



PROJECT SANWADA

INTELLIGENT MOBILE ASSISTANT FOR HEARING IMPAIRERS TO INTERACT WITH THE SOCIETY

Project ID: 17-092

Project Final Report

A. M. O. P. Bandara (IT14076176)

B.Sc. Special (Hons) in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

Submitted on 04/10/2017

SANWADHA

INTELLIGENT ASSISTANT FOR HEARING IMPAIRERS TO INTERACT WITH THE SOCIETY

A.M.O.P.Bandara

IT14076176

B.Sc. Special (Hons) in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

4th October 2017

DECLARATION

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

Author:

Student ID	Name	Signature
IT 14076176	A.M.O.P. Bandara	

ABSTRACT

The Internet has taken communication to unprecedented heights today. People all around the world use the Internet to get connected and communicate with those from around the world. These include methods such as emailing, community sites and most importantly chat systems. Using chat systems to communicate has become a trend and the most fashionable way to connect with people all around the world. However, these privileges of the Internet are limited only to people who are normal and are abled. But people who are hearing-impaired are isolated and denied these uses of the Internet. To help the hearing-impaired with their communication the “Sanwadha” chat system has done come up. This chat application will include different means of communication other than the conventional text to text keyboard conversation. Unlike an ordinary chat system, the “Sanwadha” chat system is intelligent to determine the mode of communication of the user. The user in this context means a hearing-impaired person, according to disability. The “Sanwadha” chat system is a collection of technologies that already exist, technologies such as the conversion of voice to text and vice versa and text to text, and new incorporates technologies such as the conversion of sign language. This document describes the “Sanwadha” System and its impact on society today. It indicates clearly the background of the “Sanwadha” system using literature survey and the problem which must overcome by the “Sanwadha” team.

ACKNOWLEDGEMENT

First and foremost, I am heartily grateful and indebted to our supervisor of CDAP module Prof. Samantha Thelijjagoda (Head/Department of Information Systems Engineering(SLIIT) for valuable guidance and support for the ongoing research.

TABLE OF CONTENTS

DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
LIST OF TABLES	viii
LIST OF FIGURES.....	ix
LIST OF ABBREVIATIONS	x
1. INTRODUCTION.....	1
1.1 Background Study	1
1.2 Literature Survey	2
1.3 Research Gap.....	3
1.4 Research Problem.....	4
1.5 Research Objectives	5
1.5.1 Main objectives	5
1.5.2 Specific objectives.....	5
2. METHODOLOGY	6
2.1 Project Initiation	7
2.3.2 Feasibility Study.....	7
2.1.1 Requirements Gathering and analysis	8
2.1.2 System Implementation.....	9
2.1.3 Testing and debugging	9
2.1.4 Documentation	10
3. RESULT AND DISCUSSION.....	11
3.1 Summary of the function	11
3.2 2D Model Creation and Convert Signs in to Text.....	12
3.2.1 Reply Mechanism.....	12
3.2.2 Learning Sign Language Game	17
3.3 Discussion	22
4. CONCLUSION	24
REFERENCES.....	25

Glossary.....	27
APPENDICES.....	29

LIST OF TABLES

Table 2.3.2.1 Software associated with the function.....	14
Table 3.1 Outcome Satisfaction of the function: Software Components.....	36

LIST OF FIGURES

Figure 3.1.1 System diagram of the text conversion.....	26
Figure 3.2.1.1 Main window of the reply mechanism.....	27
Figure 3.2.1.2 Previous chat that user sent.....	28
Figure 3.2.1.3 Deaf reply mechanism keyboard.....	28
Figure 3.2.1.4 Selected gifs that want to send.....	29
Figure 3.2.1.5 Generate small gifs in to a completed one gif.....	29
Figure 3.2.1.6 Generated gif that sent.....	30
Figure 3.2.1.7 Converted Sinhala text that sent.....	30
Figure 3.2.2.1 Main interface of game.....	31
Figure 3.2.2.2 Categories of game.....	32
Figure 3.2.2.3 Alphabets game.....	32
Figure 3.2.2.4 Greetings game.....	33
Figure 3.2.2.5 Numbers game.....	33
Figure 3.2.2.6. Add marks.....	34
Figure 3.2.2.7 Zero marks.....	34
Figure 3.2.2.8 Game loading interface.....	35
Figure 3.2.2.9 Game score interface.....	35

LIST OF ABBREVIATIONS

2D	Two Dimensional.
3D	Three Dimensional
SRS	Software Requirement Specification
GIF	Graphic Interchange Format
NLP	Natural Language Processing
ASR	Automatic Speech Recognition
SLU	Spoken Language Understanding
SLG	Spoken Language Generation
UI	User Interface
TTS	Text to Speech Synthesis
IM	Instant Messaging
API	Application Program Interface
HDD	Hard Disk Drive
RAM	Random Access Memory
D-User	Deaf user

1. INTRODUCTION

1.1 Background Study

In the last half of the 20th century the communication through the internet developed rapidly. [1] Today, this development has made communication in the day-to-day life easy. With the advancement of the technology most people have the access to the internet; therefore, people are more disposed to use the internet as a means of communication more frequently. [1], [2]

Today, to communicate with other people over the internet used many different methods by people. These include methods such as emailing, community sites and most importantly chat systems. Using chat systems to communicate has become a trend and the most fashionable way to connect with people all around the world. [3]

Although this is the case, today this facility is restricted only to people who are normal. But people who are hearing-impaired are isolated and denied of this facility just because of their disability. [15]

A language is an entirely human method for communicating thoughts and feelings. There is a gap between non-hearings impaired and hearing-impaired people when it comes to communication. [2] Most of the non-hearing-impaired people cannot understand what Sign language is. Sign language is a language which use body language, facial expressions, and movements of body parts to communicate. It's not a universal language, may vary within a country like a normal language. [3]

Most of the non-hearing-impaired people are lack of understanding sign language and it leads hearing impaired people to face many difficulties. In Sri Lanka, deaf education capability also in a low state and many deaf people are not educated even up to a considerable level. Matured person can manage to deal with non-hearing-impaired person, but not most youngsters, children and who had less education level. This is a critical situation to deal. To overcome this problem, with oral language and sign language

communication they need an accurate translator to work with. [7] As a help to these people so far, many applications, systems and devices have been introduced. But the main problem is to connect both non-hearing impaired with hearing impaired simultaneously. For that there are only limited number of systems are evolved. There are applications which can only turn voice to text or sign language to text separately. This research is introduced this system as a two-way communication system. [15] These kinds of systems mainly focused on accuracy level. When working with hand gesture recognition part, many systems used image processing as the technique. It takes lots of time and lots of processing to work on. Developing a system to solve this is much more complex than developing any other translator. Product should be easy to use, easy to carry and most importantly it should be accurate. The “Sanwadha” mobile application is a translator with light weighted and simple so this comes in handy to use anywhere anytime. [17]

1.2 Literature Survey

The deafness is variable. It can occur at any stage of life cycle, it may impact on the individual's ability to function on a day-to-day basis and it may or may not be disabling. Conversational speech can be measured as having a Loudness of approximately 60 decibels (dB). Hearing is considered significantly. [5]

As the first language, used sign language by 75 million of deaf people in the world. Each country has one or sometimes two or more sign languages. There are some common techniques used by deaf people to communicate with normal people. Some deaf people use speech or sign language only or a combination, some may use finger spelling or writing or body language and facial expressions. Like spoken languages, signed languages vary. Sign languages have their own accents, dialects, and idiosyncratic vocabulary. Signs may be limited to regions, schools, or even families [6].

Recognition of no manual markers in American Sign Language (ASL) using non-parametric adaptive 2D-3D face tracking

This one address the problem of automatically recognizing linguistically significant non-manual expressions in American Sign Language from video. Develop a fully automatic system that can track facial expressions and head movements, detect and recognize facial events continuously from video. [12] The main contributions of the proposed framework are the following:

- Built a stochastic and adaptive ensemble of face trackers to address factors resulting in lost face track.
- Combine 2D and 3D deformable face models to warp input frames, thus correcting for any variation in facial appearance resulting from changes in 3D head pose.
- Use a combination of geometric features and texture features extracted from a canonical frontal representation. The proposed new framework makes it possible to detect grammatically significant non-manual expressions from continuous signing and to differentiate successfully among linguistically significant expressions that involve subtle differences in appearance [12].

Most of these systems and devices are only focused on a one side communication. But in this application, both focused on text to sign language and sign language to text. The specialty of this system is there is no such a system invented and not for Sinhala language.

1.3 Research Gap

There is a communication gap between hearing-impairers and the ordinary people. Most of the time that is being filled through an interpreter. It would be a problem when there is no Interpreter. By now, there are some solutions to cover this problem. But those solutions couldn't reach the Sri Lankan Deaf community. Most of them are not flexible with the

deaf users and they are not casing all the extents they need. So, by today hearing-impairers have challenged with a huge communication gap in their day to day life. Our proposed application would be the finest solution for this gap.

1.4 Research Problem

During the last five decades communication through internet, developed rapidly. Today, this development has made communication in the day-to-day life more conveniently. With the advancement of the technology most people have the access to the internet; therefore, people are more prone to use the internet as a means of communication more frequently [2].

There are various kinds of difficulties that the hearing-impairers are facing. The main problem that the hearing-impairers face is the communication difficulty. These difficulties affect access to public information, opportunities to express oneself and access to essential services such as health, housing, transportation, education and employment.

In this research project, decided to build a very special, innovative and multi featured chat application especially for the people with disabilities. This chat application included different means of communication other than the conventional text to text keyboard conversation Major aspect of our system is to let the hearing-impairers to interact with the modern society via internet. As far as found in literature survey, there are various kinds of chat applications. Some of them are normal text chat systems and some of them only facilitate voice chatting. But the uniqueness of “Sanwadha” is it facilitates all types of chatting in one single application. Other thing about “Sanwadha” is whatever the input type that the user uses for chatting; the system ultimately converted it in to text before sending through the network. There is a very huge traffic in internet because the number of uses is very high. If used video streaming by us, it need a big bandwidth and various network resources. But as send only a text through the network for any kind of chatting it need much low bandwidth. As it mentioned earlier “Sanwadha” is specially build for

the hearing-impairers, but normal people also can use this system with its special facilities. The uniqueness of the “Sanwadha” is, it supports normal chat using text, chat using voice and chat using sign language.

1.5 Research Objectives

1.5.1 Main objectives

- To minimize the barriers between hearing-impairers people and normal people.
- To become one of the best top 10 chat applications among hearing-impairers in future.

1.5.2 Specific objectives

- To minimize barriers in communication
- To minimize barriers in education
- To eliminate barriers in healthcare
- To minimize barriers in developing human relationships

2. METHODOLOGY

This chapter illustrates the methodology for handling the project's relevant function. It's a methodical approach to the research, gathering requirements, designing and implementation to create effective solution to an existing problem an area where improvement is required.

Proposed solution presents an intelligent assistant for hearing impairers to interact with the society.

The project has a very significant research area like, Natural Language Processing (NLP), Voice Detection, Machine learning, Artificial Intelligence, Graphic Interchange Format (GIF) conversion and Mobile platform development. Machine Learning and GIF conversion is important for the identification of individual words in each Text and converted sign language send via compressed GIF files. Research conducted further study on above mentioned research areas then the information can be used to achieve the objectives.

To increases the quality of the “Sanwadha” CHAT system, must had better methodology to process. Selecting a better methodology for the research based software is providing better consequence in shorter delivery time. There are several methodologies which can apply for the research based software with Software Development Life Cycle (SDLC). In “Sanwadha” CHAT System used Iterative Waterfall model. Because “Sanwadha” chat system needs more project management from the beginning to end. By using this waterfall method, it is very easier to manage the system in different life cycle phases. Because of that “Sanwadha” chat system uses iterative waterfall method.

2.1 Project Initiation

The initiation of the “Sanwadha” involved in the gathering of foundation information for the development of the “Sanwadha” chat system and background study on the other chat applications to identify unique features.

2.3.2 Feasibility Study

- ✓ Identification of the problem domain.

Isolation of hearing impairers in today's world has become a severe problem even though the modern and developed world today has failed to realize. People who are differently able, not care for by their families, alone in places under the care of never met charity workers, are left out to be so alone. As humans, being natural socially sophisticated living beings, this loneliness is hard to bear. Also, normal people who are used normal chat applications in day to day life are very busy with their works haven't much support from currently used chat applications as they wish such as voice to text or text to voice features. Through the “Sanwadha” CHAT System to give these people a chance at a normal life and become a part of today's society.

Examination of alternative solution strategies and their benefits, taking the resources required, development, cost and time as factors in respect of the alternative solutions done in this phase. The financial feasibility depends on the software which must be purchased, the overall cost of software and whether it is within the financial limits of the project team. Here mainly focusing on the feasible solutions which are identified in the technical feasibility and select which is the most suitable according to the financial feasibility. Depending on the solutions thought of by the group members, the best solution would be chosen to be carried out mainly in terms of cost and time as well as resource constraints. Number of human work hours involved, the total number of developers will be taken into high consideration. Thus, on the reasons mentioned, the project studied and decided whether the project will be financially feasible to continue with it or not. “Sanwadha”

chat system did expect commercial benefit from the final product and it is not totally free for the users, therefore the cost of producing “Sanwadha” chat system must be a average cost. Therefore, with the problem domain identification completed and with the affirmation of the project being financially and technically feasible the requirement analysis was decided to be initiated.

2.1.1 Requirements Gathering and analysis

✓ Requirements Gathering

Gathering Requirements was a very important phase in a software development life cycle. As a research based project did literature survey about my function area. In this manner, used to read research papers and gather requirements via those papers. The function implemented not only for specific client but also for every user who willing for use it in future. Therefore, also gathered information from people who works with differently able people to identify what they were expected from such an application. After knowing what they want, it is easier to get an understanding of how the system should work and what must implement. The whole purpose of "Requirements Gathering" is to identify "WHAT" the system must do. If the requirements gather phase is conducted properly, all the other phases can be carried out relatively smoothly. Therefore, this stage of development is critical and it defines the future of the project and its progress

✓ Requirements analysis

This phase depends on the results of the Requirements Gathering phase. The gathered requirements were analyzed and examined carefully to identify ambiguous, incomplete or/and inconsistent requirements. These identified issues were discussed with project supervisor and clarified before proceeding with the project further. Meanwhile, background researches are discharged on similar existing systems; previous researches on integrating multi featured chat applications for hearing impairers with mobile

applications and on areas concerning multi featured chat applications for hearing impairers.

2.1.2 System Implementation

The latter stages of the Systems Analysis and Design phase saw the commencement of the System Implementation phase. The actual function was developed, initially developing a progress presentation-ii of the which described about 85% of the functionality of the “Sanwadha” chat system. The function was coded using Android Studio Java framework Integrated Development Environment (IDE). The language that was used for the implementation of the “Sanwadha is Java; programming was carried out in the Object-Oriented format.

2.1.3 Testing and debugging

Testing of the function contained 4 sub-phases; prototype testing, unit testing, integration testing, and system testing.

- **Prototype Testing**

The prototype built mid-way implementation was tested prior to releasing the functioning prototype. This was conducted by integrating certain components of the function that were developed for the functioning prototype. Prototype Testing was conducted using the black box testing method which tests whether the output of the system for certain functions were true as per the given inputs and the white box testing method by testing the manner data travels through the function in order to produce the results. Errors were also input to the system to test whether appropriate error messages were displayed.

- Unit Testing

Every single unit/component developed for the function was tested individually before integrating all components together to fabricate the chat system. This method too utilized the methods of black box testing, white box testing and error seeding.

- Integration Testing

The individually tested components were assimilated to fabricate the “Sanwadha”. While integrating, the integrated components were tested.

- System Testing

The “Sanwadha” chat system was tested in the development environment and then deployed in the user operating environment.

2.1.4 Documentation

Documentation was mandatory during the execution of a project to facilitate clarity in understanding its progress and functionality not only by the client, but also by the team members / developers. There were many instances during the execution of the project plan where documentation was required. Documentation of the project proposal was the initial document that proposes the development of the chat system the software requirement specification describing the requirements. The System Design Document is a vital aspect of a project execution process for it provides the audience a detailed view and description of the infrastructure of “Sanwadha” System. The Project Report is documented at the completion of the project, which summarizes all the activities executed throughout the development of the system.

3. RESULT AND DISCUSSION

3.1 Summary of the function

When someone wants to use the “Sanwadha chat system, the first requirement they must fulfill is to have a valid Gmail mailing address. By using the Gmail address the can login to the system. Password authentication is done by Gmail chat server. When the user enters a valid Gmail address and the password he can login to “Sanwadha”, then will display the people who are on his friends list. As we mentioned earlier “Sanwadha chat system is a multi-feathered chat application. So, the user can select the chat mode out of the three modes, normal, sign language or voice. The main uniqueness of system is whatever the chat mode that the user is using it will be converted in to text by the client application and sent through the network. At the receiving end, the message will again have converted into the relevant chat mode.

The following figure demonstrates the text conversion.

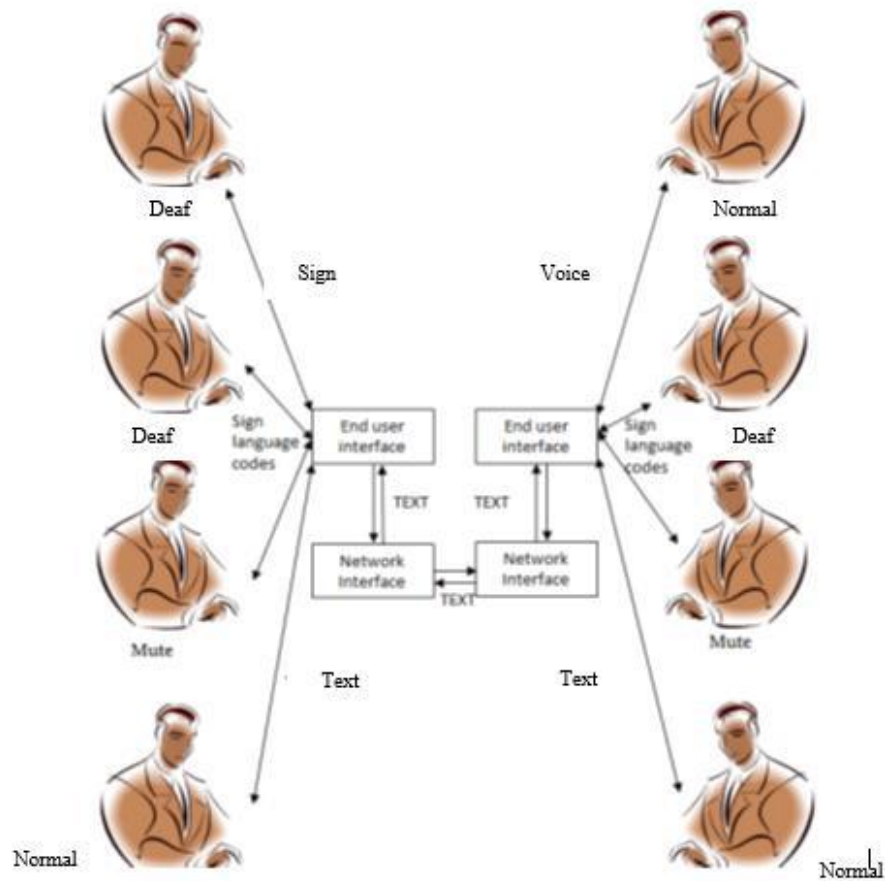


Figure 3.1.1 system diagram of the text conversion

3.2 2D Model Creation and Convert Signs in to Text

3.2.1 Reply Mechanism

This was the main interface of the deaf reply mechanism. Deaf person can select relevant gifs and stickers that he wants to send as reply. Once selected the small gifs that small gifs were converted to a fully completed gif. Then if want to send that completed gif he

can send it or otherwise if he wants to convert that gif in to a Sinhala gif he can click “Send Text” button and that gif convert to Sinhala text. And can send that Sinhala text.

And, user can see his/her previous messages that he/she send.

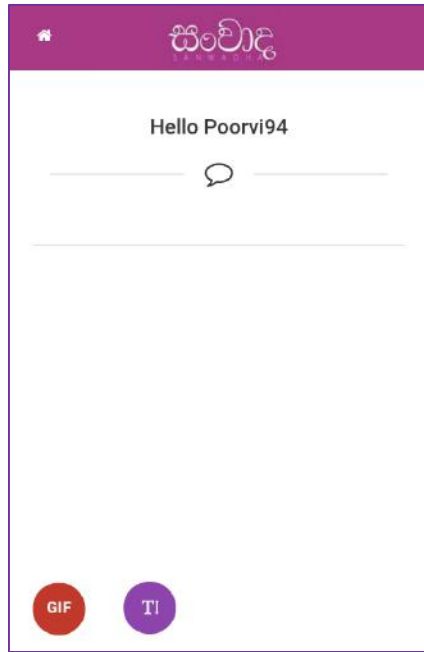


Figure 3.2.1.1 main window of the reply mechanism

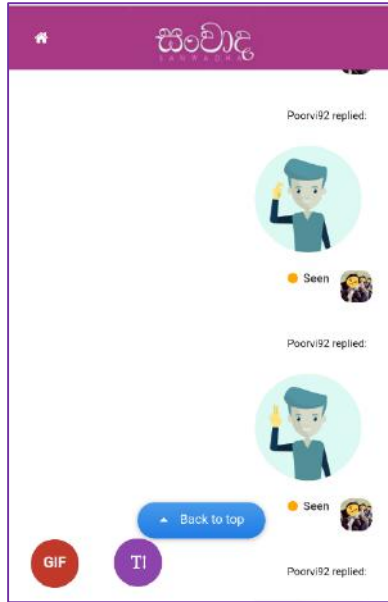


Figure 3.2.1.2 previous chat that user sent

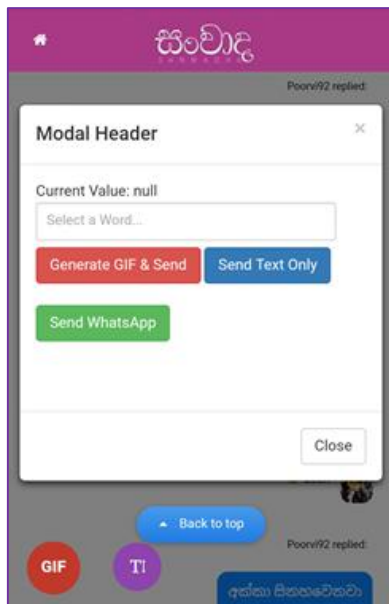


Figure 3.2.1.3 Deaf reply mechanism keyboard

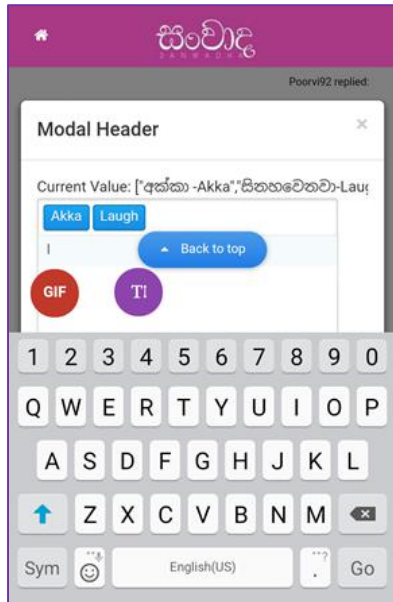


Figure 3.2.1.4 Selected gifs that want to send

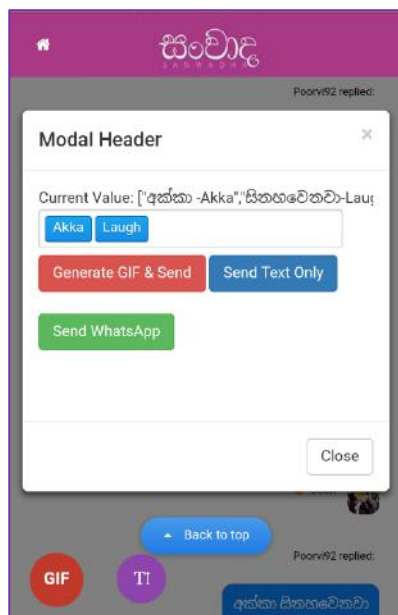


Figure 3.2.1.5 generate small gifs in to a completed one gif

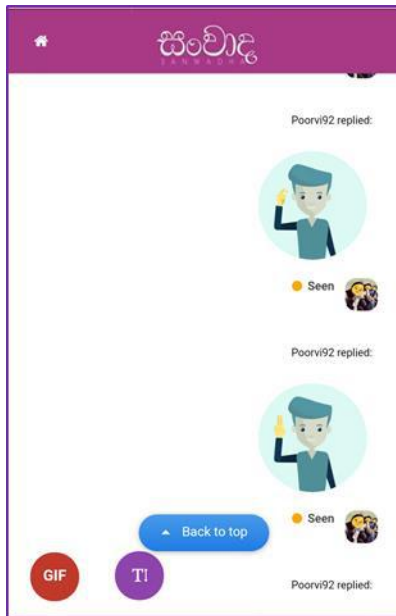


Figure 3.2.1.6 generated gif that sent

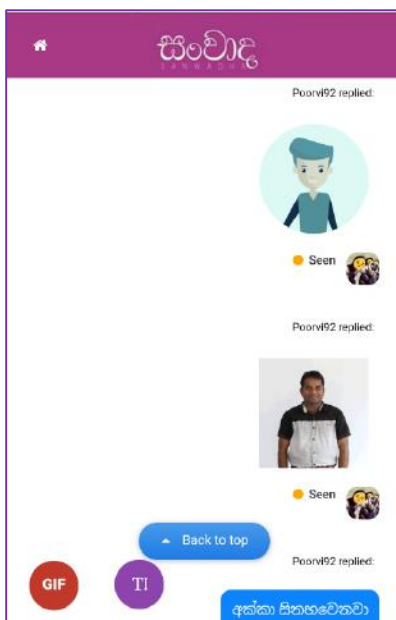


Figure 3.2.1.7 converted Sinhala text that sent

3.2.2 Learning Sign Language Game

The use of this game was to learn Sinhala deaf sign languages. Some people really like to learn Sinhala sign languages because of they interact with deaf people in their day-to-day lives.

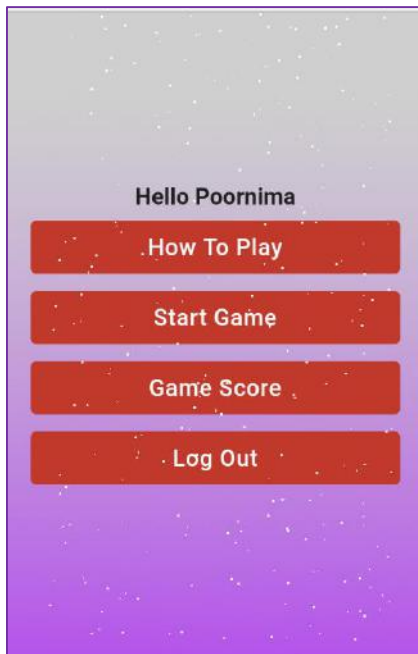


Figure 3.2.2.1 Main interface of game

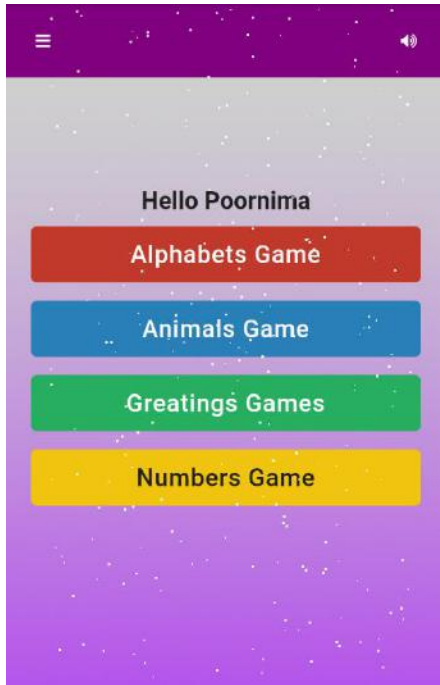


Figure 3.2.2.2 categories of game



Figure 3.2.2.3 Alphabets game

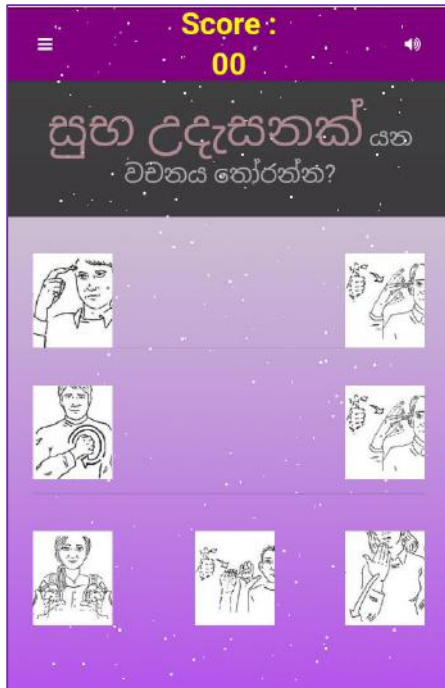


Figure 3.2.2.4 Greetings game



Figure 3.2.2.5 Numbers game

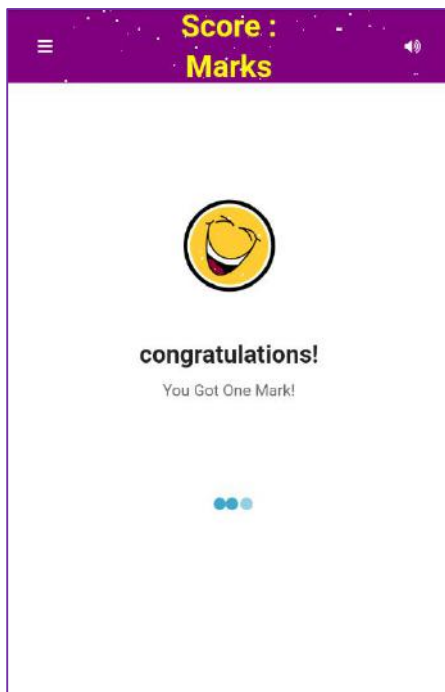


Figure 3.2.2.6. Add marks



Figure 3.2.2.7 Zero marks

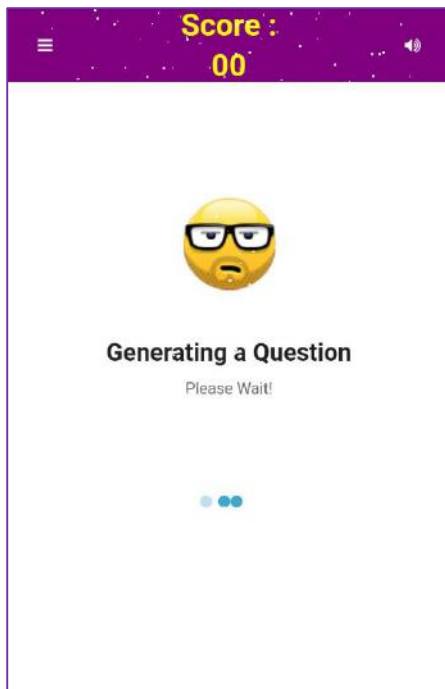


Figure 3.2.2.8 Game loading interface

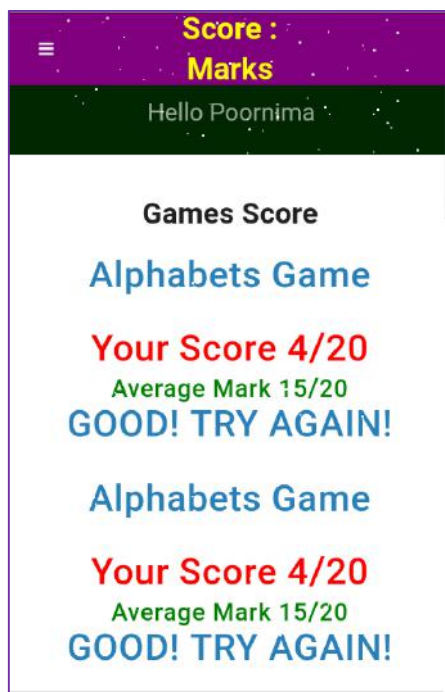


Figure 3.2.2.9 Game score interface

3.3 Discussion

The results of the 2D model creation and sign convert in to test process of the “Sanwadha” prove to be satisfactory on an average. A clearer analysis is depicted in Table 3.1 which shows the review of the function components

Table 3.1 Outcome Satisfaction of the function: Software Components

Name of Outcome	Review
Game loading	HIGH
Game accuracy	MEDIUM
View Text in Text Mode	HIGH
View Text in Sign Language Mode	MEDIUM
Text Narration	MEDIUM
Cancel message sending	MEDIUM
Delete a message	HIGH
Share a message	HIGH
Automatically update user requests	HIGH

The satisfaction of the non-functional requirements of the function are depicted in the following table, the review based on a scale of 05 - Poor outcome having a value of 01 and a very good outcome (exceeding expectations) having a value of 05.

- 100% accuracy in timely delivery of chat messages

The functions to its fullest potential - in terms of speed and accuracy of the Server to deliver a chat message to the client. The timeliness beyond this point will not be a responsibility of the “Sanwadha”.

4. CONCLUSION

In conclusion, let us look at some few points with which the course of future could be changed for the betterment of all.

The main research area of the system is to design a network transfer method which uses texts for data transfer in local and wide area network systems. Today, when some person wants to send a spoken message to a receiver then the two people must first connect through a call and then send the vocal message. But the idea here is to first convert the sending message to text and then send it across the network as a text message and then narrates it at the receiver's end. The main advantage here is that users do not need to have special software to make a call or to register at a telephone company or pay money to make that call. Instead the user needs only to have an email account and the chat ability between the person whom he wants to communicate and an internet connection. If the person we want to communicate is online using an email account (only @gmail.com) for the time being and have the internet connection then the two people can communicate with each other either speaking words or typing text.

If this could be improved in the future then we can eliminate forever the need to have a telephone provider or ever use a telephone. Thus, people will only need a small i-pod sort of device to login to their email accounts and an internet service provider to get the internet access.

This way the huge amount of money people spends daily to make their calls can be reduced only to the internet charges and still make their daily calls. Since only text is sent across the network, network traffic could also be reduced.

But with all these advantages it comes with one disadvantage. It is that the two people communicate can never hear each other's own natural voice. As far as we see it, it is just a reasonable tradeoff according to the current cost factor when making actual calls.

With a thorough research and a development effort, we believe that we could forever change the way we live, work and communicate.

REFERENCES

- [1] Census of Population and Housing, population tables, Department of Census and Statistics, Sri Lanka, 2012. pp 2-13
- [2] Anna Middleton, Working with Deaf People – a Handbook for Healthcare Professionals, CAMBRIDGE UNIVERSITY PRESS, 2010. pp 27-34
- [3] M. Marschark, H. G. Lang and J. A. Albertini, Educating Deaf Students, Oxford University Press, 2002. pp 2-9
- [4] R. S. NICKERSON, D. N. KALIKOW, and K. N. STEVENS, A computer-based system of speech-training aids for the deaf, National Computer Conference, 1974. pp 2-4
- [5] J. Siby, H. Kader and J. Jose, “Hand Gesture Recognition”, (IJITR) International Journal of Innovative Technology and Research, Volume No.3, Issue No.2, February – March 2015. pp 7-11
- [6] N. A. Nafis and Md. S. Hossain, “Speech to Text Conversion in Real-time” International Journal of Innovation and Scientific Research ISSN 2351-8014 Vol. 17 No. 2 Aug. 2015, pp. 271-277. [Online serial]. Available: <http://www.issr-journals.org/links/papers.php?journal=ijisr&application=pdf&article=IJISR-15-139-02> [Accessed: Feb. 14, 2017]
- [7] D. Metaxas, B. Liu, F. Yang, P. Yang, N. Michael and C. Neidle, “Recognition of Non-manual Markers in American Sign Language (ASL) Using Non-Parametric Adaptive 2D-3D Face Tracking” Available: <http://www.thesai.org/Publications/ViewPaper?Volume=3&Issue=1&Code=IJACSA&SerialNo=1> [Accessed: March 5, 2017]
- [8] Spiritually Enlightened Deaf Community through Pure Buddhism, "Ahanna (listen)", 2016 Ahanna.Org. Available: <http://www.ahanna.org/en/about/> [Accessed: March 7, 2017]
- [9] University of Moratuwa, “KATHANA” [Online] Available: <http://lms.uom.lk/sf/shantha/Project-web-sites/2009-10/PI-33-kathana/overview.html> [Accessed: March 9, 2017]
- [10] Wikipedia, “Semantic Analysis” [Online] Available: [https://en.wikipedia.org/wiki/Semantic_analysis_\(linguistics\)](https://en.wikipedia.org/wiki/Semantic_analysis_(linguistics)) [Accessed: March 16, 2017]
- [11] Command Line Fanatic, “How LZW (GIF) Compression Works” [Online]. Available: <http://commandlinefanatic.com/cgi-bin/showarticle.cgi?article=art010> [Accessed: March 10, 2017]

- [12] Alex Cheparev, "Easy Hand Modeling Tutorial in Maya", Nov 9, 2015.[Online]. Available: <https://www.youtube.com/watch?v=vRchh9ye7TY> [Accessed: March 15,2017]
- [13] "Speech Recognition System by Iqbal" [Online]. Available: <http://www.slideshare.net/asifmai/speech-recognition-by-iqbal-2560194> [Accessed: March 10,2017]
- [14] Sneha Latha at the Dept. of Computer Science, Jamia Millia Islamia, New Delhi, "Challenges in Automatic Speech Recognition". [Online] Available: <http://developeriq.in/articles/2009/jun/27/challenges-in-automatic-speech-recognition/> [Accessed March 13,2017]
- [15] wikiHow, "How to Communicate with Deaf People", [Online] Available: <http://www.wikihow.com/Communicate-With-Deaf-People> [Accessed March 14,2017]
- [16] ONLINE-CONVERT, "Convert files to GIF", [Online] Available: <http://image.online-convert.com/convert-to-gif> [Accessed March 14,2017]
- [17]"Deaf hearing chat" [Online].Available: <https://play.google.com/store/apps/details?id=g.example.android.BluetoothChat&hl=en> [Accessed: March 5, 2017]
- [18] "Deaf Chat" [Online].Available: <http://deafunity.org/article-interview/top-10-apps-for-deaf-people/> [Accessed: March 5, 2017]

Glossary

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

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

APPENDICES

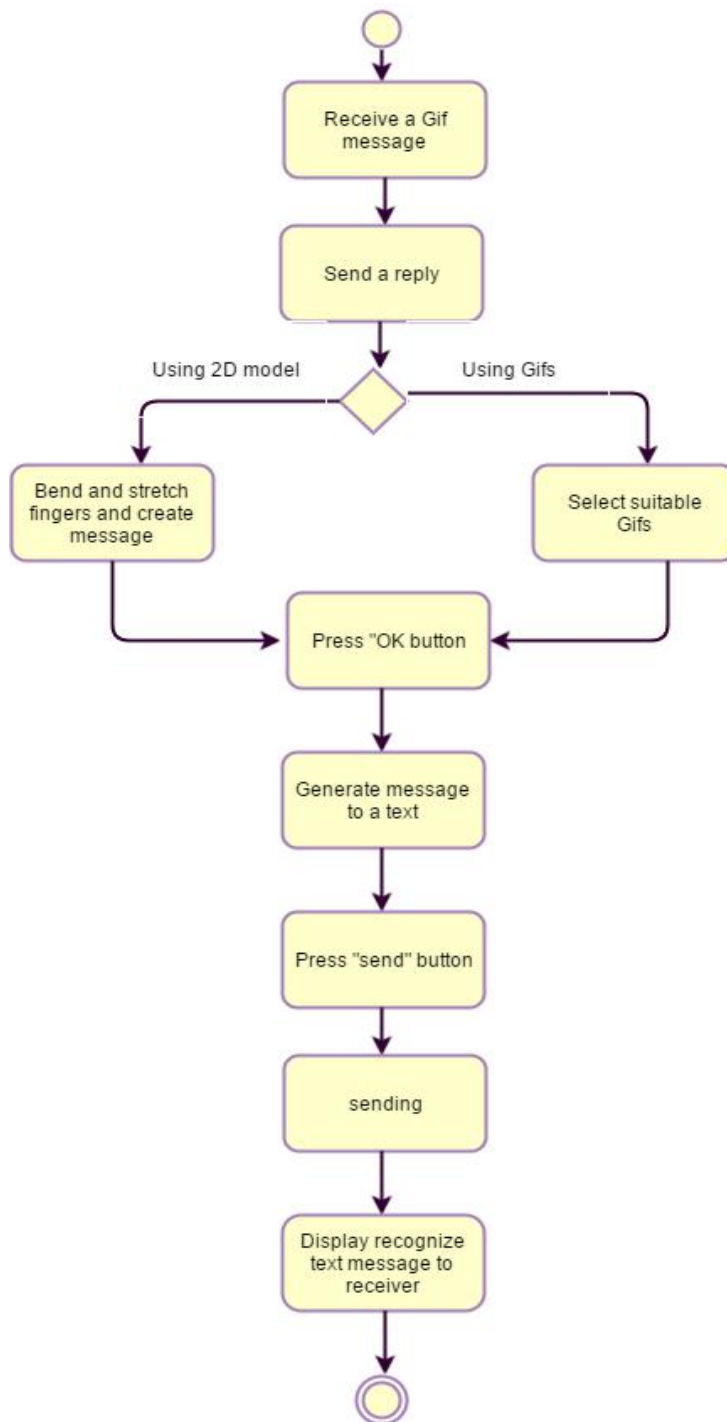


Figure 1: Activity diagram for convert sign to text

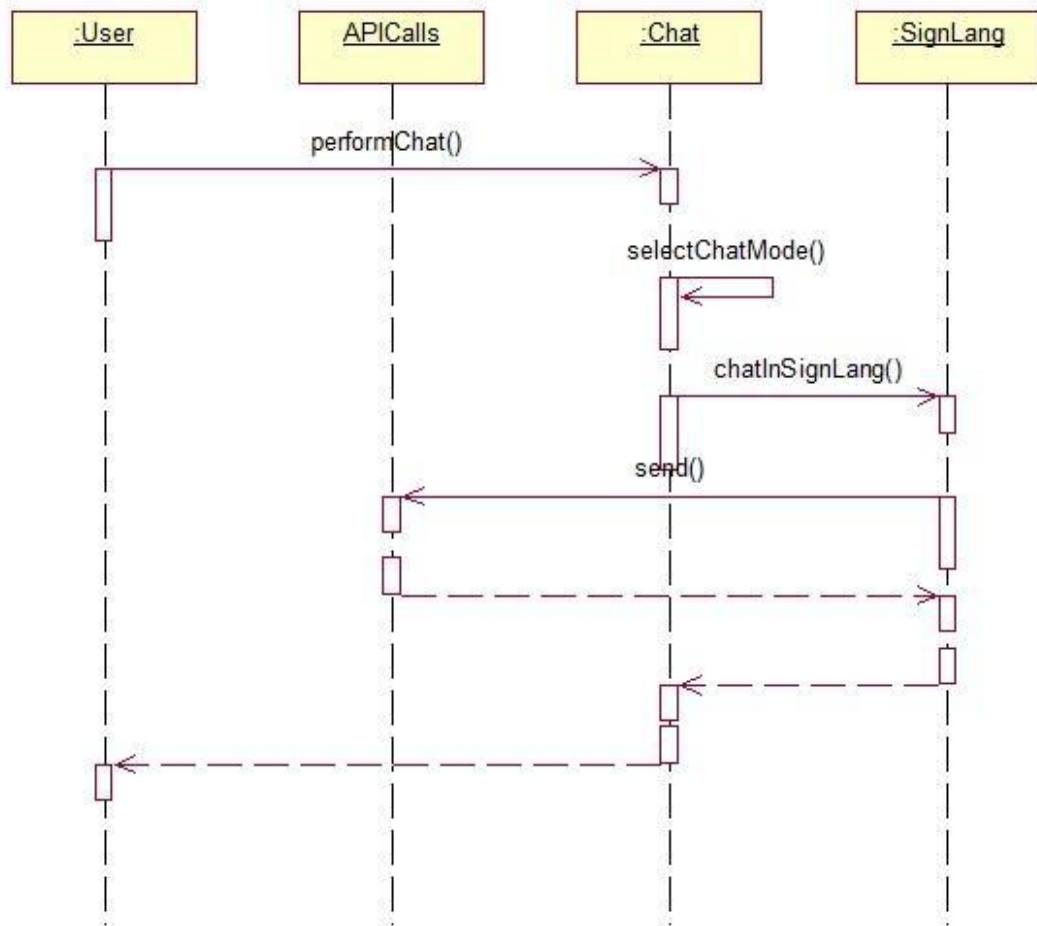


Figure 2: Perform chat using sign language mode