ONLINE LEARNING PLATFORM FOR HEARING IMPAIRED PEOPLE

Project ID: 2022-059

Final Report

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Specializing in Data Science

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DECLARATION

We declare that this is our own work. This proposal does not incorporate, without acknowledgment, any material previously submitted for a degree or diploma in any other university or Institute of higher learning. To the best of our knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the.

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

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Signature of the Co-supervisor   Date

(Mr. Yashas Mallawarachchi)

ABSTRACT

When the Covid-19 pandemic happened, most people had to stay at home for so long time, and it unbales to do their normal work such as studying, working on their jobs, and other needful things as the usual way by traveling from place to place. Instead of that, people had to do everything online using the internet as much as possible. Then that became the new normal, and the whole world adjusted to these new ways. Education also got advanced using online learning platforms centered around Zoom, MS Teams, Google Workspace, and various other platforms. But there are some people who are not fully covered by these platforms. The best example is people with disabilities. They need some special technical help to get their learning from home facilities. Here we focus on people who are hearing impaired.

Keywords: *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

1. INTRODUCTION

1.1 Hearing impaired and Sign Language

Hearing impairment is defined as the inability of an individual to hear sounds adequately. This includes people with any degree of hearing loss and individuals who have lost hearing entirely by birth or later in life. The primary communication method of these individuals is using sign language. Sign language is the mean of communication using hand gestures and body movements. One of the main misconceptions regarding sign languages is that it is the same wherever you go. Nevertheless, 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].

1.2 Features of sign language

Facial expressions are an essential 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 can speak and 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 chat 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

1.4 Component Overview

This research component focuses on developing a chatbot to user where user can find anything through Google. Therefore, this component works as an intermediate between user and Google search. User can ask the question using SLSL and Chatbot translates it into a Google. Then first ten results of the Google search will be converted into SLSL using the component and present it to the HIP user. If user selects one component reads and present the content. Other than that user can ask for more results or retry the Google search in other way. That is the basic behavior of the component.

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 much trouble for people around the world, and many had to suffer huge losses due to this. However, many industries began transforming 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 their systems were customized to cater to their way of providing education. Even though these systems were used, they were based on the traditional education system (Teacher to student). This transformation was 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 needs 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 2.1.1.
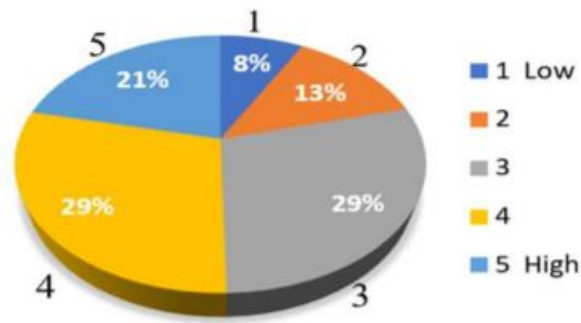
Figure 2.1.1- Student's preference for online learning in the future

Figure 2.1.1 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, he environment at home for online learning and devices used for online learning.

Figure 2.1.2 - Digital approaches that motivate students to learn

Figure 2.1.2 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

- ● I am learning in my own pace comfortably
- ● My situational challenges are not suitable
- ● I can learn better with uninterrupted network connectivity
- ● I am distracted with various activities at home, viz. TV, chatting etc.

25.1%
21.3%
11.2%
42.5%

Figure 2.1.3 - The online learning experience of students

Figure 2.1.3 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

- A laptop/desktop computer — 341 (76.1%)
- A tablet — 26 (5.8%)
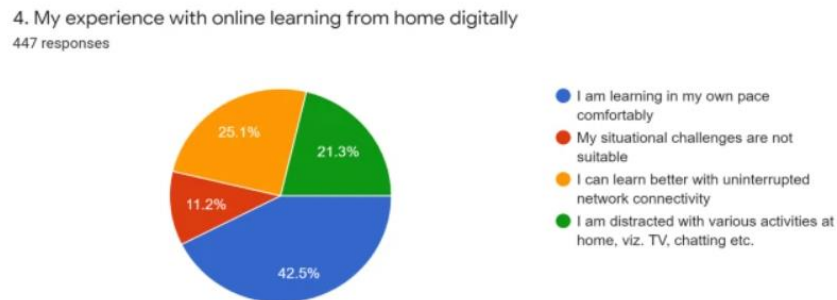- A smart phone — 263 (58.7%)
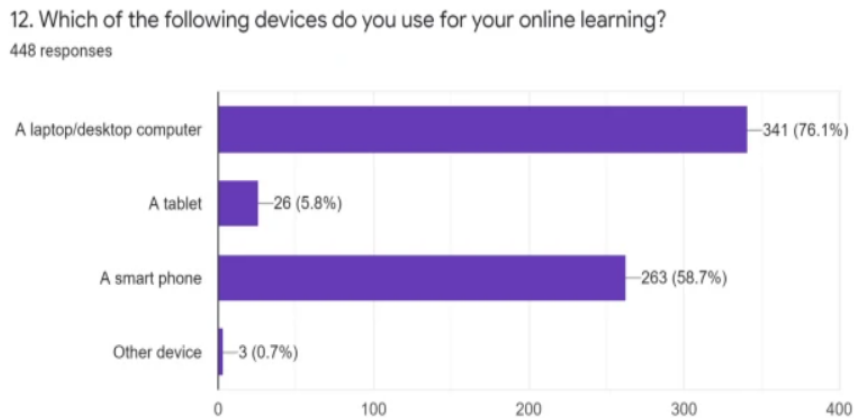- Other device — 3 (0.7%)

Figure 2.1.4 - Devices used for online learning

Figure 2.1.4 shows that 76.1% of the students use a laptop or a desktop for their online learning purposes.

These survey results suggest than 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 the society for the foreseeable 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 has been implemented. Most of these solutions has 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 interpret 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. Many such research have been done on improving the 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 majority 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 majority of HIP are having trouble reading.

In [16] the authors have been able to develop a system which shows user 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 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 the 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-leaning 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 of 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 the proposed system

Feature / Research	Based on SLSL	Generating captions in the form of sign language	Analysing of emotion in each video	Conversion to sign language
Research A [4]	✗	✗	✗	✓
Research B [6]	✗	✗	✗	✓
Research C [7]	✓	✗	✗	✓
Research D [16]	✗	✗	✗	✓
Proposed system	✓	✓	✓	✓

4. RESEARCH PROBLEM

HIP Users are lacking resources to connect with the world. It can be Google or YouTube or in any platform. Therefore, within this pandemic and the evolution of the world to a digital world, it is suitable to go for online learning platforms to enhance education system of humans. Then comes to the special learning platforms to the HIP and we identified even in learning platforms not all the platforms focus on everything. We introduced a special feature to connect with google and search anything so HIP users can learn from multiple ways, and it is considered to be a better achievement because most of the obstacles will be destroyed.

5. OBJECTIVE

5.1 Main Objective

The main objective of this component is to give the opportunity for a HIP to search anything through Google and learn anything fast.

5.2 Specific Objective

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

- **An algorithm to identify SLSL and converts it to text then Google**

This objective focus on converting it to a text and search through Google in the next step. Then component identifies search results and identifies title of first ten search results.

- **Presenting search results using 3D Model.**

This objective aim on presenting SLSL using a 3D avatar model which we identified search results and content of selected search result.

6. METHODOLOGY

The objective as mentioned of this component is to provide the HIP the ability to get knowledge through Google search by converting the content to sign language and vice versa. To achieve this first the real time video is captured using Open CV. Then converted to a text and search through Google. Then system will identify search results in bundles of ten. Then title of first ten research bundles will be displayed using 3D avatar model.

6.1 System Architecture Diagram

Figure 6.1.1 - System Architecture Diagram

6.2 Software Solution

SDLC, or Software Development Life Cycle, is a well-known efficient method of developing computer programs that ensures 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 time frame 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:
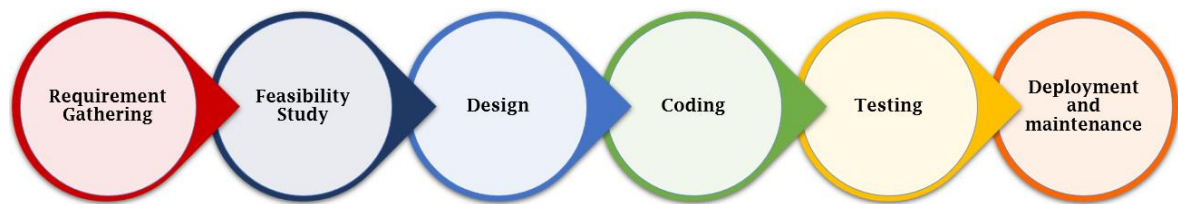

Figure 6.2.1 – Stages of Software Development Life Cycle

6.2.1 Requirement Gathering

This stage includes gathering of requirements which is to be used to get a clear idea and plan on 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 the 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 their already exist a dataset about SLSL. It is planned to gather additional data from certain organizations. These 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 the emotions.

6.2.3.4 Plan on Mapping emotion with SLSL

The plan on mapping 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 identifies emotions integrated to the avatar as facial expressions. The plan is to achieve this by using Maya Autodesk.

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

6.2.4 Testing

- **Unit Testing** – both subcomponents (emotion identification and SLSL conversion) will be tested separately for the accuracy.

- **Component Testing** – After unit testing, the two components will be mapped and combined and will be tested for the 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 as a whole 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 6.3.1 - 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 used video.

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. GANNT 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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