ONLINE LEARNING PLATFORM FOR HEARING IMPAIRED PEOPLE

Project ID: 2022-59

Project Proposal Report

Ramawickrama H.N – IT19174686

Bachelor of Science (Hons) Degree in Information Technology

Specializing in Data Science

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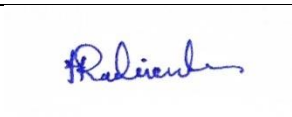
DECLARATION

We declare that this is our own work, and this proposal 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.

Name	Student ID	Signature
Ramawickrama H.N.	IT19174686	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

……. ……

Signature of the supervisor Date

(Dr. Lakmini Abeywardhana)

…….. …….

Signature of the Co-supervisor Date

(Mr. Yashas Mallawarachchi)

ABSTRACT

Communication is the masterpiece of human interaction in a society, out of which, sign language, which is a gestural language has become the primary means of communication of the deaf community worldwide. Majority of children with hearing loss, suffer with various stigmas such as social isolation, loneliness, and anxiety due to lack of communication. Considering this matter many approaches are being made to reduce the communication gap between the deaf and the ordinary communities. There are 138 to 300 varieties of sign languages across the world yet, there is no universal sign language that is being standardized. Through this research component, we mainly focus on the language barrier within the HIC, where both terminals have difficulties in communication due to the absence of knowledge of each other's sign language. In fact, this research gap covers the necessity of Sri Lankan sign language to be translated into one of the most commonly spoken sign languages across the globe i.e., American Sign language (ASL). This enables the Sri Lankan hearing impaired community to interact with another similar user across the world by learning the translated sign language and using it in communication. The proposed system will use computer vision and machine learning techniques to capture the hand gestures through a webcam and convert to a text format, which will be translated to the selected form of sign language by the user and will be presented through a 3D avatar model.

Keywords: Sri Lankan Sign language, American Sign Language, Hearing Impaired Community, Computer Vision

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LIST OF ABBREVIATION

SSL	SriLankan Sign Language
BSL	British Sign Language
ASL	American Sign Language
OC	Ordinary Community
HIC	Hearing Impaired Community
SL	Sign Language
ML	Machine Learning
CNN	Convolutional Neural Network

1 INTRODUCTION

1.1 Background Study

Sign language is a gestural language used by the HIC through bodily movements as their mode of communication [1]. There are around 138 to 300 different sign languages around the world. However, there is no universally accepted sign language that is being standardized yet [2]. The countries that share the same spoken language do not share the same sign language. When considering English, it has three varieties of sign languages: American sign language(ASL), British sign language(BSL) and Australian sign language [3]. The figure below that was taken from a source displays how disabling of hearing loss has unequally distributed across the world [4]. This also shows how sign languages can vary worldwide.

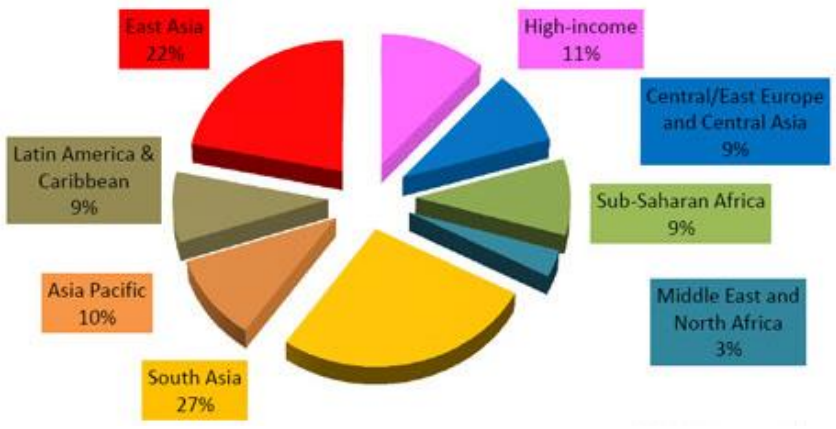

Figure 1. 1 - Sign language distribution across the world

Since the ordinary community do not understand the sign language and also due to the fact that there is no standardized sign language for the hearing-impaired community to interfere worldwide, there have been many problems that has arisen.

Most of which are problems such as social isolation, loneliness or anxiety disorders that are commonly be seen within the HIC [5].

With the evolving technology numerous chat applications, visual communication channels are being introduced to interact even with someone who is in a different geographical location. In such situations the HIC may be deprived out of the opportunities due to the absence of knowledge on another foreign sign language [6].

An article released by the Australian Department of social services, reports on the supply and demand for the interpreters for the deaf community in Australia [7]. According to the article it's reported that many deaf users rely on interpreters in their day-to-day interactions. The figure 1.1.2 below which was taken from a source, depicts how often the HIC needs interpretations during their regular daily activities.

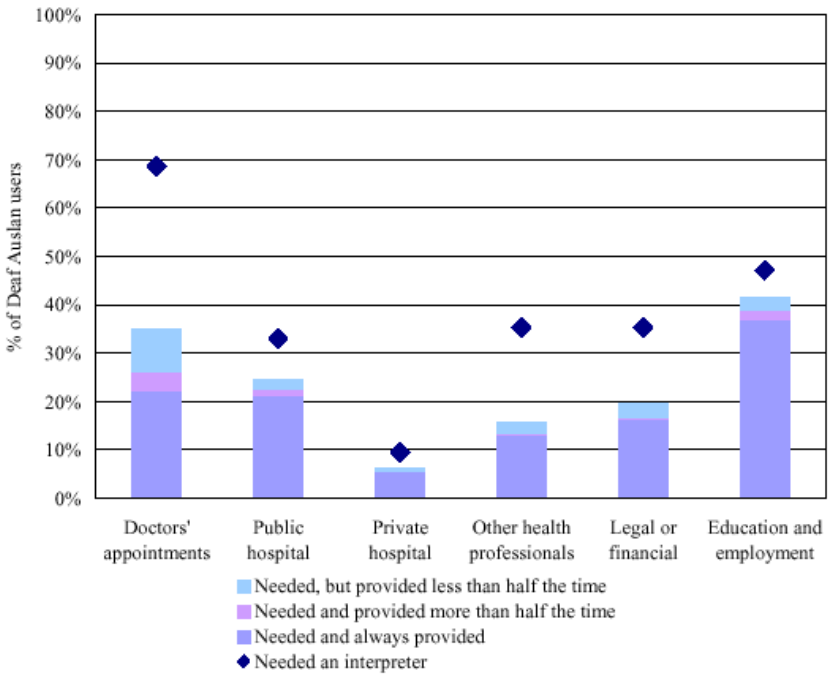

Figure 1. 2 - Need for interpreters for the HIC

According to an article in ‘Conversation’ there are various approaches made by different countries to address hearing loss which includes cochlear implants, hearing aids and learning sign language [8]. But it is not always possible for the HIC to access them due to economic limitations and lack of resources in many countries.

As a result this approach is made to develop a system that can that can translate between sign languages in order to address the above mentioned problems and give more exposure to the HIC to learn a non-native sign language.

1.2 Literature Survey

According to the world health organization more than 430 million people suffer from hearing loss [1]. The article ‘verywellmind’ states that a large part of the HIC suffer from various psychiatric conditions such as mood disorders which is mainly due to communication difficulties [9]. This primarily includes lack of interpretation between sign language and spoken language. As a result, the need for a suitable system which can help reduce the communication barrier within these communities has come to the attention of many researchers. Hence, researches are conducted in order to enhance the opportunities for the HIC to interact efficiently with one another.

The mobile based application ‘'Sanwadha” provides real time communication between the ordinary and the hearing impaired community [10]. The application consists of functionalities such as conversion of text into Sign language, voice to sign language and also GIF conversion. In text conversion once a text is entered in English or Sinhala, the set of strings will be translated into sign language and will get transformed into a GIF format. Similarly in voice conversion, the application introduces a 2D model or an animated sticker for the deaf user to input the sign and the result will be delivered to the normal user through a voice output.

EasyTalk is another similar application which translates SSL into text and audio formats as well as the verbal language into the SSL [11].

This application captures the hand signs through a hand gesture detector using pre-trained models and using an image classifying component it classifies and translates the detected hand signs. The identified hand signs produce a text, or an audio formatted output with the aid of text and voice generator components.

UTalk is an SSL converter developed using Computer vision and Machine learning techniques [12]. This mobile application focuses on interpreting static as well as dynamic signs that are expressed in SSL. The system captures the video of the user performing sign language as the input, while extracting the frame segment and removing the background out of those frames with the aid of the image processing techniques. These frames that are being preprocessed are made to go through two separate machine learning models stated as static sign classifier and dynamic sign classifier, after which the output will be fed to a language model and presented in a text format.

Another research introduced static sign language recognition using deep learning [13]. The system was based on a skin color modeling technique where the predefined skin color range will extract the pixels from non-pixels, in other words the hand is separately recognized from the background. The images are then fed into the model Convolutional Neural Network (CNN) for image classification and is later trained using Keras. The system obtained an accuracy of 93.67%

A Japanese team of researchers developed a CG-Animation system for sign language communication between different languages [14]. The system analyzes the image of the sign language gesture, and the image is being described through text and programs. CG animation is generated through these text and programs. Apart from sign language to text conversion, it's been noted that there are few other systems that have been implemented text conversion into the relevant sign language.

Considering text to sign language conversion, a study was conducted by a group of researchers from university of Pennsylvania where they implemented a system which converts English to ASL [15].The implementation is done based on two approaches where, initially the English text which is taken as the input is converted into an

intermediate representation after which it is further converted to a set of quantitative parameters which controls an articulated 3D human model to produce the ASL.
Similar research was done using Russian sign language. In this research a semantic analysis algorithm is developed and introduced. The aim of semantic analysis is to model the meaning of the words in the sentence [16].

1.3 Research Gap

As mentioned in the above literature survey many research projects are proposed to interpret sign language into spoken language or vice versa. However due to the fact that there is no universal sign language for the HIC across the world, and different countries have their own unique sign language, a system that is implemented for one particular sign language cannot be directly used to understand another. Hence the necessity for a platform that can translate one sign language to another remains yet to be introduced. Considering these issues in the existing systems, we have presented a solution in the proposed system to convert SSL to ASL. Shown below is a summary of some of the notable gaps that was found in the previous research projects. Table 1.3.1 will show a list of previous researches compared with our proposed system.

Table 1.3.1 - Comparison between previous research and proposed solution

	Conversion of natural language (text/audio to sign language)	Conversion of sign language to natural language (text/audio)	Translation of one sign language to another	Based on SSL	Computer Vision based approach
Utalk: Sri Lankan Sign Language Converter Mobile App	✗	✓	✗	✓	✓
Static Sign Language Recognition Using Deep Learning	✗	✓	✗	✗	✓
Sanwadha: Mobile Assistant for Hearing Impairers	✓	✗	✗	✓	✓
A Machine Translation System from English to American Sign Language	✓	✗	✗	✗	✓
EasyTalk: A Translator for Sri Lankan Sign Language	✓	✓	✗	✓	✓
Proposed System	✓	✓	✓	✓	✓

1.4 Research Problem

Most of the existing systems were implemented to facilitate the necessity to translate from a sign language to a spoken language or vice versa. However, a system that is implemented to understand one particular sign language cannot be used to understand another foreign sign language. Due to the unavailability of such interpreters, there is a need for a platform that can provide the HIC to familiarize themselves with various other sign languages. Therefore, this application reaches out to the HIC in Srilanka who needs support with getting SSL translated to a non-native sign language which would further enhance their knowledge on a sign language that they are not familiar with while expanding their communication skills.

A survey that was conducted with 27 participants presented that its beneficial to have a platform that can be used to learn American Sign language. The figure 1.4.1 below shows a diagram of responses for the conducted survey.

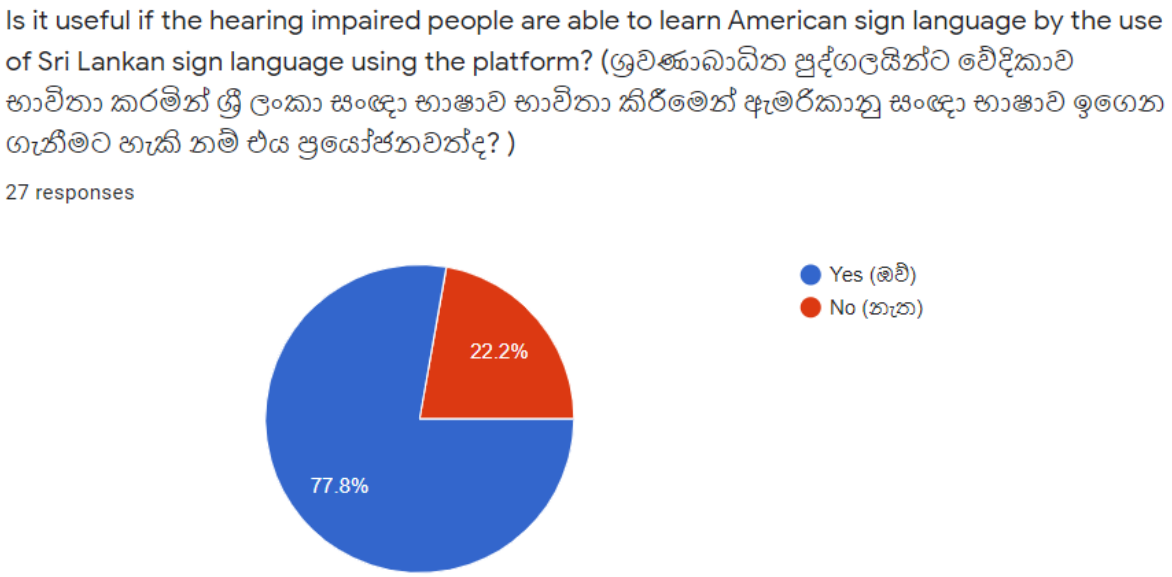

Figure 1. 3 - Survey responses

A 77.8% of a notable number of responses were given for the above questionnaire which indicates that this platform will be useful for a significant number of people.

2 OBJECTIVES

2.1 Main Objectives

Main objective of this research is to develop a system that can facilitate the HIC to learn SSL in an efficient manner and discover different aspects of sign language worldwide. Moreover, it will provide a platform that can respond to various user inquiries. It also focuses on translating the content of a specific video into SSL while enabling the hearing-impaired user to have access to most of the services that the ordinary community can use.

2.2 Specific Objectives

Some of the specific objectives of the research within the main objectives are:

- Creating an interactive and an efficient learning platform for the HIC by enhancing their communication aspects.
- Ensure that an accurate response is given by the system according to the user requirements.

3 METHODOLOGY

3.1 System Architecture diagram

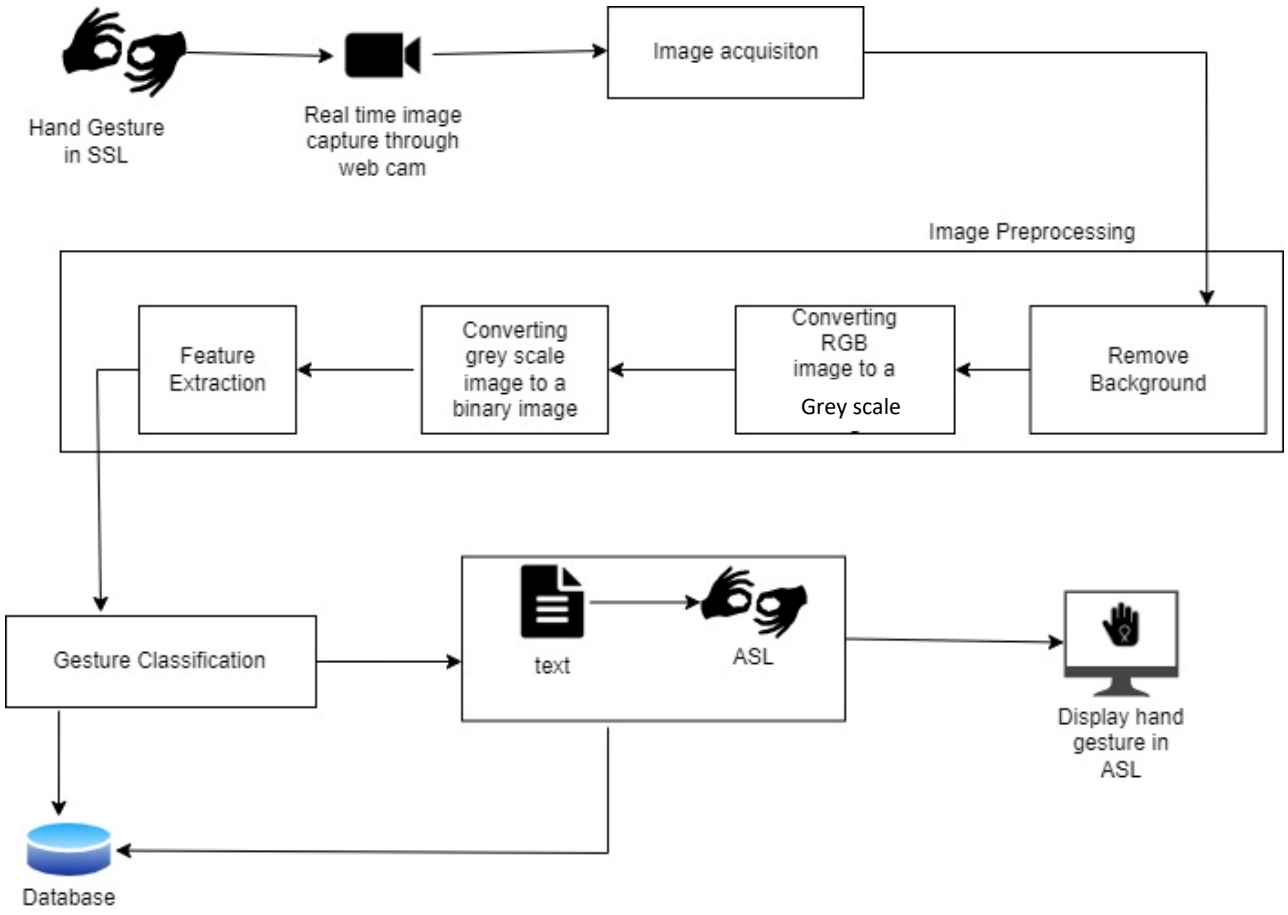

Figure 3. 1 - System Architecture Diagram

3.2 **Converting SSL to ASL**

3.2.1 Image Acquisition

Initial hand gesture will be given in SSL and it will be captured through the web camera. Once the image is captured it will be sent for preprocessing.

3.2.2 Image Preprocessing

Since its difficult to differentiate the hand gesture based on the skin colour, the image is transformed into different colour space conversions.

Initially the background will be removed from the image. Once the background is removed from the image it will be converted to a grey scale and then to a binary image. When the image is in the binary form it will only be displayed in two colours where the hand sign will be in white and the background will be displayed in black. This method will be much less complicated when differentiating the hand gesture from the background. Fig 3.2.1 shows colour space conversions of an image from the original image to a grey scale and finally to a binary image. In the feature extraction phase, the image will be resized according to a given pixel range and only the sufficient features will be extracted.

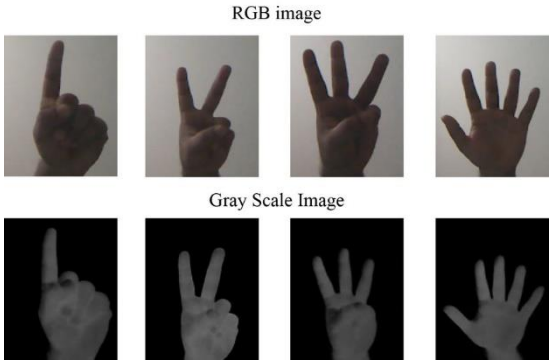

Figure 3. 3 - Colour space conversion

Figure 3. 2 - Hand gesture in Binary form

3.2.3 Gesture Classification

In the model the hand gestures are pretrained and tested. Based on the previously trained gestures, the hand signs will be classified as the relevant hand gesture will be given as a text output.

3.2.4 Final Output

In the database the predefined set of words with the corresponding ASL will be stored. When the initial input image is converted into a text format, it will run through the database and fetch the relevant hand gesture in ASL for the corresponding text. The final output hand gesture in ASL will be denoted through a 3D avatar model.

3.3 Tools and Technologies

3.3.1 Technologies

- Image Processing

3.3.2 Tools

- Image processing – Python and Open CV
- Labelling the images – LabelImg Tool
- Building the CNN model – Tensorflow and Keras

3.3.3 Algorithms

- Training and classifying images - Convolutional Neural Network (CNN)
- Colour space conversion Algorithm – HSV

4 PROJECT REQUIRMENTS

4.1 User Requirement

- User should have some knowledge on the SSL

4.2 Functional Requirement

- Identifying the hand gestures
- Provide options for the user to select the relevant sign language that needs to be translated into
- Translating SSL to the relevant sign language

4.3 Non-Functional Requirement

- **Accuracy**

  The system should perform a precise output as the user is engaging in a platform to gather knowledge.
- **Usability**

  System should maintain a high usability so that the user can engage with the system in a productive manner.

- **Reliability**

  The system should be able to perform without any breakdown throughout the translation process.

5 WORK BREAKDOWN STRUCTURE

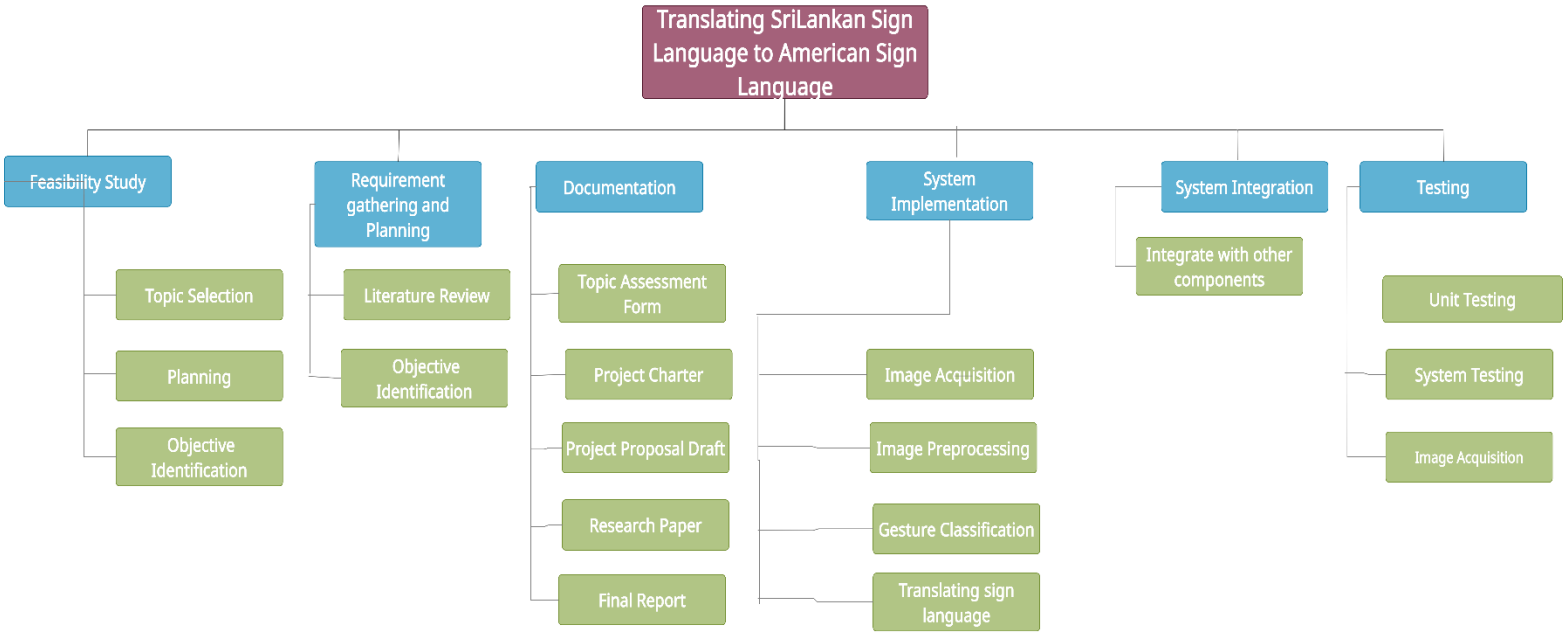

Figure 5. 1 - Work Breakdown Chart

6 GANTT CHART

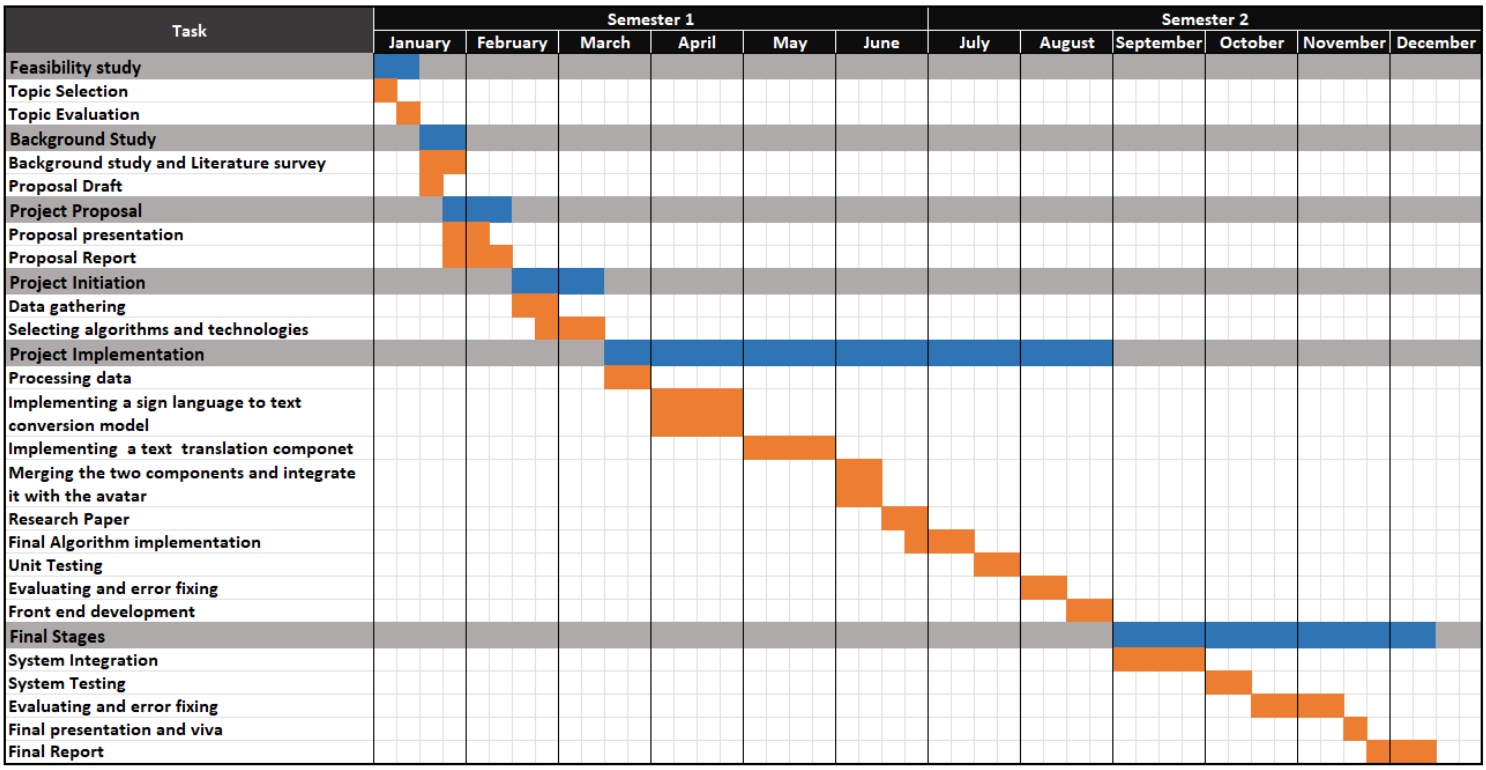

Figure 6. 1 - Gantt Chart

7 COMMERCIALIZATION

Introducing this platform will enhance number of opportunities for a wide range of people to communicate with someone even in a different geographical location. Regardless of the fact that there are many such applications that are presented to assist the society in such cases, this application will give more exposure to the user to learn and interact with a similar user who is aware of a remote sign language.

This will further give access to a variety of carrier opportunities. With the increase of globalization, language skills will be much beneficial for a hearing-impaired user to engage in multiple range of job roles.

Moreover, learning a new language would generally open up chances to access information that could be off-limit due to language limitations.

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9 APPENDICES

Survey link: https://docs.google.com/forms/d/e/1FAIpQLSd3GQeVu3_k8lL2uvtTy2hGc8-he1msLWR_5Y_hzZWGgeVKpA/viewform