developed by Google for Android.
- The recognition is accomplished by a simple and efficient rule classifier instead of the sophisticated but complicated classifiers such as SVM and CRF.
- Amazon Web Services (AWS) is a subsidiary of Amazon that provides on-demand cloud computing platforms to individuals, companies and governments, on a metered pay-as-you-go basis. In aggregate, these cloud computing web services provide a set of primitive, abstract technical infrastructure and distributed computing building blocks and tools. One of these services is Amazon Elastic Compute Cloud, which allows users to have at their disposal a virtual cluster of computers, available all the time, through the Internet.

CHAPTER 4 - DESIGN SPECIFICATIONS

4.1. SYSTEM ARCHITECTURE

4.1.1. ARCHITECTURE

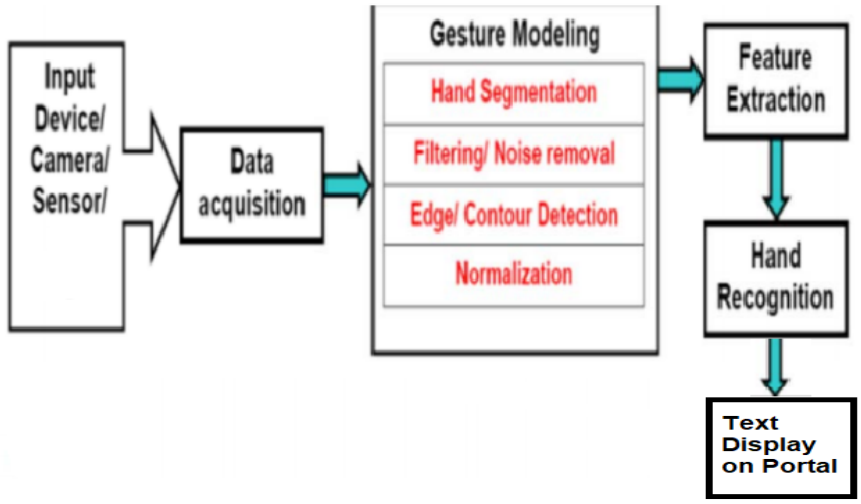


Figure 4.1- Architecture

4.1.2. TIER ARCHITECTURE

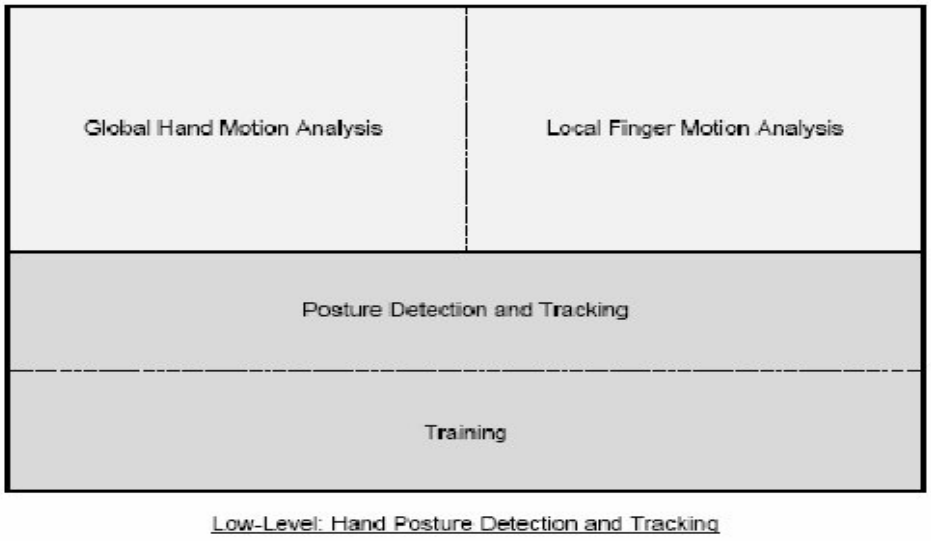


Figure 4.2- Three tier Architecture

4.1.3. MVC ARCHITECTURE

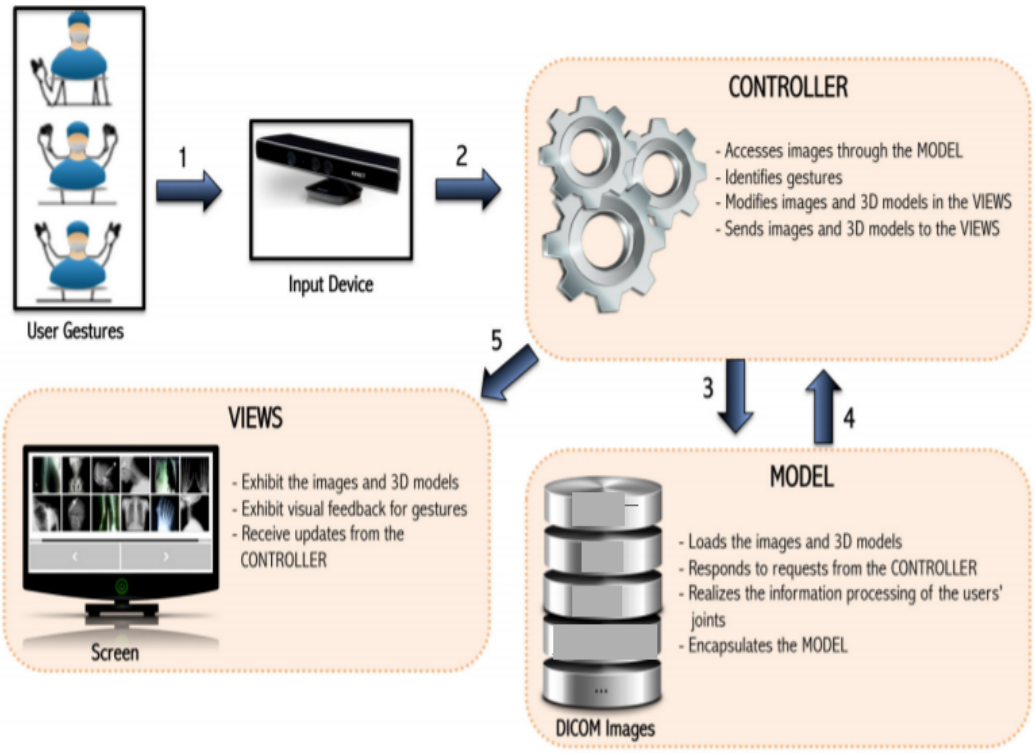


Figure 4.3- MVC Architecture

4.2. DESIGN LEVEL DIAGRAMS

4.2.1. E-R DIAGRAM

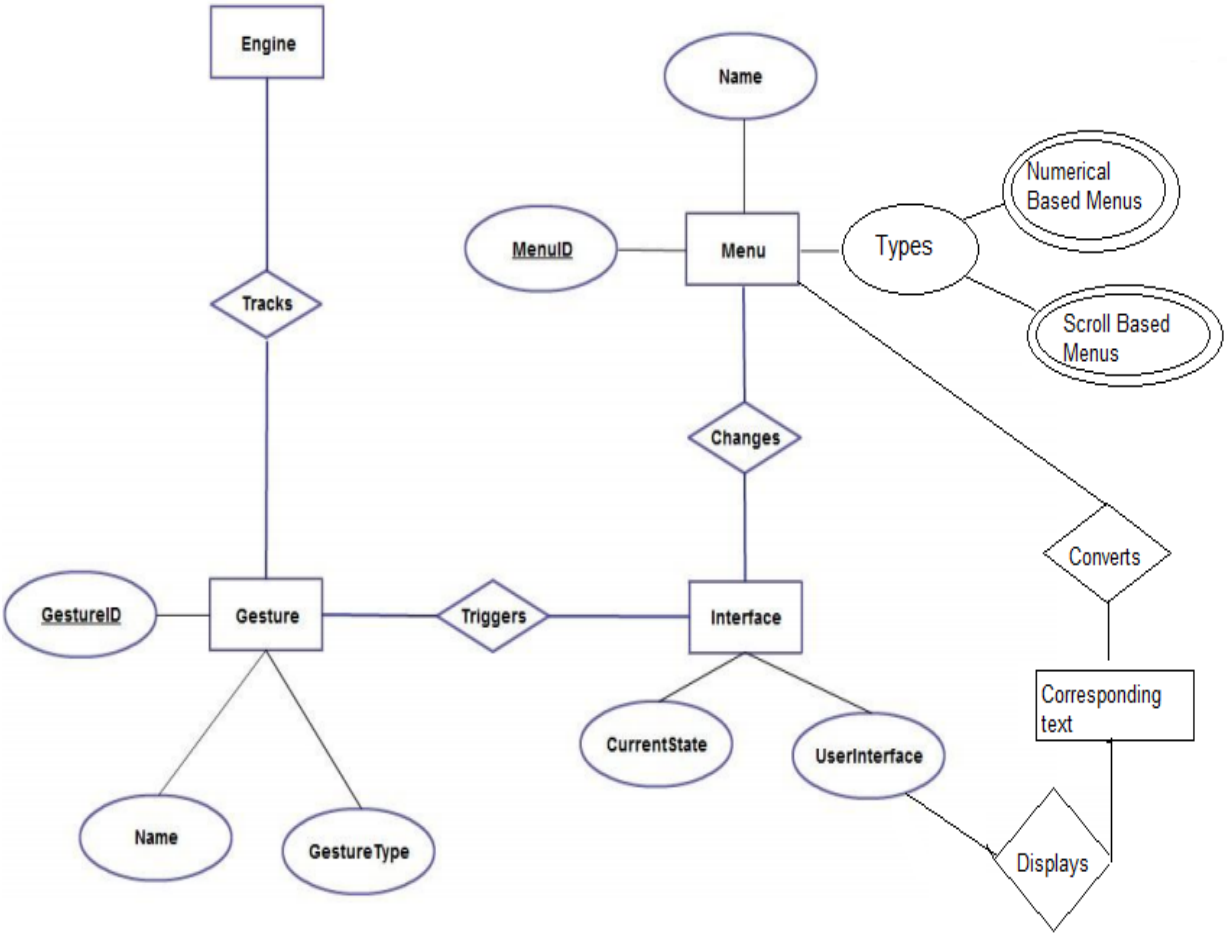
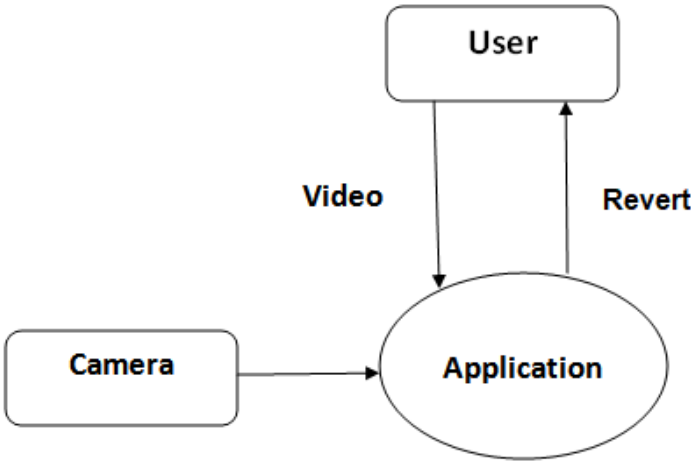
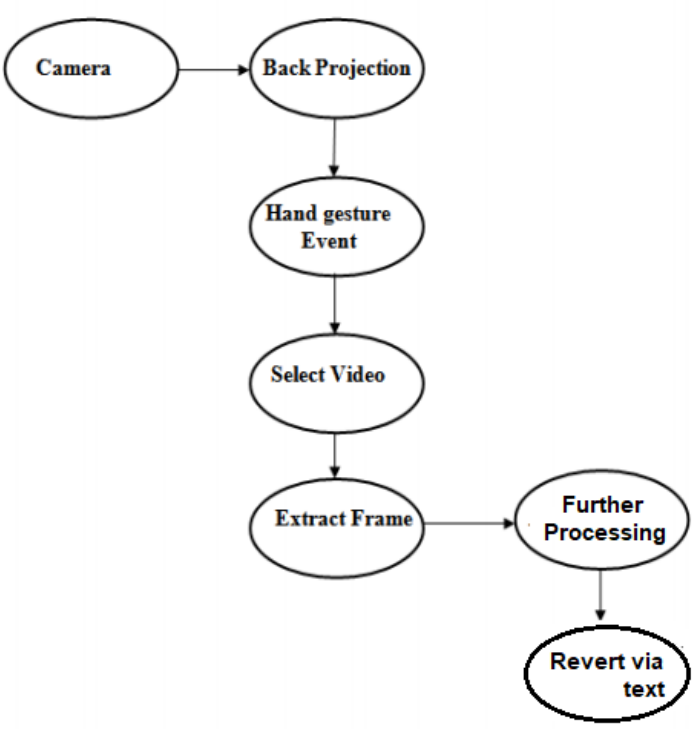


Figure 4.4 – E-R Diagram

4.2.2. DATA FLOW DIAGRAM



Level 0



Level 1

Figure 4.5 – Data Flow Diagram

4.2.3. CLASS DIAGRAM

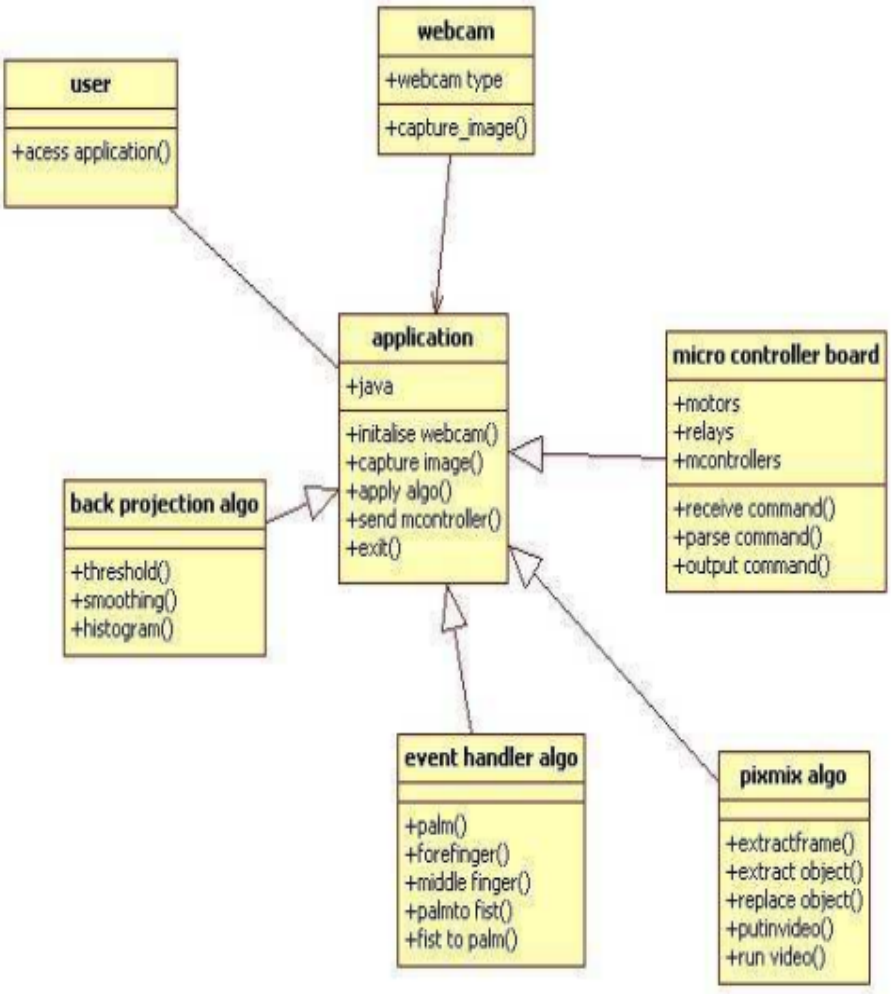


Figure 4.6 – Class Diagram

4.3. USER INTERFACE DIAGRAM

4.3.1. ACTIVITY DIAGRAM

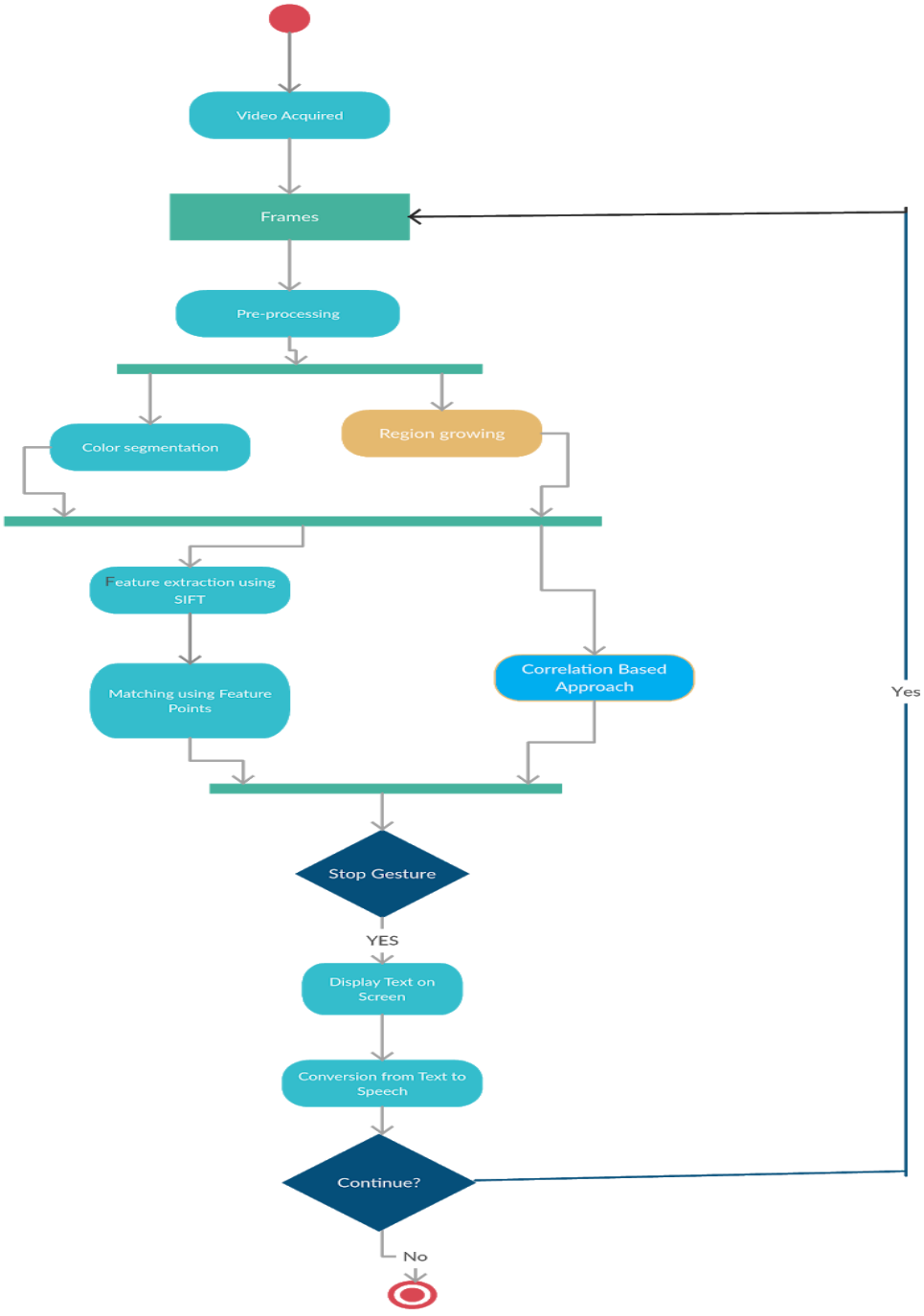


Figure 4.7- Activity Diagram

4.4. SNAPSHOTS OF WORKING PROTOTYPE MODEL

4.4.1. WELCOME SCREEN

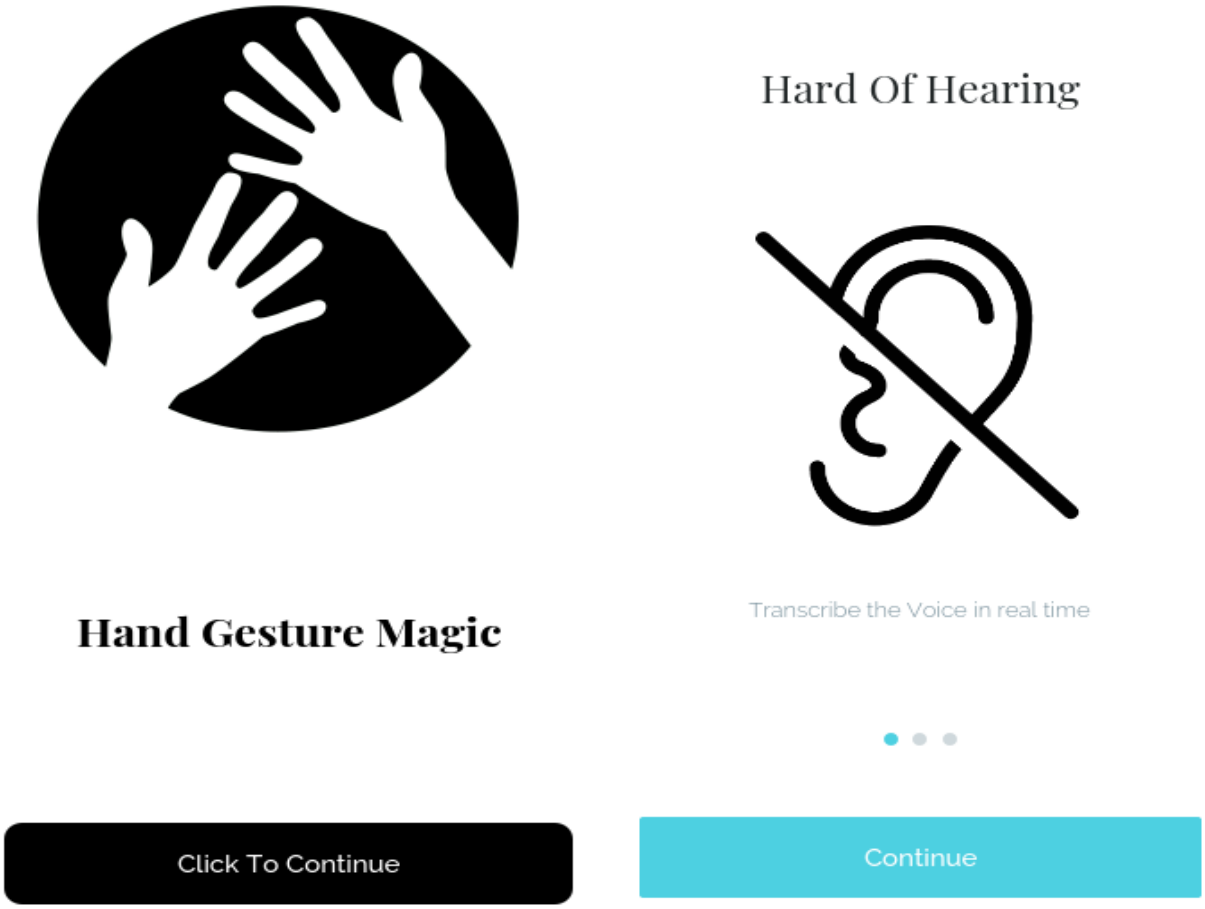


Figure 4.8 – Snapshot of Welcome Screen

4.4.2. PAYMENT SCREEN FOR SUBSCRIPTION

Figure 4.9- Payment screen for Subscription

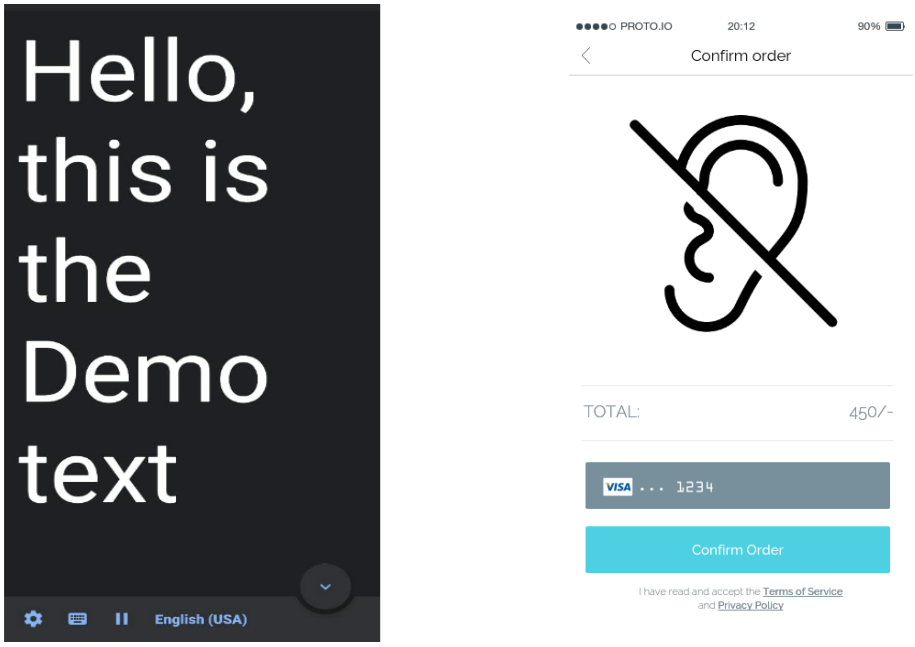


Figure 4.10- Working Prototype

CHAPTER 5- CONCLUSIONS

5.1. WORK ACCOMPLISHED

We found out about the various sign languages and the datasets we could derive from them. We searched and analyzed various data preprocessing techniques and training of machine learning models to detect the gestures and output the corresponding text. We searched for various datasets which can be used for model training and construction. Then we researched about the various data preprocessing techniques and various Machine Learning models which could be implemented in our project. Along with the implementation, we also analyzed the functional and non-functional requirements of the project. The project has been depicted via data flow diagrams, use cases, activity diagram, system architecture and few other data representation techniques.

5.2. CONCLUSIONS

We conducted surveys to conclude the need for our model to be implemented. Further, we had first-hand interaction with deaf and mute people to know about their problems in depth. We searched for various datasets which can be used for model training and construction. We found that most people do feel the need for a medium to communicate with people using Sign Language. We also found that the only existing application that fulfills these requirements is in Brazilian. There is a dire need for an application that uses other languages too.

5.3. ENVIRONMENTAL BENEFITS

Our app would bridge our audience's day-to-day hurdles while communicating with each other. For people related to this field, it would be a stepping stone as there are no other major sources available for them to develop and grow shoulder to shoulder with other human beings (with no disabilities). It will also help to increase the literacy rate and the economy. Furthermore, since our product is reliable on phones, the environment will be benefitted as the use of books for translation will reduce, thus reducing paper consumption and indirectly helping the economy.

5.4. FUTURE WORK PLAN

We intend to detect the gestures by extracting features that are relevant to our model, from the input image. We intend to develop our model using various machine learning techniques which are mostly related to deep learning. Further, we intend to use the Amazon Web Services for our database.

APPENDIX A: REFERENCES

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