EASYTALK: A TRANSLATOR FOR SRI LANKAN SIGN LANGUAGE

Final (Draft) Report

G.M.A.S. Bastiansz
IT17143950

B.Sc. (Hons) Degree in Information Technology
Specialized in Software Engineering

Department of Software Engineering

Sri Lanka Institute of Information Technology
Sri Lanka

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G.M.A.S. Bastiansz
IT17143950

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute higher learning and to the best of my 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.

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G.M.A.S. Bastiansz	IT17143950	

The above candidate is researching the undergraduate Dissertation under my supervision.

…….. ……..

Signature of the Supervisor: Date:

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ABSTRACT

Communication is a necessity of all the people from ancient days. In past human beings tested various kinds of message passing modes. The best example for a message made was doves. After some years, they invented a kind of letters which was able to use to speak, write as well as read. Also, when people got into various groups, they represented different kinds of spoken languages specific to each group. As a result of past inventions, today we can identify hundreds of language types all over the world. Sign language is the common way of communication of the people with difficulties in speaking & hearing. There are translators which use to translate sign language to normal vocal language & vise-versa. But there are only few quantities of these interpreters in Sri Lanka& this quantity is not enough for a wide communication system. As Sri Lanka is still known as a developing country, most of the people don't have clear understanding about the interpreters or about the sign language system which used in Sri Lanka. Therefore, many ordinary people are refusing to communicate or express their feelings, ideas with deaf or mute people. So do the people with difficulties in hearing & speaking. Only the people who must communicate those hearing-impaired or mute community are only considering on leaning sign language. Due to the expensive budgetary process needs to come up with interpreters, Sri Lankan people do not feel interest on learning SSL. Our research is based on creating a translation system which should be able to convert Sri Lankan Sign Language into English sentences & to convert English text format into Sri Lankan Sign Language. The research component, which is describing in this report mainly focuses on converting English texts to Sri Lankan Sign Language using multiple techniques in Machine Learning.

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LIST OF ABBREVIATIONS

SSL – Sri Lankan Sign Language

GIF – Graphics Interchange Format

ML – Machine Learning

NLP – Natural Language Processing

NIE – National Institute of Education

NISD – National Institute of Social Development

UGC – University Grant Commission

CPU – Central Processing Unit

OS – Operating System

SDLC – Software Development Life Cycle

1. INTRODUCTION

1.1. Background & Literature Survey

"Language is a system that consists of development, acquisition, maintenance & use of complex systems of communication, particularly the human ability to do so; a language is any specific example of such a system"[1].

Estimated number of languages in the world vary between 6000 to 7000. Usually, verbal and sign languages can be categorized as the most commonly using natural languages. Instead of these categories, any language can be encoded into secondary media using auditory, visual or tactile stimuli [1]. The reason for this encoding is the modality-independence at human language.

Ordinary people use verbal languages such as Sinhala, Tamil, English in their daily lives to communicate with each other. In verbal languages, words are made up using a set of vowels, constants & tone. Normally, the same set of words with different types of tones & communicate methods represent different meanings, while complexing & more interesting the verbal language.

Sign language is usually used by people who have difficulties in speaking & hearing. As they are unable to use vocal language to communicate with each other, body gestures are used. The component which is going to describe through this report mainly targeting the deaf community in Sri Lanka. According to a recent statistic through Sri Lanka, there are more than 300,000 people with difficulties in hearing. Among this 300,000, more than 75,000 are the youth population in the country who are unemployed due to the limited education & vocational training they had got.

One of the main reasons for not having proper education & vocational training is the lack of attention on hearing-impaired people even there are 25 special schools & 730 special units for them. Other than that, the teacher who is teaching these schools knows only to teach the students most of the time. They do not have a proper understanding of the language they teach. Therefore, it is hard for teachers to communicate with the student to dive into their minds & identify the abilities,

weaknesses, feelings the student have. Finally, this fact makes the hearing-impaired student uneducated.

As a result, this situation makes the various learning challenges due to the minimum access to learning resources that the special school previously got. The main purpose of this component, "Converting textual format into Sri Lankan Sign Language" is to come up with a system, which can be used by any person who is in interesting with learning SSL. After getting a proper self-guidance, the ordinary people will be able to communicate with hearing-impaired people to make a space in Sri Lanka to present their abilities too.

According to the Census of Population and Housing undertook in 2012, there were 21 people per 1000 are suffering from hearing-impaired difficulties. Also, there are 180,833 Sri Lankans who suffer from difficulties in speaking as displays in Table 1.1

Table 1.1: Population of hearing-impaired and inarticulate of Sri Lanka in 2012

Type of Difficulty	**No. of Persons**	**% to Total Cases**	**No. of Persons not possible at all**	**% to Total Cases**	**Difficulty published in Census**	**% to Total Cases**
Hearing	354,871	22.8	28,674	20.3	389,077	24.0
Communication	133,623	8.6	47,210	33.5	180,833	11.2

Without a recognized age gap any person can affect to these hearing-impaired and inarticulate disabilities. More importantly, these disabilities may impact on person's day-to-day functions very critically. Especially, this problem is highlighted in communication. Therefore, to assist these hearing-impaired and inarticulate communities, some applications were invented through different researches. These applications are based on different sign languages such as American Sign Language, Indian Sign Language, Sri Lankan Sign Language, etc. Since SSL is unique for Sri Lanka many translation machines in Sri Lanka is based on SSL. These applications are mainly aiming Sri Lankan hearing-impaired and inarticulate community.

“Nihanda Ridma”, “Ahanna” and “Sanwadha” are few examples for translation applications based on SSL and below contain detailed descriptions about each these applications.

1.1.1. Nihanda Ridma System

Nihanda Ridma system was implemented aiming Sri Lankan children with hearing-impaired diagnoses. Since the system was built as a game-based learning system, it is easy to learn SSL for hearing-impaired children. The system consists of 3 components namely, 3D model monitoring, motion tracking and voice recognition. 3D model animation we used to display the result to the hearing-impaired child. Motion tracking component had used a leap motion controller to convert the tracked movements of the child into voice-format output. This is the key ingredient to recognize the sign gesture. By using Nihanda Ridma, a hearing-impaired child can get a proper avatar animation clip for entered text. The overall system demonstrates the method of identifying an individual sign and phonetics through images and videos. Since different mind-teaser games are used throughout the system, the hearing-impaired children can self-motivate themselves to sharp their abilities of learning. At last, this system outputs a 2D animation clip for the appropriate voice-input. [2]

1.1.2. Ahanna System

Ahanna system is a web-based application with the main intension of spreading Buddhism between Sri Lankan hearing-impaired community. This application mainly uses SSL and provides many valuable activities, innovative products and new thoughts to improve the knowledge and education of Sri Lankan hearing-impaired users who are willing to use this system. [4]

1.1.3. Sanwadha System

Sanwadha is a user-friendly intelligent assistant which can be used by hearing-impaired and inarticulate users in order to interact with society. Since this application is mainly targeting on Sri Lankan hearing-impaired and inarticulate community therefore, SSL is used as the sign language throughout the application. Sanwadha application contains SSL features as well as chat mode function. The hearing-

impaired users can use this application under voice mode while both hearing-impaired and inarticulate can use this under sign mode. Also, Sanwadha can convert normal Singlish text into SSL mode and SSL into normal Singlish text format. Therefore, this application can also use as a communication mode between Sri Lankan ordinary user and a user among hearing-impaired or inarticulate communities. Sanwadha consists of 4 main features namely: text-to-text communication, text-to-voice communication, voice-to-text communication and text-to-sign communication. This is a mobile-based application which can be used as an API in Messenger [3].

All these mentioned applications were mainly implemented based on SSL. Therefore, these applications can be used by any person who can understand SSL. Other than these "Nihanda Ridma", "Ahanna" and "Sanwadha" systems, there are some applications which were designed based on other sign languages too. Even they cannot see within Sri Lanka, many people around the world with the difficulties in hearing and speaking are using these applications to interact with the societies whether they belong to. Some examples for these applications can be summarized as follows:

1.1.4. Deaf Chat

Deaf Chat can be used as a communication method between a hearing-impaired person and an ordinary person. This can be used as an alternative instead of papers and pencils. Also, through this application, users can communicate with each other while staying at moderate distances. Deaf Chat application mainly uses as a mobile-based application. Once a user in one side enters a text message as a voice-input or a keyboard-input through his/her local text area, the message will be sent to the second user in the other side's remote text area. This system allows a network connection such as Wi-Fi, Intranet connection or Internet connection to provide the maximum benefit to the users [5].

1.1.5. Deaf-Hearing Chat

Deaf-Hearing Chat is a face-to-face communication system which can be used between a hearing-impaired person and an ordinary person who does not have hearing difficulties. This application can be used without a sign interpreter. Deaf-Hearing Chat system can be used in everywhere: at home, workplace, restaurants and even in

institutes. If the user suffers from difficulties in hearing, he/she can continue a face-to-face conversation using this Deaf-Hearing Chat. Also, if a user is an ordinary person without any difficulty in hearing, he/she can communicate with hearing-impaired people in the normal way through this system [6].

Table 1.2: Comparison with Existing Systems

Feature	**Nehanda Ridma**	**Ahanna**	**Sanwadha**	**Deaf Chat**	**Deaf-Hearing Chat**	**EasyTalk**
Text recognition system	✗	✗	✓	✓	✗	✓
Convert simple English text into SSL	✗	✗	✗	✗	✗	✓
Display already-defined hand signs as a GIF image	✗	✗	✗	✗	✗	✓
Display a combination of hand signs as a GIF	✗	✗	✓	✗	✗	✓
Web-based application (can detect images taken from low-resolution web cameras)	✗	✗	✗	✗		✓

1.2.Research Gap

There is always a communication gap between ordinary people and hearing-impaired or inarticulate people all over the world. Therefore, interpreters are used by ordinary people while communicating with these special communities. But it becomes a huge problem when there are not enough interpreters which can be used by all ordinary people.

To avoid this problem, many countries like America, India invented different types of sign language translation machines which can easily translate sign language into verbal language. Also, there are on-going researches based on sign language translation. But Sri Lanka cannot use this invented translation machines because of the uniqueness of the sign language from one country to another country. Although, most of those translation machines were invented targeting only ordinary people or hearing-impaired and inarticulate people. Apart from this, the uniqueness of sign languages and the rigidness of current translation machines, there are some more highlighted reasons for not having a unique translation method to Sri Lanka.

The first reason is the difficulty to spend a large amount of money to study and buy new tools and technologies which are used by other countries to invent translation machines. Since Sri Lanka is still listed as a developing country. The Sri Lankan government cannot allocate that amount of money only for one purpose because there are many other aspects which need the government's attention urgently. The second reason is, even there are some translation machines for Sri Lankan sign language, they are only specific for the schools with hearing-impaired and inarticulate students. Therefore, ordinary people cannot use them for their purposes. Also, most of the translation machines invented within Sri Lanka are based on the Sinhala language. Due to this, people who are not fluent in the Sinhala language would not be able to operate these machines.

Therefore, by today ordinary people who are willing to communicate with hearing-impaired or inarticulate people have challenged with a massive communication gap in their daily lives. This application would be the best solution to reduce this communication gap mentioned above.

1.2.1. Research Gap in Creating Real-time Application

The purpose of this project is to implement a real-time application among Sri Lankan ordinary people and hearing-impaired or inarticulate community. This application is normally used to communicate using SSL. The ordinary people would be able to clarify relevant hand sign for the simple English format text within minutes due to the real-time feature of the application.

1.2.2. Research Gap in Semantic Analysis

Semantic analysis is used to get the definition of any given set of words and convert that definition into a GIF image. By using this technique, the user would be able to understand the way of using the hand sign without having a nonsense set of images for that hand sign.

1.3. Research Problem

Communication between each other is one of the essential things. Not only human beings but also all the creatures follow their way to communicate with each other. Communication is used as a possible and the easiest way to express the one's feeling, suggestions to another party.

Usually, human beings use verbal language to communicate with each other. By using verbal language, they can express what in their mind to another person in an understandable way. As mentioned earlier, there is a special community in the society which consists of people with hearing and speaking disabilities. Unfortunately, this community is having difficulties in communicating with ordinary people. The language used for communication by that is not well-known to the rest of the population. Therefore, it is important to build a strong bridge between ordinary people and hearing-impaired and inarticulate people to reduce this communication gap.

To fulfil this task, both ordinary people and hearing-impaired or inarticulate people should have a good understanding of each other's communication methods. On order to get this knowledge, first, it is important to consider the way of handling languages to express their feelings. When considering about hearing-impaired and inarticulate communities, visual and physical communication methods are more preferred to them compared to audible communication. Because of the sign language they use in their daily lives, it is difficult to express their feelings to their opposite person when they stand in distance to each other. As mentioned previously, Sri Lanka has a list of special signs which are used by hearing-impaired and inarticulate communities in the case of communication. Since these signs are taught to a selected special community, ordinary people lose the chance to study the sign language. Therefore, most of the ordinary people feel uncomfortable and become annoyed while trying to communicate with a

hearing-impaired or inarticulate person. This situation gets worst when there are no interpreters which can be used as a common feature between verbal language and SSL. Due to this situation, the gap between the ordinary community and hearing-impaired and inarticulate community get more distanced day-by-da. On the other hand, this special community try to be more anti-social because they cannot express their feelings or anything unless there is any person from the same special community.

As a solution to reduce this communication gap between these two Sri Lankan community, the government universities, NIE, Department of Disability Studies of medical faculty of Kelaniya University and NISD had introduced many degrees and diplomas based on disability studies [7]. These degrees and diplomas are few of the successful ways to distribute knowledge in sign language among ordinary people. But according to the UGC statistics, among 160,000 students who pass G.C.E (Advanced Level) examination only 25,000 to 30,000 students get chances to enter a Sri Lankan government university in every year [8]. Among this, only a small percentage of students be lucky to get selected to study the degree offered by the Department of Disability Studies. Therefore, it is very clear that only a few numbers among Sri Lankan population get the chance to study and use SSL with proper guidance. Also, there are some other institutes with different diplomas based on SSL, people will not get any notice about them because of the poor understanding. Therefore, it is easy to recognize that the main reason for having poor knowledge of SSL among the Sri Lankan ordinary community is the inappropriate guidance they get. The outcome of this issue is the ordinary community start to refuse to be friendly with hearing-impaired and inarticulate communities.

Apart from introducing different degrees and diplomas to study SSL, there is another solution to ordinary people to reduce the communication gap with this special community. They are sign language interpreters. By using interpreters while talking, the communication becomes more comfortable because the interpreters can translate sign language into the verbal language as well as verbal language into sign language very easily. Unfortunately, there are only a few numbers of interpreters are distributing among Sri Lanka. Although most of them are implemented based on hearing-impaired and inarticulate people, they can be used to translate SSL into the

verbal language most of the times. Also, most of the interpreters are unable to provide the guidance to do these two translation routes at the same time too. On the other hand, due to the smaller number of interpreters, only a few ordinary people can get the assist of them. Therefore, it is clear that even there are solutions to build a strong communication bridge between the ordinary people and hearing-impaired and inarticulate people, it is not way too easy because only a limited number of the ordinary community can access them. Therefore, the process of gradually growing communication distance between the ordinary community and hearing-impaired and inarticulate community will not be unstoppable, if there do not have a common solution which can be accessed by every Sri Lankan ordinary person.

This is a problem addressed in this research. Even several types of research had tried to overcome this problem, almost all of them could not reach to the final target successfully because all of them are only considering in translating SSL to verbal language (most of the time Sinhala language). Therefore, through this research, it is hoped to address the problem of translating common verbal language (English) to SSL by implementing a proper application as an assistant to Sri Lankan ordinary community who are willing to communicate with the hearing-impaired and inarticulate community.

1.4. Objectives

1.4.1. Main Objective

- The main objective of this research is to offer huge support to Sri Lankan ordinary people who usually use Sinhala, Tamil, English languages in their day-to-day lives as a way of expressing their emotions to communicate with hearing-impaired and inarticulate people actively interact with Sri Lankan special community in minimum time and effort.
- Moreover, providing a self-learning system to these ordinary people to study about SSL is also an adding intension of this research.
- To assist the Sri Lankan ordinary community with the maximum technology evolution to make them more comfortable in the global world.

1.4.2. Specific Objectives

- To verify that the product is reliable for any ordinary user who is interesting to maintain a better communication bond with hearing-impaired and inarticulate people.
- To determine the use of web-based applications with low-resolution web cameras, for both ordinary user and hearing-impaired or inarticulate user in Sri Lanka can be monitored as an intensity which allows them to access the maximum usage of the application as a self-study material as well a translation machine.
- To introduce the application in a simple English language to maximize the influence Sri Lankan ordinary user in a practical way.
- To display the identified hand sign as a GIF image to express the output with a more alluring and detailed manner.

2. METHODOLOGY

This section defines the methodology for handling the project. In here, it describes the methodical approach to the project, requirements gathering, designing and implementation to solve the existing research problem by giving an effective solution. The solution which is presented to the current problem is an intelligent assistant for Sri Lankan ordinary people to communicate with hearing-impaired and inarticulate people easily by translating the English language to SSL.

This project has very serious research areas like Machine Learning, Natural Language Processing, Graphics Interchange Format Conversion and web platform development. Machine Learning, Natural Language Processing and GIF conversion are important for the recognition of individual word entered by the user, translation to SSL and deliver the identified SSL as a GIF image. Research managed more study on above-indicated areas, then knowledge can be used to fulfil the research objectives.

2.1. System Overview

Considering the literature survey, it is important to decide about the most applicable tools and technologies which can be used to implement the application efficiently. The software solution has also highlighted a fact on behalf of implementation. The implemented solution can be categorized into the following key components:

- User Input Recognition
- Hand Sign Identification
- GIF Image Creation and Presentation

2.1.1. User Input Recognition Mechanism

User Input Recognition mechanism regarding Text to SSL Conversion component is based on Tokenization concept appears in NLP. Once the user enters any input which needs to be translated to SSL, the component will first apply Tokenization to the input to tokenize it.

Natural Language Processing is one of the important fields in programming as the natural language is created by the software. NLP consists of many applications such

as sentiment analysis, language translation. Fake news detection, grammatical error detection, tokenization etc. Tokenization is the method of separating a text into smaller units. These units are known as tokens. The token is also known as the building blocks of natural language. There are several types of tokens which can be varied from situation to situation such as word, character or sub words. Therefore, the tokenization process can be categorized into 3 subcategories namely: word, character and sub-word categorization [9].

In this research component, it was used word tokenization and character tokenization algorithms. Word tokenization is the most used algorithms. It uses to split a text into individual words regarding the delimiters. Character tokenization is used to split a text into a set of characters.

Both of these tokenization algorithms were used to split the user-input as follows:

- Once the user enters the input the application will search whether the entered text already defined in the application's database. If the text does not appear, then applies Word Tokenization and split the text into words.
- In the second step, a selected tokenized word will match with the application's database to find out a matched word. If the word has not appeared, then the Character Tokenization is applied and split the word into characters.

Below Figure 2.1 displays the entire system overview diagram for Text to SSL Conversion component.

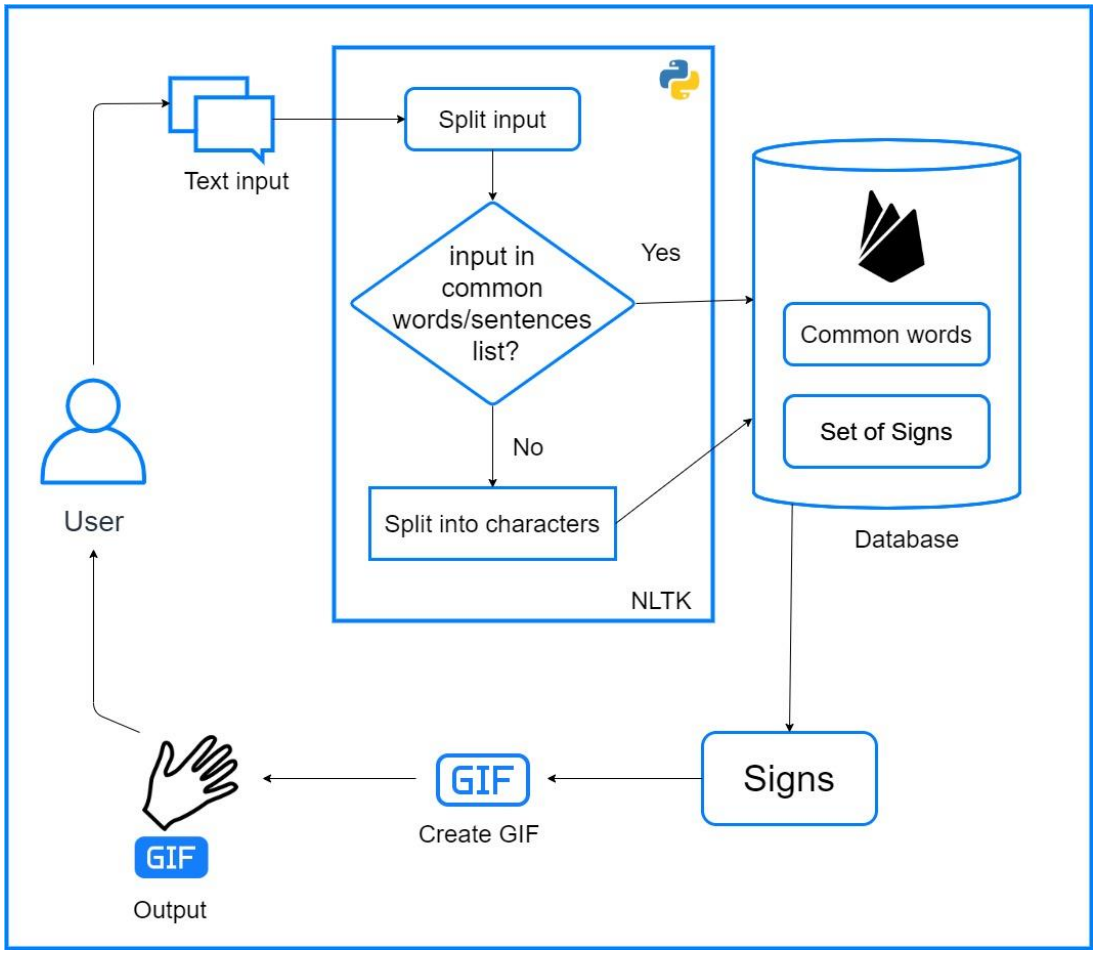

Figure 2-1: System Overview Diagram for Text to SSL Conversion component

2.2. Resources Needed

2.2.1. Software Boundaries

- Visual Studio Code

  The application should be compatible with any computer type with a web camera. Visual Studio Code is a light-weighted and powerful source code editor. It consists of built-in support for JavaScript, TypeScript, and Node.js. Other than providing support for these languages, Visual Studio Code also provides a rich ecosystem of extension for C++, C#, Java, Python, Go, .Net and Unity runtime tools. Since Python is one of the top extensions in this software, it is easy to use Visual Studio Code as a productive alternative to PyCharm too. Also, by using this software to develop the project, it is not needed to get the assistance of other software to develop parts in the project.

Also, Visual Studio Code can work on any operating system with multiple python interpreters.

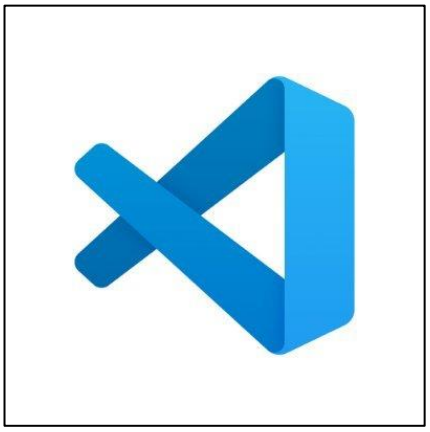

Figure 2-2: Visual Studio Icon

- Cloud Storage of Firebase

  Cloud storage of firebase is very useful in cases of uploading and sharing user-generated contents which can be used to build rich media content into applications. Also, firebase cloud storage can be used to upload these user-generated contents directly from mobile devices and web browsers very safely. It can handle spotty networks easily. Therefore, this firebase cloud storage is used to upload and store necessary images and video clips of SSL hand signs.

Figure 2-3: Firebase Cloud Storage Icon

2.2.2. Hardware Boundaries

Hardware equipment is needed to execute the implemented application. For designing, implementing and testing aspects it is identified that laptops with low-resolution web cameras are the best solution. Since a web-based application is used

to display the outcome, these mentioned laptops are the best selection as hardware equipment.

2.2.3. Communication Boundaries

- The connection bandwidth which needs to execute the application may differ according to the user-entered text. Therefore, the connection bandwidth capacity can change from time to time. Since the application deals with GIF images delivery, it is recommended to have higher connection bandwidth.
- Minimum 3.5G connection of the laptops can be used to data transmission between the application and firebase cloud storage.
- If Wi-Fi is not available at the time the application works, the user can connect the application with mobile data hotspot to data transmission between web application & firebase cloud storage.

2.2.4. Operations

The ordinary person who uses the system is capable of following operations.

- Input text – The ordinary user can enter sentences or texts which needs to convert into SSL hand signs. To reduce the time of loading the GIF image, the length of the text should not be larger than 50 characters at one time.

Site Adaption Requirements

- Any Sri Lankan ordinary person who can read, write and understand simple English language is the main user of this application. Since the application is targeting ordinary users from child to adults, it is a requirement to build the application more user friendly.
- The laptop or any device which use to execute the application should have internet connectivity.
- The GIF image should be clearer and more accurate to the user.

2.3. Flow of Project

2.3.1. Feasibility Study

In the Feasibility Study section, it is discussed about the factors which used to estimate the project's probability, limitations which were taken throughout the process of implementing the application mainly. Apart from these, the technical as well as functional limitations which were burdened while the implementation process is discussed in detailed. When considering the feasibility study on

Work Breakdown Structure for the Component

The Work Breakdown Structure defines the way of planning the completion of the component considering the period between January 2020 to August 2020. The WBS for Text to SSL Conversion is displayed in the below Figure 2.4 and Figure 2.5

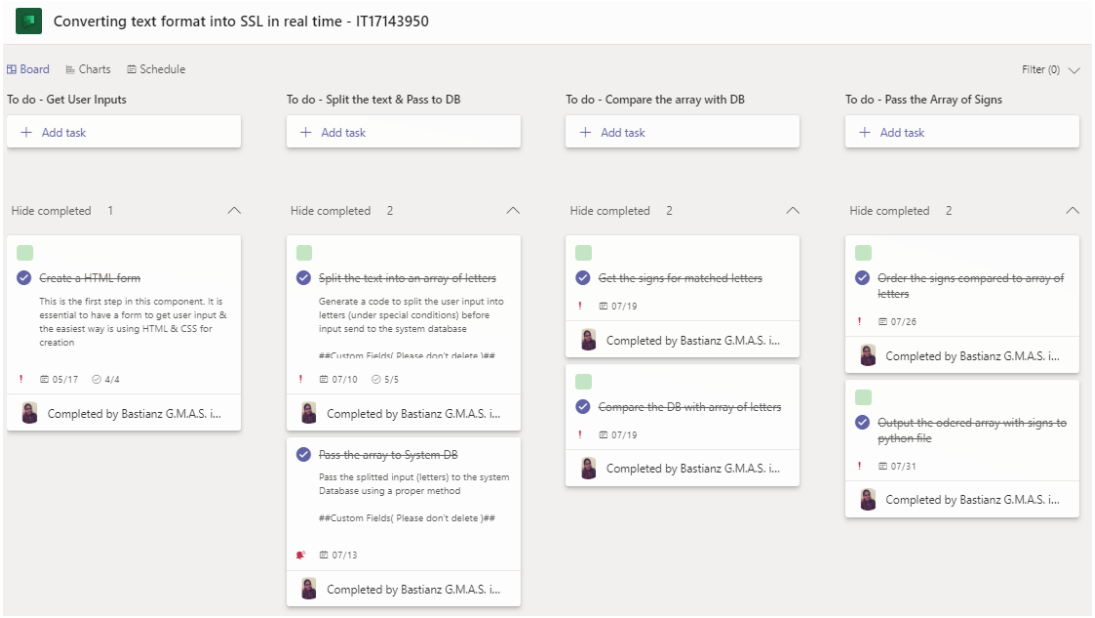

Figure 2-4: Work Breakdown Structure part I

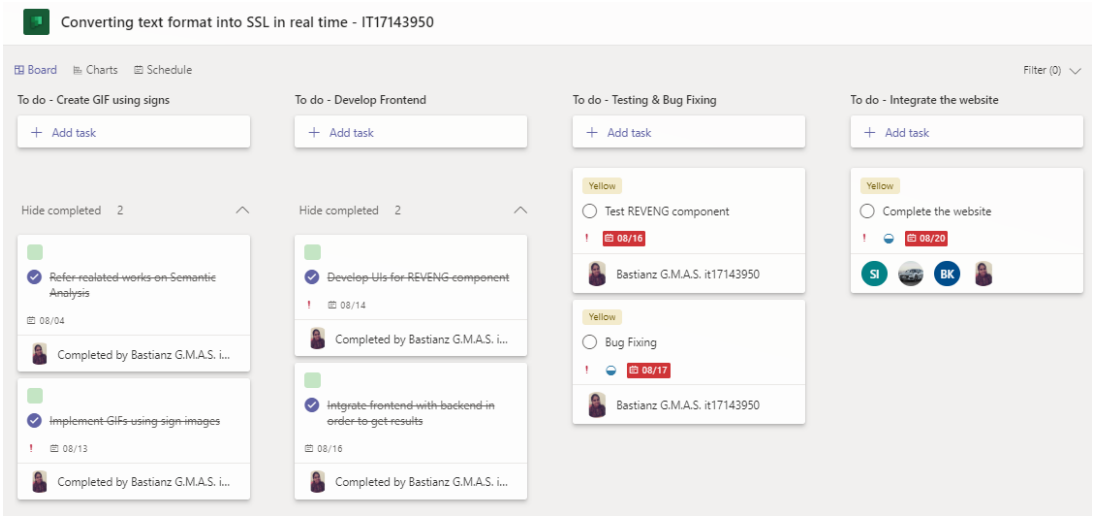

Figure 2-5: Work Breakdown Structure part II

These figures are described that how the subcomponents of Text to SSL Conversion component were divided according to the chosen period and how the assigned works had completed compared to the planned due date.

Component Timeline

The component timeline is also a summary of the WBS chart which describes monthly-wise the assigned tasks to the component completion as shown in Figure 2.5.

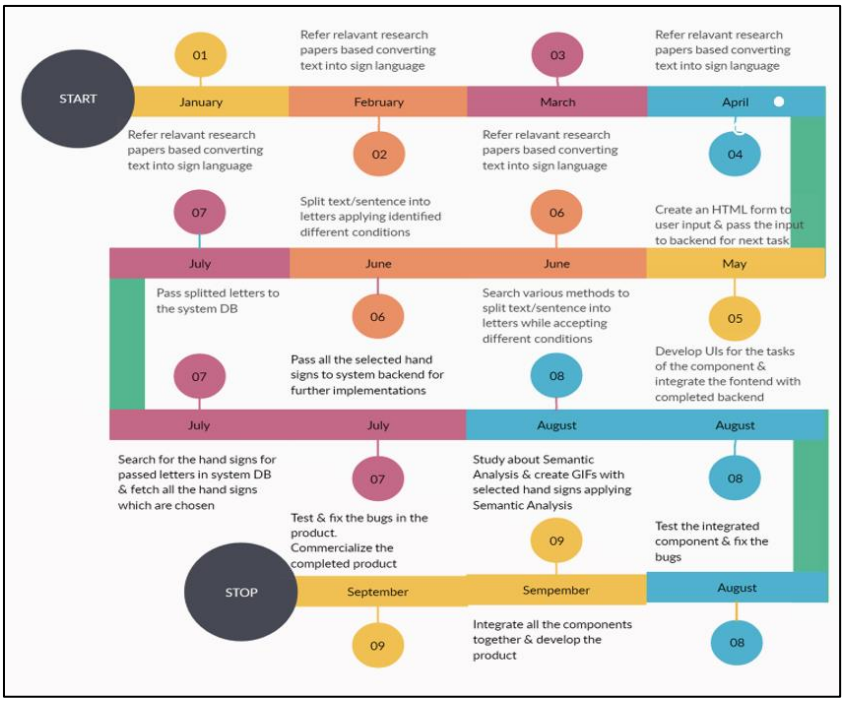

Figure 2-6: Component Milestone

Data Collection

Since the main intention of this component is providing a translator assistant for the Sri Lankan ordinary community to communicate with hearing-impaired and inarticulate communities, the application is considered to display a GIF image for each entered user-input. Hence, Sri Lankan sign language has covered a vast space, in the first implementation it was decided to convert the user-inputs into SSL alphabetical letters as well as the common phrases and the words that are used in a basic communication system. Therefore, as data collection, the application consists of two separate databases with images that were captured regarding SSL alphabetical characters and SSL basic communication phrases. The images were captured by one person's hand because it is not best practice to create GIF images using different images of hands.

Technical Possibility

The technical possibility describes offering a considerate of the new technological sources and their correctness regarding the application's feasible requirements. It defines that the implementation reaches to the system requirements quickly. This contains the overall idea of the technical possibility of the implemented component. Since it is planned to implement this application as a chat application in future, it is essential to focus on the APIs and source codes in other applications, advanced ML algorithms, GIF compression and extraction algorithms in the technical judging.

Operational Probability

Operational probability section defines the way of commanding the application and the way of satisfying the documented conditions in the moment of analyzing the SDLC. At the situation of correct recognition of the problem, it was requested to having a previously-gathered the conditions hence it would enough for the translator. According to the outcome of the current application, assured that it is better to have an immediate expansion.

2.4. Commercialization Aspects of the Product

The Text to SSL Conversion component is mainly aiming at one main category namely: Sri Lankan ordinary people who can use verbal languages to communicate with each other. Apart from that, the hearing-impaired and inarticulate communities can also use this section with the purpose of self-studying various words in verbal languages.

Therefore, many highlighted benefits could be raised in EasyTalk application for the above users as mentioned below:

- Assist ordinary people to communicate with hearing-impaired or inarticulate communities
- Assist ordinary people to learn about the SSL regarding the different types of words or phrases which use in basic communication
- Assist to hearing-impaired and inarticulate people to learn verbal languages if interested.

2.4.1. Business Pitch

The user base of EasyTalk has no analytical or geographical boundaries or even limitations. In the second version of EasyTalk, the user will be able to use the application wherever he/she stays since according to the plans the second version would be a mobile application of EasyTalk. In that time, the application would be more beneficial to the Sri Lankans.

The sources of funds for the commercialization include:

- Funds through the GoSL and ICTA approvals
- Direct Aid Program for Sri Lanka and the Maldives
- Approval funds from NSPD

The application can be delivered in a method that there will be a set of services where the users could use them for free up to a limit. If the user wants more experiences through EasyTalk, then they have to pay on an amount which will unlock a certain feature. Once the user pays more increments, then he/she should be able to maximize

their experiences with EasyTalk while unlocking more exciting features. The process of unlocking special features can be mentioned as below:

- **1st stage:** Free trial of EasyTalk for one month
- **2nd stage:** Subscriptions offer Sign Language to Text Translation for all three languages where the output is given as a textual-format or as an audible-format
- **3rd stage:** Paid access granted for the beginner levels
- **4th stage:** The user will be able to get audio (TTS) output along with text and text output in all three languages. The user gets access to Text-To-SSL where they can translate text into SSL. In this stage, all the unlocked features will be available for 12 months
- **5th stage:** Yearly price will be charged for translations
- **6th stage:** Paid access granted for the pro levels
- **7th stage:** This would be the topmost access level of the EasyTalk application. In this stage, the application will unlock all the features. Apart from the features mentioned in the previous access levels, the user will be able to design their own profile and sync their translations with devices. They could be able to save and translate the words that are often used and create lists of words too. They will also get text and voice output in all three languages. All these features will be free forever
- **8th stage:** Since the application will be mostly used by special-needs schools and homes, the product will be licensed for the organization and the organization can pay for the actual users. This can also result in a situation where government could fund part of the licensing cost of the organization

EasyTalk will also available on the Web, Google Play Store and Apple App Store where ordinary users can download and get the maximum use of it. They will also get a chance to unlock the amazing features in the application and enjoy it.

EasyTalk application will also be available as an extension to the leading chat applications like Facebook Messenger, Microsoft Teams etc. The main intension of

this is, attracting the foreign investments hoping it is possible to scope for the international market through enabling support for all sign languages used in the world.

Google AdSense

Since the solution is a mobile and web-based application, it is possible to use ads in the gray areas of the UI which would generate income. Excluding the pro-level users, all other users will be seeing ads on the application.

Figure 2-7: Google AdSense

2.5. Testing & Implementation

Web-based application testing is one of the most important and critical factors of web application development. It is essential to have the necessary well-defined and well-experienced web-application testing strategy and framework. The main components of a web application testing strategy include unit, functional, usability, performance, security. Apart from them, various devices, browsers and platforms testing can be conducted as non-functional testing strategies for the implemented web application.

Moreover, testing a web application across different network connection speeds, focus on the use of Wi-Fi, 3G, 4G connections are also well-explained about a complete web application testing strategy. These testing which is applied to the implemented web application should challenge the obstacles such as screen resolutions, screen brightness, CPU, memory and OS optimization. At the final, an organization should acknowledge the test approaches, the use of Google Chrome Developer Console other than actual devices or even real-user monitoring.

After completing the web needs of the team and developing web application testing strategies, a problem arises about the way of conducting the decided testing strategies effectively as a segment of an on-going web application lifecycle.

2.5.1. Web Application Testing Process

As usual, an end-to-end web application testing process should begin from deciding and designing the test cases of the application, performing user acceptance and finally browser and device testing step. The steps in web application testing process can be defined as shown in the below table.

Table 2.1: Testing Process for EasyTalk SSL Assistant Translator

Designing test cases	Begin by designing the test case document.
Identifying the automated scripts	Identify the automation scripts that can be reused again.
Modifying the automated scripts	Modify the automation scripts according to the user requirements.
Processing Manual Testing and Automated testing	Apply both the designed manual and automation test cases to the web application.
Applying Usability Testing	Check the usability loopholes, navigation and the content entered in the application because the user experience is the main point for the web application to get the end-users' approvals.
Applying Performance Testing	Test the performances of the implemented web application. In this phase, the responsiveness of each page, scalability, the level of using resources and stability based on standards would be tested especially.
Applying Security Testing	In this step, it would be tested that the application is secured from validations, data dumps and other security threats.

Applying Browser Compatibility Testing	Execute all the test cases in other browsers.
Applying Device Compatibility Testing	Execute all the test cases in other devices.

Moreover, other testing techniques can also be applied to the web application in order to ensure the long existence of the assistant translator.

2.5.2. Identified Testing Types

It is an essential concern that EasyTalk application should execute in any web device because there can have various selections of web devices with the end-users. To assure that the web application reacts well with all the web devices, a chosen combination of manual testing, automation testing was applied.

Functionality Testing

By applying functionality testing, the connection with firebase cloud storage, the validations of the form which used to submit and get the user-input, the links which used to route to other web pages were tested sharply.

Usability Testing

By applying usability testing, it was measured the characteristics of the application from the client side. In detailed, through this process the supplication was ran to identify the weaknesses in navigation, user requirements completion, user satisfactions and the appearance of the application were thoroughly tested.

Interface Testing

In interface testing process, it was tested that the communication between hardware, software, network and the database as same as the plan.

Compatibility Testing

The compatibility testing based on Text to SSL Conversion component in EasyTalk was done under two main subcategories namely device compatibility testing and

browser compatibility testing. In device compatibility testing, it was tested that the application is compatible with any hardware device such as laptop and desktop computers. In order to do this testing, Google Chrome Developer Tools were used. In browser compatibility testing, it was tested whether the application is compatible with different browsers such as Google Chrome and Mozilla Firefox.

Performance Testing

The responsiveness, stability, resource usage and the user interfaces of the component were tested by applying performance testing.

2.5.3. Implementation

A well-designed, highly understandable, simple and easily handled web application can excite the targeted audience. Also, the audience would share the application with the others in their community too. But the challenge is that the implementing a well-mannered real-time web application which satisfy all the above-mentioned characteristics. Therefore, following steps can be followed towards to build a real-time web application.

- Application requirements identification
- Strategize
- Set the scope
- Assess Internal resources
- Planning the implementation

3. RESULTS & DISCUSSION

3.1. Results

In this section, it is discussed about the results got from Text to SSL Conversion component in EasyTalk web application. To get more understanding about the results, this chapter divided into two main subcategories namely Survey Results and Component Results. The survey results section defines the results got from the survey which was conducted on behalf of gathering requirements to implement the application. The Component Results section defines the results got from the execution of the research component, Text to SSL Conversion.

3.1.1. Survey Results

In order to design the application, a survey was conducted at the first stage. The main intension of this survey was gathering the user requirements to present a fully functioned application which fulfils all the objectives of the component. Hence the "Text to SSL Conversion" mainly target on Sri Lankan ordinary community, the survey was distributed among the ordinary people. 33 have participated in the survey and the results got from them can be mentioned as below.

Among the information gathered from the survey, the following facts got highlighted:

- The average level of experience in SSL among Sri Lankan ordinary community
- The fluency verbal language in daily lives
- The reasons for not interesting in using sign language in day-to-day lives
- The familiarity of using sign language translators
- The most familiar language to implement the application
- The type of translator needs to build

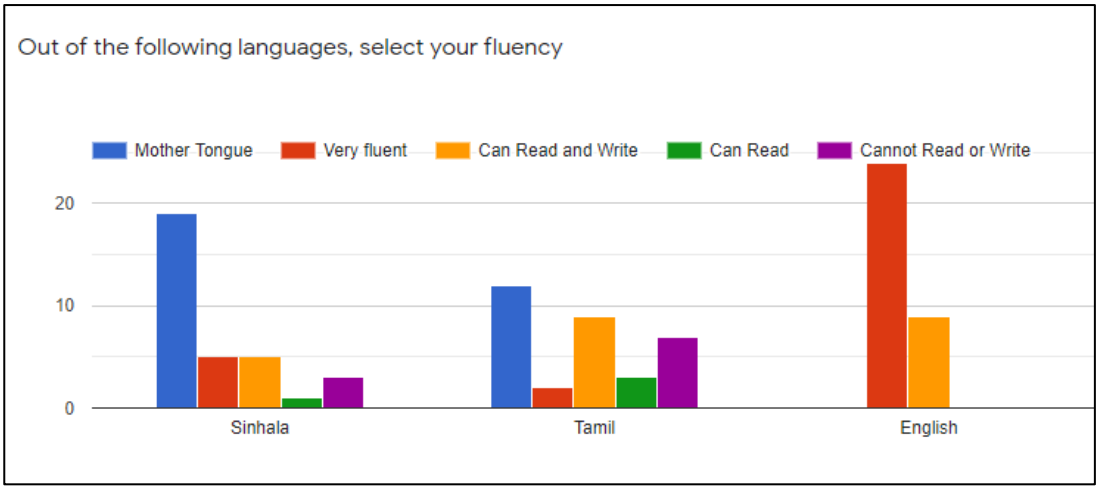

Figure 3-1: The Verbal Language Frequency among Ordinary People

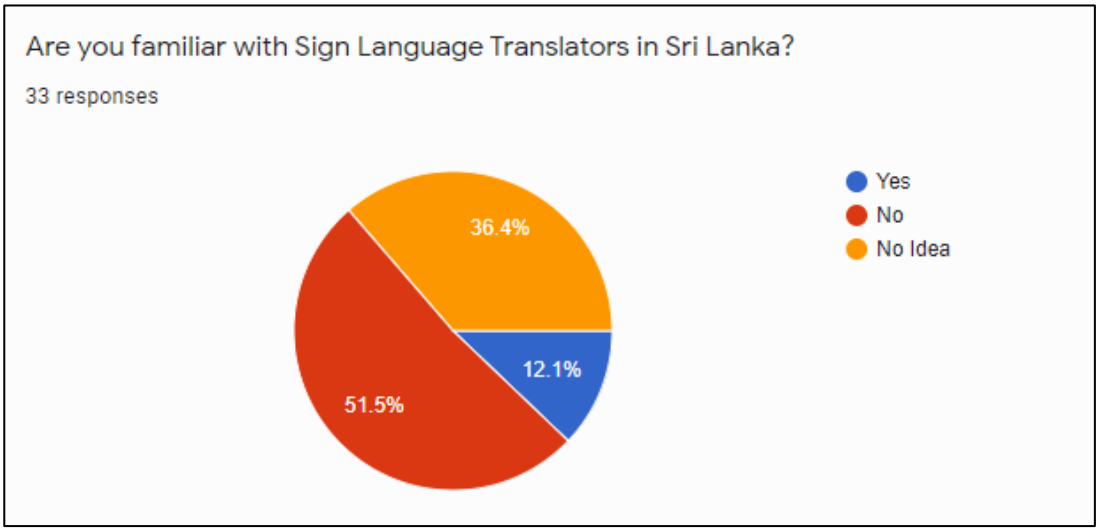

Figure 3-2: The Familiarity of Sign Language Translators

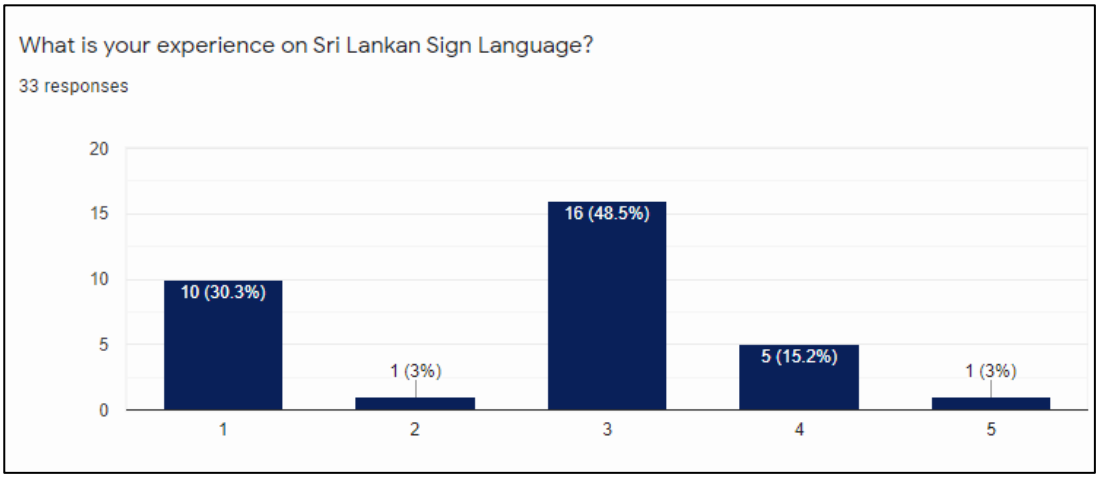

Figure 3-3: The Average Experience of SSL among Ordinary People

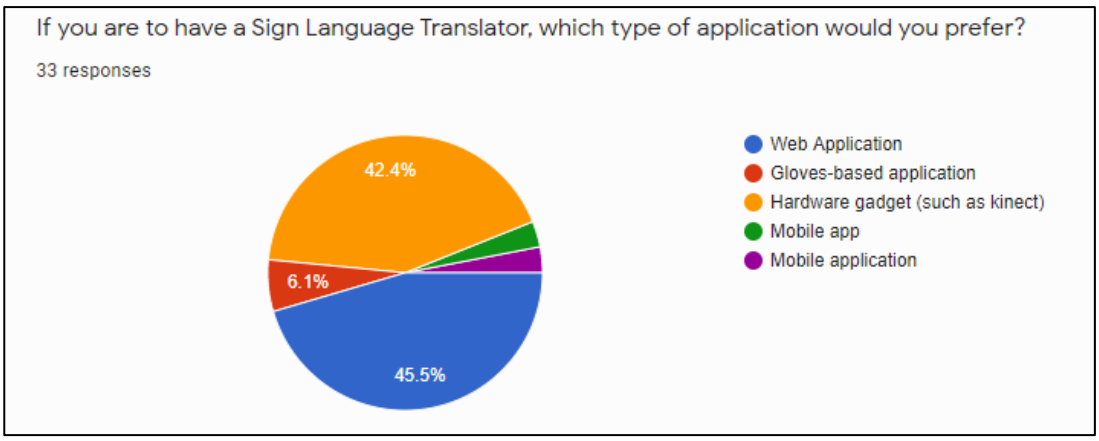

Figure 3-4: The Preferable Sign Language Translator Type

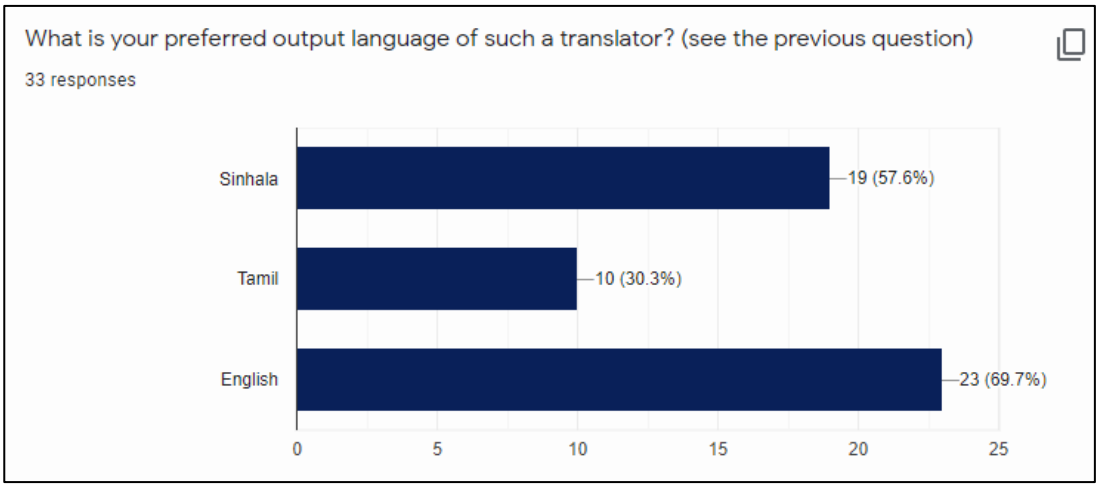

Figure 3-5: The preferable Language to Handle Translator

3.1.2. Component Results

The Text to SSL Conversion component is implemented as an assistant which can translate a common verbal language (English) into SSL. The main tasks of the component are,

- Detect the user-entered input in real-time
- Identify the input as a sentence or text or a character
- Fetch whether the user-entered text is defined in the application
- Fetch the hand signs which are matched to the input
- Create a GIF image using the array of hand signs
- Display the created GIF image to the user real-time

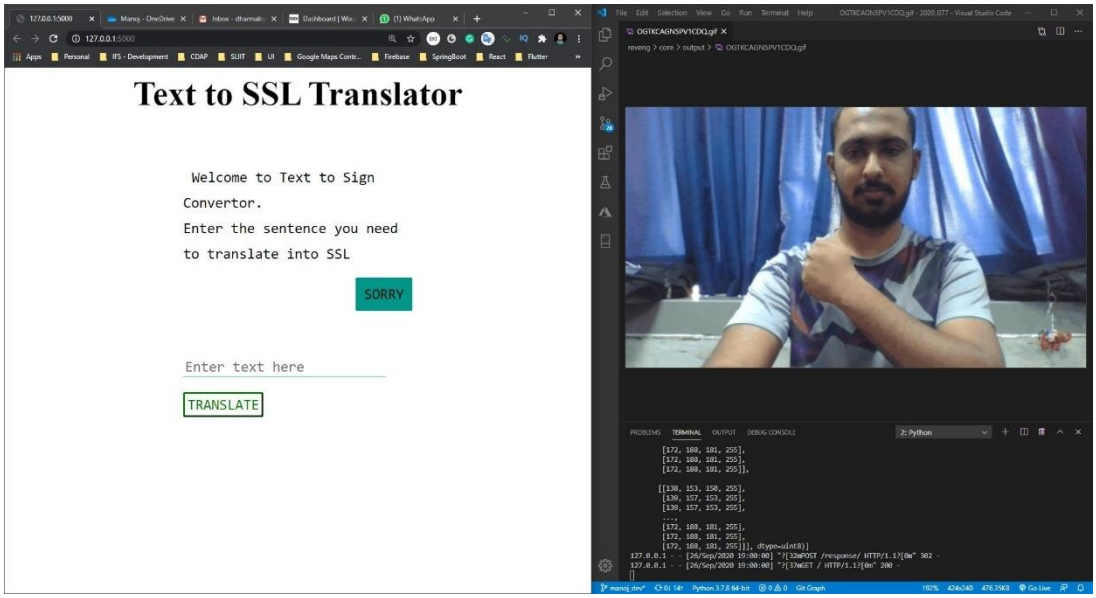

Figure 3-*6*: Display GIF image for the user-input entered in upper-case

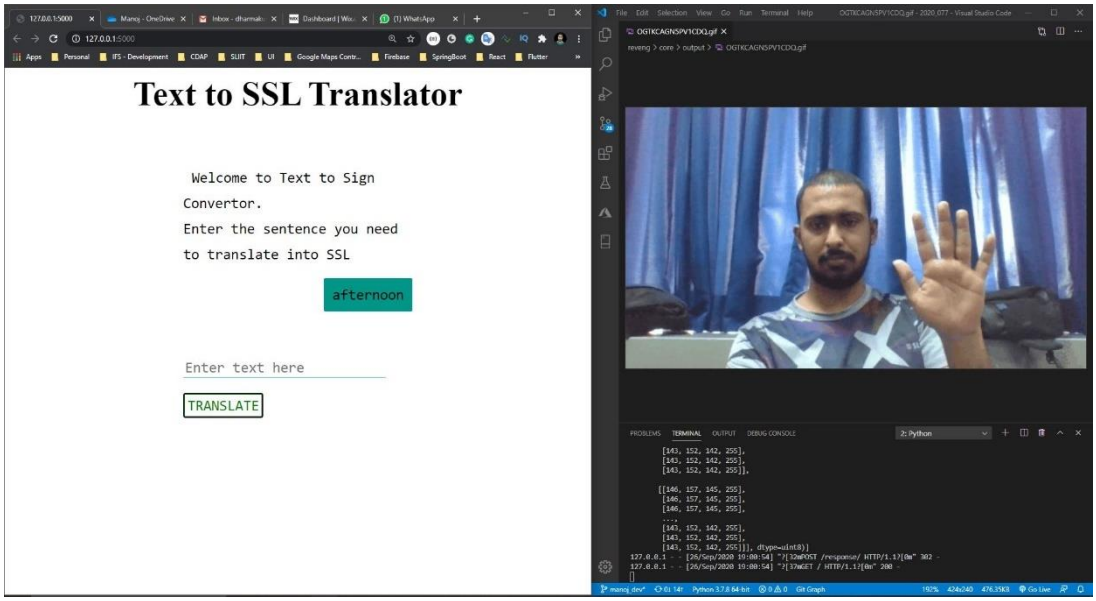

Figure 3-*7*: Display GIF image for the user-input entered in lower-case

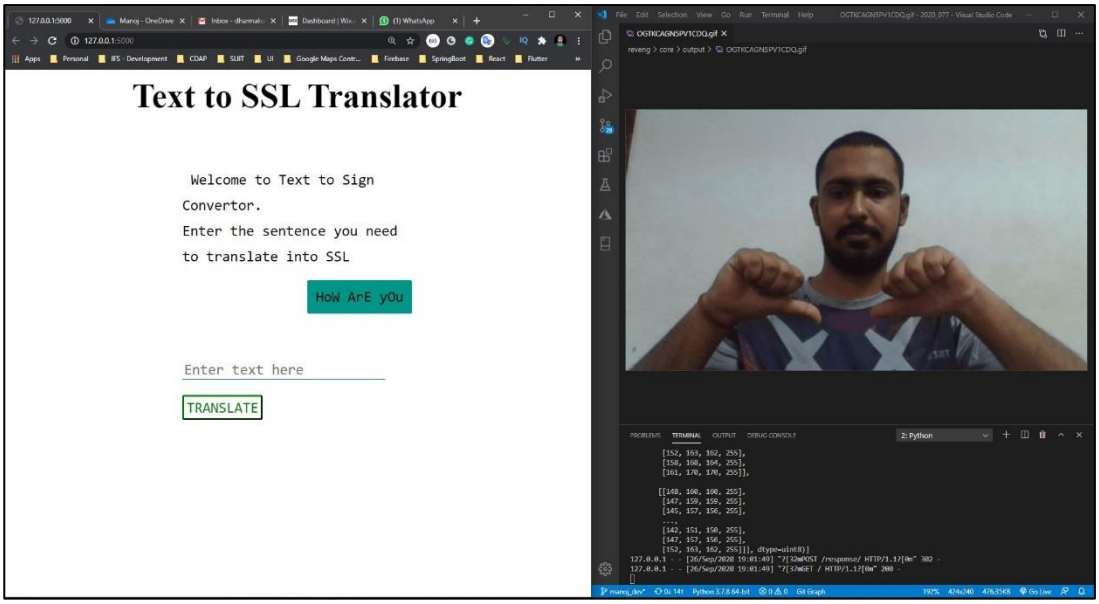

Figure 3-*8*: Display GIF image for the user-input entered using both cases

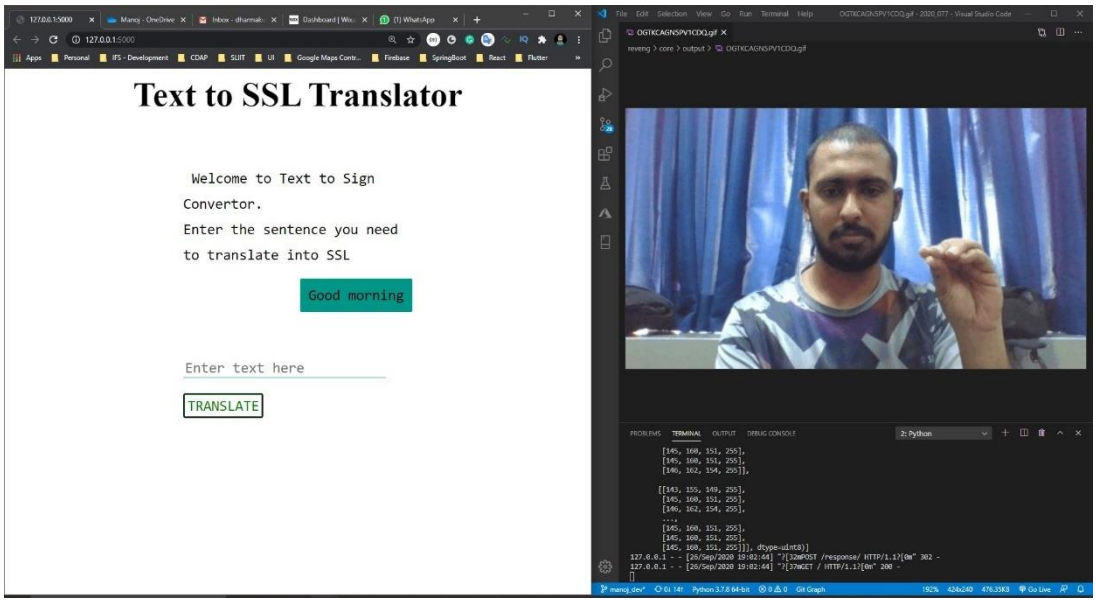

Figure 3-*9*: Display GIF image for “Good morning”

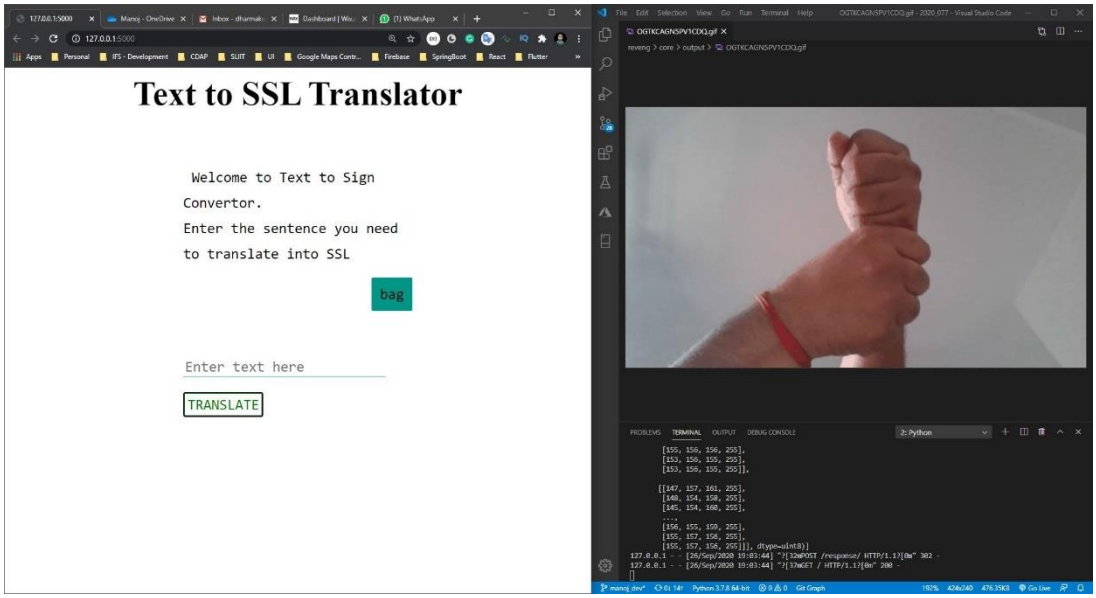

Figure 3-10: Display GIF image for “bag”

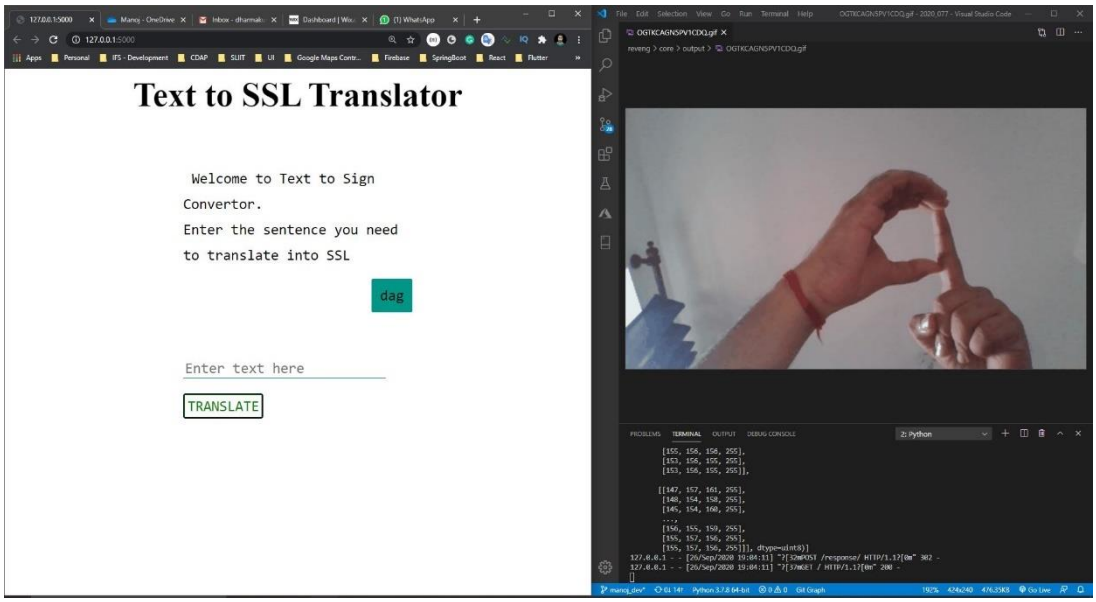

Figure 3-11: Display GIF image for “dog”

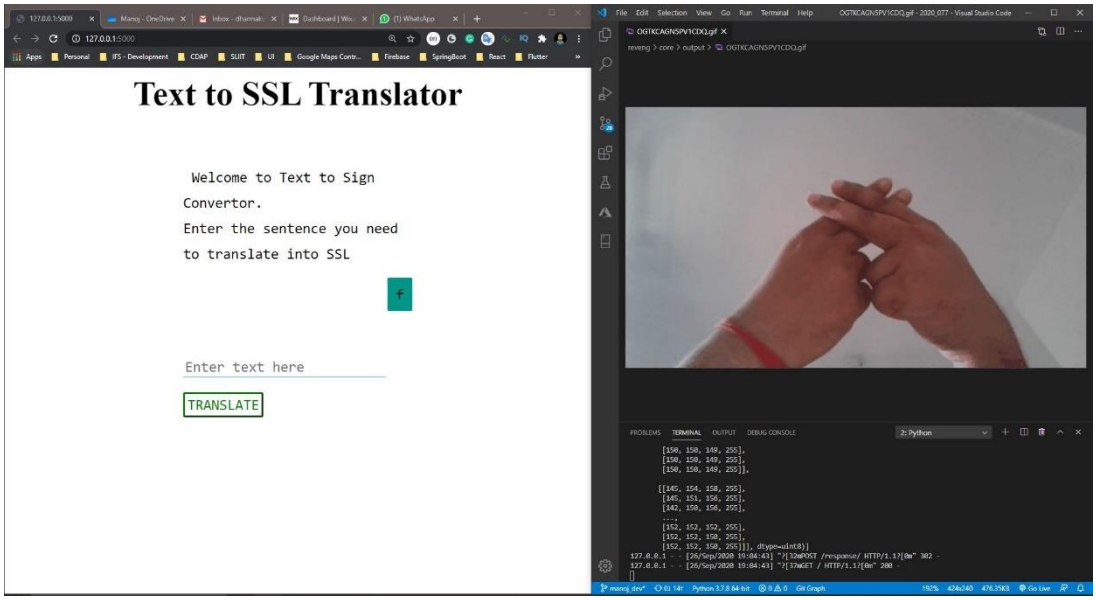

Figure 3-12: Display GIF image for “f”

3.2.Research Findings

From the results obtained from testing the Text to SSL Conversion component, the component was able to display a series of GIF images with an overall accuracy of 90%. The number of GIF images are varied starting from one GIF considering the number of sentences user is going to add at one time. The accuracy speed of displaying a GIF image for a single term like “sorry” is high compared to the speed of displaying a GIF image for multiple words at once. Also, the component reacts equally for the inputs which are entered in lower-case or upper-case or both. On the other hand, displaying GIF images for these three types of inputs are also same. But compared to getting GIF images for an already-defined term, the speed of getting GIF images for the undefined terms are slow. This situation can be seen equally in converting both text and sentences into SSL.

3.3. Discussion

From the research carried out for the Text to SSL Conversion component and the test results, it is noticed that there is a fail in the speed of identifying the user-inputs when a user enters a long text for translations compared to entering short input to translate. This mainly happens because the application is trained for the short-length input for this phase. The reason for training the application for the short-lengthy terms is

because of the component has designed based on the common words which can be used in basic communication need such as “good morning”, “good afternoon”, “sorry” etc. Therefore, the number of characters which can be entered at one time is limited into fifty too. In order to get the relevant GIF image according to the user needs, it is recommended to use a short-lengthy input at a time.

This component is mainly created based on five main user-inputs namely, already-defined phrases, already-defined words, undefined phrases, undefined words and alphabetical characters. Based on the user-input the inner-process of the component changed accordingly. If a user enters an input that belongs to the already-defined phrases, already-defined words or characters, the speed of getting the result is comparatively high compared to non-defined categories. The reason for this is, the component was trained with the phrases, words used in basic communication and whenever the user enters any input which belongs to any category, other than basic communication, then the component gets some more time to identify the characters in the input and to gather the relevant hand signs. In displaying GIF images to undefined phrases or words, displaying GIF images to undefined phrases takes more time compares to displaying GIF images to undefined words. This is happening because of the component is collecting character-wise hand signs to create GIF. In here, when a user enters an undefined word, the component is easy to create a GIF image with all the character-wise hand signs since “one word – one GIF” concept. At the incidents, the component has to create GIF for undefined phrases, following the above concepts the user can be seen more than one GIF at a time. In detailed, once the user enters an undefined phrase, the component creates the GIF after following a complex process as described in the methodology section.

Also, the user can enter the input in any case format (upper case/lower case/both). Since the component automatically converts the input into lower-cases, the speed of displaying the GIF image is not affected by case-format. Finally, the overall application acts as a real-time translator, user can see the relevant GIF image for any type input (which length is shorter than 50 characters) after a bit of time he/she enters the input.

3.4.Summary of Contribution

Student ID of Group Member: IT17143950

Name of the Group Member: G.M.A.S. Bastiansz

Table 3.1: Summary of Contribution

Task	Description
Getting the core meaning of the user-entered text	By using semantic analysis, it is easy to get the core meaning of the user-entered text after removing the unnecessary words (grammar standards, punctuation marks, etc.) and translate it into a GIF image.
Converting identified hand signs into GIF images	In the process of converting sign language to a GIF image, a set of identified hand sign images relevant to the user-entered text gets converted again into a GIF image. By creating GIF images out of the set of images, the application can reduce the traffic of image loading and also, it gives the ordinary user a better understanding of the relevant SSL.
Creating GIF images	Creating GIF images for the words and sentences which are very useful for the day-to-day communication would make the application more user-friendly, attractive and flexible for the user

4. CONCLUSION

In this report, was present an application which could translate Sri Lankan Sign Languages to text &voice and vice versa. First, to detect the hand signs, we used R-CNN based model and to translate them, used the ML-based API which developed. This API can be used in future developments which are related to the sign languages. Developers do not have to build a classification model from the beginning. They can just use this API with a valid dataset. The text & voice assistant acts as to identify the words segment from collections of alphabets then spelling correction and convert word segment to speak them. We used the NLP based API which we developed. They can use this API for NLP related languages translation not only for sign language. We also reverse-engineered the process for the regular people to get an idea about sign language. So, the text to sign language translator does convert the text sent by the user into GIFs of corresponding Sign Languages using Semantic Analysis. For the moment, the system is proposed to be a web application and soon will be made into a mobile application with faster responses and lower processing time. Further, with the introduction of 5G, the response times will be faster.

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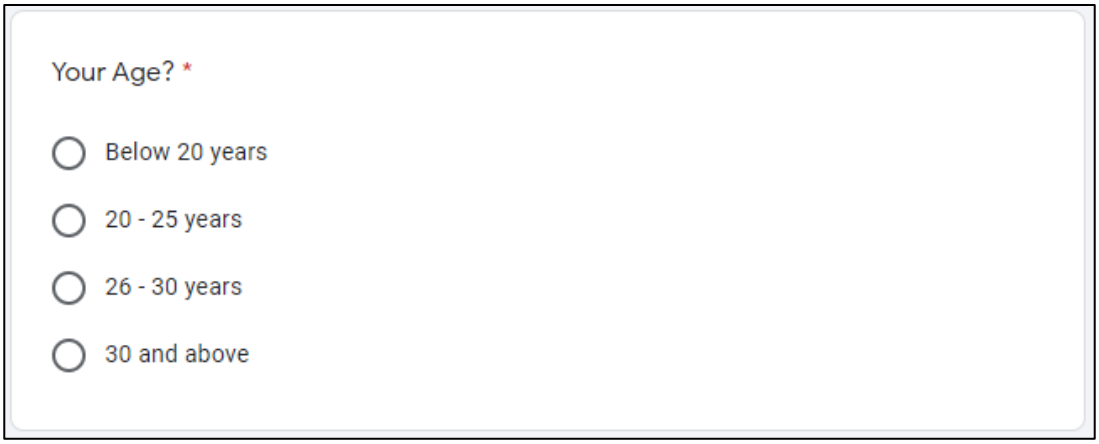
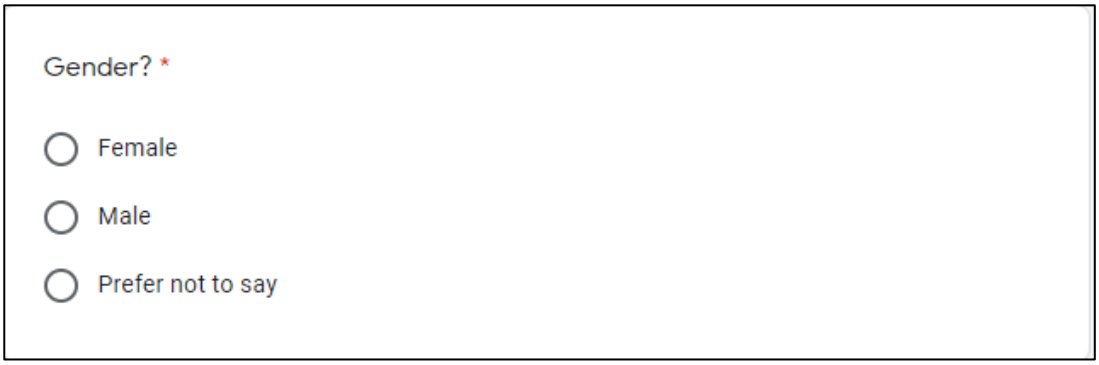
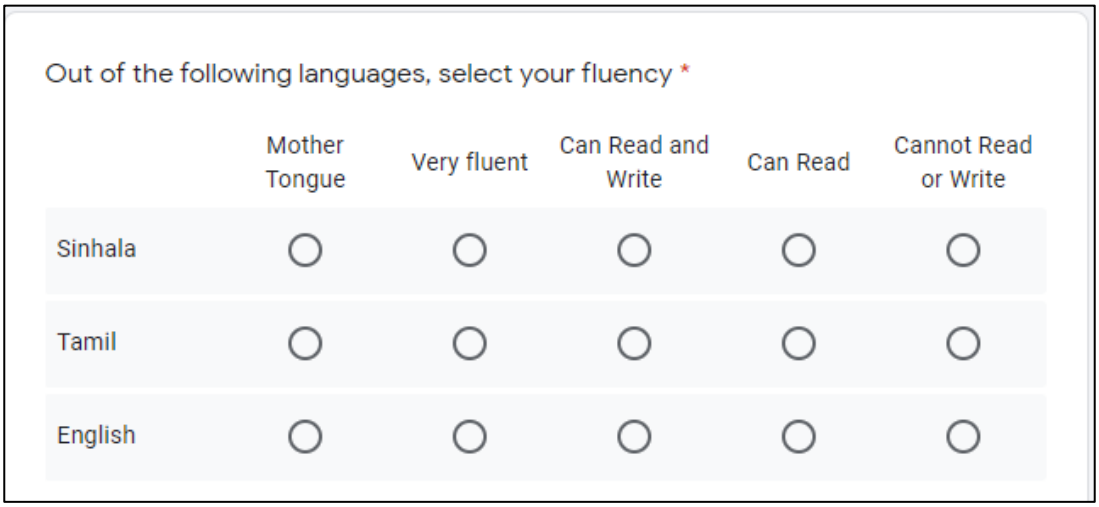
APPENDICES

Appendix A : Survey Questionnaire







What is your experience on Sri Lankan Sign Language? *

	1	2	3	4	5	
No Idea what is Sri Lankan Sign Language	○	○	○	○	○	I am very fluent in Sri Lankan Sign Language

How often do you communicate in Sri Lankan or any sign language in the following places? *

	Always	Often	Sometimes	Never	Never heard of a Sign Language
School / Universities	○	○	○	○	○
Workplace	○	○	○	○	○
Out in the road	○	○	○	○	○
Religious and cultural places	○	○	○	○	○
Social Media	○	○	○	○	○

If you were to learn Sign Language of some sort, what could be the possible barrier in learning them? *

Your answer

According to your opinion, why do you think the hearing and verbally impaired community is reluctant to talk to the ordinary people? *

Your answer

Are you familiar with Sign Language Translators in Sri Lanka? *

- ◯ Yes
- ◯ No
- ◯ No Idea

If you are to have a Sign Language Translator, which type of application would you prefer? *

- ◯ Web Application
- ◯ Gloves-based application
- ◯ Hardware gadget (such as kinect)
- ◯ Other: _____

What is your preferred output language of such a translator? (see the previous question) *

- ☐ Sinhala
- ☐ Tamil
- ☐ English

What is your preferred output type of the translator? *

- ☐ Output should be displayed on the screen
- ☐ Output should be presented through audio

Out of the following characteristics, which one would you prefer to have in such a sign language translator? *

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Can be used as a learning material	○	○	○	○	○
Can be used as a mode of communication	○	○	○	○	○
Ability to detect live images rather than sending still images	○	○	○	○	○
Ability to convert sign language into text or speech	○	○	○	○	○
Specific to one domain (health care, industrial, educational etc.)	○	○	○	○	○