

ONLINE LEARNING PLATFORM FOR HEARING IMPAIRED PEOPLE

Project ID: 2022-59

Project Proposal Report

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Specializing in Data Science

Department of Information Technology

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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.

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The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

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Date

ABSTRACT

As a result of the current pandemic situation, most of the companies have taken steps to function through online systems. Schools and universities have taken steps to provide education to the students using online systems such as teams, zoom and google meet. In addition to these there are specific systems that are implemented to specific organizations to meet their expectations in providing education using online delivery of lessons. Although most people can learn using these systems, there is still a portion of people who are unable to learn through these systems. The hearing impaired are unable to learn through these systems. As a solution to the mentioned problem, we are proposing an online learning platform specifically for hearing impaired people of Sri Lanka. This specific research component of the proposed solution will give hearing impaired people the ability to gain knowledge through video resources. The content of an online video which is available in you tube will be converted to Sri Lankan sign language and will be displayed in the form of a 3D avatar which will be embedded to the video as a caption. The necessary processing steps will be done using Natural Language Processing, speech recognition and machine learning techniques.

Key words: Hearing Impaired, Sign Language, Sri Lankan sign language, Online learning, Natural Language Processing

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LIST OF ABBREVIATIONS

| | |
|------|-------------------------------------|
| SLSL | Sri Lankan Sign Language |
| HIP | Hearing Impaired People |
| NLP | Natural Language processing |
| ML | Machine learning |
| ASL | American Sign Language |
| BSL | British Sign Language |
| WHO | World Health Organization |
| SER | Speech Emotion recognition |
| MFCC | Mel-frequency cepstral coefficients |
| MLPC | Multi-Layer Perceptron Classifier |
| AWS | Amazon Web Services |

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1. INTRODUCTION

1.1 Hearing impaired and Sign Language

Hearing impairment is defined as the inability of an individual to hear sounds. This includes people with any degree of hearing loss along with individuals who have loss hearing completely by birth or later life. The main communication method of these individuals is using sign language. Sign language is a means of communication using hand gestures and body movements. One of the main misconceptions regarding the use of sign language is that it is the same wherever you go. But it is not the case. According to an article published by Richard Brooks [1] There are 138 to 300 sign language variations used around the world today. Among these variations the variation used in Sri Lanka is known as Sri Lankan sign language [2]. Also according to [17] majority of HIP does not read better than elementary level meaning that they have trouble reading long sentences.

1.2 Features of sign language

Facial expressions are a crucial factor in sign language [3]. Facial expressions are used to express emotions when communicating. For example, if a person is happy the greeting “Good morning” would be said with a smiling face and if sad it would be said with a sad facial expression just like people who are able to speak greet with a happy tone when happy and with a sad tone when sad. In sign language if a person is right-handed the right hand is used as the dominant hand to gesture signs.

1.3 Area of Research

A lot of research has been done in breaking the barrier between HIP and who are not hearing impaired. Many chats applications [4], translating applications [5] and sign language teaching applications [4], [6], [7] has been developed over the years. This research focuses on studying and developing an automated learning platform for the hearing impaired taking some issues that they face to give them the opportunity to learn using online tools adapting to the new normal situations due to the pandemic.

1.4 Component Overview

The focus of this research component is to develop a way for the HIP to gain knowledge using video resources. Although some video resources provide sign language translations along with the video for accessibility, they are more focused on ASL or BSL rather than SLSL. This component will provide a solution so that the HIP will be able to understand the content of a video in YouTube through the embedded avatar who will be translating the content to sign language with facial expressions.

2. LITERATURE REVIEW

2.1 Background Study

Since the end of 2019, the world has been dealing with the pandemic which was caused due to the Covid-19 virus outbreak. This had initially caused a lot of trouble for people around the world, and many had to suffer huge losses due to this. But with time many industries began transformation towards online platforms to provide services and continue with their targets without being affected by the pandemic. As mentioned earlier, schools and other educational institutes adapted online learning to provide education to their students without being interrupted due to the pandemic. In Sri Lanka Schools, universities and other educational institutes used MS Teams, Zoom and in some cases had their own systems which were customized to cater their way of providing education. Even though these systems were used they were based on a traditional education system (Teacher to student). This transformation was a successful for the majority, but it was not an ideal solution for some groups such as the HIP.

According to the article [8] the author has stated that according to the WHO approximately 9% of Sri Lankans suffer from hearing loss while 15% of them are completely deaf according to Sri Lanka Federation of Deaf. These numbers will keep increasing as for the statistics mentioned by author of [9] from 131 million to 267 million by 2050 in South Asia region where south Asia region consists of Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Maldives, Myanmar, Philippines, Sri Lanka, Thailand, Timor-Leste, and Vietnam. According to these factors it is evident that the issues faced by this group of people need to be addressed

Currently as the covid-19 situation is at minimum state most educational institutes move towards a hybrid delivery of education (on premises and online according to guidelines provided by health authorities). But according to a survey done by the research team of [10] 50% of students prefer online education in the future as well which is shown by the figure 2.1

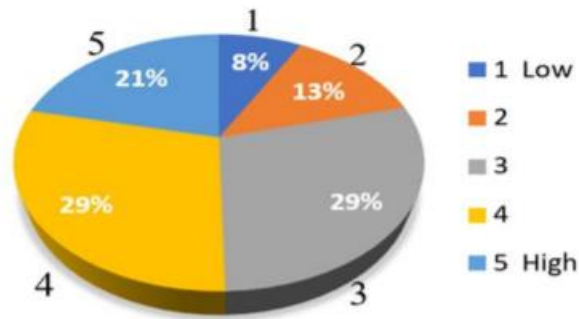


Figure 2.1 - Student's preference for online learning in the future

Figure 2.1 shows that while 21% of the students do not prefer online learning for the future half of the students prefer online learning in the future.

According to a study done in 2021 [11] on the effectiveness of online learning in India the authors have used a questionnaire to identify what motivates students to learn through online, their experiences, disturbances during online learning, the environment at home for online learning and devices used for online learning.

3. Which of the digital approaches motivate you to learn
446 responses

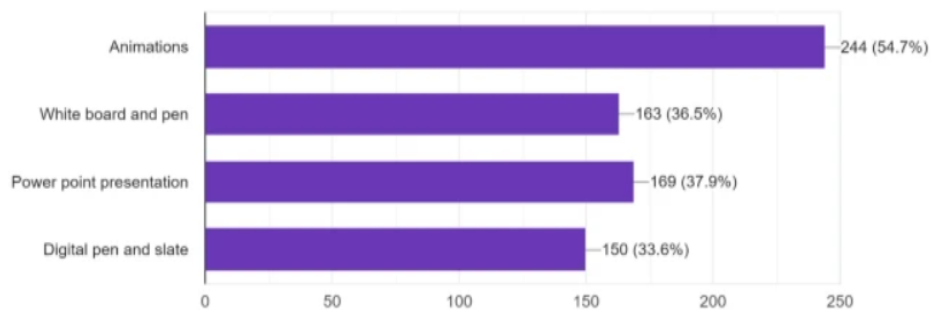


Figure 2.2 - Digital approaches that motivate students to learn

Figure 2.2 shows what motivates students to learn when using online learning. From the figure it is visible that 54.7% of the students which is the majority are motivated to learn using animations.

4. My experience with online learning from home digitally
447 responses

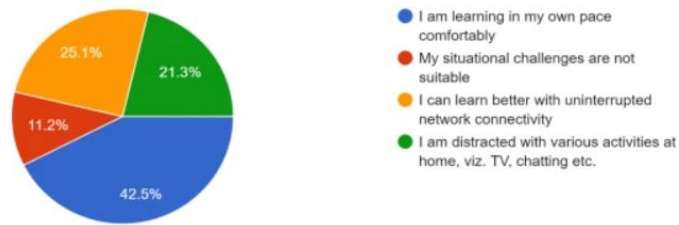


Figure 2.3 - The online learning experience of students

Figure 2.3 shows the learning experiences of students. 42.5% of the students have said that they are able to learn at their own pace comfortably through online learning.

12. Which of the following devices do you use for your online learning?

448 responses

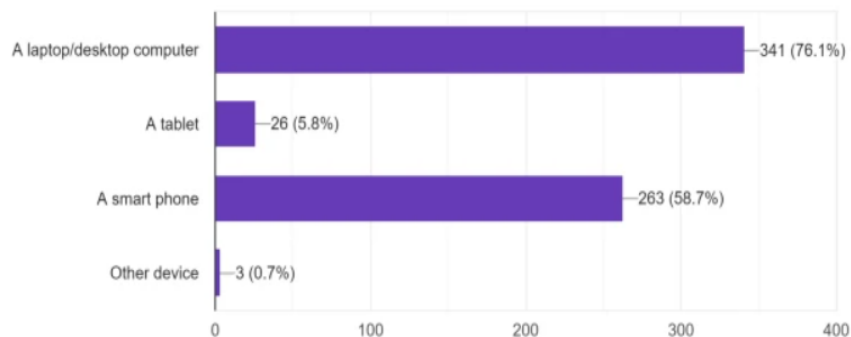


Figure 2.4 - Devices used for online learning

Figure 2.4 shows that 76.1% of the students use a laptop or a desktop for their online learning purposes.

These survey results suggest that online learning is a successful learning method, and it would not dissolve and would be used by majority of students even after the pandemic

situation is over. It is safe to say that online education has a place in society for the near future.

According to [12] HIP face challenges such as limited access to tools to study and communication issues. Also, HIP face accessibility issues when using online learning platforms which makes their learning harder.

In [12] it is mentioned that many studies done on this area suggests of an online learning platform for hearing impaired to learn interactively. Hence an online learning platform is the best solution to issues of HIP.

2.2 Literature Survey

For the problems faced by HIP many solutions have been proposed and have been implemented. Most of these solutions have been implemented to break the communication barrier that is between HIP and normal hearing people. For instance, in [13] The authors have developed a mobile application which captures the signs performed and interpreted in human readable language using computer vision and machine learning. This application is built to detect Sri Lankan sign language as the author has mentioned that many such applications has been developed for the use of American sign language.

EasyTalk [14] is another application that is developed based on Sri Lankan sign language. The authors gave mentioned that using this application users can convert verbal inputs to Sri Lankan sign language and vice versa. The users also mention Hand Gesture Detector uses pre-trained models to capture hand gestures. The detected hand signs are classified and translated by the Image Classifier. For detected hand signs, the Text and Voice Generator generates a text or an audio structured output. Finally, the Text to Sign Converter converts entered English text into animated graphics based on sign language. Much such research has been done on improving accuracy and improving the ability to interpret sign language to text or speech.

In [15] the authors have developed an android based learning application for the hearing impaired. According to authors this application contains videos and materials posted by teachers on a variety of subjects. If necessary, it is possible to download it. It means that users can study whenever and wherever they want, without having to worry about time constraints or internet availability. Quiz, set a schedule, event, chat, and a memory game are among the app's other features as well as additional tools to help hearing-impaired people get the most out of online learning. This system is a teacher-based teaching environment which enables the hearing-impaired students to chat with each other if necessary. This system does not address the issue that most of the HIP (deaf) do not know how to read written text. Many such research has been done and has developed learning platforms that can be used by HIP but many of these do not address the issue that the majority of HIP are having trouble reading.

In [16] The authors have been able to develop a system which shows users the correctness of their gestures. The authors have proposed a platform that makes use of sign language to help students and tutors communicate more effectively while also providing sign language learning resources, practice opportunities, and Q&A sessions. The system includes a low-light enhancement module that enhances the videos submitted by the instructor, as well as a module that converts the uploaded lessons to American Sign Language and converts the sign language questions to text. In the paper the authors mention that for the uploaded lessons to be converted to sign language they have used the caption of the video as a text and a text to ASL conversion has been done. The expectation of the author is to provide a user with the ability to get the content of the uploaded lesson on ASL.

3. RESEARCH GAP

According to the literature survey done above the following issues were found as research gaps,

- Limited systems use SLSL as the dialect of the language.
- Systems use text as caption and does not use sign language as caption which would make it easier and would make it accessible to HIP who cannot read.
- Existing systems lack the analyzing of emotion which is essential to be integrated with sign language.

So, this research is done to provide a solution to these identified gaps by developing a system with the ability to convert the content of a video to sign language along with the analyzed emotions integrated to the animated avatar.

When we consider existing implementations in this area:

- In Research A [4], the authors have presented a 3D virtual reality environment where HIP can communicate with each other and to assist the learning and teaching process of the Brazilian sign language.
- In Research B [6], the authors have proposed a teaching environment for sign language which gives live gesture feedback for Irish sign language.
- In Research C [7], the authors have proposed a system for teaching Sri Lankan sign language which would be beneficial for primary school students to learn the basics without any help or guidance from their parents or teachers.
- In Research D [16], the authors have proposed an e-learning platform for the HIP where a lecturer uploads the lesson video, and the user can see the content of the

video as caption along with the video. This system also facilitates communication between students and the teacher and teaching sign language. This system has also proposed a video enhancing feature which would enhance low light videos uploaded by the lecturer without any third-party involvement to produce a clear enhanced lecturer video to the students. This system is based on American sign language.

Table 3.1 - Comparison between existing studies and proposed system

| Feature Research | Based on SLSL | Caption generation in sign language | Emotion analysis using speech | Text to sign language conversion |
|-----------------------------|------------------|---|-------------------------------------|--|
| Research A [4] | ✗ | ✗ | ✗ | ✓ |
| Research B [6] | ✗ | ✗ | ✗ | ✓ |
| Research C [7] | ✓ | ✗ | ✗ | ✗ |
| Research D [16] | ✗ | ✗ | ✗ | ✓ |
| Proposed system | ✓ | ✓ | ✓ | ✓ |

4. RESEARCH PROBLEM

A HIP has limited access to videos and resources that they could refer to when they need. A non-HIP would be able to use search engines like google to search for any problem that they might get and get answers within seconds. Also, they can get knowledge using YouTube videos which the HIP is not able to do unless the person who has uploaded the video has added accessibility for the HIP or the video is specifically for the HIP. In such cases these individuals have to face limitations when accessing these types of videos.

Therefore, it is necessary to develop a feature where they would be able to search and refer to the content of a certain video in sign language. This will enable a HIP person to gain knowledge or clear doubts by refereeing videos even if they are unable to read, which is the case in many situations.

Based on the survey conducted by the research team the following issues were identified

Do you think it would help the hearing impaired if content of youtube videos to be translated to Sri Lankan sign language to gain knowledge? (ශ්‍රවණබාධිත අයට දැනුම ලබාගැනීම සඳහා යු ටියුබ් වීඩියෝවල අන්තර්ගතය ශ්‍රී ලංකාවේ සංඥා භාෂාවට පරිවර්තනය කළහොත් එය උපකාරයක් වේ යැයි ඔබ සිතනවාද?)

27 responses

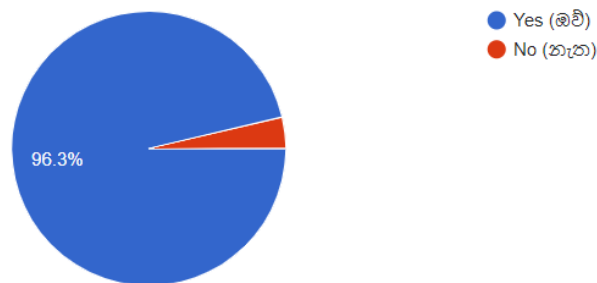


Figure 4.1 - Response: Captioning in sign language

According to the figure 4.1 96.3% of the responses prefer the captioning of videos in SLSL. This is because it makes it easier for them to understand the content and as it is mentioned earlier majority of HIP do not read better than an elementary level. Therefore, this survey

results suggest that a feature where the content of the video to be captioned in SLSL would be helpful for these people.

As mentioned earlier majority of HIP do not read better than an elementary level and if the videos are captioned in text this would only allow only a few HIP to understand the content of these videos. Therefore, we are introducing a system with a feature where the videos will be captioned in SLSL instead of text.

What do you think is the best way to display translation of videos? (විඩියෝ පරිවර්තන පෙන්වීමට හොඳම ක්‍රමය කුමක්දැයි ඔබ සිතන්නේ කුමක්ද?)

27 responses

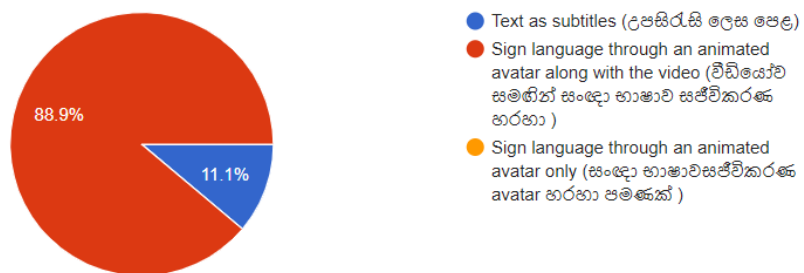


Figure 4.2 - Response: display captions through an avatar

According to figure 4.2 88.9% of the responses prefer the captions of sign language to be displayed as an animated avatar along with the video. This is because it will enable them to see the facial expressions of the avatar to see emotions.

5. OBJECTIVE

5.1 Main Objective

The main objective of this component is to give the opportunity for a HIP to gain knowledge through referencing videos which will be captioned in SLSL.

5.2 Specific Objective

The following sub objectives should be fulfilled to achieve the specified objective.

- **An algorithm to identify emotions using speech recognition.**

This objective aims at analyzing the extracted audio of the video part by part to identify the emotion that is expressed. The identified emotions will be used as facial expression when building the 3D animated avatar. This will give the HIP the opportunity to understand the emotion of the video along with the content.

- **Extracting content of the video and converting to SLSL**

This objective aim is to convert the content of the video into SLSL so that the user will be able to understand what is being said in the video easily with the language that they are most familiar with.

- **An algorithm to map converted sign language and the identified emotions.**

This objective aims at an algorithm to match to map the identified emotion and the converted signs so that it can be used to build the SLSL signing avatar with facial expressions. This will be helpful for the Hip in Sri Lanka to clearly understand the content of the video to gain knowledge from them.

6. METHODOLOGY

The objective as mentioned in this component is to provide the HIP the ability to get knowledge from videos by converting the content to sign language. To achieve this first the audio should be extracted from the video, and it will be converted to text to be used to convert to SLSL. Then the extracted audio will be used to identify the emotions using SER. At last, the identified emotions and the converted sign language will be integrated and will be attached to the video as a 3D avatar.

6.1 System Architecture Diagram

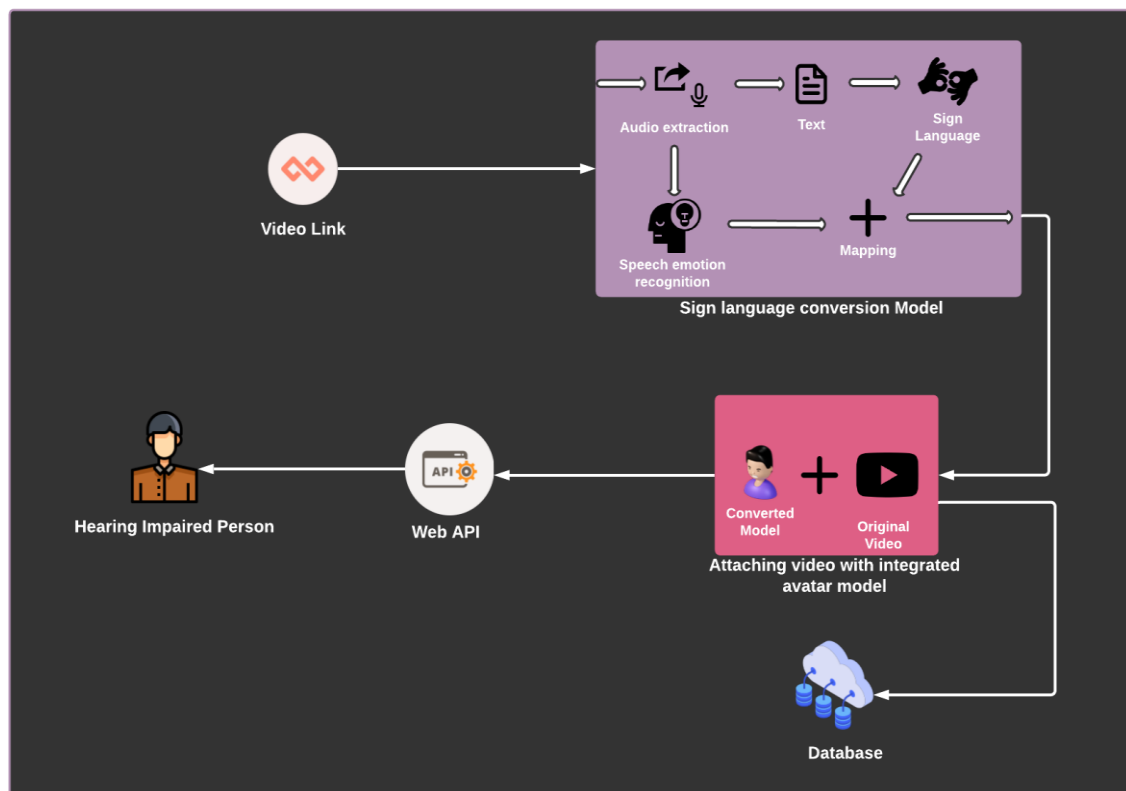


Figure 6.1 - System Architecture Diagram

6.2 Software Solution

SDLC, or Software Development Life Cycle, is a well-known efficient method of developing computer programs that ensure the quality and correctness of the final product. This aids developers in producing high-quality programs that suit the needs of clients. The system should be completely improved within the period that has been set. SDLC is a detailed strategy that explains how to organize, build, and maintain a certain computer program. Each step of the SDLC has its own set of processes and deliverables that feed into the next. This technique is broken into several major stages, which are as follows:

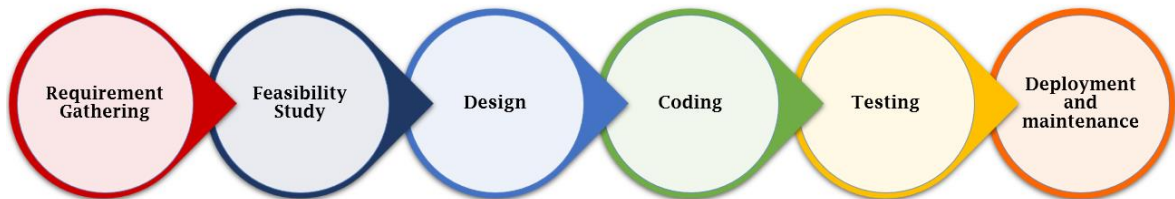


Figure 6.2 - Stages of Software Development Life Cycle

6.2.1 Requirement Gathering

This stage includes a gathering of requirements which are to be used to get a clear idea and plan what the system should be and what needs to be implemented. To gather information for this stage a survey was done on conducted on a set of hearing-impaired students on their opinions and ideas regarding an online learning platform for HIP.

6.2.2 Feasibility Study

1. Schedule Feasibility

To deliver the best results a timeline should be created at the beginning and the work should be done sticking to the deadlines in the timeline. This should include a proper work breakdown structure.

2. Technical Feasibility

The proposed system should be compatible with the existing technologies and students should be able to use the system using commonly used computer systems. The developing solution will be built so that it will be technically feasible.

3. Operational Feasibility

The proposed solution should be built on taking the requirements of the HIP into consideration and to cater their needs. The systems that have been already proposed should be analyzed to identify the gaps that they have not been able to fill, and the proposed system should be built including solutions to these gaps to improve the performance of the system.

6.2.3 Design and Implementation

Under the design phase a sketch of the proposed approach to achieve the sub objectives should be created. After the designing phase is completed, the project can be moved to the coding phase which is also known as the implementation of the system.

6.2.3.1 Datasets

The RAVDESS emotional audio dataset will be used for the process of identifying emotion. Since the dataset is too large initially a part of the dataset will be used to build the model and afterwards the full dataset will be used for final implementation.

For the conversion of text to SLSL a dataset will be created after gathering information from a few organizations and will be using a dataset which is already available on Kaggle.

6.2.3.2 Conversion to sign language

The audio of the given video will be extracted and the text that is extracted will be used as the source to convert the content to SLSL using NLP. The required data for the conversion of the SLSL will be taken from the Kaggle as there already exists a dataset about SLSL. It is planned to gather additional data from certain organizations. This data will be gathered by the team as it is essential to be used in every component of this research.

6.2.3.3 Speech Emotion Recognition

The extracted audio from the above-mentioned will be used here to analyze the emotions using speech recognition. It is planned to use the RAVDESS emotional audio dataset as the data for emotional analysis. MFCC will be used for the feature extraction along with MLPC for this purpose of identifying emotions.

6.2.3.4 Plan on Mapping emotion with SLSL

The plan to map the analyzed emotion with the converted SLSL would be to break the extracted text from the audio by sentences. Afterwards the text can be converted sentence wise and will be stored afterwards. The audio will be then broken into parts by sentence by sentence so it will be easier to map the identified emotion with the text. Finally, the identified emotion will be mapped with each sentence, respectively.

6.2.3.5 Final Output

The final output will be presented as a 3D avatar signing in SLSL with the identified emotions integrated to the avatar as facial expressions. The plan is to achieve this by using Maya Autodesk or Blender.

6.2.3.6 Tools and technologies

- AWS S3 buckets for database requirements
- Python Libraries for modeling
 - Librosa
 - Numpy
 - Sklearn
- Visual Studio code as the IDE for model implementation
- Blender / Maya for animation creation

6.2.4 Testing

- **Unit Testing** – both subcomponents (emotion identification and SLSL conversion) will be tested separately for accuracy.
- **Component Testing** – After unit testing, the two components will be mapped and combined and will be tested for accuracy and for any errors.
- **Integration testing** – After component testing the combined component will be integrated to the system and will be tested for the correct integration and any faults that could occur during the integration.
- **System testing** – After integration, the system will be tested to check the performance of the system functionalities together and to check the flow of the system.
- **User Acceptance testing** – The system will be tested by the users of the system to check the satisfaction level of the system.

6.2.5 Deployment and Maintenance

Once the testing phase is completed the system should be deployed to the target audience to be used. The initial plan is to deploy the web application to the cloud using AWS which would enable the target audience to use the system with 99.9% availability. After the deployment, the developing team is responsible for resolving issue and adding feature for the system and maintaining the system so that the users will be able to use the system without any issue and the system will be up to date with the current needs.

6.3 Work Breakdown Structure

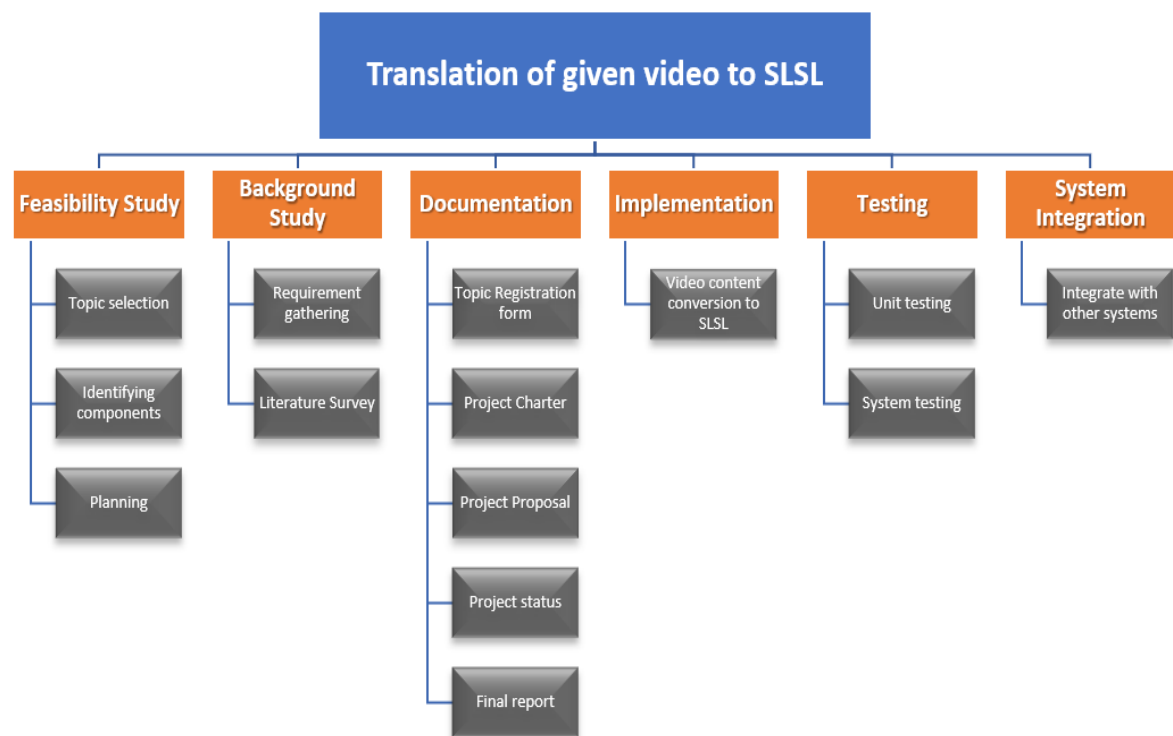


Figure 6.3 - Work breakdown Structure

7. PROJECT REQUIREMENTS

7.1 Functional Requirements

- Ability to convert video content to SLSL
- Ability to observe facial expression from avatar.

7.2 Non-Functional Requirements

- Performance – To generate captions in SLSL in meaningful way where the user can understand it correctly.
- Usability – System should be easy to understand and use for the users who are going to use the system
- Accuracy – Generated captions and the associated facial expressions should be accurate and relevant with the video used.

7.3 User Requirements

- HIP person should be able to see the video content in SLSL.
- HIP should be able to understand the emotion while looking at the content in SLSL.

8. GANTT CHART

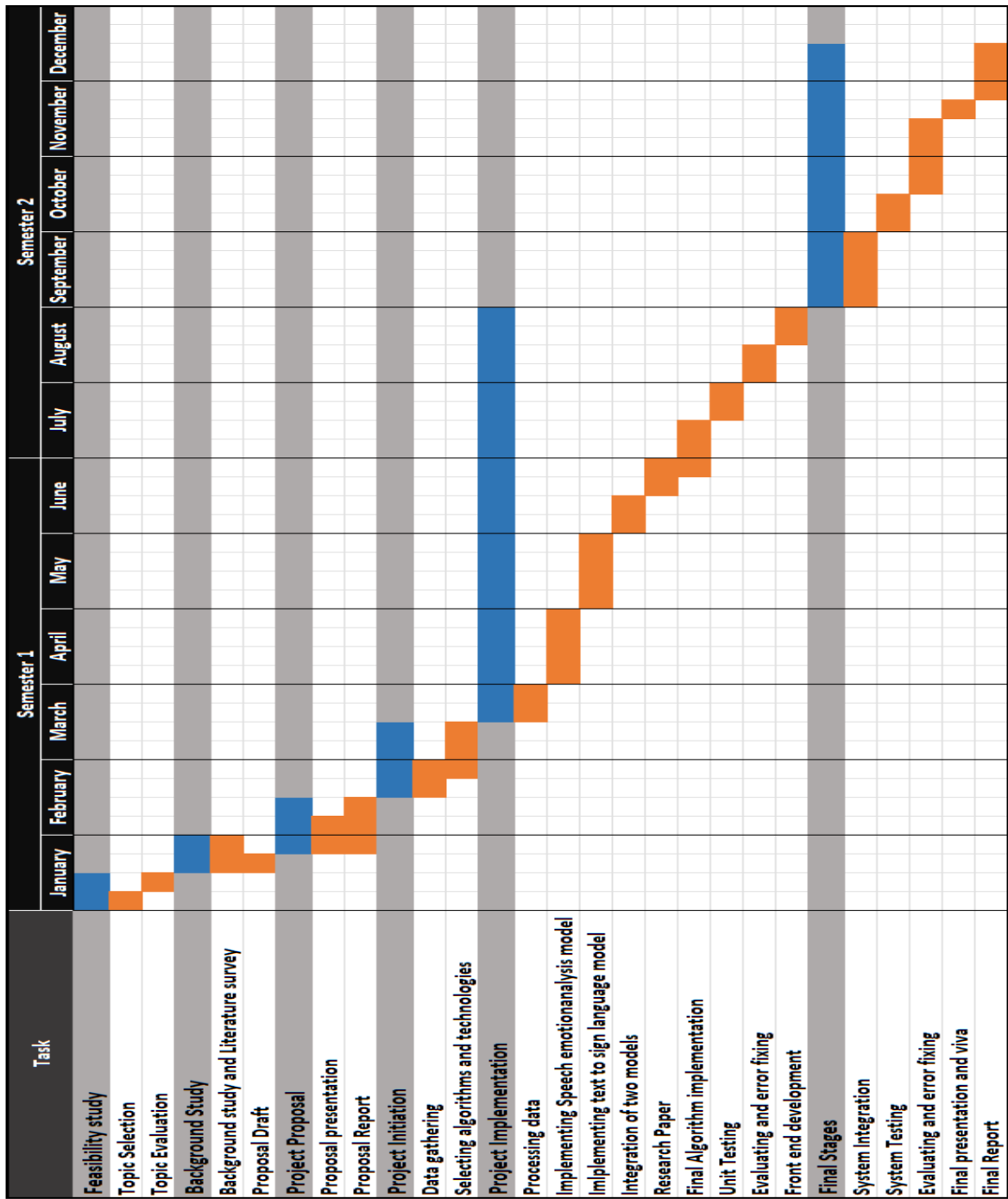


Figure 8.1 - Tentative Gannt Chart

9. COMMERCIALIZATION

The system will be developed as a web application and will be hosted in the cloud. As a future improvement the system could be developed as a mobile application as well as a desktop application. The system could provide services to the users based on a monthly subscription basis and it could contain packages so that universities and other educational institutes could use the system to provide accessibility to their students. The system would feature a free tier where limited access to the services could be provided.

Target audience:

- Deaf and dumb students
- People who work with HIP

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APPENDICES

Appendix A: Survey Questionnaire

What do you think is the best way to display translation of videos? (විඩියෝ පරිවර්තන පෙන්වීමට හොඳම ක්‍රමය කුමක්දැයි ඔබ සිතන්නේ කුමක්ද?)

- ☐ Text as subtitles (උපසිරැසි ලෙස පෙළ)
- ☐ Sign language through an animated avatar along with the video (විඩියෝව සමඟින් සංඥා භාෂාව සජීවීකරණ හරහා)
- ☐ Sign language through an animated avatar only (සංඥා භාෂාව සජීවීකරණ avatar හරහා පමණක්)

How likely are you to use a system that is teaching Sri Lankan sign language through an automated platform with interactive features and animated avatars? 1 being highly unlikely, 10 being highly likely (අන්තර්ක්‍රියාකාරී විශේෂාංග සහ සජීවීකරණ avatar සහිත ස්වයංක්‍රීය වේදිකාවක් හරහා ශ්‍රී ලාංකේය සංඥා භාෂාව උගන්වන පද්ධතියක් භාවිතා කිරීමට ඔබ කෙතරම් දුරට ඉඩ තිබේද? 1 බොහෝ විය නොහැක්කකි, 10 බොහෝ දුරට ඉඩ ඇත)

- | | | | | | | | | | |
|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Is it useful if the hearing impaired people are able to get real time feedback on the mistakes in gestures when interpreting words in sign language? (ශ්‍රවණාබාධිත පුද්ගලයන්ට සංඥා භාෂාවෙන් වචන අර්ථකථනය කිරීමේදී අභිනයන්වල ඇති වැරදි පිළිබඳව තත්‍ය කාලීන ප්‍රතිපෝෂණ ලබා ගත හැකි නම් එය ප්‍රයෝජනවත්ද?) *

- ☐ Yes (ඔව්)
- ☐ No (නැත)

How would you expect the system to provide feedback on the answer they have given? (ඔවුන් ලබා දී ඇති පිළිතුර පිළිබඳව පද්ධතිය ප්‍රතිපෝෂණ ලබා දෙනු ඇතැයි ඔබ අපේක්ෂා කරන්නේ කෙසේද?)

- ☐ State only the correct answer without any feedback on the answer. (පිළිතුර පිළිබඳ කිසිදු ප්‍රතිපෝෂණයකින් තොරව නිවැරදි පිළිතුර පමණක් සඳහන් කරන්න.)
- ☐ State only if the answer is correct or wrong (පිළිතුර නිවැරදි හෝ වැරදි නම් පමණක් සඳහන් කරන්න)
- ☐ State what percentage of answer is correct or wrong along with the mistake they have done and the correct answer (කර ඇති වැරද්ද සහ නිවැරදි පිළිතුර සමඟ නිවැරදි හෝ වැරදි පිළිතුරේ ප්‍රතිශතය කොපමණද යන්න සඳහන් කරන්න)

Do you think it would help the hearing impaired if content of youtube videos to be translated to Sri Lankan sign language to gain knowledge? (ශ්‍රවණාබාධිත අයට දැනුම ලබාගැනීම සඳහා යු ටියුබ් විඩියෝවල අන්තර්ගතය ශ්‍රී ලංකාවේ සංඥා භාෂාවට පරිවර්තනය කළහොත් එය උපකාරයක් වේ යැයි ඔබ සිතනවාද?) *

- ☐ Yes (ඔව්)
- ☐ No (නැත)