SANWADHA

Intelligent Assistant for Hearing Impairers to Interact with The Society

Software Requirement Specification Document

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Author:

Student ID	Name	Signature
IT 14029264	S.Y.M. Perera	

Supervisor

………………………………………………………….

Prof. Samantha Thelijjagoda

DECLARATION

I declare that this is our own work and this software requirement specification does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Author:

Student ID	Name	Signature
IT 14029264	S.Y.M. Perera	

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1. Introduction

The introduction of the Software Requirements Specification (SRS) document mainly provides a scope description and an entire overview of everything included in the Software Requirements Specification (SRS) document. This includes purpose, definitions, acronyms, abbreviations, references and overview of the SRS.

2.1. Purpose

The purpose of this document is to give a detailed description of the requirements for the project "Sanwadha" as an intelligent assistant for Hearing Impairers to interact with the society using Machine learning and Natural language processing. This document will illustrate the purpose and complete declaration of development of the system to give an in-depth insight of "Sanwadha". It will also explain product's target audience, system constraints, interfaces and interactions with other external applications, features of the system, functional requirements, nonfunctional requirements, data requirements, quality requirements, hardware requirements and software requirements. Issues related to the current system and actions to be performed by the development team are described in order to come up with a better solution. This document can be used to verify whether the software meets the user's actual needs and requirements. In Development team's perspective SRS is valuable as it describes scope of the project, plan system's design and eventual implementation.

In short, the purpose of this SRS document is to provide a detailed overview in Text and Voice translation to Sign language and creating 2D model of the software product "Sawadha", its parameters and goals.

The intended audience of this System Requirement Specification are, the members of the research group, project supervisor Prof. Samantha Thelijjagoda.

1.2. Scope

This document covers product perspective and details of the designing process functionalities of the "Intelligent assistant for Hearing Impairers to interact with the society".

This document covers all aspects in "Sanwadha" project related to Text to Sign language translation using machine learning techniques, Voice to Sign language translation using natural language processing techniques, GIF delivering using GZIP compression algorithm, creating 2D model using Maya Autodesk.

Speech Recognition

User input is given as voice commands and should be detected via a speech recognition module. Speech is a continuous audio stream where rather stables mix with dynamically changed states. This brings a challenge because there are no clearly distinguishable parts in an audio recording which is a waveform. Words are understood to be built of the phone (the smallest unit of a waveform) but it is not hundred percent true, various factors such as phone context, speaker, style of speech influence a waveform, thus the same word can be presented in two different waveforms.

The common wat to recognize speech is the following, take a waveform, split it on utterances by silence then try to recognize what is being said in each utterance. There models are needed for the above-mentioned task, An acoustic model (waveform to phenome mapping), a phonetic dictionary (word to phenome mapping) and a language model(words).

Natural Language Processing

This is implemented using Python NLTK which is a tool for working on computational linguistics using Python.

Text-To-Speech

Appropriate responses to user inputs are generated by this module. A conversation can be thought as a series of volleys, which is an input-response sequence. There have been several technologies which have been used to implement conversational agents, starting with AIML which is an XML based language.

The conversational agent of the current system is implemented using Rive script, which is an advancement from AIML. Conversations are categorized into topics and each topic has a

sequence of input/response patterns. Some inputs require the invocation of a system call, e.g. Opening an application. This is done by invoking a python script which is also handled by the conversational agent.

1.3. Definitions, Acronyms and Abbreviations

1.3.1 Definitions

Term	Definition
Sanwadha	An intelligent assistant for hearing impairers to interact with the society
Sign language	A language which chiefly uses manual communication to convey meaning, as opposed to acoustically conveyed sound patterns. This can involve simultaneously combining hand shapes, orientation and movement of the hands, arms or body, and facial expressions to express a speaker's thoughts.
Hearing impaired	A hearing loss that prevents a person from totally receiving sounds through the ear.
Real time	A system in which input data is processed within milliseconds so that it is available virtually immediately as feedback to the process from which it is coming.
Natural Language Processing	Natural language processing (NLP) is a field of computer science, artificial intelligence and computational linguistics concerned with the interactions between computers and human (natural) languages.
Machine Learning	Machine learning is a type of artificial intelligence (AI) that provides computers with the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs that can change when exposed to new data.
GIF	The Graphics Interchange Format is a bitmap image and lossless format for image files that supports both animated and static images.
API	Application program interface (API) is a set of routines, protocols, and tools for building software applications. An API specifies how software components should interact.

Animation	A simulation of movement created by displaying a series of pictures, or frames. Cartoons on television is one example of animation.
GZIP Compression Algorithm	GZIP is a file format and a software application used for file compression and decompression.
SRS	A software requirements specification (SRS) is a description of a software system to be developed. It lays out functional and non-functional requirements, and may include a set of use cases that describe user interactions that the software must provide.

Table 1.3.1.1: Definitions

1.3.2 Acronyms, and Abbreviations

2D	Two Dimensional.
SRS	Software Requirement Specification
GIF	Graphic Interchange Format
NLP	Natural Language Processing
ASR	Automatic Speech Recognition
SLU	Spoken Language Understanding
SLG	Spoken Language Generation
UI	User Interface
TTS	Text to Speech Synthesis
IM	Instant Messaging
API	Application Program Interface
HDD	Hard Disk Drive
RAM	Random Access Memory
D-User	Deaf user
CC	Creative Cloud

Table 1.3.2.1: Acronyms and Abbreviations

1.4. Overview

The proposed system would give the perfect solution for the problems occurred in communication of hearing impairers and hearing people.

A language is an entirely human method for communicating thoughts and feelings. There is a gap between non-hearings impaired and hearing impaired people when it comes to communication. Most of the non-hearing impaired people cannot understand what Sign language is.

The main intention of the investigation is to deliver excessive support by enabling hearing impaired people to communicate with others, share feelings and ideas, actively interact with the society and help that they require with minimum amount of effort and time. And, allowing the hearing impairs to play the role by way of ordinary people without having desertions.

To establish the pathway for investigation, research papers and documents were surveyed mostly. Furthermore, the real obligation was discovered through the interviews conducted with students of Deaf School.

To determine the use of mobile applications for deaf people can be observed as a diligence that allows them regardless to utilize to any need of learning and communication at any time anywhere.

To emerge the application in Sinhala language to reach the Sri Lankan deaf community in an effective way.

To advance the text message to a Graphic Interchange Format (GIF) to get the message in sign language with more accurate and attractive manner.

To allow the generation of own sign language using 2D model provided which makes hearing impairers more comprehend about the message they want to direct.

To enhance Sinhala voice recognition algorithm.

To interact with the most popular social media like Facebook Messenger.

This document contains a detailed description about user and system requirements of the system and how the system going to implemented according to those requirements. Format of the SRS and content of the next sections of this document is stated below.

Chapter 2 provides an overall description of the system with the product perspective, different interfaces of the system, memory constraints and operations. Further the chapter 2 describes major product functions, user characteristics, the constraints that may limit developer's options, assumptions and dependencies and order in which requirements are to be implemented.

Chapter 3 describes external interface requirements such as user, hardware, software and communication interfaces. Classes/objects, performance requirements, design constraints and software system attributes like reliability, maintainability, availability is also described under chapter 3.

Finally, all the references and supporting information is provided at the end of the document.

2. Overall Descriptions

The proposed system is a mobile based application named as "Sanwadha". The main ideology of the system is to provide a real-time communication tool between deaf persons and normal persons. It converts text into sign language and voice into sign language.

When considering the system architecture basically it is an instant messaging application. All user interfaces are in mobile phone. But then again, some processing parts are implemented in a web server. Thus, the consumption of the processer of the mobile phone is very low. Because of we needed to make an application which is light weighted and efficient. Text to sign conversion, Voice to sign conversion, GIF conversion and displaying are done in the mobile phone. Other functionalities suchlike creating signs using 2D model are implemented in web server.

Since this is a mobile application it supports for portability but need to support for the real-time communication. The algorithms used must be efficient enough to speed up the application. Also, must be produced most accurate outcomes. To satisfy above requirements developers need to be in good understanding of each functionality of the application.
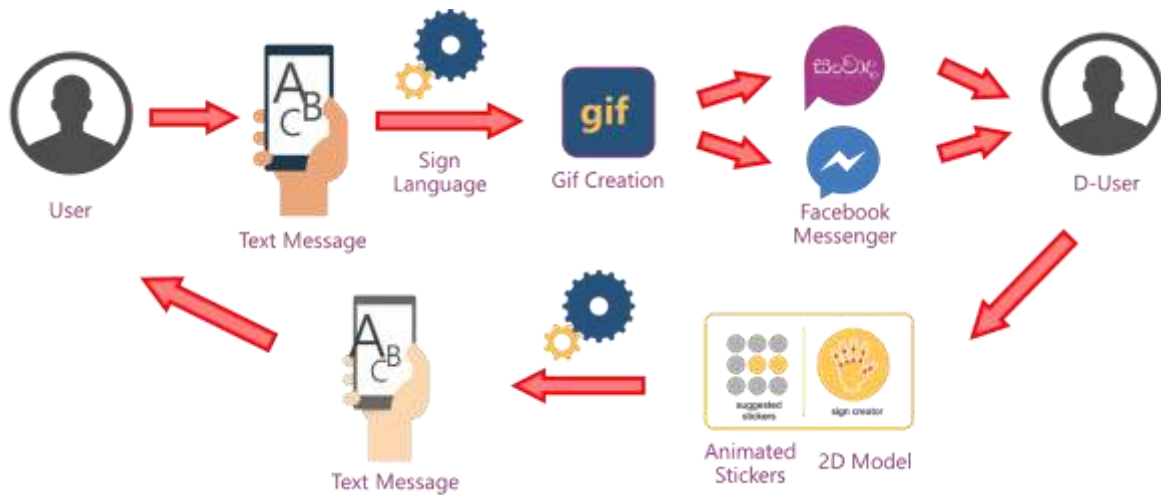
Figure 2.1: System diagram for Text conversion

Figure 2.1 mainly describes the text conversion of proposed system architecture. Text is entered and the text can be either Sinhala and Singlish. Input text would be converted into sign language which is in a format of String. Set of strings is transformed to the GIF format. GIF can be send via either Facebook messenger or proposed application "Sanwadha" to the hearing-impaired user. In the reply scenario, deaf user can select either 2D model or animated stickers. Reply is delivered to the Normal user as a text message.

Figure 2.2: System diagram for Voice conversion

Figure 2.2 mainly describes the voice conversion of proposed system architecture. Deaf user can select either 2D model or animated stickers. That sign would be converted into text. Now the text to speech part is occurred in a high accuracy level. Finally, normal user get the voice output. In the reply scenario, reply is delivered to the deaf user as a GIF message through the process of speech to text.

2.1. Project Perspective

Considering the outcome of the literature review, it is conceivable to decide the most appropriate tools, technologies and software solutions for the implementation phase. In some cases of design conclusions, study more than one possible technologies and take performance and dependencies into deliberation.

The projected solution can be divided to following key components:

- 2D Model creation

- Text Conversion Mechanism

- GIF file Compression and Extraction Mechanism
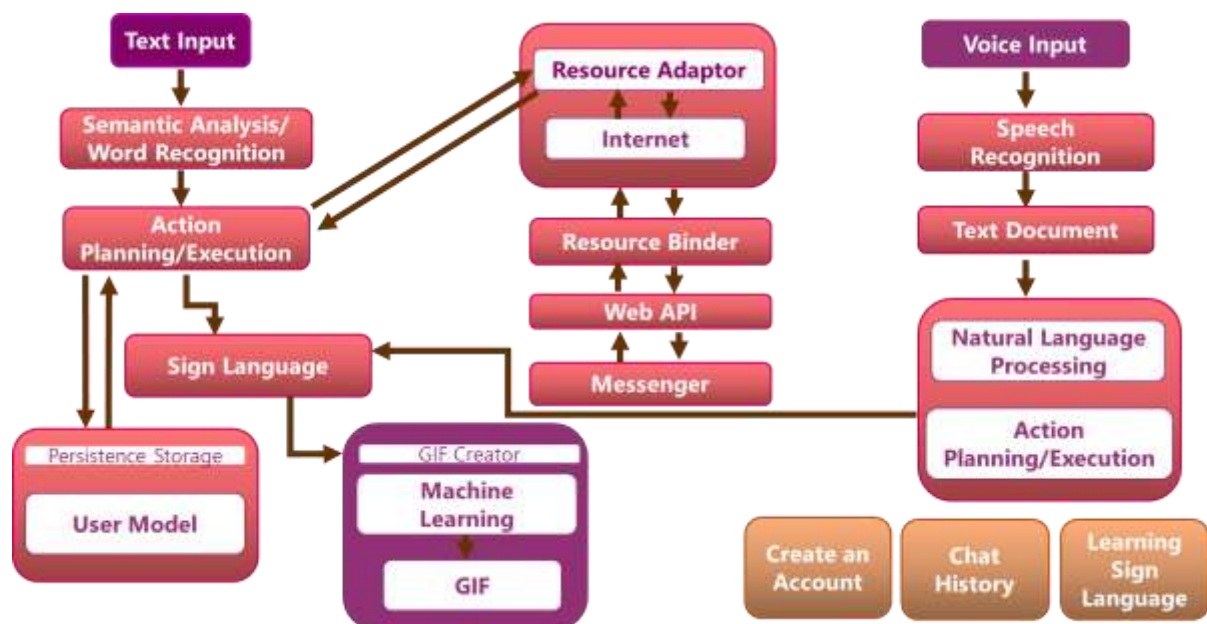
- Voice Recognition Module

Figure 2.1.1: Technical diagram for the system.

In voice recognition, there is a cycle of events that occurs between a voice utterance and the response to that utterance from the machine. This sequence of events referred as voice dialog circle.
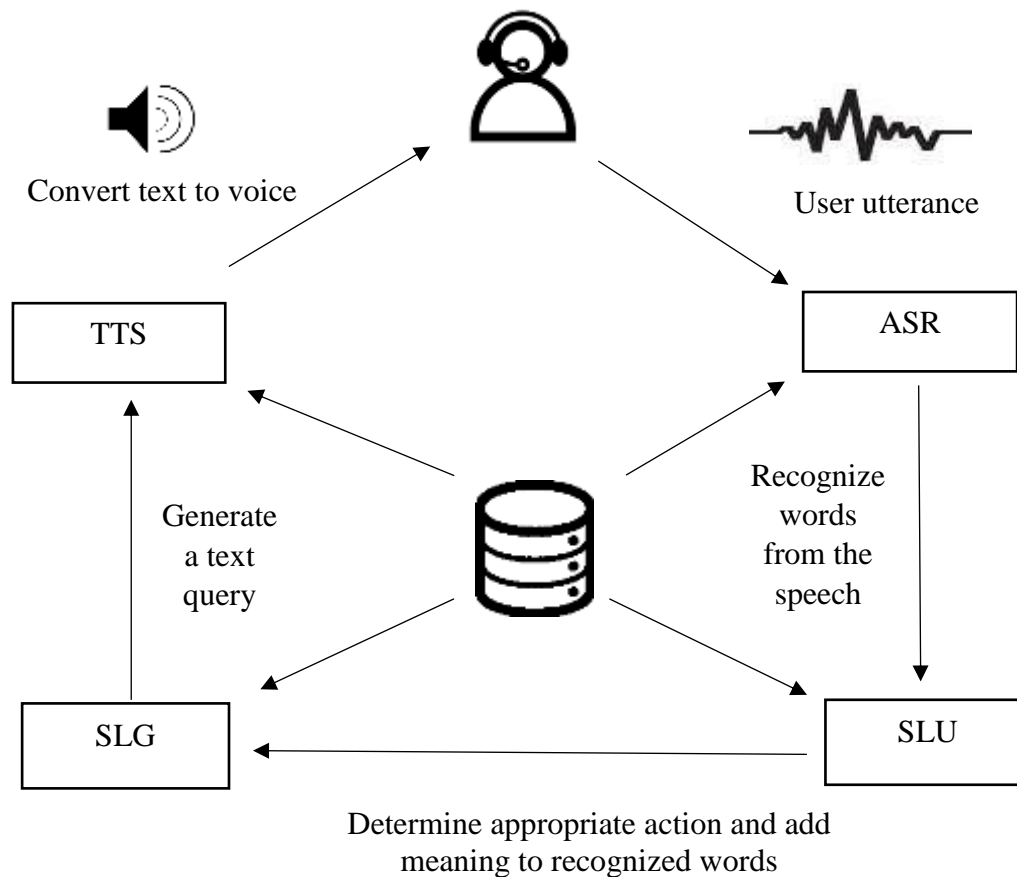

Figure 2.1.2: Voice Dialog circle

The supporter (ordinary man) makes a reply by speaking that is sent to a module, which attempts to recognize, fully sentence basis, the spoken speech. The process of recognizing the words in the speech is called Automatic Speech Recognition (ASR). ASR will recognize the words from the given speech. ASR can be considered as the most important part of the voice dialog circle. To gain accurate results, the system must train to recognize factors associated with the user's voice. After this training, the user must speak in a clear and partially modified manner for his spoken words to be both recognized and correctly translated [01], [02], [03], [04].

Next the spoken words are analyzed by a Spoken Language Understanding (SLU) module, which attempts to attribute meaning to the verify words. The meaning that is attributed is in the context of the task being handled by the voice dialog system. Once meaning has been determined, examines the state of the dialog per a prescribed operational workflow and determines the course of action that would be most appropriate to take. A text query would be generated by the Spoken Language Generation (SLG) module to clarify the meaning and help determine what to do next [02], [04].

The query text is then sent to the final module, the text-to-speech synthesis (TTS) module, and then converted into intelligible and highly natural speech, which is sent to the user [05], [06].

2.1.1. System Interfaces

The proposed system will interact with API's listed below

- Facebook messenger
- Singlish API
- Rest API

2.1.2. User Interfaces

Proposed system is a mobile application connected with a remote server. Additional libraries will be used to improve the appearance of the GUIs and offline messaging. All user interfaces are described in detailed in section 3.1.1.

Key user interfaces

- Main user interface
- Secondary interfaces
    i. Text messaging
    ii. Voice approach

2.1.3. Hardware Interfaces

Hardware requirements will need to run the developed application without having any problem. For the designing, implementation and testing purposes we have identified few hardware requirements. Suchlike,

- Mobile phones – Android OS 5.0 or later
- Microphone
- Speaker
- Dual-core or Octa-core processor
- 2 GB RAM

2.1.4. Software Interfaces

These software components are mainly used created in this application.

- Windows 10 Operating System
- Microsoft Visual Studio 2017 (.Net)
- Microsoft Azure
- SQLite Database
- MAYA Autodesk
- Photoshop CC
- CorelDraw X7

2.1.5. Communication Interfaces

- 3G or 4G connection of the mobile phone will be used for data transmission between the mobile app and the web server.
- Wi-Fi If the mobile data is not available, user can connect to an available Wi-Fi router to get the internet connection in order to use the application. And this will also be used for data transmission between the mobile app and the web server.
- Required Connection bandwidth might differ time to time. Since large data load is travelling through the network, having a high bandwidth internet connection will help a lot for the users to use the application with ease.

2.1.6. Memory Constraints

- 70 Memory Capacity.
- 1 GB RAM Android mobile phone.

2.1.7. Operations

System User is capable of following operations

- Create profile – User can provide user name and password to login to the application.
- View and edit profile – User can view the profile and update any information.
- View chat history – User can view the previous chat threads.
- Save model – User has the privilege to save the generated 2D models.
- View design history – The application save models and user can view design history.
- Add features to model – User can enhance the sign by adding Time frames, Facial expressions.
- Input text – User can input text either in Sinhala or Singlish
- Input voice – User can feed in voice to interact with deaf people

System Administrator is capable of following operations

- Login – Admin can provide user name and password in order to login to the application.
- Manage the user details – Has the privilege to manage user details.
- Upload 2D models – Application allow admin to upload models.
- Approve relevant signs – Accept the signs created by the deaf users.

2.1.1. Site Adaption Requirements

- Both normal and Deaf people are the main users of the application. Hence, it is a requirement to build the application in a simple, understandable and innovative manner to make the application more users friendly.
- Internet access should be provided to the mobile.
- The voice output should be clear and accurate to the user from the beginning.

2.2. Product Functions

Our team has determined the following functions to be most important and pertinent for system to provide.

Figure 2.2.1: Use Case diagram of the system.

Use Case No	01
Use Case Name	Read Text
Actors	Application
Pre-Condition	Insert valid text to read.
Main success scenario:	1. Use case starts with once after the user (Regular user or Blind user) clicks on play button. 2. TTS will perform text analysis and linguistic analysis before reads the text. 3. TTS will read sentence by sentence and while reading it will highlight the currently reading sentence.
Extensions	2.a. If TTS identified invalid word or symbol it will skip the pronunciation.

Table 2.2.1 Use case Scenario: Read Text

Use Case No	02
Use Case Name	Change Speech Volume
Actors	Blind user, Regular user
Pre-Condition	TTS should starts reading the document.
Main success scenario:	1. Click on configuration button. 2. In popup window adjust speech volume using volume slider or using buttons. (Volume control buttons of the device can also use for change the volume)
Extensions	2.a If wants to reset the volume to default level, click on Reset TTS button.

Table 2.2.2 Use case Scenario: Change Speech Volume

2.3. User Characteristics

This application is developing for special determination of helping people who are deaf. Users for this application can be

- Hearing Impaired people
- Ordinary people
- Application Developers
- Any other people who need study sign language

Since this is not a critical application developers have not defined any priority levels to the users of the application. Deaf people can use this application when they communicate with a person who has no idea about the sign language. With the use of this application they can communicate without any intimidation or trouble. Using this application for hearing impaired people can communicate with other hearing impairs. Likewise, this application can be used for teachers who teach the students at Ragama Deaf School and who guide for the hearing-impaired persons.

Application developer performs a main role here. Because updating the application and keep it bugs free is their responsibility. Research group will release new versions when this application and the database of this application have been updated.

As mention above sections, there is enormous communication gap between normal people and hearing impaired people in the Sri Lanka. Due to lack of knowledge about the sign language this problem has been occurred. Thus, this application can be used to get knowledge of the sign language. To get the support from ordinary person at any time anywhere. Furthermore, communication can be done in between ordinary users and hearing impaired user as well as among hearing impaired users.

2.4. Constraints

In this development process of the "Sanwadha" application, development team had to consider about many types of constraints which were affected to the projected application. Those identified constraints are as follows,

- Hardware constraint

This proposed application going to develop as mobile application. Because of that development team had to consider about resource limitations. In order to perform best out of this application, it is a must to upright microphone and speaker of mobile phone. Otherwise this may cause wrong outcomes to the end user. Another hardware limitation of this application is, to run this application it is a must to AMD Phenom™ II or Intel® Core™ i3, i5 or i7 processor; 4GB RAM; USB 2.0 port 80GB free hard disk space and Internet connection.

- Software constraint

Use C# for Xmarine and Azure database to implement our application and custom the external library for offline messaging.

- Time constraints

The system should be completed by September 2017.

2.5. Assumptions and Dependencies

When designing this application there are some assumptions observed.
- Most of the deaf people uses mobile phones and prefer to update with the modern technologies.
- All deaf people and ordinary people who are willing to interact with the deaf community will download and install the application to the mobile phone.
- Users have at least a slight knowledge to operate the mobile phone and the application properly.
- Normal persons will help those deaf persons to communicate using the application. (user involvement)

Dependencies observed throughout the application are as follows.

- The accuracy of the System depends on the input text. Thus, it is very important to have a meaningful sentence of Sinhala or Singlish language.
- Need to have a better network connection to access the internet.
- The speed of the GIF file transfer depends on the network connection and the processing power of the mobile phone.

Furthermore, moving to the future enhancements all the regional sign languages in Sri Lanka are going to be addressed within the application. Since a less number of day to day scenarios covered in the application by now, an enhancement is done by approaching more scenarios. Implement the application by mounting all the other sign languages in order to advance the communication all around the world.

2.6. Apportioning of Requirements

The requirements described in sections 1 and 2 in this document are referred as primary specifications. Details in section 3 referred as requirements specifications. The two levels of requirements are intended to be consistent. Inconsistencies are to be logged as defects. If a requirement is stated within both primary and functional specifications, the application will be built from functional specification since it is more detailed.

Section 3 describes all the essential requirements which are going to implement in this version of "Sanwadha" application. In section 3.6 describe other requirements which contain desirable requirements and optional requirements. Desirable requirements are to be implemented in this release if possible, but are not committed to by developers. It is anticipated that they will be part of future release. Optional requirements will be implemented at the discretion of developers.

3.Specific Requirements

3.1. External Interface Requirements

3.1.1. User Interfaces

User interfaces are required to analyze the user friendliness of the application. These interfaces are the only interfaces that the user will interact with. All the functional requirements are implemented using the least number of interfaces to reduce any complexities and make the application much more user friendly.

This interface will be appeared once the application loads successfully. Then user can enter username and password and sign in if the user is already registered

Figure 3.1.2: Sign in

Users who are not registered will be directed to this interface. They are required to fill details and press "Sign up" button to complete the registration process. After that the user is directed to the user profile window.

Figure 3.1.3: Sign up
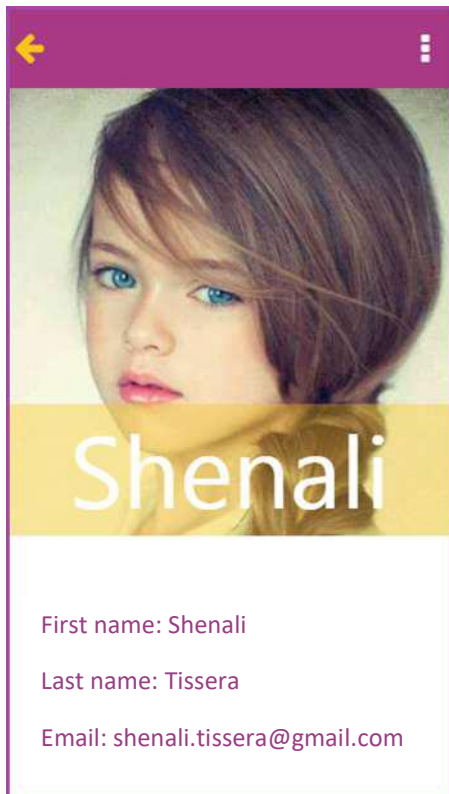
Figure 3.1.4: Profile

This is the interface directed after user registration is completed. Here the created user profile can be viewed with relevant to user details.

Figure 3.1.5: Friends list
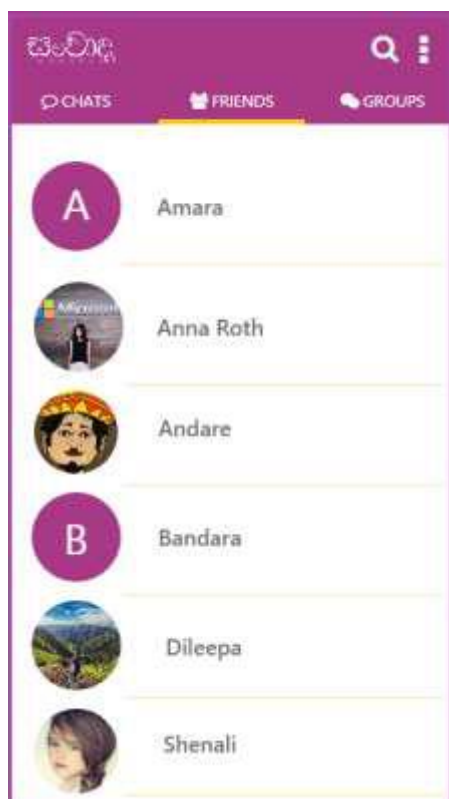
This is the interface of friends list. This allows the user to choose a friend to have a chat. Relevant user details can be viewed by clicking on the contact.

This interface implies the Chat history. User can view previous chat threads also can delete any chat thread.

Figure 3.1.6: Chat history

3.1.2. Hardware Interfaces

Microphone

Since this is a voice based application, system needs capture user`s voice regularly to perform actions. Thus, it is compulsory to have microphone installed and configured properly.

3.1.3. Software Interfaces

- SQLite
- MAYA AutoDesk
- Microsoft Visual Studio 2017 (.Net)

3.1.4. Communication Interfaces

Internet.

If user wants to perform any activity that requires internet, there should be proper internet connection.

3.2. Class / Objects

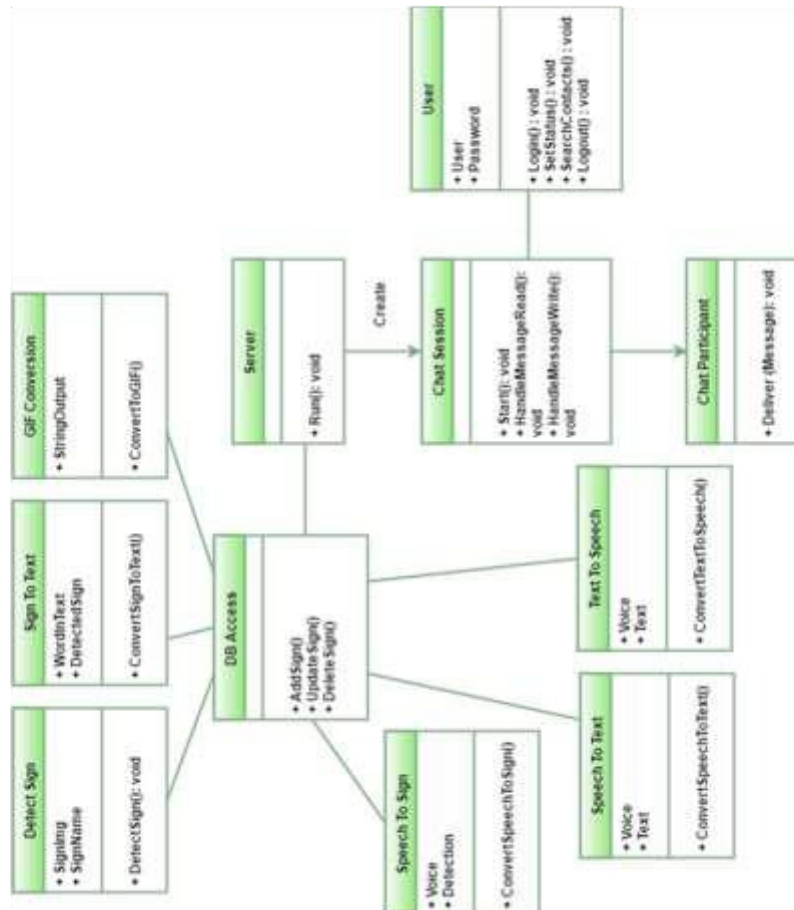**3.3. Performance Requirements**

Figure 3.2.1: Class diagram of the system

This application will be developed as an android application and therefore will be running on a mobile device. When compared with a desktop computer, the processing power of a mobile device is low. Due to this reason, the application should be developed in a way which it will consume minimum number of resources work efficiently.

The background sound recognizing feature will also use the same database for a fast and accurate result retrieval by comparing the background sounds with the samples in the database making it more efficient.

The main target is to make the application to run smoothly and efficiently and provide the user an accurate and quick result making it a very reliable application to use in day to day activities.

3.4. Design Constraints

In system design, a design constraint refers to some limitation on the conditions, when the system is developed, or on the requirements of the system. During system design, it is as important to identify each design constraint as it is to elicit requirements since the design constraints place an overall boundary around the system design process.

- Time Factor

This will be done as a partial requirement to the degree under the guidance of SLIIT. Therefore, in dealing with projects artifacts it is strictly advised to follow the given schedules and deadlines.

Therefore, dealing with the time limitations has become one of the major concerns among the development team in the process of designing.

- Human resource factor

This module will be done as a group project. Even though the sub modules have been divided among group members it's very difficult to come to a conclusion when carrying out some work since there are many more ideas generated by the group members. Finding an appointment to have group meetings and to meet supervisor have become another problem with the busy schedules of everyone.

3.5. Software System Attributes

3.5.1. Reliability

The reliability is a critical issue in this application. This system is deployed as a voice application and the ability of a system or component to perform its required functions under stated conditions for a specified period is a critical issue of the system. Reliability is depending on some varied factors.

- Quality of the microphone – If quality is high then reliability also high
- Operating environment – If system operate on less noisy environment then reliability is high

In detail, the consistency of the system measurement, or the degree to which an instrument (e.g. microphone) measures the same way each time it is used, under the same condition, with the same subjects, is important. The system contains hard ware and software. Therefore, hardware reliability and software reliability should also be considered. The reliability of the final product should be high and quantitatively it can be specified as Mean Time to Failure (MTTF) of greater than 10000 working hours.

3.5.2. Availability

Availability of system is totally dependent on the specific system outage (System down time) and the reliability of the system equipment (e.g. microphone, Bluetooth).

3.5.3. Security

User have done the authentication when using the mobile phone. Mobile phone security plus application passwords can be used externally. All communications are open to internet so future modification should be done after integrating and launching of this version of the product.

3.5.4. Maintainability

Maintainability is defined as the probability of performing a successful repair action within a given time. The proposed application will be easily maintained because application is developed according to the object-oriented principals and modularization. Also, the source code will be well commented and documented for any changes or modifications done in future.

"Sanwadha" application will be developed as version by version. A new version of Sanwadha will be released when the developers make any modifications to the application. Users can download and install the updated version of Sanwadha from Google app store.

3.5.5 Accuracy

Accuracy of the system is also depending on following factors

- Quality of the microphone – If quality is high then accuracy also high.
- Operating environment – If system operate on less noisy environment then accuracy is high.

3.6. Other Requirements

- Database requirement
- 2D designs

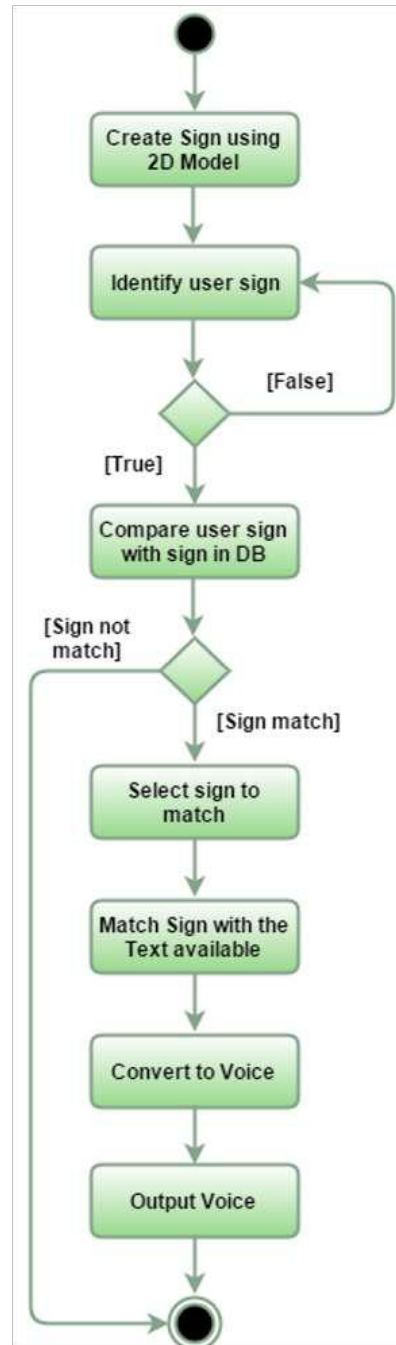# 4.Supporting Information

4.1. Appendices

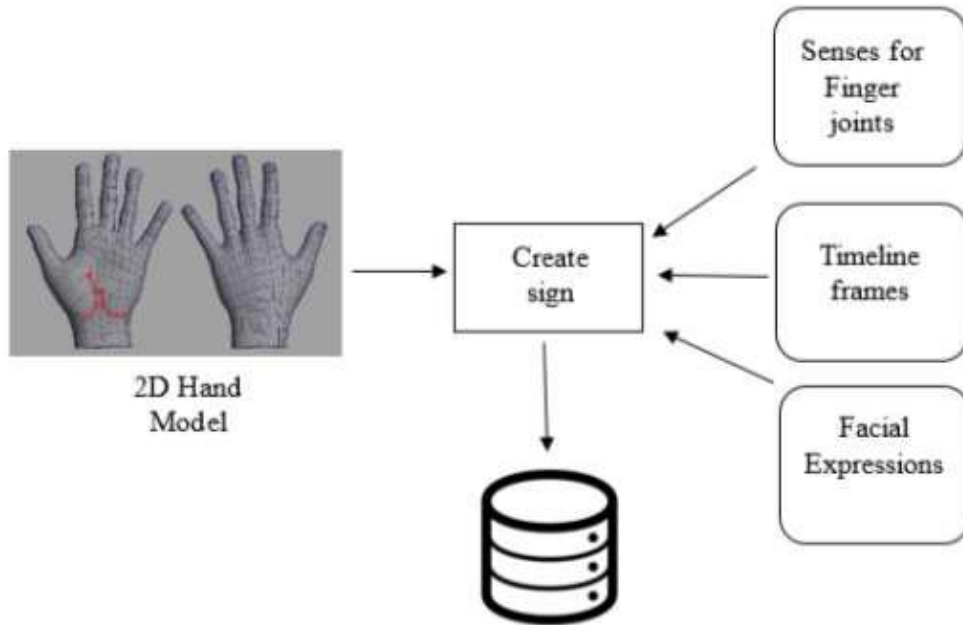Figure 4.1: Activity diagram – Sign to Voice conversion
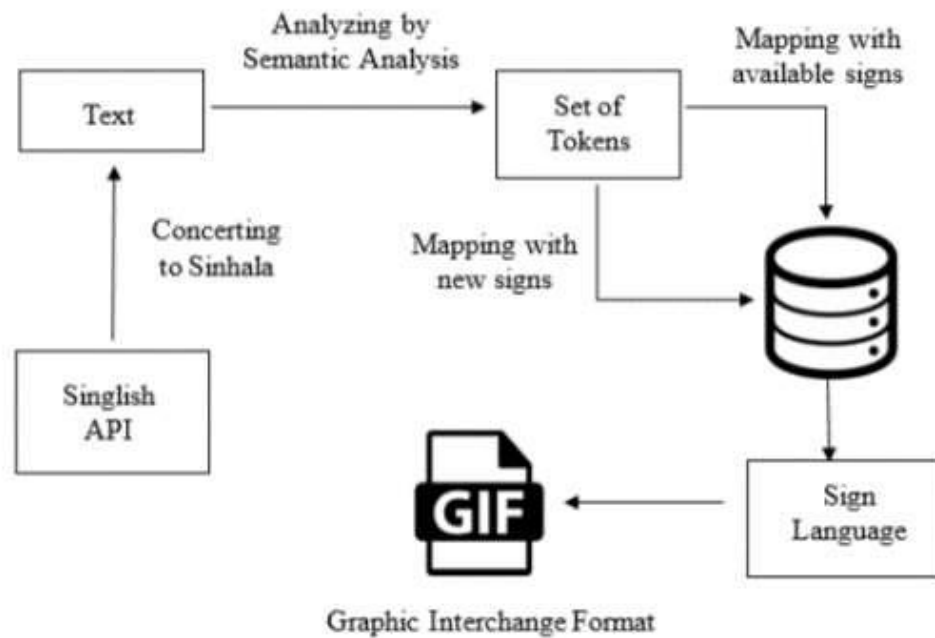
Figure 4.2: 2D Hand Model procedure

Figure 4.3: 2D Hand Model procedure

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