TALKING FINGERS: TEXT/AUDIOTO INDIAN SIGN LANGUAGE CONVERSION

A PROJECT REPORT

Submitted by,

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Under the guidance of,

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CERTIFICATE

This is to certify that the Project report "**TALKING FINGERS:TEXT OR AUDIO TO INDIAN SIGN LANGUAGE CONVERSION**" being submitted by **Naga Nikitha P, Sarthak Mishra, Darshan S**, bearing roll number(s) **20211ISR0023, 20211ISR0086 ,20211ISR0073** in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Information Science and Engineering is a Bonafide work carried out under my supervision.

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DECLARATION

We hereby declare that the work, which is being presented in the project report entitled **"TALKING FINGERS: TEXT/AUDIO TO INDIAN SIGN LANGUAGE CONVERSION"** in partial fulfillment for the award of Degree of **Bachelor of Technology** in **Computer Science and Engineering**, is a record of our own investigations carried under the guidance of **Mr. Sheik Jamil Ahmed**, Assistant Professor, **School of Computer Science Engineering & Information Science, Presidency University, Bangalore.**

We have not submitted the matter presented in this report anywhere for the award of any other Degree.

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ABSTRACT

Communication is amongst the basic needs of mankind. Millions face major problems in communication since the verbal world does not accommodate people who can neither here nor speak. Of course, sign language holds a very important position in the bridge meant for these types of people. Yet, it is seldom used because the interpreters, technological instruments available, and masses are unaware of it. The problem is more serious in multilingual countries like India, with its acute linguistic diversity combined with technological disparities.

Talking Fingers" is an innovative project to address these challenges by providing a real-time text-to-sign language translation system. The tool provides inclusiveness and accessibility to people who have hearing and speech impairments. The tool supports multilingual support-translating the text into Indian Sign Language from various Indian languages and English. It shall work offline, therefore being quite feasible in rural areas where the coverage of the internet is pretty minimal. "Talking Fingers" makes use of artificial intelligence along with advanced animation techniques to provide accurate context-aware translations into sign language.

The ultimate goals of this project are to facilitate the ability to communicate effectively among hearing-impaired people, better involvement within social, educational, and professional settings, and greater awareness across society about sign language. It achieves these through several AI models used for NLP, a comprehensive database of sign language, and HamNoSys for generating realistic sign language animations. The UI designed will be intuitive, use-friendly, and accessible even to technical laymen of varied skills.

Funded by the perceived chasm around current solutions that are expensive and work only using the internet-and usually in mainstream signer languages like the ASL-mthis leaves little impact for the whole country of India-"Talking Fingers" tries not to carry most of these traits forward. In other words, "Talking Fingers" proposes a feasible solution that not only is pretty low-cost to use but even functions offline when this mode of communication actually will be availed of frequently in India-with the added icing on the cake by adapting to regional contexts.

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CHAPTER-1
INTRODUCTION

Background

Communication lies at the very heart of human interaction and involves the conveyance of ideas, feelings, and information by individuals. On the other hand, millions of hearings and speech disabled all over the world experience a serious barrier in the way of effective communication. They resorted largely to sign languages as their primary mode of communication in the United States, although they were mostly isolated and disconnected from groups due to a lack of interpreters, public awareness, and infrastructural conducive conditions. In multilingual and diversified societies like India, the scenario becomes a more critical one. More than 19% of India's disabled population suffers from hearing impairment as per the 2011 Census. The condition is worsened by the unavailability of affordable and inclusive tools, which makes communication difficult for people. This will become a barrier to their access to opportunities and full participation in society."Talking Fingers" aims to fill this gap by introducing technology that could provide real-time translation from text into sign language. It is an Indian Sign Language tool supposed to be used even in the absence of the internet for cases in rural areas and areas where connectivity is poor. This makes "Talking Fingers" enable hearing-impaired clients who cut across both the economically deprived and even the rich, ensuring this is made achievable at minimal costs. While the sign language interpreters may be the on-spot connections between the verbally communicated and non-communicated word, their existence itself is not sufficient. Out of a few thousand certified sign language interpreters, India still has less than 300 for its millions of hearing-impaired citizens, and this number itself says how much there is a pressing need for technological intervention. The assistive technologies available today are strongly limited regarding:

They are mainly centered on American Sign Language, which has nothing to do with the Indian users. Most of the solutions rely on the Internet, which leaves out many residents in rural and remote areas; multiple tools are very expensive and not very user-friendly, further reducing their usage. "Talking Fingers" addresses all these problems through the following solutions: Multilingual Support - It translates text of Indian languages and English into IS; Offline Functionality - This implies total access irrespective of internet connectivity. Inclusiveness: It encourages the use of sign language by providing an easy-to-use interface.

Real-World Challenges Faced by Hearing-Impaired Individuals:

People with hearing loss find many difficulties in everyday life because of the lack of any kind of communication tool and facility. Educational Barriers Most schools are without teachers trained in Indian Sign Language or any resources adapted for hearing-impaired students.
Students often feel excluded in the classroom and, therefore, cannot participate in discussions that may be a contributing factor to the rise in dropout rates.
Example: A hearing-impaired student in a rural school may not understand any lesson as neither the teacher nor fellow students can use ISL Employment Restrictions: The communication barrier at the time of interviews or at work will not allow the hearing-impaired to prove their talents. The employer may also be unaware of assistive tools or technologies, making them absolutely out of reach for these people A hearing-impaired programmer might have difficulty understanding what other members of his team are discussing, or what exactly a client needs Healthcare Restrictions Miscommunication between patients and healthcare providers often results in improper diagnoses or treatments During emergencies, the inability to convey symptoms can delay critical decisions A hearing-impaired patient in a rural clinic may struggle to communicate symptoms to a doctor who does not know sign language Social Isolation Everyday activities like shopping, traveling, or attending public events become stressful due to communication gaps Social events inevitably end up being very exclusive, keeping out many deaf and dumb people Many hearing-impaired individuals suffer from low self-esteem and social isolation.

Communication barriers during interviews or in the workplace impede the possibility to show their skills. The employer may also be uninformed about the assistive tool or technology, rendering it absolutely out of reach for these people.
Example: A hearing-impaired programmer may be unable to comprehend most of what other members of his team are discussing or what exactly the client needs. Healthcare Restrictions Miscommunication between patients and healthcare providers typically leads to inaccurate diagnoses or wrong treatments During emergent situations, inability to correctly communicate symptoms holds up critical decisions A deaf patient in rural clinics may barely understand how to explain symptoms of a disease he or she was suffering from to a physician who does not understand sign language Social Isolation Everyday activities - shopping, commuting, or watching public events- become stressful in the face of communication gaps at every turn Social gatherings always tend to be super exclusive, barricading many deaf and dumb people. Many hearing-impaired people experience low self-esteem and social isolation.

Translation of spoken or written languages into sign languages is a unique and complex challenge that NLP and AI have to put up with. Sign languages are natural languages of the deaf community, and they differ considerably from spoken languages, such as English, not only in modality but also in the use of spatial grammar and multidimensional expression. Solving this cross-modal MT problem calls for innovative approaches that bridge the linguistic and structural differences.

The Zardozi system is a state-of-the-art effort in AI research to translate English text into fluent sign language. Using a blackboard architecture for knowledge integration, Zardozi exploits an interlingual representation that acts as an intermediary between the verbal input and the gestural output. A number of knowledge sources and interacting components make up the system to analyze English text and generate the corresponding gestures in sign language, thus enabling translations into different variants of sign language.

American Sign Language is the primary means of communication for a majority of deaf individuals in the United States. ASL is a linguistically complete, complex language unto itself, independent of systems that attempt to represent English by manual means. Unlike signing systems based on English, ASL has its grammatical rules and does not contain articles, suffixes, and other morphemes present in the English language. This is not a limitation but a reflection of the unique linguistic organization of ASL, as is the case with many languages around the world.

Sign systems such as "Signed English" attempt to express English text or speech manually by placing signs in the order their English equivalents occur. These tend to omit some elements, such as articles and verb suffixes, and the resulting expressions can often be matched to more than one English sentence.

For example, the Signed English for "The cat is sleeping on the fence" would be "CAT SLEEP ON FENCE," which could also translate to other English variations, such as "A cat is sleeping on a fence to address these gaps, systems like Signing Exact English (SEE) were developed. SEE introduces signs for missing components like articles and suffixes, enabling users to sign phrases like "THE CAT IS SLEEPING ON THE FENCE" with greater fidelity to English grammar. These systems were designed not only to assist deaf students in learning English but also to help hearing parents of deaf children communicate effectively by learning lists of signs. It is an invaluable medium of communication for the deaf and mute, helping them to communicate in a world where the majority communicate through speech. The demand for sign language is considered high in India because about 2.7 million people have hearing or speech impairments, out of which 98% use sign language as their main medium of communication. However, the severe shortage of competent human interpreters poses significant challenges to ensuring communication and access to services for such populations. With the development of artificial intelligence and computational techniques, new avenues are being opened for the automation of recognition and translation of sign languages. These technologies aim at bridging the gap in communication by accurately identifying and classifying sign gestures, hence improving accessibility for deaf and hard-of-hearing individuals.

This paper reviews computational methodologies from around the world that have been used in the area of Sign Language Recognition, with a particular focus on artificial intelligence-based techniques. Out of a pool of 587 research papers, 95 studies were found specifically

addressing SLR using machine learning and deep learning approaches. This review categorizes these methodologies. By language and then explores several dimensions: sign type, signing modes (static vs. dynamic), processing techniques. Signed English is a manual representation of spoken English using a mixture of fingerspelling and gestural signs. It is an extremely important means of communication and learning within the deaf and hard-of-hearing communities. Realizing this need for accessible learning tools, a prototype Hand Sign Translator system was developed that can graphically translate English text into Signed English, using two-handed animations. The HST system provides a very practical interface allowing the learning process to be easier by converting textual input into visually accurate sign representations.

The main two steps in the HST translation process are input environment and the animation process. In the input stage, text analysis is conducted by the system to retrieve required kinematic data from the English-Sign Dictionary (ESD). These act as the bases for the animations. This would include a skeleton model of keyframe images, interpolation of in-between poses, application of volume models to represent surface skin, generation of paintable shapes, and rendering of final images with smooth animation. Put altogether, these components provide an interactive and educational platform for mastering Signed English.

1.1 Background

Communication is the hub of human interaction, where a person expresses one's ideas, feelings, and information. However, it seems like millions of hearing and speech disabled people around the world are confronted by this big barrier to effective communication. In the United States, they resorted largely to sign languages as their primary mode of communication, though mostly isolated and disconnected from groups owing to a lack of interpreters, public awareness and infra-structurally conducive conditions. The scenario becomes far more critical in multilingual, diversified societies such as India. As many as more than 19 % of its disabled population suffers from hearing impairment in India according to the 2011 Census. This is an aggravating condition since the unavailability of affordable and inclusive tools renders communication not easy for people. The result will be a factor limiting your access to opportunities fully and to participation in society.

"Talking Fingers" tries to bridge this with technology and translating text into sign language in real-time. It is also supposed to be an Indian Sign Language system that works even without the internet in rural and low-connectivity areas. In this case, therefore, making "Talking Fingers" well empower a hearing-impaired clientele, cutting across both economically deprived and even the wealthy, to achieve it at the cheapest cost.

1.2 Significance of the Project

Sign language interpreters may be the on-the-spot links that bridge between the verbally communicated and non-communicated word, but their mere presence is not enough. Of the few thousand certified sign language interpreters, India still has less than 300 serving its millions of hearing-impaired people, which the strong necessity of technological intervention points to: present assistive technologies have powerful limitations as far as it concerns them. They are focused mostly on American Sign Language (ASL) and have nothing to do with Indian users. Most solutions rely on Internet access, leaving out many residents of rural and remote areas. The tools are too expensive and not user-friendly; thus, the number of users reduces even more. "Talking Fingers" tries to help with all the problems described above with the following solutions: Multilingual support-it translates the text of Indian languages and English into ISL; offline functionality means that the application allows total access regardless of connectivity; inclusiveness-the adoption of sign language should be encouraged with the simplest and intuitive interface.

1.3 Real-World Challenges Faced by Hearing-Impaired Individuals

Hearing-impaired individuals encounter numerous challenges in their daily lives due to the lack of communication tools and resources Educational Barriers Many schools lack teachers trained in Indian Sign Language or resources tailored to hearing-impaired students Students often feel excluded in classrooms and are unable to participate fully in discussions, leading to higher dropout rates A hearing-impaired student in a rural school may be unable to understand lessons because neither the teacher nor fellow students can use ISL Employment Restrictions Communication barriers during interviews or at the workplace will not allow hearing-impaired people to demonstrate their skills The employer may also be unaware of assistive tools or technologies, making them absolutely out of reach for these people.
Example: A hearing-impaired programmer might have difficulty understanding what other members of his team are discussing, or what exactly a client needs

Healthcare Restrictions Miscommunication between patients and healthcare providers often results in improper diagnoses or treatments During emergencies, the inability to convey symptoms can delay critical decisions A hearing-impaired patient in a rural clinic may struggle to communicate symptoms to a doctor who does not know sign language Social Isolation Everyday activities like shopping, traveling, or attending public events become stressful due to communication gaps Social events inevitably end up being very exclusive, keeping out many deaf and dumb people. Many hearing-impaired individuals suffer from low self-esteem and social isolation.

1.4 Background of the Project

The lack of interpreters and supporting technologies in Indian contexts inspires "Talking Fingers." It empowers the deaf/dumb, as it will provide a fully reliable offline translation engine to make all people effectively communicate-indeed, work independently without interpreters. Engage Everyone Ensure Inclusion:

1.5 Project Objectives

The broad objectives of "Talking Fingers" are to design a real-time text-to-sign language translation that supports multiple Indian languages, including English. Offline functionality for the users from rural and low connectivity areas A cost-effective tool which is user-friendly and available to the mass that can cater to different ranges of technical expertise. Contribution towards social awareness and inclusiveness through the usage of ISL.

1.6 Scope and Applications

Talking Fingers" can be revolutionary for deaf people in any particular domain of life: Education The tool can help students understand lessons using the text-to-sign translation facility. The tool can also help teachers learn and communicate in ISL Healthcare This system can be used by doctors and patients in clinics and emergency settings to fill the gulf, especially in the rural clinic settings Workplaces This tool allows employees to follow instructions and engage in discussions, thus bringing an inclusive atmosphere in workplaces Public Services It can be used in the offices of the government, banks, and transport systems to help handicapped people to access the services Social Integration "Talking Fingers can be used in social settings helping individuals to express their confidence and be able to fully participate in events.

CHAPTER-2
LITERATURE SURVEY

1.1 Literature Survey Table

Papers	Advantages	Disadvantages
1. Ahuja C, Lee DW, Ishii R, Morency LP. No gestures left behind: Learning relationships between spoken language and freeform gestures. In Findings of the Association for Computational Linguistics: EMNLP 2020, pages 1884–1895, Online, Nov. 2020. Association for Computational Linguistics.	Learns the relation between spoken language and free-form gestures, improving both gesture recognition and generation.	It requires a large dataset of synchronized speech and gesture data, which is difficult to collect.
2. Alexanderson S, Henter GE, Kucherenko T, Beskow J. Style-controllable speech-driven gesture synthesis using normalizing flows. Computer Graphics Forum, 39(2):487–496, 2020.	Allows for style-controllable speech-driven gesture synthesis.	The flow model of normalization can be computationally expensive and may require careful tuning of hyperparameters.
3. Andriluka M, Pishchulin L, Gehler P, Schiele B. 2d human pose estimation: New benchmark and state of the art analysis. In 2014 IEEE Conference on Computer Vision and Pattern Recognition, pages 3686–3693, 2014.	enabling more expressive and natural gestures.	This will always run the risk of the benchmark and analysis becoming outdated as the field advances, hence needing updates now and then.

4. Blender Foundation. Blender, 2023. Computer software.	A new benchmark is presented with the analysis of state-of-the-art regarding 2D human pose estimation, highly important for gesture recognition.	Blender does have a steep learning curve, and most of the advanced features require a good deal of expertise to use correctly.
5. Camgoz NC, Hadfield S, Koller O, Ney H, Bowden R. Neural sign language translation. 03 2018.	Blender is an open-source, free, 3D creation suite which can be used for various tasks in the area of gesture animation and visualization.	It requires a huge dataset of sign language videos along with their translations, which may be difficult to collect and annotate.
6. Crawshaw M. Multi-task learning with deep neural networks: A survey, 2020.	This is a neural network-based approach towards sign language translation, which may provide better accessibility and communication to the deaf and hard-of-hearing community.	This is because surveys can become outdated as the field advances, and in practice, multi-task learning is complex and needs careful design.
7. da Silva EP, Costa PDP, Kumada KMO, de Martino JM. Facial action unit detection methodology with application in Brazilian sign language recognition. Pattern Analysis and Applications, 25:549 – 565, 2021.	This provides a comprehensive survey of multi-task learning with deep neural networks that can be utilized for jointly learning related tasks such as gesture recognition and pose estimation.	On the other hand, this methodology could be partially modified or extended by different datasets of sign language or another cultural background.
8. da Silva EP, Kumada KMO, Costa PDP. Analysis of facial expressions in Brazilian sign language (libras). European Scientific Journal, ESJ, 2021.	It proposes a methodology for facial action unit detection, which can be useful in sign language recognition and understanding.	This may be a language-specific analysis to Libras and needs to be extended to other sign languages.
9. Dachkovsky S, Sandler W. Visual intonation in the prosody of a sign language. Language and Speech, 52(2-3):287–314, 2009. PMID: 19624033.	Facial expressions in the Brazilian Sign Language-Libras are analyzed for the development in the design relating to the recognition	These findings may be specific to the sign language studied and need to be validated across different sign languages.

	and generation of sign languages.	
10. Devlin J, Chang M, Lee K, Toutanova K. BERT: pre-training of deep bidirectional transformers for language understanding. CoRR, abs/1810.04805, 2018.	It also investigates the prosody of visual intonation in sign language to provide for more natural and intuitive design in generating sign language.	It requires a lot of computational resources to pre-train and fine-tune BERT, which may be limited in several resource-constrained environments.
11. Ebling. SMILE Swiss German sign language dataset. In Proceedings of the Eleventh International Conference on Language Resources and Evaluation (LREC 2018), Miyazaki, Japan, May 2018. European Language Resources Association (ELRA).	BERT is a powerful pre-trained language model, which can be fine-tuned for various natural language processing tasks, such as sign language translation and understanding.	Then the collected dataset may, therefore, confine to certain sign languages as well as its cultural context while having poor ability regarding generalization toward other sign languages.
12. Grishchenko I, Bazarevsky V. Mediapipe holistic — simultaneous face, hand and pose prediction, on device, Dec. 2020.	It provides a very useful dataset for Swiss German Sign Language, which can be used for training and testing of sign language recognition and translation.	Mediapipe Holistic may not perform as well or be as accurate due to the on-device constraints and complexity of the task.
13.Gussenhoven C, Chen A. The Oxford Handbook of Language Prosody. Oxford University Press, Dec. 2020.	Mediapipe Holistic is a real-time, on-device solution that predicts face, hand, and pose all together. It could be useful for gesture recognition and analysis. Provides an overview of the prosody of language which may inform the development of more natural and expressive sign language generation systems.	This is probably because the handbook is oriented towards spoken language prosody and thus needs supplementation by research into the particular prosodic features of sign languages.
14. Huber PJ. Robust Estimation of a Location Parameter. The Annals of	It covers robust estimation methodologies that can help in mitigating noisy or outlier-prone data in the	Some of the mathematical techniques presented may be difficult to implement and

CHAPTER-3
RESEARCH GAPS OF EXISTING METHODS

The motivation for developing an efficient text-to-sign language translation system like "Talking Fingers" came from the limitations and shortcomings of the existing methods. The existing solutions in the field of assistive communication machinery for deaf and speech-impaired persons show promise; however, they do not resolve the problem at the core level-which, in this case, pertains to the Indian scenario specifically. The present chapter is dedicated to discussing the lapses in the existing methods, technologies, and systems that "Talking Fingers" will try to conquer.

1. No ISL Support

Global Focus on ASL: Most of the research and tools in this domain are highly concentrated on ASL-for example, Microsoft Translator and Sign All. That is because, even though ASL enjoys international recognition, it does not apply to those relying on ISL in India since it is a different grammatical structure, another set of gestures, and carries other cultural elements as well. In the absence of ISL facilitation, these products are irrelevant and useless to deaf Indians. Variations in ISL India has a very diversified linguistic and cultural background. The sign language is also not an exception to this fact. Even though ISL is the norm, regional variations do exist. That creates the difficulty in making one tool that suits all. Existing tools are inflexible and too rigid to allow regional variations. For example, the gesture identified as "school" is different in northern India when compared with that in southern regions.

2. Internet Dependence Internet Connectivity Issues:

These, like Google's Live Transcribe and Sign All, are web applications; hence, they do require proper internet connectivity for real-time processing and translation of such tools, which cannot be put to work in any rural area or place devoid of proper or any net connectivity. Indian context: About 30% of villages in India are still bereft of decent internet services, where access to all these online gadgets is out of reach for an enormous section of the population. High Data Consumption: The processing involved in the signing language translations done into its audible audio version in a real-time premise may be at the cost of huge amounts of data consumed. Of course, this is a point of concern in cases where users have limited data plans or low-bandwidth connections.

3. High Costs and Hardware Dependency Expensive Equipment:

Most of the existing systems require supplementary hardware such as sensors, cameras, and microphones to support them in getting on with their activity. For example, Sign All requires a pair of cameras to capture gestures and facial expressions. Moreover, these facilities are beyond the affordability of ordinary people, especially those living in developing countries of the world, including India. In schools, health centers, and public services

Large-scale introduction. Exclusions for reasons of This excludes poor hearing-impaired citizens in Indian countries and such institutions also that cannot feasibly afford this heavy expenditure for economically poor majority because expensive technology nor the services can be afforded bythemselves. According to NCPEDP, several Indian families who contain hearing impaired members have lesser earnings than INR 10 000 from the profit motive monthly due to affordability overall becoming crucial.

4. Missing Multilingual

Dominance of English Support: Currently, only a few languages of the world, including English, are supported by the tools at hand, such as Microsoft Translator and Google Live Transcribe. This is different from India, with its 22 official languages and over 1,600 dialects. Because regional languages are not supported, this keeps many people from using these tools. For instance, a deaf person who uses only Tamil or Hindi will not be able to use an English-based system. Indian Contextual Translation Accuracy: Most of the translation tools in support of multilingual translation are at fault due to the lack of contextual understanding of the languages and their nuances of Indians.

Example: The translation of the Hindi word पढ़ाई करना (which means "to study") in sign language for a deaf needs awareness of the culture and the context surrounding it, which currently most of the systems lack.

5. Poor User Experience and Accessibility

Complex Interfaces: Most of the available tools have interfaces which are too technical to be used by non-technical users. In many cases, hearing-impaired people staying in rural areas tend not to be updated about the technical skill. For example, tools that require several steps to input the text or run hardware will minimize usage. Poor adaptability for various users: Generally, the available tools are designed for specific users in a typical corporate environment, school-going students, and people who have the ability to learn and understand information. It does not cover other large groups like Hearing-impaired senior citizens, rural citizens lacking awareness of technology.

6. Lack of Contextual Meaning

Literal Translation Problems: Most of the tools translate literally, which leads to misunderstandings. There is much dependency on context, facial expressions, and cultural context in sign language, which literal translation fails to translate.

Example: the idiomatic expression "break a leg" if translated word by word will be confusing since in idiom usage it is synonymous with "good luck". Lack of Emotion and Expression in Animations sign language, by nature has embedded emotion conveyed through facial Expressions and body language. Existing tools fail to allow addition to their animations, thereby failing to communicate as effectively.

7. Limited Scalability and Dataset Availability

Small sign language databases: Most tools rely on small datasets, which restrict the degree of translation for different words or phrases. There does not exist an extensive dataset for ISL in multiple languages and regional dialects in India. Scalability Issues: Most of these tools are not scalable. Adding support for new languages, phrases, or expressions in most cases involves large-scale redevelopment; hence, inflexible regarding future requirements.

8. Lack of Awareness and Adoption Low Public Awareness of Sign Language Tools

Most hearing impaired and their respective families are not aware of the tools already available. This lack of awareness and low uptake rate for the most advanced tool Social Stigma The stigma attached to hearing impairments in certain communities discourages a person from looking for assistive tools. Limited Institutional Adoption: Schools, offices, and hospitals do not perceive assistive tools to be of any importance in carrying out their functions. 3.9 Offline Functionality Dependency on Online Services: Modern solutions are overly dependent on the cloud system for data processing and translation. They become useless without good connectivity and hence slow down real conversations. The solutions should be available offline to cater to use cases in rural areas. As much as 65% of the total population in India lives in rural regions, and this solution needs to be available offline. Talking Fingers caters to this most important requirement.

CHAPTER-4
PROPOSED MOTHODOLOGY

The "Talking Fingers" project is proposed to work out a full-fledged text-to-sign language translation system that overcomes the shortcomings of the previously developed tools. This chapter gives the methodology adopted in designing and developing the system in such a way that its implementation can be proper. Advanced technologies such as AI, NLP, and animation systems have been exploited in building the tool real-time, offline capable, multilingual, and customized for Indian Sign Language.

1. Overview of System

The proposed system will provide an effective solution for communicating with people who have problems in hearing and speech.

It consists of three modules: Input Module: Input text in different Indian languages and English; Processing Module: Translate the text into ISL with the use of a robust database and AI models for contextual understanding; Output Module: Displaying ISL translations on a screen as dynamic animations. Salient Features of the System Multi-Lingual Support: Translation of Hindi, Tamil, Kannada, and other Indian language text into English and then into ISL Offline: It can operate with no internet connectivity and hence is suitable for rural and other remote locations. User-friendly Interface: It can be used by people with different skill levels in its usage. The system can be represented as a block diagram in flow terms from text to sign language animation.

2. System's Modules

Input Module

A minimalistic interface taking pure text input provided by the user may provide for different input types, too. The user can input from keyboard or touchscreen. Voice to Text: If the user can speak, though deaf, then it could also provide for voice-to-text functionality. Finds the detection of input language and prepares for translation.

3. Processing Module

The major module involved in the translation of the input text into ISL includes the following steps: Natural Language Processing: It segments the input text into meaningful chunks like words or phrases. Then, it checks the syntax and semantics for proper translation.

Example: "I am going to school" should be translated as one sentence in ISL, and not word by word. Translation Engine: The preprocessed text is mapped to signs in ISL with the help of a sign language database. It utilizes machine learning models like Transformers to comprehend the subtlety in contexts. Copes with idiomatic expressions, regional dialects within Database Access by Indian languages: Retrieves matching sign animations. The database contains signs of commonly used words, phrases,

Output Module

ISL animations corresponding to the translated text appear on the screen of the user. It uses the Hamburg Notation System - HamNoSys to create realistic and accurate animations. It also adds facial expressions and body movements because ISL is very expressive through the non-verbal aspects.

4. Technology Stack

Programming Language Python NLP model development, database access, and overall system integration Natural Language Processing (NLP) Tensor Flow and NLTK Libraries pre-used for text processing and language translation Animation System HamNoSys Allows precise models of the expressions and gestures of ISL Database Management SQLite or MySQL Pre-rendered animations stored along with vocabulary and mappings between text and signs. Platform Mobile and desktop platforms to allow wide accessibility. 4.4 Workflow of the system

Input Phase: The user can input text or speech, whichever is more feasible. The system identifies the language of the input and prepares it for translation. Processing Phase: The NLP engine parses the input text to identify grammar syntax and context. The Translation Engine identifies the correct text with appropriate ISL signs present in the database. Output Phase: The system generates the ISL animation corresponding to the input text. The animations would be interpolated and transition between signs would be smooth.

5. Main Advantages of the Proposed Methodology

Offline Capability: This will help to get rid of the dependency on the internet and can be used easily in rural areas. Multi-Lingual Support: It supports many Indian languages so that users from diverse linguistic backgrounds can avail their benefits. Cost-effective: No expensive hardware or application fee required. Hence, many users can afford to buy it. Context-Aware Translation Leveraging AI models to handle idiomatic expressions and context-dependent phrases with ease. Usability: Designed keeping in mind user-friendly interfaces such that even the non-technical person can get introduced to it easily. 4.6 Scaling and Future Enhancements The approach described above will be scalable for/with possible upgrade in the near/distant future: Vocabulary upgrade : Keep adding newer and newer signs for more words, phrases, covering various subjects also. Two way transfer: sign -to-text transfer on grounds of giving facility at input end. Smoother Animations: Advanced animations apply to ensure smoothness and a higher degree of realism. Integration

CHAPTER-5

OBJECTIVE

Talking Fingers" is aimed at bridging the communication gap among the deaf and mute, with an available and effective text-to-sign language translation system that is accurate in context. This chapter gives details on the specific objectives of the project by highlighting how problems identified in the earlier chapters can be resolved and the promotion of inclusiveness in communication.

1. Primary Objectives

Real-time Communication Design a real-time multilingual text translation system in several Indian languages and English into Indian Sign Language. Empower the deaf to communicate effectively in various socio-linguistic, educational, and professional settings. Major Indian Multi-lingualities besides English: Use major languages such as Hindi, Tamil, Kannada, and Bengali Lift the linguistic barrier in the multi-lingual society by integrating all nations within India, thus making it possible for all users coming from different backgrounds Offline Mode of Operation: Create a system that can function without internet connectivity so that one is able to use it even in rural and poor connectivity areas Be able to use it by people in disadvantaged regions who have very limited technological infrastructure User-Friendly Interface: Design an interface that is simple and intuitive to cater to most people irrespective of their technical background Give access to those non-technical users, especially students, senior citizens, and people from rural India Promote the ISL within communities and societies Awareness Generation: ISL as a Tool of Communication Easy accessibility through technology to adopt sign language

2. Technical Objectives AI for Contextual Understanding:

Advanced AI models such as Transformers and NLP shall be used to ensure translations that are contextually fitted in translation, handle idiomatic expressions, phrases, and regional nuances of various Indian languages. Animation Systems for Realistic Sign Rendering: An ISL animation can be created using HamNoSys - Hamburg Notation System in a dynamic and realistic manner. It includes facial expressions, hand movements, and body postures to ensure signs are accurate and expressive. Comprehensive ISL Database Development: Develop a database that will store various ISL signs representing common words, phrases, and sentences. This updating of the database continuously is very much necessary due to the new additions to the vocabulary and the development of different regional varieties. Performance for Low-Cost Devices Make sure that the system will be light and optimized for performing on low-cost smartphones and computers in an attempt to keep it accessible for customers of limited financial resources.

3. Social Objectives

Increase Social Inclusion: This would enable the deaf and hard-of-hearing persons to participate more fully in society free from communication barriers. Increase participation socially, both at school and at work. Empowerment of Rural Communities: Tools should be provided in rural and remote settings where availability of interpreters to the deaf persons and advanced technologies are not available. Equality: it would be making available the tools of communication among the minoritized groups. Improvement in Access to Education Regarding the equality of educational opportunities for hearing-impaired children, there should be provided a translation about class teaching and access given to the educational content which is in Irish Sign Language. A reduced rate of dropping out by the hearing-impaired students as their access to learning will be guaranteed. SDG Quality Education-Ensure equal access of education among students with hearing problems. Contributes to SDG 10: Reduced Inequality by giving a voice to under-represented communities and a tool that will help.

4. Future-Oriented Goals

Scalability and Upgradability: Inclusive of the design for scalability on more languages, signs, and features in the near future. Two-way communication functionality in which a user can input the ISL gesture and obtain the text output in the process of translating signs to text. Institutional adoption includes integration in schools, at workplaces, and during public services as it will further propagate equity. Engage educational institutions, healthcare providers, and others to create partnerships in scaling up applications of this utility tool. Improvement through Feedback: Continuous improvement-collect feedback from the users for improvement in the accuracy, usability, and performance of the system. Integrate suggestions provided by the users for the improvement in the functionality and usage of the tool among more people.

5. Expected Outcomes

The above-mentioned objectives are likely to result in the following outcome itself. Accessibility Safely Deploy the Tool It is one of the most reliable tools which can be used by people with a hearing disability to express their views in their mother tongue. More Awareness of ISL Make Indian Sign Language a norm for people with hearing disabilities to communicate with each other Social Empowerment Equal opportunities and socializing atmosphere can be developed such that people with hearing disabilities will not fear to communicate Contributing to Technology-Driven Solution Develop sustainable, cost-effective solution by developing assistive technology Conclusion Talking Fingers' objectives reflect a commitment toward the development of a change-making tool for hearing and speech-impaired people. The project fills in the essential gaps in those existing systems where it lays considerable emphasis on the usability and easy accessibility of technology.

CHAPTER-6
SYSTEM DESIGN & IMPLEMENTATION

The guarantee of the accessibility, efficiency, and scalability of "Talking Fingers" was that the systematic design and its robust implementation would let the solution work so smoothly. The aim of this chapter is to provide an overall system architecture explanation and the design methodology that has been used to develop each module and technologies.

1. System Overview

The "Talking Fingers" system provides fluent text-to-sign language interpretation, including multilingual input, machine translation using AI, and dynamic rendering of signs. It will, therefore, provide a chance for effective communication by deaf and mute people. It is an offline system; it will be effective even in areas where there is low network connectivity. To make things even easier, this design has used a very simple interface.

2. System Architecture

Components present within it include the modular architecture of the "Talking Fingers": The Input Module for accepting text entry in Indian language word space/ English,; Processing Module changing textual form entered by the individual into ISL through natural-language processing and use of translation engine The Output Module : its results will be observed in the end through dynamic visual animations of 3D interactive avatars from input text by appropriate action Diagram Include below a block diagram representing the step-by-step workflow that shows: Data flow into actuations from an entered user using its input to provide the output With the interaction or incorporation of the said modules.

3. Modules and Their Functions

Input Module

Features Include text input via keyboard or by touchscreen. It shall, through some form of language detection algorithm, automatically detect the input language. If appropriate, it includes Voice-to-Text for those users who would prefer to input by voice. Technology Used Python with libraries such as Lang Detect to recognize the language.

Processing Module

The core of the system is the processing module, which does the translation of text into ISL. Components NLP Breaks down the text into meaningful phrases and ensures contextual accuracy Translation Engine Translates text into equivalent

Database of ISL gestures Fetches database management of ISL gestures, signs, and animations used. Technology Used TensorFlow and NLTK NLP and AI-based Language.

Understand SQLite or MySQL Store and retrieve sign language animations.

Output Module

It will output ISL animations corresponding to the translated text It has been used HamNoSys, which will most definitely assure totally modelled appropriately gestures, mimes and body postures Technical Used - Software and libraries for animation into realistic flowing ISL end.

4. System Workflow

Text Input The user inputs his natural language of choice into the interface. If the input isn't English, the system translates it into an ISL-compatible format. Processing Tokenize and analyze the structure and contextual meaning of the text. Translation engine matches the appropriate ISL gestures for each word or phrase. Sign Rendering The system retrieves the desired ISL animations from the database. These then are rendered in order such that the ISL animations onscreen and show smooth, coherent output for the given text. Output Display the ISL animations on screen come up on his device's screen and thereby the user shall be able to communicate effectively. FLOWCHART Provide a flowchart showing, step by step how an input process has to be provided with the result here.

5. Implementation Details

Development Environment

Programming Language Python Frameworks and Libraries Tensor Flow For AI-driven translation NLTK For any form of NLP like tokenization and context analysis SQLite/MySQL for database MatplotlibPyGame For rendering ISL animation.

Database Design

Database containing A vocabulary of common words and phrases in ISL, Pre-rendered sign animations for every word/phrase. Metadata describing the animations including gestures, facial expressions and transitions.

Rendering Animations

The system will implement HamNoSys to generate detailed signs. Every sign is coded for handshape, movement, and position. Gestures are combined with facial expression and body posture in a timely manner to create realistic ones.

6. System Design Features Offline Functionality:

The database and translation engine are persisted locally, which in turn means there is no need to have a net connection for operation. Multilingual Interface Support: Text input is supported using many Indian languages - Hindi, Tamil, Kannada, Bengali, and also English. User-Friendly Interface: The interface is developed through simple steps with large buttons, Intuitive navigation with minimal input-output steps.

7. Challenges of Implementation Limitation of Dataset:

The ISL dataset regarding various languages and their regional dialects is hard to find. Complex in Animation: Smoothing out transitions, fluidity of expressions without loss of much in realism requires great computation. Accuracies on Contextual Signs: Idiomatic expressions are intricate to translate due to the needs of advanced NLP capabilities for such sophisticated translations in regional language and linguistics. Optimizing the System: The most important was balancing the performance against resource consumption, allowing this tool to be available even on low-cost devices.

8. Testing and Validation Unit Testing:

Functional and logic aspects of the various Modules were tested for their functionality and correctness. Integration Testing: The modules interacted and smooth data flow was ensured between the modules. User Testing: The usability and accuracy of the entire system were tried out by using users with hearing impairments. Performance Metrics: Translation Speed, Animation quality, and so on, measured user-satisfaction metrics over the system.

CHAPTER-7

TIMELINE FOR EXECUTION OF PROJECT (GANTT CHART)

Task	Sep 2024	Oct 2024	Nov 2024	Dec 2024
1. Project Planning and Design				
2. Development				
3. Integration				
4. Testing				
5. Deployment and Final Review				

Table 7.1

CHAPTER-8

OUTPUTS

Fig 8.1: This Figure Shows The Signup Page

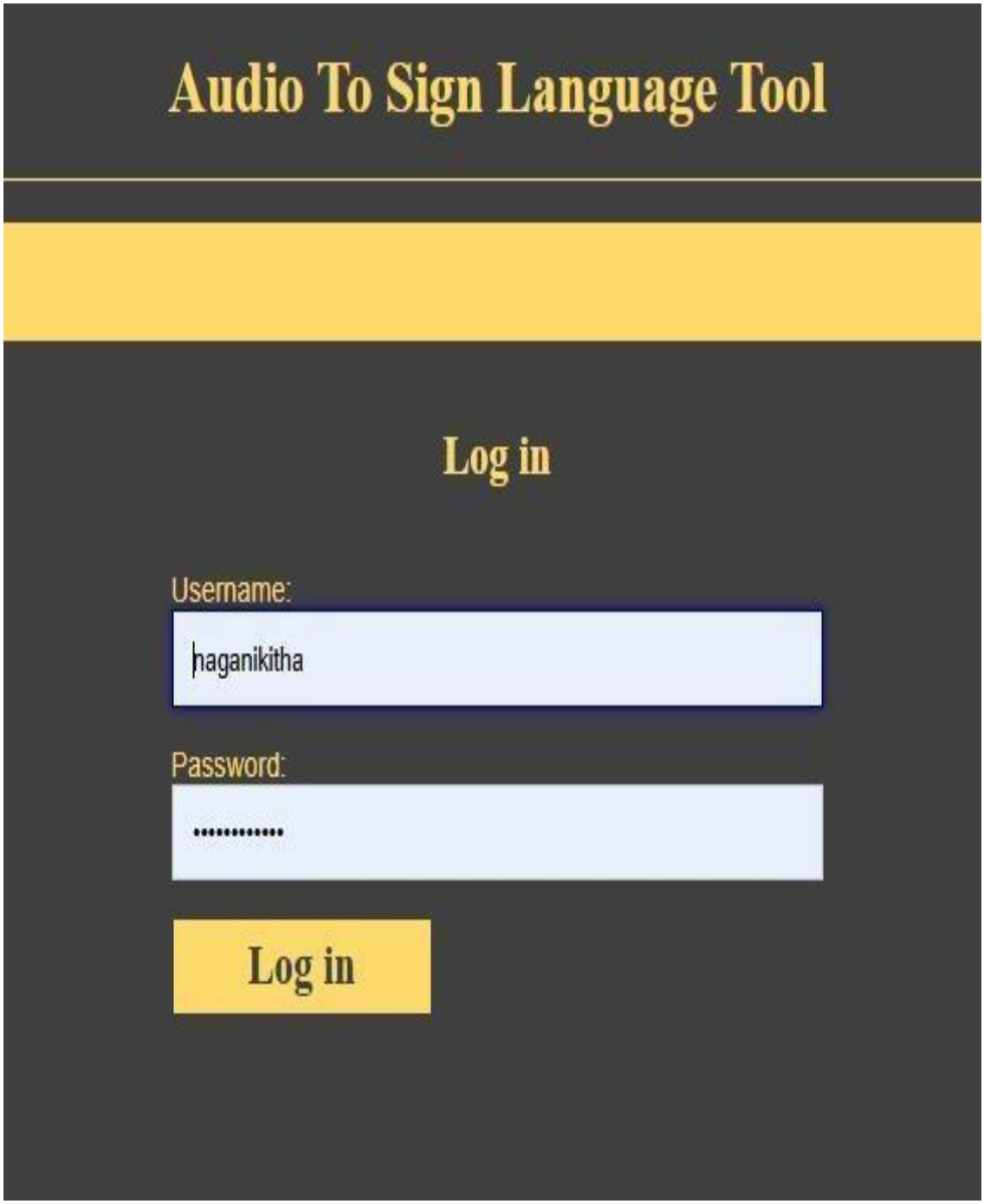

Fig 8.2: This Figure Shows To Login

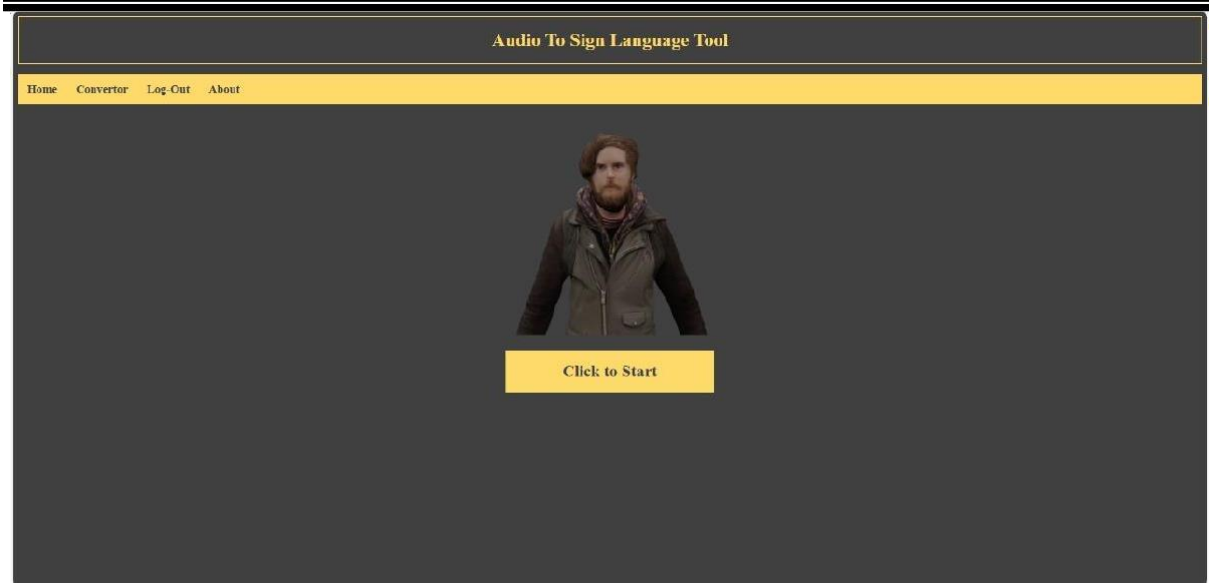

Fig 8.3: Click to Start Button

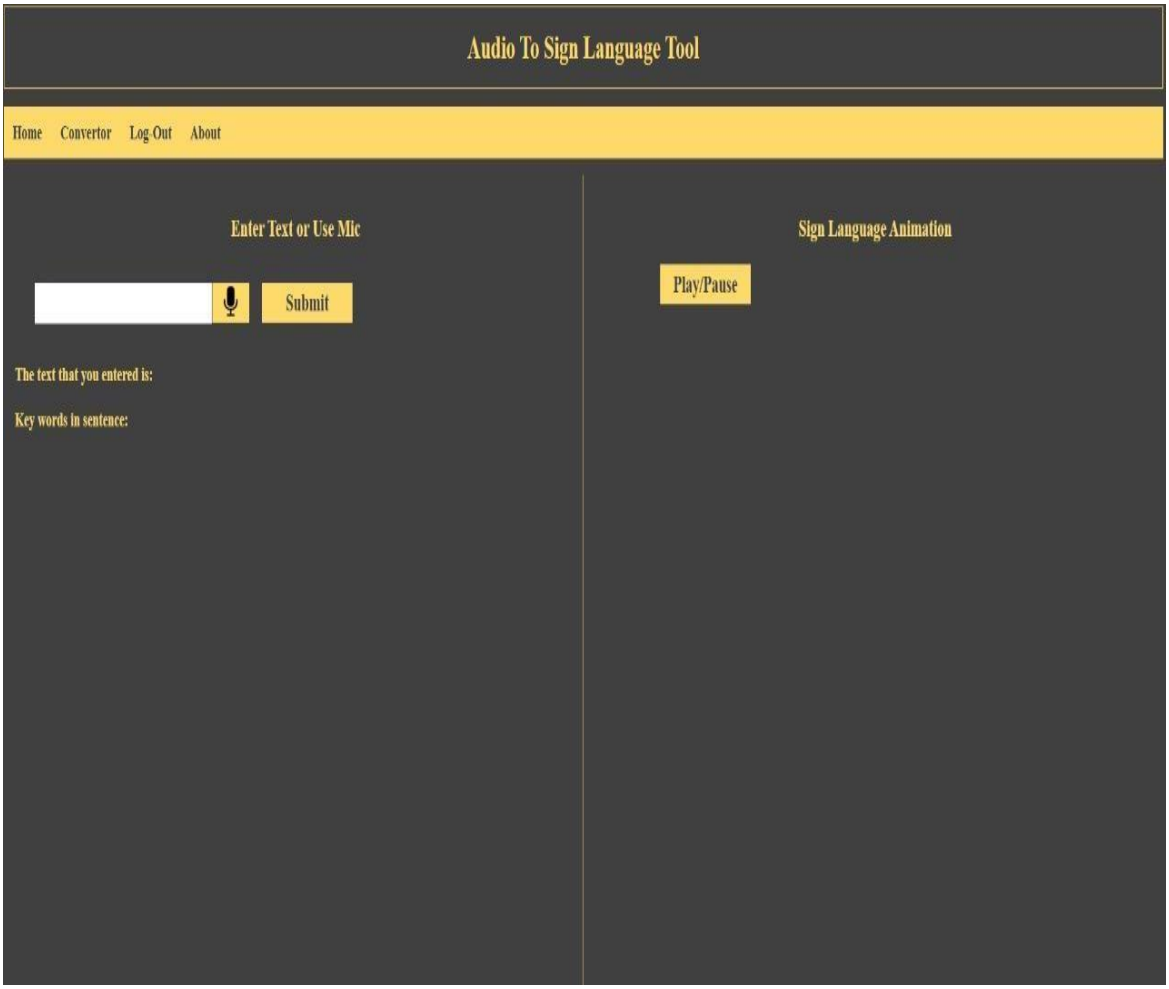

Fig 8.4: Shows the Search And Speech Recogination

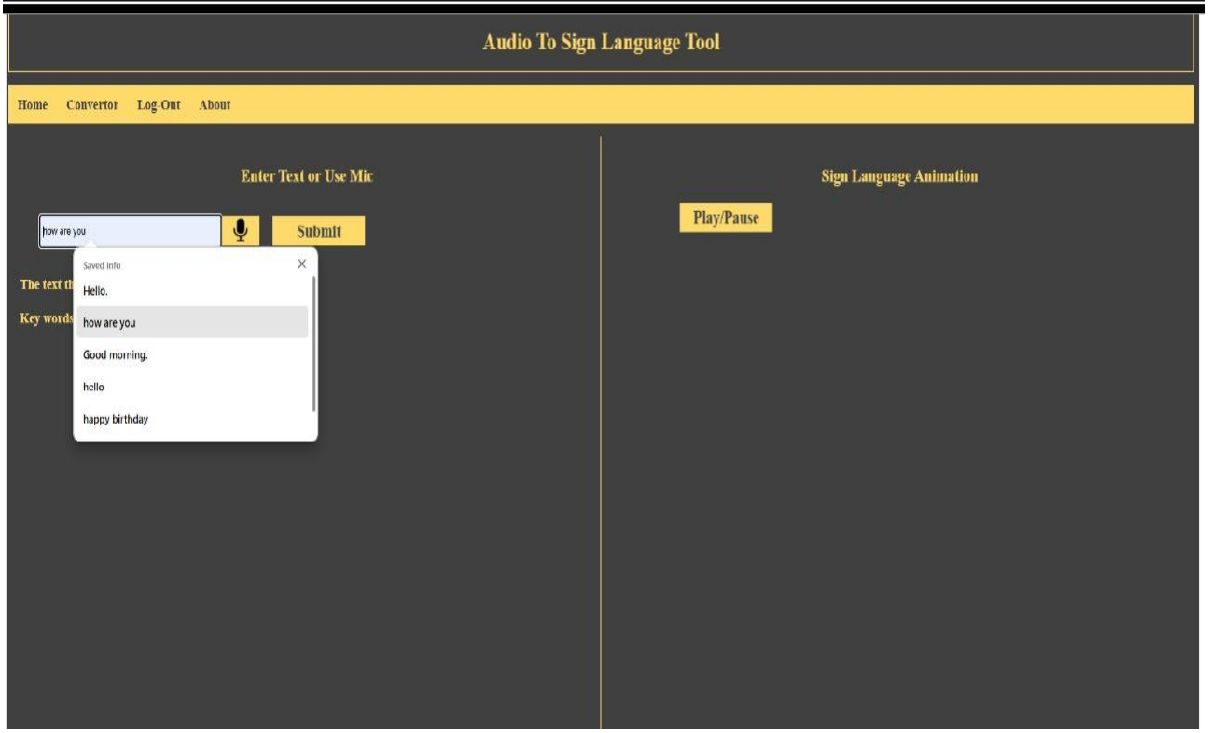

Fig 8.5: Type to Search output you want

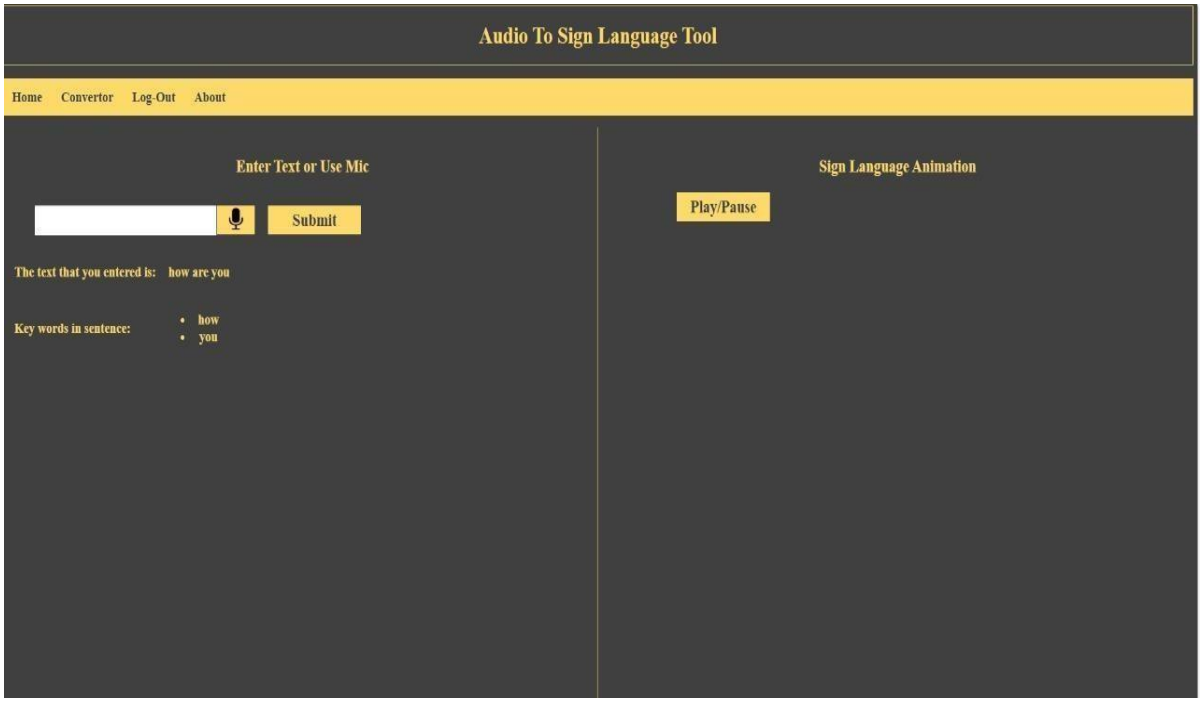

Fig 8.6: play and pause button popups after giving the text or speech

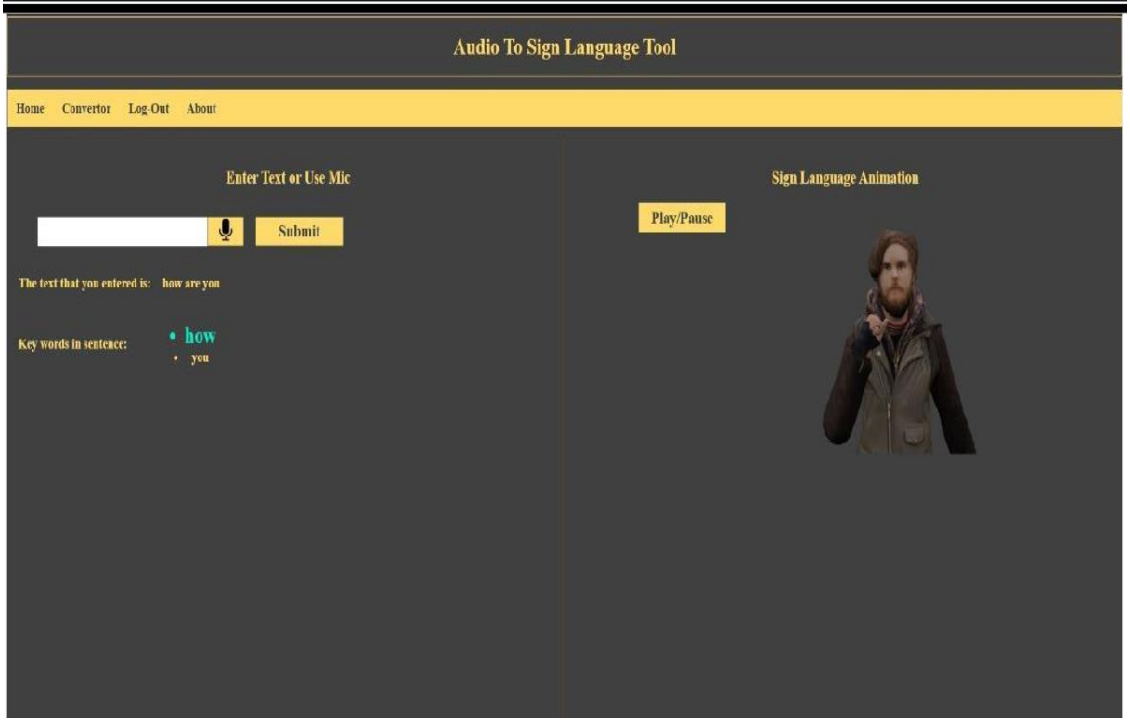

Fig 8.7: It Shows the output of letter how and you in text form

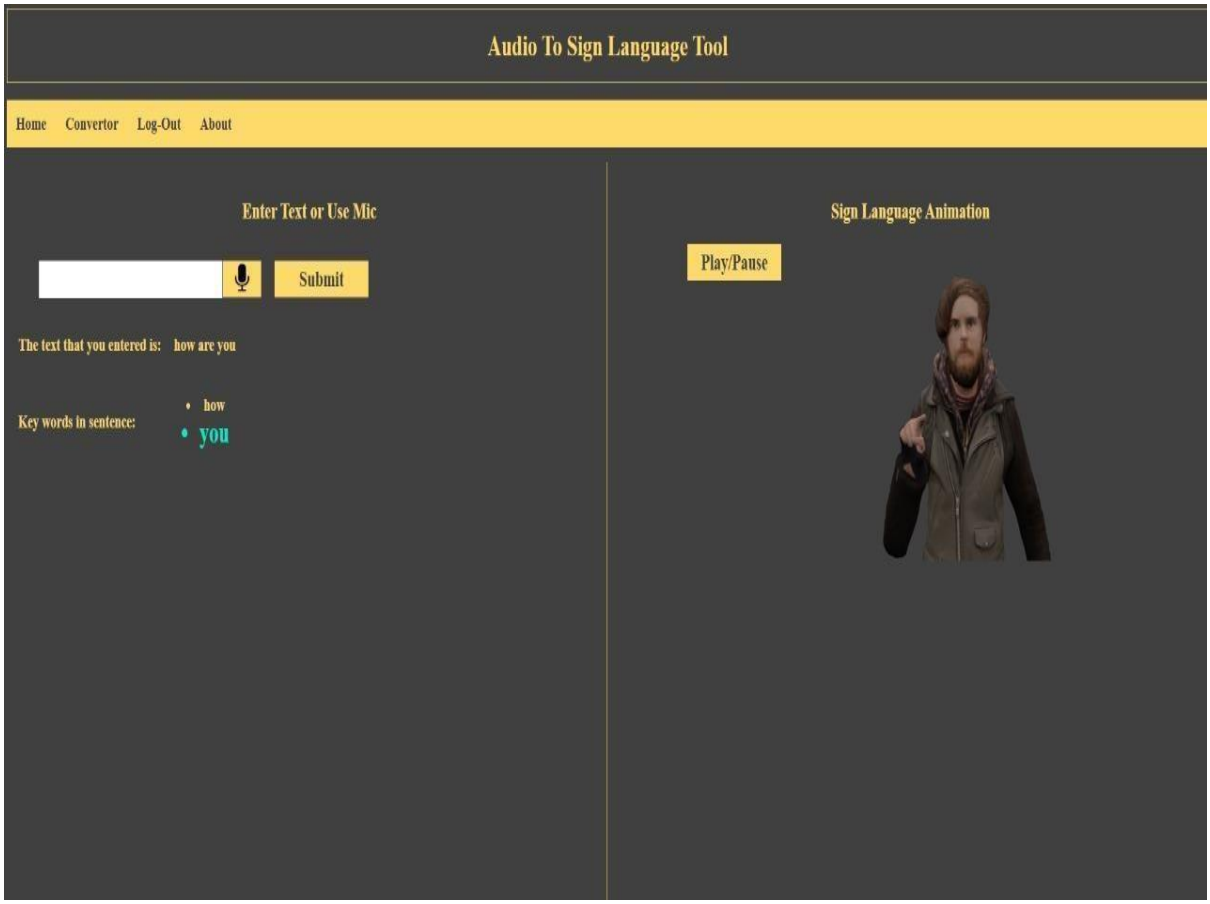

Fig8.8: It Shows the output of letter how and you in the form of Animation

CHAPTER-9
RESULTS AND DISCUSSIONS

Introduction to Results and Discussion
Introduce a brief reiteration of the purpose of the project-text-to-sign language conversion.
Mentioned the goals achieved in the project.
- Describe datasets, tools, and techniques involved, for example GIFs, sign databases, machine learning, etc.

Results

A. **System Functionality**

- Feature Description:
  Discuss all the implemented features each;
  Text-to-sign conversion using GIFs.
  Display of GIFs for corresponding words.
- Handling unknown words with default gestures.
- Explain how the system will interact with real-time requests (if it interacts).

- Performance:

- Metrics such as
- Time taken by the system to convert text into sign language.
- Sensitivity while associating the text with signs.
- Example:
- Input: "Hello, world."
- Output: Relevant GIFs for "hello" and "world."
- Scenarios:
- Test different input scenarios:
- Single-word inputs (e.g., "Hello").
- Multi-word sentences (e.g., "How are you?").
- No word from the dictionary or unverified input for example "Quantum".

B. User Experience
Feedback of potential users with deaf communities and sign language learners that include:
- Usability,
- Accessibility of the app interface.

Discussion on UI intuitiveness: how easy the UI is to use for non-technical people.

C. Case Study Illustrations
- Explain the input-output transformation in great detail with images.
- Demonstrate edge cases and how the system resolves them.

3. Discussion

A. Advantages of the System

- Usability:
- Explain how the app streamlines communication for people who are not accustomed to signing
- Performance:
- Point out the response time of the system as fast, accurate matching of GIFs, and smooth transition in GIFs during display.
- Accessibility:
Discuss on how it brings together people from hearing and deaf worlds
- Additional vocabulary or languages come easily

B. Challenges Identified

- Vocabulary Limited:
- Talk about challenges when it comes to creating or accessing a comprehensive database of sign language GIFs or videos.
- Syntax Mismatches:
Discuss issues where the grammar in spoken language and sign language differ.
For example, English sentence structure vs. Topic-Comment in ASL
- Unknown Words
- Default actions when the words are not in the dictionary.
- Performance Under Load:
- Failure with big text inputs or unsupported characters.

C. Comparison to Existing Solutions

- Assess how your app is different from or better than other existing text-to-sign language apps.
- Focus on special features such as the use of GIFs for translation or the ability to translate.

D. Technical Enhancements

- Talk about efficiency methods:
- File size minimization to load the GIF
- Enhancing transitions to ensure seamless GIFs
- Consider implementing AI or machine learning for contextual translation.

E. User Feedback Insights

- Summary of feedback:
  Praises for common occurrences (e.g., clear signs, user-friendly interface).
  Suggestions for improvement (e.g., phrases to add, increase speed of sign).
- Quantitative ratings (e.g., 4.5/5 for ease of use).

4. Future Scope

- Scalability:
Vocabulary enlargement through signs.
- Multi-language supports for sign languages: (such as British Sign Language, Indian Sign Language).

5. Advanced Features:

- Superimposing speech-to-sign in real-time.
- Utilizing dynamic signs in 3D avatars rather than static GIFs
- Machine Learning Integration:
- Implement gesture recognition with models such as MediaPipe or TensorFlow.
- Community Collaboration:
- Validation and improvement based on deaf communities' feedback.
- Cross-Platform Accessibility:
- Make it accessible on the web and iOS.

6. Conclusion

- Summarize the major achievements of the project
  Reflect on how the app addresses communication challenges.
- Emphasize the social impact and potential for future development.

7. Appendices

- Include screenshots of the app interface.
- Provide sample inputs and outputs.
- Show flowcharts or diagrams of the system architecture

CHAPTER-10

CONCLUSION

Communication is the birthright of every human being, and improper communication would always form barriers for disabled people who have hearing/speech impairments. In today's world, where verbal interaction has been the ruling factor, millions of people remain excluded because of the absence of accessible and inclusive tools. "Talking Fingers" addresses this critical gap by providing a comprehensive text-to-sign language translation system catering to the diverse needs of Indians. It compensates for the shortcomings of existing solutions by incorporating Indian Sign Language and multilingual capabilities, all in offline functionality. Current solutions, promising as they may be, have a tendency to focus on American Sign Language and insist heavily on internet connectivity, thus not being accessible to rural populations and irrelevant to India's linguistic diversity. "Talking Fingers" goes beyond these limitations by offering a low-cost, user-friendly platform that supports multiple Indian languages and functions without an internet connection, thus empowering users across urban and rural divides. AI, NLP, and HamNoSys are some of the advanced technologies used in the research methodology to make the translation almost accurate and realistic. A context-aware NLP engine coupled with a very large ISL database empowers the system to offer instantaneous and meaningful translations, not limited to literal word-to-word conversions. This means nuances and the cultural elements of Indian languages are preserved in the translated signs. This project has the potential to change the face of communication in academic institutions, places of work, health facilities, and even public services in general. The project opens up classes of ISL to hearing-impaired students, empowers workers to participate more meaningfully in their work, and enables patients to express themselves to their health caregivers. The project sensitizes people towards Indian Sign Language and its integration into society for a more inclusive atmosphere. Scaling and continuous improvement is the bigger vision of "Talking Fingers". Future improvements might include bidirectional communication, where sign gestures would be translated into text; further, regional languages and idiomatic expressions could be integrated. With continuous user feedback, the system would have evolved to meet emerging needs and range. "Talking Fingers" is way beyond an appliance; it's a step toward breaking barriers in communication and building inclusiveness. In this respect, "Talking Fingers" would allow hearing and speech-impaired people to participate in full in social life, a project contributing to achieving global goals such as Reduced Inequalities (SDG 10) and Quality Education (SDG 4). With its focus on accessibility, affordability, and adaptability.

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APPENDIX-A
PSUEDOCODE

Pseudo-code: Text-to-Indian Sign Language Conversion

1. Front-end Development
The front-end is responsible for interacting with the user, collecting input, and displaying output.

1.1 plaintext
Create an HTML layout with:
- A text input field for manual input.
- A button to activate speech recognition.
- A display area for the processed text.
- A canvas/WebGL area to show 3D animations.

1.2 Style the user interface using CSS for a clean and user-friendly design.

1.3 Implement user interaction logic using JavaScript:
- Function `startSpeechRecognition()`:
  - Activates the Web Speech API for capturing user speech input.
- Function `processTextInput()`:
  - Reads the text input entered by the user.
  - Sends the text to the text preprocessing module for further processing.

2. Speech Recognition (JavaScript Web Speech API)
Speech recognition captures spoken input and converts it to text.

2.1 plaintext
Function: `startSpeechRecognition()`
- Initialize the Web Speech API.
- Start listening for speech input from the user.
- On detecting speech:
  - Convert the spoken words to text.
  - Pass the resulting text to the `processText()` function for preprocessing.

3. Text Preprocessing (Python with NLTK)
The preprocessing module cleans and tokenizes the text for mapping it to sign language gestures.
3.1 plaintext
Function: `processText(text)`
- Import required libraries, including NLTK.
- Perform the following preprocessing steps:
  1. Convert the text to lowercase.
  2. Tokenize the text into individual words.
  3. Remove stop words (e.g., "is," "the") and punctuation.

- Map each tokenized word to a corresponding sign language gesture using a predefined Dictionary.
- Return a list of gestures corresponding to the input text.

4. 3D Animation Rendering (Blender and WebGL/Three.js)
This module displays the corresponding Indian Sign Language gestures as 3D animations.

4.1 plaintext
Function: `displayAnimation(gestures)`
- Import Blender animations into the JavaScript environment (e.g., using Three.js or WebGL).
- For each gesture in the `gestures` list:
    1. Load the corresponding animation sequence from the 3D model.
    2. Play the animation on the canvas/WebGL area.
    3. Wait for the animation to complete before displaying the next gesture.

5. Integration and Workflow
The following workflow integrates all components for seamless operation.

plaintext
Function: `convertTextToISL()`
- If the user selects speech input:
    1. Call the `startSpeechRecognition()` function.
    2. Pass the recognized text to the `processText()` function.
- If the user selects text input:
    1. Retrieve the input text from the text field.
    2. Call `processText()` to preprocess the text.
- Pass the processed text (list of gestures) to `displayAnimation()` for rendering.
- Display the animations sequentially.

Bind the user interface buttons to their respective functions:
- Speech recognition button → `startSpeechRecognition()`
- Text submission button → `convertTextToISL()`

6. Word-to-Gesture Mapping
- Create a dictionary mapping individual words or phrases to their corresponding sign language gestures.
- Handle unsupported words with a fallback mechanism, such as fingerspelling animations.
Error Handling
- Handle errors like:
  - Speech not recognized.
  - Unsupported words or missing gestures in the mapping dictionary.
  - 3D animation file loading errors.

This pseudo-code provides a clear and modular structure for implementing the Text-to-Indian Sign Language conversion system. It integrates user input, speech-to-text conversion, preprocessing, and 3D animations into a cohesive workflow.

APPENDIX-B
PLAGIRISM REPORT

SK Jamil Ahmed TALKING_FINGERS_GROUP12_review2_final[1] (4)

ORIGINALITY REPORT

7%	6%	5%	3%
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APPENDIX-C
CERTIFICATES

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Is hereby awarding this certificate to

Naga Nikhitha Peddisetty

In recognition the publication of the manuscript entitled

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