Project Report Entitled

English to Indian Sign Language Translation

Submitted in partial fulfilment of the requirements for the award of the degree of

Bachelor of Technology (B. Tech.)

In

Information Technology Engineering

SUBMITTED BY

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UNDER THE GUIDANCE OF

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(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

AY 2021-22

Certificate

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Project Report Entitled

English to Indian Sign Language Translation

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Tanvi Shroff

Vedanti Donkar

Rutuja Jadhav

Sayali Oak

ABSTRACT

Sign language is used by the deaf and dumb communities to communicate. Sign language is a visual language that includes facial expressions but does not use words. It is a form of visual communication. In sign language, the posture of the hands, the movement of the fingers, and the expressions on the face are all important. The vocabulary of sign languages is extremely limited. It's difficult to decipher the grammar. Conversely, spoken languages all across the world have a large vocabulary. It is difficult for signers to understand a spoken language. The preliminary goal of this project was to convert English speech or text to Indian Sign Language (ISL). We attempted to implement the system using HamNoSys and SiGML. This system was especially difficult because there was no legitimate Hamburg Notation System (HamNoSys) dataset available. Another system that we put in place converted English to Graphics Interchange Format (GIF).

Keywords: Generative Adversarial Network (GAN), Hamburg Notation System (HamNoSys), Indian Sign Language (ISL), Language Translation, Sign Language (SL), Signing Gesture Markup Language (SiGML).

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ABBREVIATIONS

GAN	Generative Adversarial Network
GIF	Graphics Interchange Format
GUI	Graphical User Interface
HamNoSys	Hamburg Notation System
ISL	Indian Sign Language
JASigning	Java Avatar Signing
LOTS	Hand location(L), Hand Orientation (O) in the 3D space, Hand Trajectory movement (T), Hand shapes (S)
POS	Parts of Speech
SiGML	Signing Gesture Markup Language
SL	Sign Language

CHAPTER 1. INTRODUCTION

1.1 BACKGROUND

Equal opportunity is a fundamental right that every human being has. Every citizen, including the world's deaf community, deserves access to a full range of knowledge. For those who are deaf or hard of hearing all throughout the world, gestures have long been a means of communication. In order for it to work, there needs to be a means for hearing and deaf individuals to communicate directly. In this instance, a human translator can assist, but this will compromise the privacy of the communication, such as between a lawyer and a client or a doctor and a patient. It is now necessary to automate this communication in the twenty-first century so that deaf individuals are not dependent on human translators. There is a pressing need to create a system that connects spoken and sign languages. It's difficult to translate spoken languages into sign languages.

According to a World Health Organization report, India has about 6 crore deaf or partially deaf people. That is approximately 4% of our population or the population of the country of France. The country only has about 700 schools which teach sign language. In India, there are approximately 250 certified sign language interpreters. Only in 2017 did the Rights of Persons with Disabilities (RPwD) Act 2016 come into effect, recognising sign language as a form of communication that is particularly effective for communicating with people who are deaf or hard of hearing. The ISL has progressed from 4000 words to 10,000 words, with the goal of broader adoption in mind. Non-recognition of a standard language obstructs education and contributes to a teacher shortage, as well as causing mental health concerns among deaf children who are unable to interact with their parents.

1.2 FEATURES OF ISL

The features of ISL that make it different from other sign languages are:

1) Number Signs: You must hold up the hand/hands with proper hand gestures and forms to make numbers from zero to nine. The number of outstretched fingers represents the numbers one, two, three, four, and five. Special hand forms are employed for zero and the numbers six to nine, which are derived from written numbers.

2) Alphabet signs: Alphabet signs can be formed in the same way, i.e. by forming appropriate hand shapes. Some alphabets require only one hand, while others require both. There are certain alphabets that demand active motions in order to produce the letters.

3) ISL does not use any articles.

4) ISL does not have gerunds.

5) ISL has its own grammar which is different from English grammar.

The figure below shows the classification of ISL. [1]

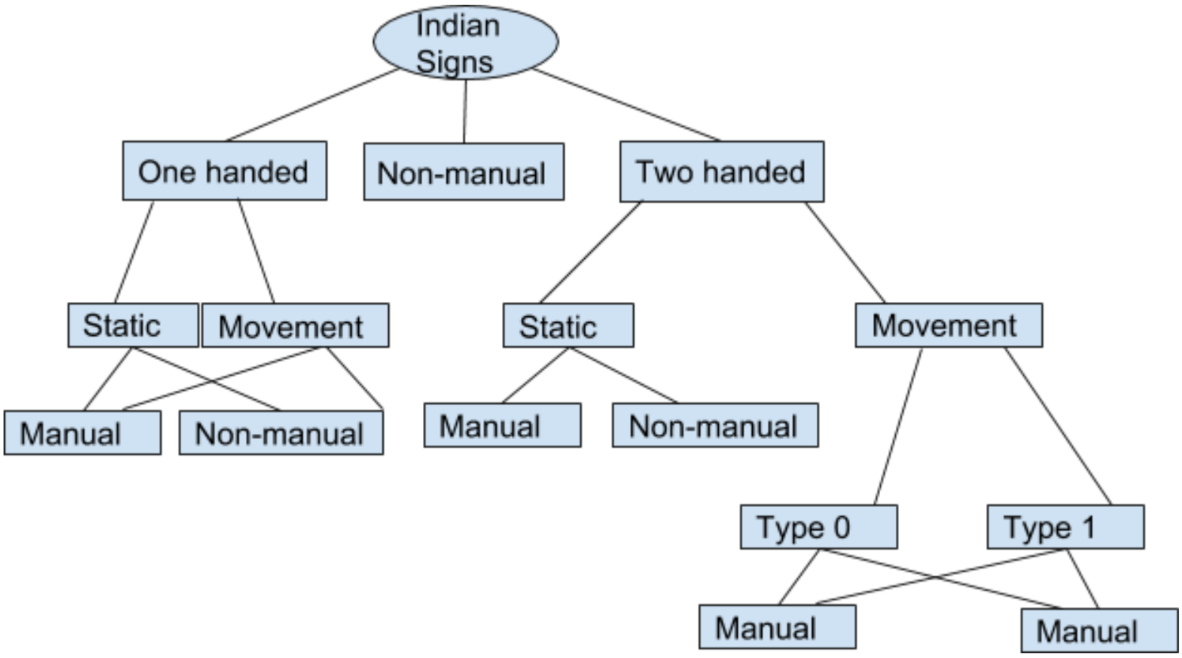

Figure 1: Classification of Indian Sign Language

CHAPTER 2. LITERATURE SURVEY

Researchers have been researching SL generating technologies for the past couple of decades. The systems used can be divided into categories based on the different animation systems as follows:

2.1 GENERATIVE ADVERSARIAL NETWORK

[2] uses video representation of words according to the ISL dictionary as the dataset. The videos were cleaned which doubled the size of the dataset. The frames for each video were further extracted and their skeletal poses were obtained using OpenPose which were concatenated according to the order of the frames. This is used to train the GAN. The input English text goes through the CoreNLP parser which outputs phrase structure as indicated by the ISL language rules. The sentence is organized in a Subject-Object-Verb design subsequent to applying the ISL rules. The stop words are taken out and assuming a word is absent in the word reference then its equivalent is utilized. The words are further lemmatized using the Textblob NLP technique. To generate skeletal poses, a total of 124 joint directions are removed from the recordings utilizing OpenPose. Here, Pix2Pix GAN is used which without any noise learns the mapping of the input image with the output image. U-Net is utilized as the generator and Patch GAN is utilized as the discriminator. The Patch GAN, instead of predicting if the whole image is real or fake, predicts if a patch of the picture is genuine or counterfeit by outputting a feature map. After the text is converted into gloss, frames for the corresponding glosses are generated. This is fed as an input to the generator which outputs a realistic video. Here, OpenPose sometimes failed to detect the finger joints correctly so the output video was distorted.

2.2 HamNoSys

The system proposed in [3] supports both English and Hindi texts. Numbers, words, and sentences can all be used as input. There are two options for Hindi input. The user can either use transliteration or directly enter Hindi words or sentences into the interface. The next step is to parse the input using UDPipe (a natural language processing toolkit). As root words, labels, and tense data, the handled results are coordinated into an information structure. This data structure is used to process words according to ISL grammar rules for tense, aspect, and modality. Subject-Object-Verb is the order of processing. A data set of the ISL Dictionary is grown physically through the administrator board by the SL specialists. The framework extricates the HamNoSys from the information base for each root word in the ISL sentence. Following that, the framework produces SiGML documents from its HamNoSys. Each SiGML document represents a word's sign. For further processing, the SiGML document generated by HamNoSys is utilized as information. For the purpose of generating animation frames, the animation server uses it. Moreover, these casings are utilized to characterize a symbol's posture. A 3D avatar animation is used to play the sign for the user through these frames. The advantage here is that this system uses HamNoSys in real-time to render gestures rather than pre-recorded videos, allowing for greater symbol generation flexibility. The dictionary, on the other hand, is made physically, which is a tedious cycle. Furthermore, the system searches for the HamNoSys of each word, which is a time-consuming process.

This system was developed for the Indian Railway reservation counter [4]. This system, named INGIT meaning “signed” in Sanskrit [4], utilizes a conventional methodology that creates the semantic construction straightforwardly where conceivable and falls back to a compositional model for the rest. Input Parser, Ellipsis Resolution Module, ISL Generator (counting ISL vocabulary with HamNoSys phonetic portrayals) are the framework's fundamental modules. INGIT accepts interpreted communication in language strings that can be labeled for sound examples as info. It only supports one of these tags, the "?" tag. For inputs that match a unit development (or expressions in creation that match such a development), the immediate semantics map for the information will be produced promptly, or then again if a sub-structure, it will be passed to the proper design. If the semantic structure is swamped, it is passed to the ISL generator; otherwise, it is passed to the ellipsis resolution module, which fills in any missing parameters. Once the ISL gloss is ready, it is given as input to the ISL generator to produce signs. This system uses the HamNoSys Notation. The corpus for validating this system was small. It constituted 230 utterances (many repeated) and a vocabulary of only 90 words.

2.3 JASigning

This paper specifically focuses on the representation of SL [5]. This system is a Java Avatar Signing (JASigning) synthetic SL animation system. The avatar software in this system is implemented in Java. SiGML, an XML application closely based on the HamNoSys, is the input for a JASigning application [6]. The signing avatar in this system is formulated on conventional 3D computer animation methods. These techniques are supplementary data files included in the system that define the avatar qualities that are required to increase the system's SL performance. This system uses AnimGen software which is used to generate a sequence of animation frames. JASigning System is particularly like SiGMLSigning System as far as its capacities, however, the vital contrast between SiGMLSigning and JASigning is that the SiGML Signing System could run uniquely on Windows PC frameworks, while JASigning System can be conveyed on numerous platforms.

2.4 LOTS NOTATION

The proposed system here consists of three parts [7]. 1.) an interface where the user can enter English text, 2.) a language processing system that translates English text to ISL format as well as a virtual avatar that serves as a translator at the interface. To translate the input English text into ISL various steps are followed such as Part of Speech tagging followed by an Eliminator which removes the unwanted tokens from the input text followed by Stemming which converts the verb in the input text into its corresponding root form. Figure 3 below shows Part of Speech tagging and Stemming. Here the sentence “I am buying vegetables” is broken down into parts of speech where “I” is the pronoun, “am” is the auxiliary verb, “buying” is a verb and “vegetables" is a noun. Then in the stemming part, the words are shortened to convert them into the root form. The word “buying” is converted into “buy” and “vegetables” is converted to “vegetable”. Unwanted words like “am” are removed and the words that you get after this are “I”, “buy”, “vegetable”.

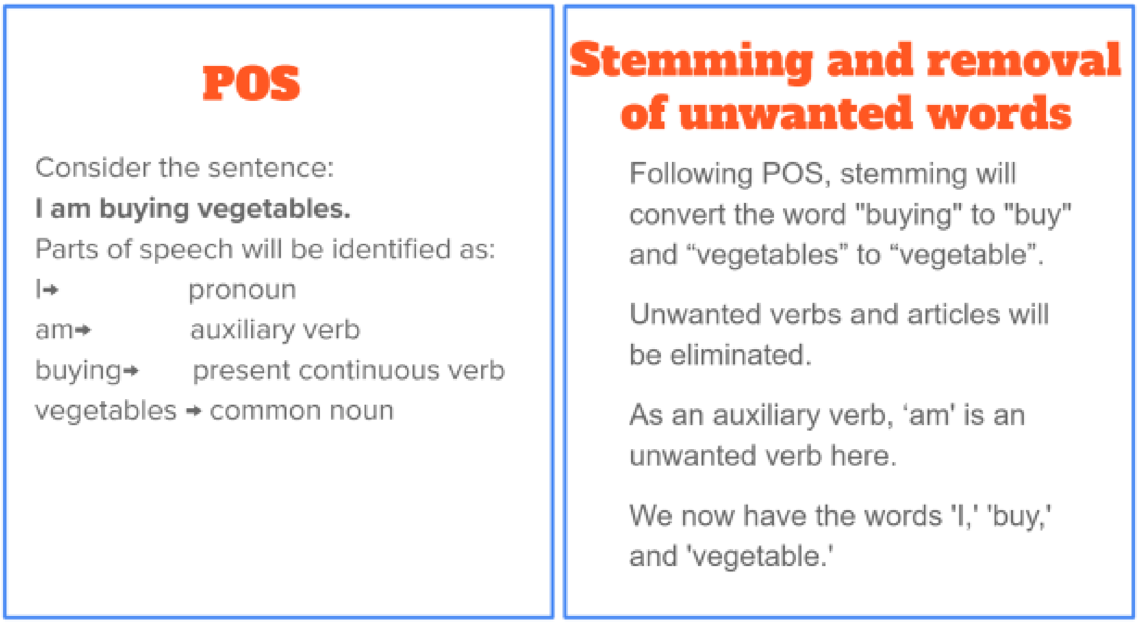

Figure 2: Stemming and POS tagging

Lastly, Phrase Reordering is done where the sentence structure is changed based on the ISL grammar regulations. ISL essentially imitates a Subject-Object-Verb Agreement. Once the input text is translated into ISL it will be queried in the database which has the notation format for every word. This is LOTS Notation which represents characteristics such as Hand location(L), Hand Orientation (O) in the 3D space, Hand Trajectory movement (T), Hand shapes (S) and non-manual elements. The Loader Module queues the sequence of notations based on the order of occurrence. The Animator produces the animation of the input sentence. In this system, the speed of the animation is increased as the inter sign transition gesture is inserted to reduce gesture jitters.

CHAPTER 3. SYSTEM ARCHITECTURE

3.1 SYSTEM OVERVIEW

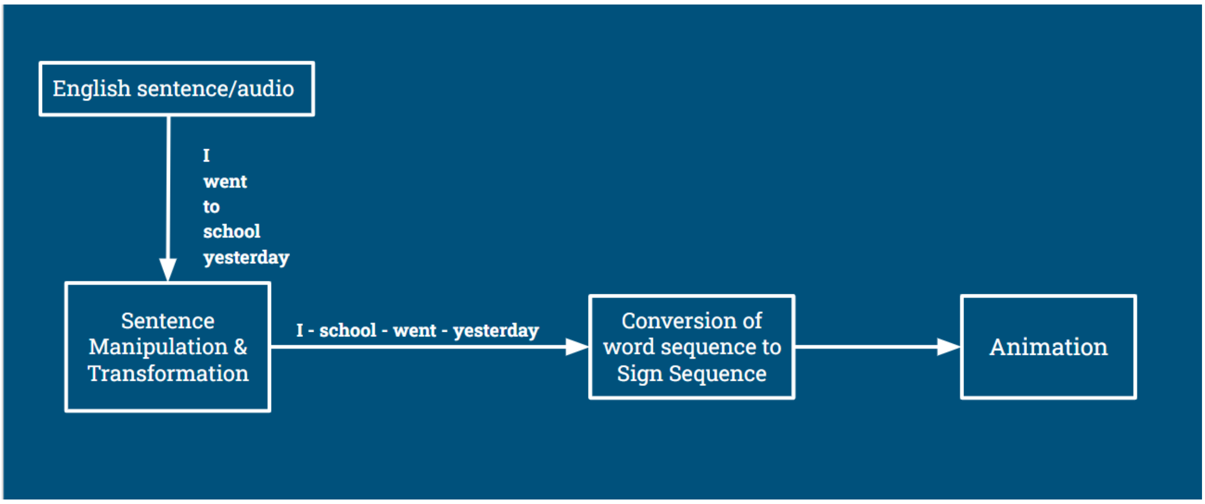

Figure 3: System Overview

The input is taken in the form of English text or audio. This text then undergoes sentence manipulation and transformation. This is done because the rules of English grammar and ISL are not the same. This step transforms the English sentence into an ISL sentence. This ISL sentence is then converted to a sign sequence from a word sequence. This sign sequence is then converted into an animation. The animated avatar signs the input text.

CHAPTER 4. IMPLEMENTATION

4.1 WORKING

The second approach we have used is implemented using HamNoSys and SiGML. The system diagram is shown in the figure below in detail [8].

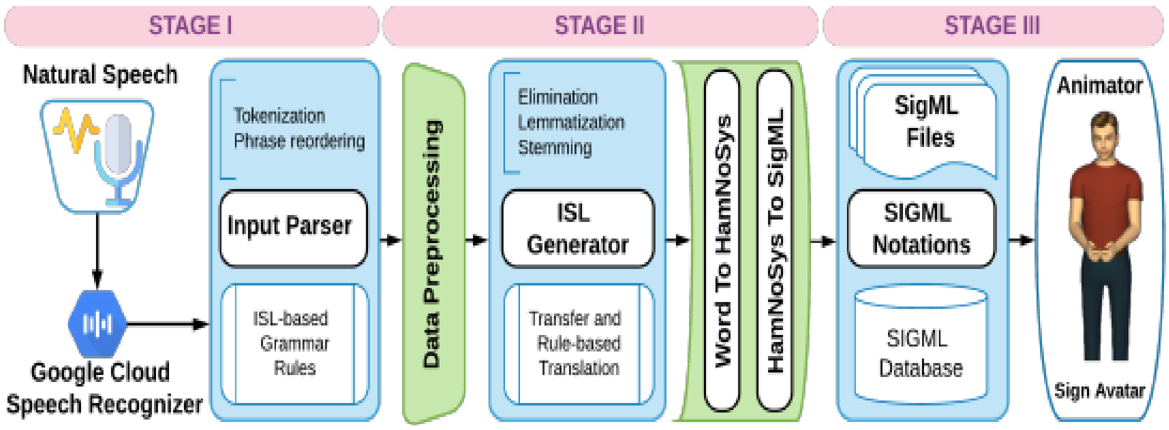

Figure 4: Detailed system diagram

In this approach, input is taken in the form of English text or audio. The audio is further converted to text for processing. Grammar and spelling check is performed on the English text. If the sentence structure is incorrect or if there is a spelling mistake, the GUI displays the correct sentence and prompts the user to enter a grammatically correct English sentence.

Tokenization is performed on the grammatically correct input text. In tokenization, the text is transformed into small units called tokens. These tokens can be words, characters, numbers, etc. The text undergoes parsing after this. First, a parser is initialized by connecting to the CoreNLP server. Parsing is the process of evaluating a text's constituent words to determine its syntactic structure based on the fundamental grammar (of the language). So here grammar of the English language is considered for parsing. The output of parsing is in the form of a parse tree. The next step is phrase reordering. Phrase reordering is required as ISL grammar is different from English grammar. English grammar follows the Subject-Verb-Object agreement while ISL grammar follows the Subject-Object-Verb agreement.

Once the sentence is converted into ISL grammar format, elimination of stop words is performed. Commonly used words, for example, in English ‘the’, ‘and’, etc are some of the stopwords. The words that are not filtered undergo lemmatization. Lemmatization is the process of grouping together the inflected forms of a word. For example, words like ‘plays’, ‘played’ and ‘playing’ and grouped together and transformed into their root word ‘play’. This gives the final sentence in ISL grammar after the elimination of stopwords and lemmatization.

This sentence is then converted into its respective Hamburg Notation System (HamNoSys) form. HamNoSys is basically the symbols used to represent the corresponding words. The figure below shows the HamNoSys of the word ‘deaf’.

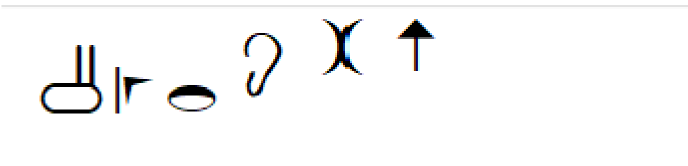

Figure 5: HamNoSys of ‘deaf’

The HamNoSys notation, that is each HamNoSys symbol, has a respective HamNoSys token. These tokens are in textual formats. The HamNoSys symbols are converted into their respective HamNoSys tokens. The figure below shows the HamNoSys tokens of the word ‘deaf’.

```
hamfinger23,hamextfingerui,
hampalmu,hamear,
hamtouch,hammoveu
```

Figure 6: HamNoSys tokens of ‘deaf’

These HamNoSys tokens are then used to create the Signing Gesture Markup Language (SiGML) files. SiGML files are based on the XML format. The figure below shows the SiGML file of the word ‘deaf’.

```
<sigml>
        <hns_sign gloss = "deaf">
        <hamnosys_manual>
                <hamfinger23/>
                <hamextfingerui/>
                <hampalmu/>
                <hamear/>
                <hamtouch/>
                <hammoveu/>
        </hamnosys_manual>
        </hns_sign>
</sigml>
```

Figure 7: SiGML of ‘deaf’

The database consists of the HamNoSys tokens of the respective words. Using these tokens, the SiGML files are created as and when required and then stored in the SiGML database. When a sentence is entered into the input section of the GUI, the SiGML files that are not present in the SiGML database are created and then used. If the word does not exist in the dictionary then it is split into characters. Each character is signed one by one. For example, if the input sentence has a proper noun - like someone's name - then the separate characters are signed. If the sentence contains any numeric data - for example, a phone number - then the digits of the number are separated. The digits are signed separately, one by one.

For a sentence, the SiGMl files of the respective words, characters and digits (if any) are concatenated and sent to the SiGML player through a socket. The SiGML player listens to port number 8052. The avatar in the SiGML player then signs the input sentence.

4.2 GUI

The GUI of the system has a white box for taking input from the user in the form of English text. There is also an option to take audio input. A help button is provided to help the user interact with the system's interface properly.

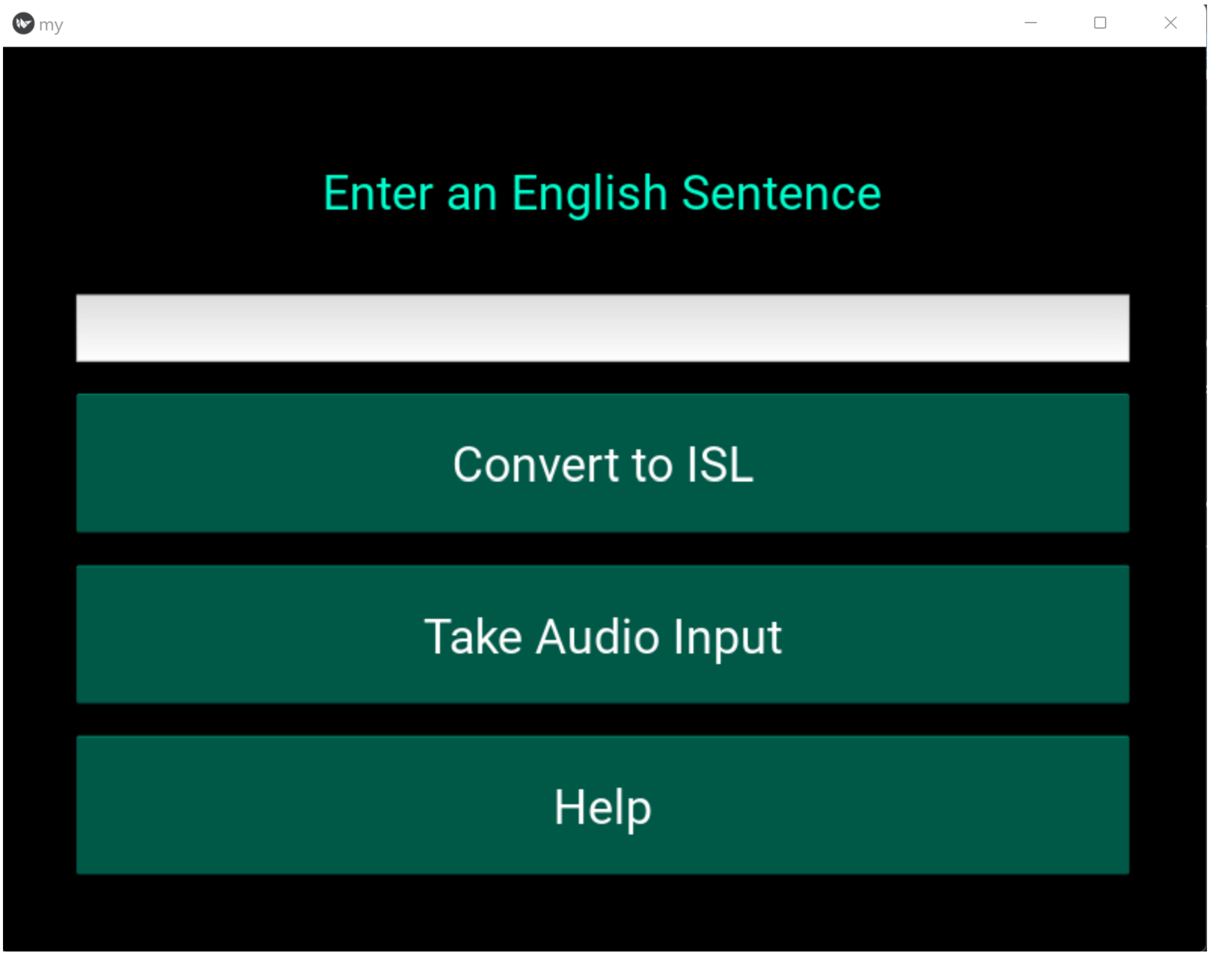

Figure 8: GUI of the system

4.3 TECHNOLOGY USED

1. SpeechRecognition: Library for taking the input in the form of audio.

2. HamNoSys: The HamNoSys is a transcription system for all sign languages, not only ASL, that has a direct relationship between symbols and gesture features such as hand location, form, and movement. The HamNoSys isn't Unicode-encoded.

3. SiGML: SiGML is an XML programme that allows sign language movements to be transcribed. SiGML is based on HamNoSys, and one variant of SiGML is effectively an encoding of HamNoSys manual features with non-manual aspects represented.

4. The Natural Language Toolkit: NLTK is a library which contains different NLP algorithms which can be used.

5. CoreNLP parser: Users can use CoreNLP to extract linguistic annotations from text, such as token and sentence borders, parts of speech, dependency and constituency parses, sentiment, and so on. The CoreNLP pipeline takes raw text, runs it through a sequence of NLP annotators, and outputs a set of annotations.

6. Kivy: Kivy is a Python framework for creating a GUI. It runs on Android, iOS, Linux, macOS, and Windows.

7. language_tool_python: LanguageTool is wrapped with a Python wrapper. LanguageTool is an open-source grammar tool that also serves as an OpenOffice spellchecker. This library allows you to identify grammatical and spelling issues using either a Python script or a command-line interface.

CHAPTER 5. RESULTS

5.1 INPUT IS A CORRECT SENTENCE

Consider the input sentence - ‘I am sorry about yesterday’.
After the removal of stopwords, the sentence becomes - ‘I sorry yesterday’.
This sentence is changed to ISL grammar and it becomes - ‘I yesterday sorry’.

The first step was a grammar check. Time required to run grammar check = 16.305157899856567-time units.

The second step was parsing. Time required to parse = 10.129821062088013-time units.

The third step was to generate SiGML files. Time required to generate SiGML files = 0.0019948482513427734-time units.

The fourth step was sending the concatenated SiGML files to the SiGML player using a socket. Time required to send SiGML files = 0.013965129852294922-time units.

The figures below show the words ‘I’, ‘sorry’ and ‘yesterday’ that are signed by the avatar.

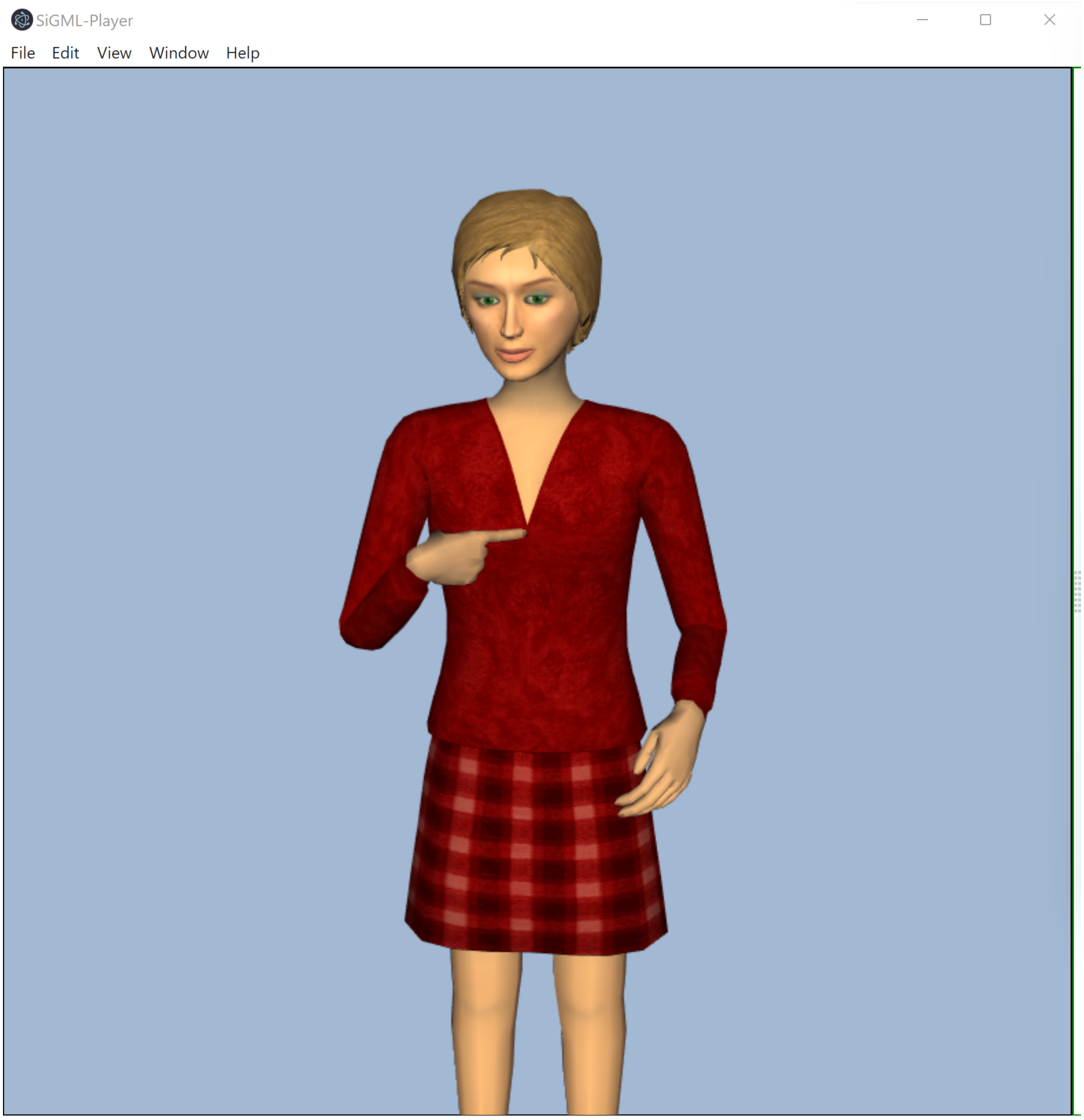

Figure 9: Avatar signing ‘I’

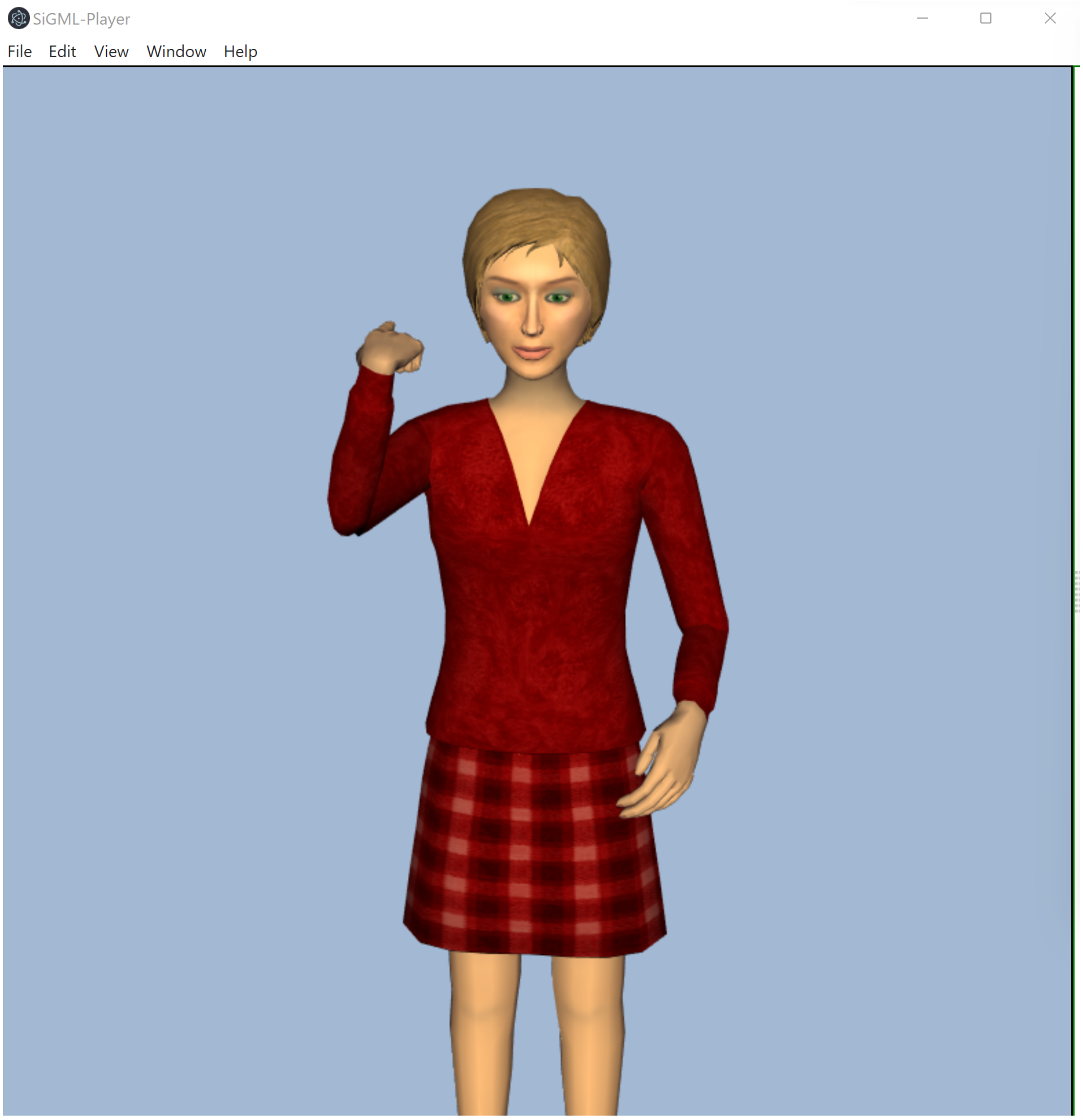

Figure 10: Avatar signing ‘yesterday’

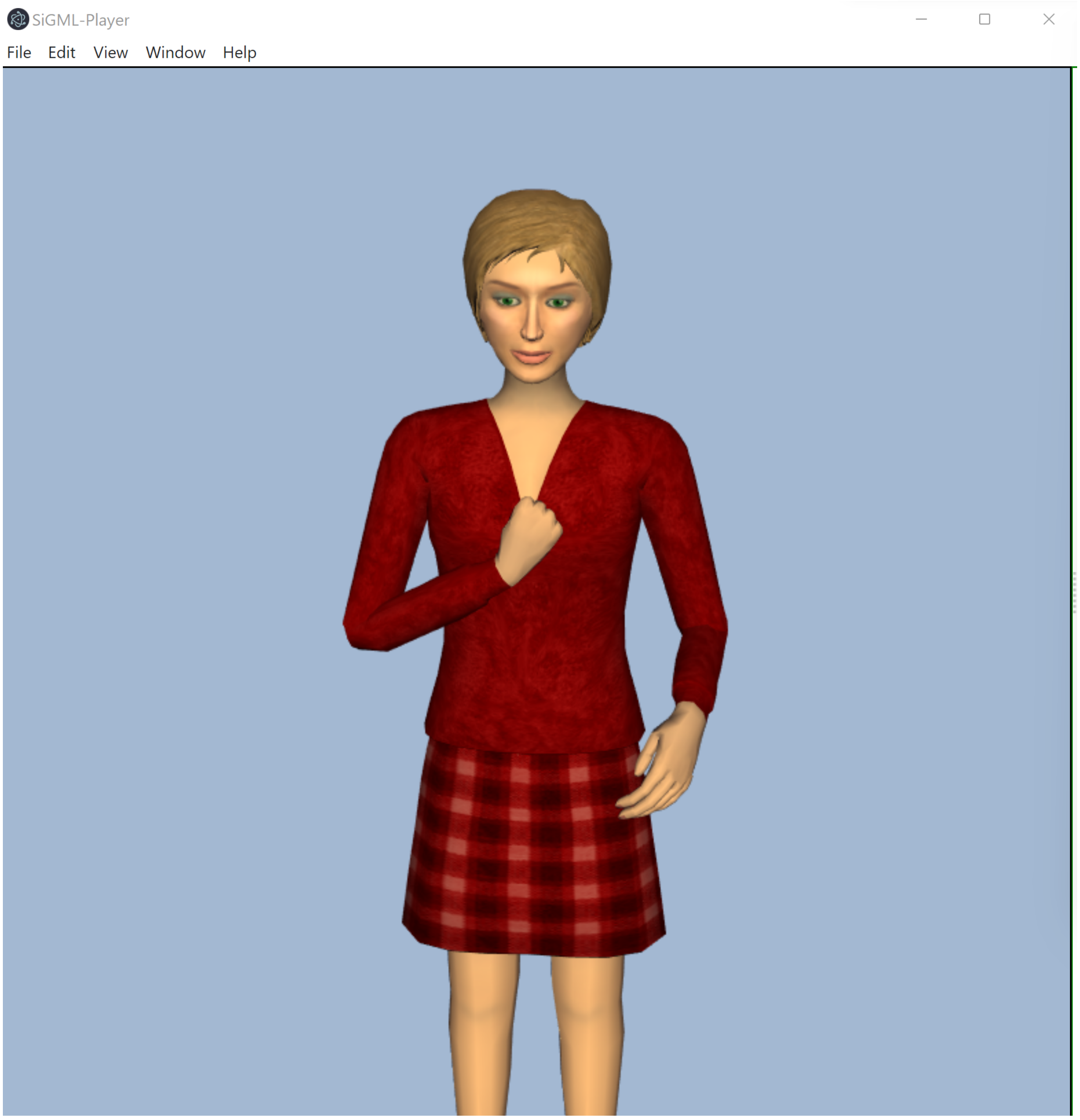

Figure 11: Avatar signing ‘sorry’

5.2 INPUT IS AN INCORRECT SENTENCE

When a grammatically incorrect sentence is entered in the input box, the GUI displays the correct sentence and prompts the user to enter a grammatically correct English sentence. The figures below show the input (grammatically incorrect sentence) and the output.

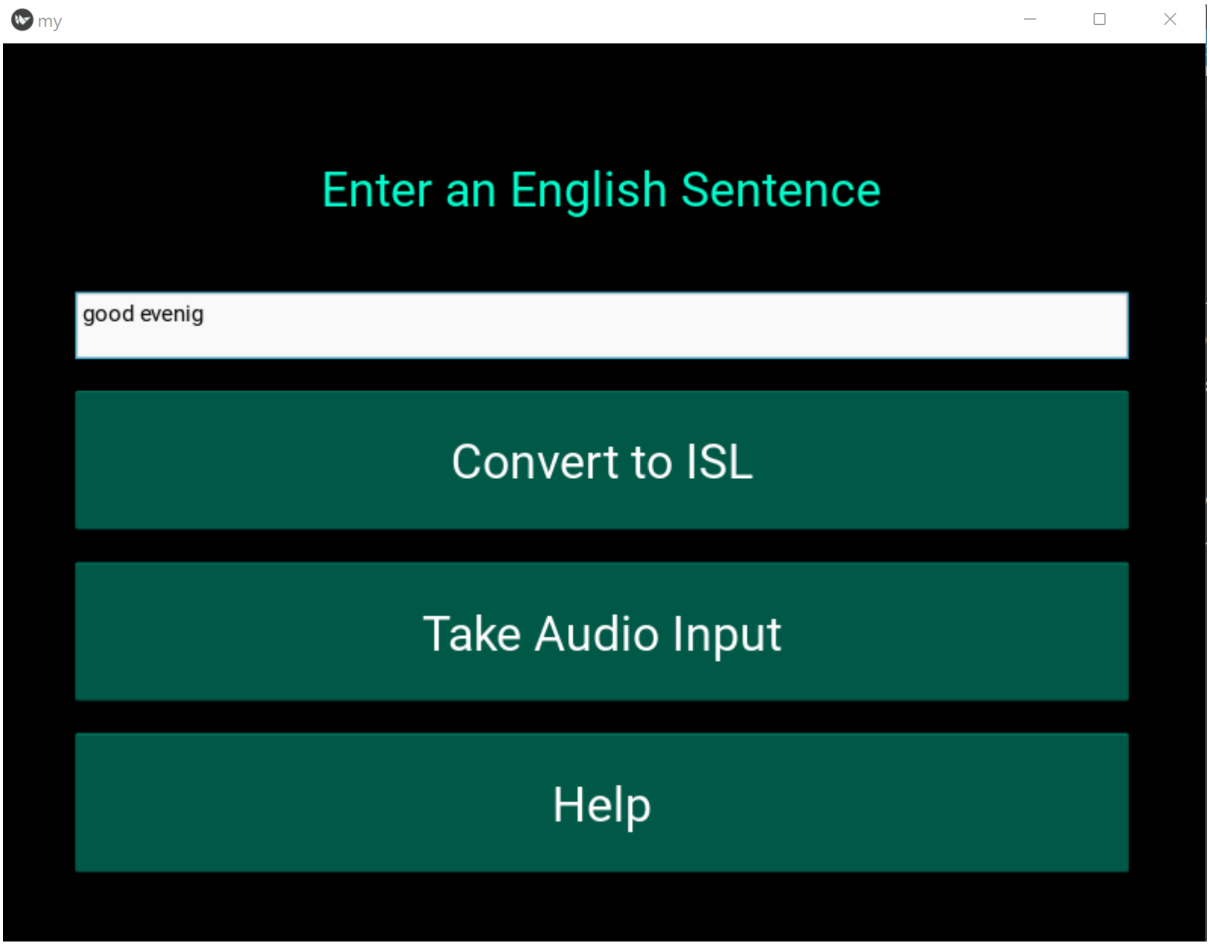

Figure 12: Incorrect sentence is entered.

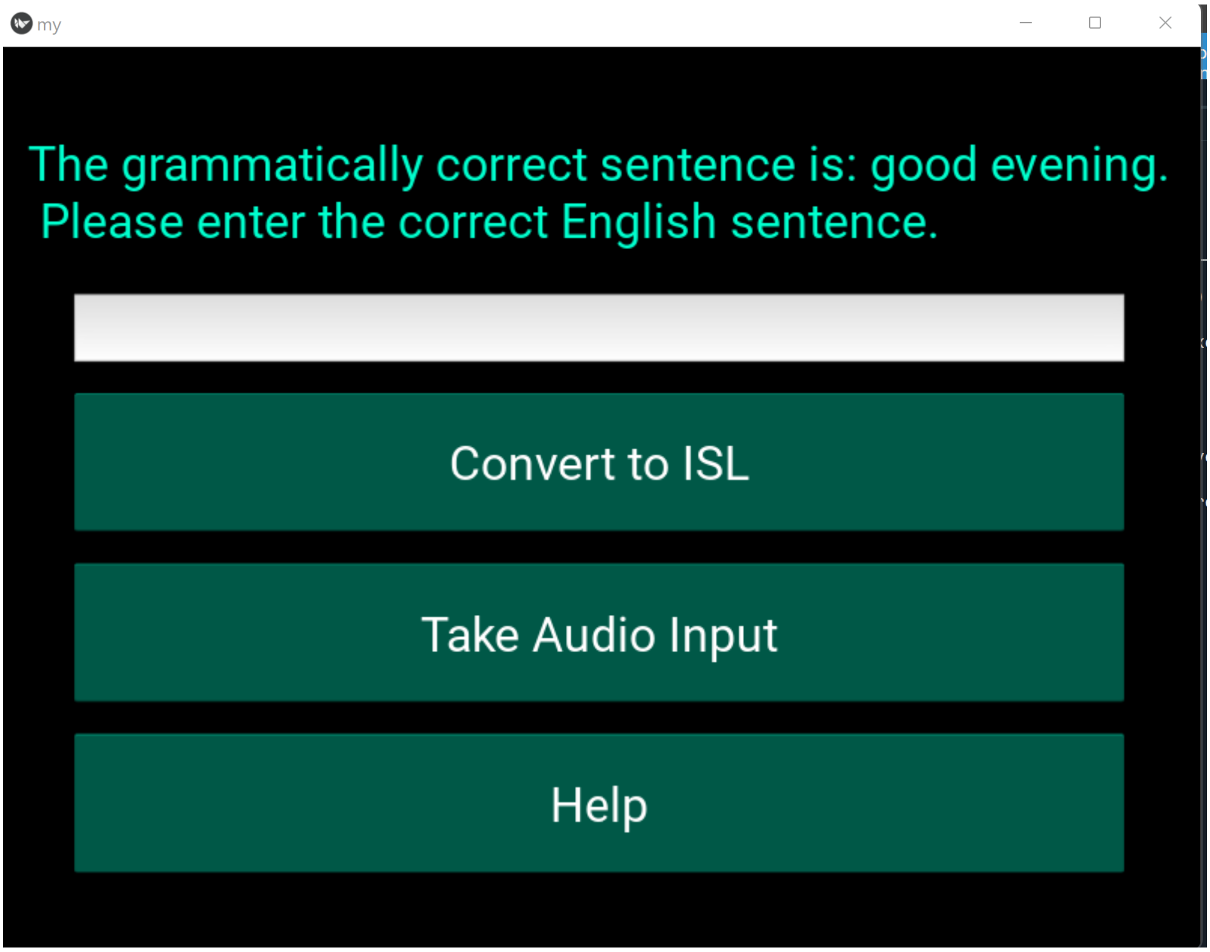

Figure 13: Grammatically correct sentence is displayed.

CHAPTER 6. SOCIAL IMPACT

Our system which converts English to ISL can have a significant impact on the lives of the deaf community. ISL is important for the purpose of education and securing jobs. This translating system can help the hearing impaired people to secure more jobs apart from the ones reserved in the government sector. In the education sector teachers have to first learn sign language in order to teach deaf students. This hurdle can be overcome using the English to ISL translator.

There are times when we come across disabled people at malls or petrol pumps and talking to them can be difficult. In public places like railway stations, announcements cannot be heard by the deaf community. A system is needed which translates the speed to text and signs in real-time would solve this problem. These are various examples of where we can create a social impact using our designed system. We believe that making a difference in the world is always important. The social impact impacts everyone in different ways that we may not even realise. We believe our system can create bigger and better changes.

CHAPTER 7. CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

In this project, we attempted to create a system that would be beneficial to disabled persons who have communication issues, allowing them to express themselves clearly and effortlessly. Instead of displaying distinct words through a GIF/ image, our model seeks to turn the full input language into a single visual, giving the model a far more realistic and vibrant appeal. This paper covers the many approaches and stages we used to execute the English to Indian Sign Language conversion.

7.2 FUTURE SCOPE

In the future scope of this project we plan

1. Allowing an administrator to add words to the dictionary as per user's suggestions.
2. Securing the database.
3. Adding subtitles to the avatar.
4. Extending the scope to regional languages.

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APPENDIX 1

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Summary

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CERTIFICATE

This is to certify that Mr./ Miss./Mrs. Sayali Oak of MKSSS's Cummins College of Engineering for Women has ~~participated~~/1st prize/2nd prize/3rd prize in **"ASPIRE 2K22"**, **National Level Project Competition** held on **28th May, 2022** organized by Department of Computer Engineering and Department of Information Technology, of PES's Modern College of Engineering, Pune-05 in Association with CSI Student Chapter.

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This is to certify that Mr./ Miss./Mrs. Tanvi Shroff of MKSSS's Cummins College of Engineering for Women has participated/1st prize/2nd prize/3rd prize in **"ASPIRE 2K22"**, **National Level Project Competition** held on **28th May, 2022** organized by Department of Computer Engineering and Department of Information Technology, of PES's Modern College of Engineering, Pune-05 in Association with CSI Student Chapter.

Prof. Dr. Mrs. K. R. Joshi	*Prof. Dr. Mrs. S. A. Itkar*	*Prof. Dr. Mrs. S. D. Deshpande*
Principal (PES MCOE)	*Head, Computer Engineering Department*	*Head, IT Department*


PROGRESSIVE EDUCATION SOCIETY'S

MODERN COLLEGE OF ENGINEERING, PUNE - 05

Department of Computer Engineering and Department of Information Technology

In association with CSI Student Chapter

CERTIFICATE

This is to certify that Mr./ Miss./Mrs. Vedanti Donkar of MKSSS's Cummins College of Engineering for Women has participated/1st prize/2nd prize/3rd prize in **"ASPIRE 2K22", National Level Project Competition** held on **28th May, 2022** organized by Department of Computer Engineering and Department of Information Technology, of PES's Modern College of Engineering, Pune-05 in Association with CSI Student Chapter.

Principal

Prof. Dr. Mrs. K. R. Joshi
Principal (PES MCOE)

Prof. Dr. Mrs. S. A. Itkar
Head, Computer Engineering Department

Prof. Dr. Mrs. S. D. Deshpande
Head, IT Department

PROGRESSIVE EDUCATION SOCIETY'S

MODERN COLLEGE OF ENGINEERING, PUNE - 05

Department of Computer Engineering and Department of Information Technology

In association with CSI Student Chapter

CERTIFICATE

This is to certify that Mr./ Miss./Mrs. Rutuja Jadhav of MKSSS's Cummins College of Engineering for Women has ~~participated~~/1st prize/2nd prize/3rd prize in **"ASPIRE 2K22", National Level Project Competition** held on **28th May, 2022** organized by Department of Computer Engineering and Department of Information Technology, of PES's Modern College of Engineering, Pune-05 in Association with CSI Student Chapter.

Prof. Dr. Mrs. K. R. Joshi	*Prof. Dr. Mrs. S. A. Itkar*	*Prof. Dr. Mrs. S. D. Deshpande*
Principal (PES MCOE)	*Head, Computer Engineering Department*	*Head, IT Department*

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SINHGAD INSTITUTE OF TECHNOLOGY, LONAVALA

Sinhgad Institutes

Organized

"A National Level Final Year Engineering Project Competition"

"Mutation 2022"

CERTIFICATE OF PARTICIPATION

This certificate is proudly presented to

RUTUJA JADHAV, MKSSS's Cummins college of Engineering for Women of Computer/IT/MCA Track for participating in National level Project Competition, Mutation 2022, organized by Sinhgad Institute of Technology, Lonavala on 13th May 2022.

Dr. D.D. Chaudhary
Vice- Principal

Certificate ID: SIT/MUTATION/2022/121

Dr. M. S. Gaikwad
Principal & Campus Director

SINHGAD TECHNICAL EDUCATION SOCIETY'S

SINHGAD INSTITUTE OF TECHNOLOGY, LONAVALA

Sinhgad Institutes

Organized

"A National Level Final Year Engineering Project Competition"

"Mutation 2022"

CERTIFICATE OF PARTICIPATION

This certificate is proudly presented to

TANVI SHROFF, MKSSS's Cummins college of Engineering for Women of Computer/IT/MCA Track for participating in National level Project Competition, Mutation 2022, organized by Sinhgad Institute of Technology, Lonavala on 13th May 2022.

Dr. D.D. Chaudhary
Vice- Principal

Certificate ID: SIT/MUTATION/2022/120

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"A National Level Final Year Engineering Project Competition"

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CERTIFICATE OF PARTICIPATION

This certificate is proudly presented to

SAYALI OAK, MKSSS's Cummins college of Engineering for Women of Computer/IT/MCA Track for participating in National level Project Competition, Mutation 2022, organized by Sinhgad Institute of Technology, Lonavala on 13th May 2022.

Dr. D.D. Chaudhary
Vice- Principal

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This certificate is proudly presented to

VEDANTI DONKAR, MKSSS's Cummins college of Engineering for Women of Computer/IT/MCA Track for participating in National level Project Competition, Mutation 2022, organized by Sinhgad Institute of Technology, Lonavala on 13th May 2022.

Dr. D.D. Chaudhary
Vice- Principal

Certificate ID: SIT/MUTATION/2022/123

Dr. M. S. Gaikwad
Principal & Campus Director

APPENDIX 3

ICDMAI

SDS SOCIETY FOR DATA SCIENCE

6TH INTERNATIONAL CONFERENCE ON
DATA MANAGEMENT, ANALYTICS & INNOVATION

CERTIFICATE

- OF APPRECIATION -

THIS CERTIFICATE IS PROUDLY PRESENTED TO:

Sayali Kedar Oak

for participating and presenting a paper titled

"Literature Review on Sign Language Generation"

during the 6th ICDMAI 2022.

JANUARY 14 - 16, 2022.

Neha Sharma — DR. NEHA SHARMA, Secretary, Society for Data Science

Amlan Chakrabarti — DR. AMLAN CHAKRABARTI, Vice President, Society for Data Science

Amol Goje — DR. AMOL GOJE, President, Society for Data Science

ICDMAI

SDS SOCIETY FOR DATA SCIENCE

6TH INTERNATIONAL CONFERENCE ON
DATA MANAGEMENT, ANALYTICS & INNOVATION

CERTIFICATE

- OF APPRECIATION -

THIS CERTIFICATE IS PROUDLY PRESENTED TO:

Tanvi Shroff

for participating and presenting a paper titled

"Literature Review on Machine Translation Systems for Sign Language Generation"

during the 6th ICDMAI 2022.

JANUARY 14 - 16, 2022.

Neha Sharma — DR. NEHA SHARMA, Secretary, Society for Data Science

Amlan Chakrabarti — DR. AMLAN CHAKRABARTI, Vice President, Society for Data Science

Amol Goje — DR. AMOL GOJE, President, Society for Data Science