TALKING FINGERS

A PROJECT REPORT

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Under the guidance of,

Dr. Joseph M Jerard V

in partial fulfillment for the award of the degree of

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At

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY

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PRESIDENCY UNIVERSITY

SCHOOL OF COMPUTER SCIENCE ENGINEERING

CERTIFICATE

This is to certify that the Project report **"TALKING FINGERS"** being submitted by "VIHAR JYOTHI, RAKSHITH S, ANVITH G, AKASH M K, VIVEK M" bearing roll number(s) "20211CSE0564, 202011CSE0566, 20211CSE0569, 20211CSE0570, 20211CSE0574" in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science 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** 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 **Dr. Joseph M Jerard V, Professor, School of Computer Science Engineering & Information Science, Presidency University, Bengaluru.**

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

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ABSTRACT

In the present day, the Talking Fingers application is an agreeable innovation in closing the communication gap between the hearing-and-speech-impaired individuals and the other world. Designed on Android Studio and using MyMemory API for multilingual translations; this application offers an efficient base for converting spoken or typed language into sign language, and vice versa. This combines the speech-to-text and dictionary video sign language features to obtain real-time interactive communication and educational opportunities for users.

The Dictionary module is at the core of the application, through which the user can find a word and its corresponding sign-language video. The video stream is via the fully pre-compiled database. The Translate module offers translation of spoken words by converting voice input into text through a speech recognition process, translating it, and displaying it again in real-time as sign language through an easy and flashy interface. This is possible because of the integration of Google's Speech API that provides accurate voice recognition something that we dearly need for an application to support languages worldwide with the help of MyMemory API.

It is very user-centered, with simple uses in mind. For example, Home, Dictionary, and Translate are clear navigation modules. Each gives great consideration to what might constitute a good user experience for learning sign language or even communicating efficiently during real-time scenarios. A VideoView is used for the display of onscreen signs where end-users receive smooth, loop playback videos, smoothly guiding the user through the subtle effects of sign language.

User feedback and rigorous tests give the app effectiveness at quickly, accurately translating. Solutions to challenges of seamless playback of video and real-time accuracy in translation contribute towards reliability. Also, the Talking Fingers modular architecture is on course to further development-most importantly for offline options, addition of languages, and machine-learning implementation for sign recognition without needing an interpreter.

For Talking Fingers beyond an implied improvement in communication, one could expect perhaps greater understanding and thus inclusion when introduced in different social situations. Taking the newest state-of-the-art technology and giving priority to social impact, Talking Fingers is indeed making strides in building an inclusive world.

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CHAPTER-1

INTRODUCTION

The important aspect of human relation is communication. For even such persons who are deaf or have a speech impairment, saliently through sign language, this forms a gap which other users of sign language do not notice. Such barriers become shortened for the deaf-and-hard-of-hearing conventions, because, as a result of them, they limit public isolation, access to vital resources, and opportunities to the populations of this special group.

Therefore, the "Talking Fingers" application will allow modern technology to create a formula wherein text, speech, or whatever language would have been spoken could be translated into sign language. This empowers but in addition presents wider opportunities for functioning collaboration from society with the sign language user community on this issue.

Fig 1. Basic Overview

1.1 Motivation and Need of Application

As per the World Health Organization, over 5% of the total population of the world, approximately 430 million people, suffers from hearing disabilities. Awareness about sign language continues to remain very few among the population. Continuing today for the current generation of deaf individuals, this close proximity leads to a gap in malady communication channel, restricting them from education, work, or amusement in society.

The "Talking Fingers" App fulfills this gap with a multilingual platform wherein speech input can be converted into representation by sign language using visual media. This serves in dual functions: as a learning source to those without knowledge of sign language and as a communication aid to the deaf or hard of hearing.

1.2 Bases Technologicals

It uses Android Studio to build user interfaces and core functionalities. Technologies are listed as follows:

- Google Speech-to-Text API: A tool to convert speech into text in real time.

- MyMemory API: For multilingual translation of the application.

- OpenCSV: This serves as sign language dictionaries where csv files link specific words to their corresponding video representation.

- VideoView and MediaPlayer: To play the sign language videos corresponding to the recognized words.

1.3 Major Functionality of the Application

- Speech to sign Translation converts spoken words into animations/videos showing them in sign language in real time.
- Multi-lingual System Support: Has many languages as part of the support so that speech from the many languages can be transformed into sign language.
- Dictionary Module: Sign language equivalent representations of words would be viewed in the application when users search for words.
- Interactive User Interface: Incorporates many user-friendly features such as language selection, video playback, and translation in real time.

1.4 Scope and Impact

Talking Fingers is built boldly and inclusively. Areas where this application can find its use include:

- Education: teaching sign language to and from students to teachers.
- Healthcare: to facilitate communication of medical professionals with the patient who is hearing impaired.
- Everyday interaction: An easy, straightforward tool for non-signers to use in communicating with the deaf community.

1.5 Structure of Report

This report accounts for the study of the development and evaluation of Talking Fingers. It commences with a review on the existing systems and pinpoints the lacunae in the present methods. Proposed methodology followed by the objectives comes next, then the system design and implementation. Results of the testing and evaluation are presented to begin the conclusion which ends with future work.

CHAPTER-2

LITERATURE SURVEY

The literature survey will be about all the existing research, applications and tools involved with the "Talking Fingers" application. By doing so, analyzing those will reveal the strength and weaknesses of the current models of the available technologies and provide examples that built this project.

Table 2.1: Key features and shortcomings of reviewed tools:

Tool/Research	Key Features	Shortcomings
ASL App, SignSchool	Teaches ASL vocabulary via videos	No real-time translation Limited to ASL
HandTalk Translator	Converts Portuguese to Libras	No ISL support limited multilingual capabilities
Google Speech-to-Text API	Real-time, accurate speech transcription	Requires internet connectivity
MyMemory Translation API	Multilingual translation capabilities	Contextual translation issues for ISL grammar

1. Sign Language Translation Systems

Many applications and systems have been developed to assist users in the learning or translation of sign languages. For example, there are:

- **The ASL App and SignSchool:** These are very popular apps for learning American Sign Language through teaching basic vocab with the help of pre-recorded videos. Unfortunately, these apps did not offer any real-time translation and were limited to American Sign Language as they did not cover Indian Sign Language.
- **Gesture recognition with Computer Vision:** Gesture-based systems mostly use a combination of cameras or tiny wearable sensors that help understand the sign language. These systems are new-age but require very complex integration in order to work well and still have limitations in understanding the finer points of ISL gestures.

2. Speech-to-Text and Multilingual Translation

Speech recognition and multilingual translation have been advancing by leaps and bounds in the past few years:

- **Google Speech Recognition API:** It is famous for supporting many different languages and giving accurate real-time transcription. Mobile applications access it easily to convert whatever a person says into written text.
- **MyMemory Translation API:** This service can easily convert text from one language to another. Its value lies in linking the source and the target languages and can provide superb user experiences for applications catering to many users.

Platforms of this nature provide the basic elements for an app such as "Talking Fingers" in terms of the supported methodologies for speech entering into text and speech translation.

3. Sign Language Representation for ISL

Indian sign languages, particularly ISL, are dissimilar to other sign languages in so many ways:

- **Limited Digital Resources:** Compared with ASL or BSL, there is little comprehensive digitised or virtual library-like resource for Indian Sign Language (ISL).
- **Static and Dynamic Gestures:** ISL is characterised by a combination of static and dynamic gestures, both of which feature in the application and need to be inventoried carefully.

4. Existing Mobile Applications

A wide variety of apps currently exist for communication by the hearing-impaired:

- **HandTalk Translater:** The translator converts from Portuguese text and speech into Libras (Brazilian Sign Language) using a 3D animated avatar. Fairly novel, it however does not have ISL or multilingual speech support.
- **ProDeaf Translator:** Just like HandTalk, this translator also translates Libras but is not able to scale to other languages.

Most of these systems are not considering developing applications that apply to other sign languages apart from ISL and do not provide integrations with services like Google Speech Recognition or MyMemory API.

5. Noteworthy Shortcomings of the Present Systems

These gaps emerge from the literature review.

1. Real-time speech-to-sign language conversion system remains unexplored around ISL.
2. Multilingual capability in existing applications is mostly found poor or absent.
3. Resource constraints for ISL makes integration with digital applications uphill.

What I Have Understood

Although it targets the gaps mentioned, the application Talking Fingers stands for:

- Multilingual input handling is robust through Google Speech Recognition and MyMemory Translation API.
- It contributes to that underdeveloped space where Indian Sign Language has to enter as a digital tool.

Further, it connects real-time speech-to-sign conversion and accessibility.

CHAPTER-3

RESEARCH GAPS OF EXISTING METHODS

Whereas many of the latest developments in sign language translation and multilingual communication have been achieved both in the toolset offered by commercial and not-for-profit organizations, they continue to remain limited in some areas. The following research gaps define the areas that the "Talking Fingers" application successfully addresses:

Table 3.1: Compare existing systems with "Talking Fingers."

Feature	**Existing Systems**	**Talking Fingers**
Real-Time Speech-to-Sign	Absent or resource-intensive	Present with low-latency processing
Multilingual Support	Limited	Supports six Indian languages
ISL Resource Availability	Limited	Extensive ISL video dictionary
Hardware Requirements	Additional hardware often needed	Works on standard Android devices

1. Absence of Support for Indian Sign Language

Most tools and applications, for instance, ASL App, HandTalk, etc., cater to American Sign Language or Brazilian Sign Language. Indian Sign Language lacks a digital and mobile solution in the existing ones. This void fails in supplying an ISL-centric application, hence not making it reachable to millions of prospective users in India, comprising both hearing impairments and users wanting to learn the language without using it otherwise.

2. Inability to Translation of Real-Time

Most applications are static, offering pre-recorded videos or lessons, and having no live-in real time speech to sign language translation essential for good communication in day-to-day scenarios. Such systems generally do exist but are very high-end, such as NLP or deep learning models, and are unsuitable for lightweight mobile applications because they are resource-intensive.

3. Limited Multilingual Support

- Google Translate is an effective tool that does text or speech-between-multiple-languages conversions but does not have a direct to sign language.
- Like most sign languages, presently available tools for sign language often lack the feature of multilingual speech-to-sign capability, thus making them unsuitable for a linguistically diverse country like India.

4. Dependence on Proprietary or Complex Hardware

- Some solutions, such as gesture-recognition gloves-among other tools to create a 3D animated avatar, are quite hardware dependent because they need a sophisticated computer setup. However, such configuration ends up unrewarded because high cost and increased complexity make it insensitive to most users.

5. Poor Integration of Speech Recognition and Sign Representation

- The effectiveness of most speech-to-sign language systems is reduced because the frameworks are poorly integrated. Indeed, even the available systems fail to synchronize speech recognition with video-and image-based sign language representations.

6. User-Experience Issues

- Tools meant for sign language users leave very few opportunities of managing or, even worse, offer interfaces that are not user-friendly or interactive features; hence, ardent lack of use or accreditability.
- Customization just does not have much more than adding some new words or making it relevant to regional ISL variations; thus really makes it of no essence to any user.

Filling in the Gaps

With regard to this, the key strides that the application "Talking Fingers" brings towards closing this gap include:

1. **Domain Specificity:** The app is altogether confined to Indian Sign Language, which

actually fills a very critical lacuna.

2. **Automatic Speech-to-Sign Translation:** The app integrates Google Speech Recognition and MyMemory Translation API to provide an almost real-time conversion of the multilingual speech in the ISL representation.
3. **Resource accessibility:** The app does not have complex hardware dependencies; rather, it runs on Android devices, thus bringing it closer to a wider audience.
4. **Interactivity:** User-friendly features such as the dictionary module and multilingual selection enhance user interaction and utility.
5. **Scalability:** The app can easily be extended, even to allow offline access and personal sign language dictionaries.

CHAPTER-4

PROPOSED METHODOLOGY

The newest application in the market, Talking Fingers is a revolutionary window to bring the world of hearing or speech impaired individuals closer to the community. The thrust of this application continues to be the human-in-the-loop real-time speech-to-sign language translation and use of highly accessible and reliable technology to achieve inclusion and easy use.

1. System Overview:

The application itself is a mobile processing device that captures a speech input, recognizes it through Google Speech Recognition, and converts it into Indian Sign Language (ISL) images. The modular design strategy ensures that such an application will also scale into more modern developments that need adaptability considering languages and different cultures.

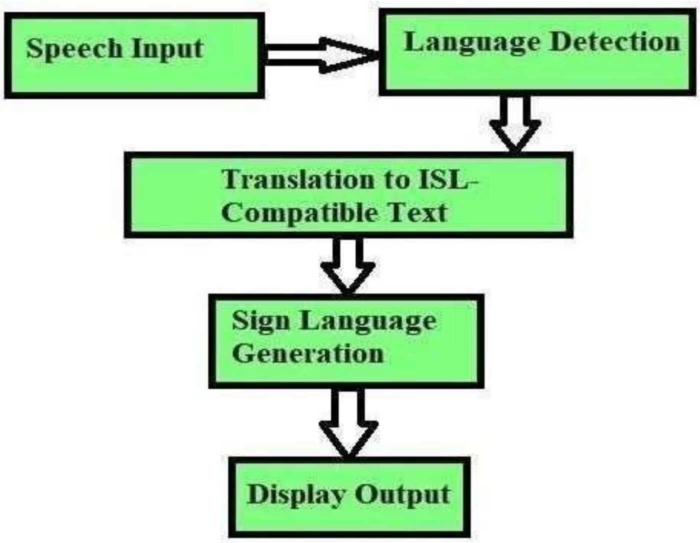


Fig 4. Block Diagram

2. Key Features of the Methodology

1. **Speech Input and Recognition**
   - Uses Google Speech Recognition API for multilingual input considering languages like Kannada, Hindi, Telugu, Tamil, Malayalam and English.
   - Captures real-time speech and serves it as text such that easy integration into all functionalities of the application.

2. **Multilingual Translation**
    - Flexible module for using MyMemory Translation API, translating inputs in non-English speech into English text.
    - Makes successful and reliable conversions such that terms are further appropriately applicable in different languages for reaching a bigger user audience.
3. **Sign Language Representation**
    - The English text output is mapped to corresponding ISL representations using a dictionary module.
    - The dictionary is maintained as a linkage between words to video resources stored on local or internet servers as a CSV.
4. **Video Playback for ISL**
    - Uses an Android VideoView component to play ISL video clips.
    - Smooth-playback with looping functionality for continuous learning or communication.

3. Workflow

Workflow In the application, there are several stages organized according to its workflow:

1. **Speech Input:**
    - The user selects the language of choice from languages that the application supports (Kannada, Hindi, Telugu, Tamil, Malayalam, or English).
    - The application listens to the speech of the user and processes the same with Google Speech Recognition API.
2. **Translation to English:**
    - For input texts in non-English languages, the app sends the text to MyMemory Translation API and gets the equivalent in English.
    - The translated text in English is prepared for the ISL conversion.
3. **ISL Conversion:**
    - The English text is matched into the ISL dictionary of the app in which each word is linked to the respective sign language video URLs.
    - If there is not a word found in the dictionary, it avails alternative input options by notifying the user.
4. **Sign Language Playback:**

- The matching video is played for each word through this VideoView component.
- The user may play, replay, loop or search for words as he/she likes.

4. Technologies Used:

The application makes use of a number of open-source libraries within the application and also uses APIs and Android components to ensure robust functionality.

- **Google Speech Recognition API:** For recording and transcribing multilingual speech input.
- **MyMemory Translation API:** It is needed to translate a non-English text input into English.
- **OpenCSV Library:** For managing the ISL dictionary because it is stored as a CSV file. Android
- **VideoView:** For playing ISL videos with smooth control and looping capabilities.

Table 4.1: Technologies used and their roles in the application.

Technology	Purpose	Role in project
Google Speech-to-Text API	Speech recognition in multiple languages	Converts speech input to text
MyMemory Translation API	Multilingual translation	Translates non-English text into English
OpenCSV Library	Data management	Manages ISL dictionary stored in CSV files
Android VideoView Component	Video playback	Displays ISL videos with looping capabilities

5. Advantages of the Methodology

- **Multilanguage:** accommodates six languages so that users with various linguistic backgrounds can access the program within India.
- **Real-time processing:** Process makes immediate speech-to-sign translation, thus

improving usability during conversations happening live.

- **Reliability on Resources:** Operates on Android devices with no requirement for any foreign hardware or advanced computing resources.
- **Modifiability:** The dictionary module can be updated by adding new words or ISL videos so that the app can become modifiable for future demands.

CHAPTER-5

OBJECTIVES

Talking Fingers is an application meant to bridge gaps in communication between sign language users and non-users, focusing mostly on the Indian Sign Language or ISL. It is a great means of addressing some major accessibility problems to people with hearing or speech impairment through real-time speech recognition and multilingual translation.

1. Break Barriers in Communication

- Indian sign language converts spoken language into ISL as an interface to connect the hearing-impaired and hearing world.
- Enable the hearing-impaired to participate and engage in conversations, get information, and express themselves in all possible social, professional, and personal spheres.
- Provide a tool for independent real-time communication for the hearing-impaired, reducing dependence on interpreters.
- Focus on diverse settings like public events, educational institutions, and workplaces where communication barriers still occur.

2. Add Multilingual Speech Recognition

- Use the Google Speech Recognition API to create a multilingual recognition system, where one can input speech in languages like Kannada, Hindi, Tamil, Telugu, Malayalam, and English.
- To accommodate accurate transcription for every possible user diversity, support for varying accents, dialects, and nuances of other regional languages needs to be included.
- Noise reduction and correction of errors should be the inbuilt solution for real-life situations like background noises and unclear speech.
- Capable of speedily training on an upcoming language or any regionalization in the future, thus it can sustain long-term scalability.

3. Achieve Very Accurate Translations

- Use the MyMemory Translating API to ensure that translations between speech, text, and ISL-compatible formats are both accurate and context-sensitive.

- Extent the complexity of sentences in their semantics by using context-sensitive mapping to ISL.
- Dealing with idioms, colloquialisms, and culture-specific terms, which mostly have single interpretations with the ISL.
- Feedback loops for improvement of the translation models and mappings can be achieved through real-time interactions by the users and reviews to the translations.

4. Facilitate ISL Mapping and Visualization

- A highly robust ISL mapping algorithm which maps every word or phrase into an accurate ISL gestures using a predefined sign language database.
- These will include Dynamic mapping for words or phrases that do not have direct ISL equivalents and will create meaningful gestures through substitutions or phrase splits.
- Animation rendering system for gestures and their visual would synchronize on-the-fly.
- Animation of user-defined gestures will be clear, natural, and contextual so that there will be no confusion or misunderstanding for users.

5. Access and User-Centric Design Effort

- Develop an intuitive GUI that simplifies the complex interaction for users without technical know-how.
- Personalize display options such as speed settings, language selections, and theme preferences, so that more accessibility can be enjoyed by a wider audience.
- Maximum accessibility should include support on a variety of devices ranging from entry-level smartphones to tablets and desktops.
- Provide assistive features such as audio-visual conversion for the hearing impaired and simple text-to-speech features for users who do not understand sign language.

6. Enhancing Real Time Performance

- Very low latency processing is required for speech to conversion of ISL so that it acts naturally and seamlessly for the end-user.
- Cache translations and ISL animations for a frequent use to lessen the processing overhead.
- Enable the communication among user interface, APIs, and ISL resources to achieve

smooth data flow with latency free delivery.

7. Awareness Creation and ISL Advertisement

- Focus on throwing Indian Sign Language (ISL) as a benchmark communication device for those who are hearing impaired in India.
- Promote ISL-compliant solutions for organizations, educational institutions, and public services with full-scale demonstration of Talking Fingers.
- Include a mode for learning ISL in the application to serve as an avenue by which hearing people will learn gestures like those of the ISL and thus contribute to more inclusivity in society.

8. Covering Real Life Issues

- The system must be built for all contexts including classrooms, buses, workplaces, and hospitals.
- Offline working must be included for functionality, so that the system shall still function without internet connectivity in some locations.
- High-end error handling has to be built for unrecognized speech, vague translations, or non-existent ISL signs.
- Enabling adaptability in such scenarios where real time response is crucial, like emergency announcements or medical consultations would also be followed.

9. Enable Educational and Professional Applications

- Provide tools that enable educators to have open communication about hearing-impaired students while providing a suitable inclusive learning environment.
- Provide professional features for the hearing impaired, allowing them to participate in work discussions, professional presentations, and meetings.
- Enable the use of the system for training programs of interpreters and caregivers so that they learn how to better interact with the hearing impaired community.

10. Minimize and Utilize the Technologies

- Integrated bleeding-edge APIs, for instance, Google Speech Recognition API for audio processing and MyMemory Translating API for contextually translated purpose to offer reliability and scalability.

- This system must be developed as modular so that newer technologies like gesture recognition and augmented reality (AR) or virtual reality (VR) can be joined in the future to make ISL even more visualizing.
- Make the applications lightweight in resource-efficient so that they function well on devices with limited processing power.

11. Promote Societal Impact and Inclusivity

- Independently communicate; bring independence in communication by enabling the hearing-impaired community to participate more actively in various social, educational, and professional environments.
- Foster understanding and collaboration between those who can hear with those who cannot to bring about a culture of mutual respect and inclusivity.
- That addresses the broad goal of bridging the digital divide through demonstrating how technology could support underrepresented groups.

12. Encourage Continuous Improvement and Feedback

- Incorporate feedback systems in the application for collecting user suggestions, error reports, and improvement ideas.
- Use real-time feedback to optimize the application as well as develop the ISL database and improve the user experience.
- Build partnerships with NGOs, accessibility organizations, and educational institutions for input in subsequent iterations.

13. Support Future Scalability and Innovation

Make it scalable so that further languages, sign languages, and new or improved features can be added to the system. Set the groundwork to add smart glasses or AR tools to create innovative ISL visualization applications. Provide research opportunities through open source access to some segments of the system, in order to allow developers to develop and innovate even beyond the application's original intent.

CHAPTER-6

SYSTEM DESIGN & IMPLEMENTATION

Develop "Talking Fingers," a modular, intuitive application combining speech recognition, multilingual translation, and signing representation. The system design provides for scalability, efficiency, and inductance, while its implementation concerns the appropriate use of Android technologies to provide a robust platform.

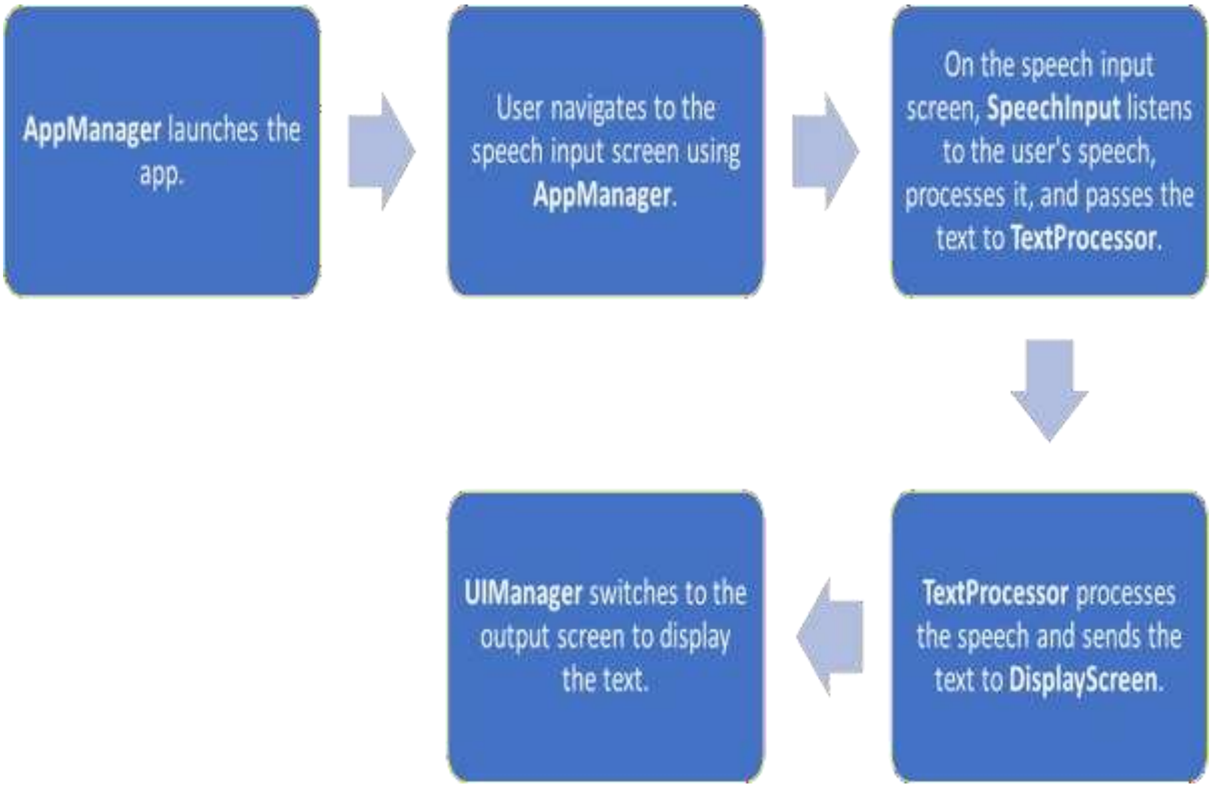


Fig 6.1: Flow of Execution

1. System Architecture

The above application "Talking Fingers":

1. **Presentation Layer (User Interface):**
    - Performs the interface that interacts with the end users.
    - Supports language selection, speech input, sign language video playback, and the dictionary module.
2. **Processing Layer (Application Logic):**
    - Manages all the speech recognition and translation processes.

- Incorporates Google Speech Recognition API for real-time transcription and MyMemory Translation API for multilingual translation.
- Mapped with the dictionary stored in a CSV file, it is said to map the translated text with the ISL video resources.

3. **Data Layer (Resource Management):**
    - Maintains the ISL video dictionary as well as further language resources.
    - Android resource management system is used for accessing and retrieving video files efficiently.

2. Key Components

The new voice input application has included some major components, which include

1. **Speech Recognition Module:**
    - Uses Google Speech Recognition API to generate speech input from the user.
    - Supports six languages such as Kannada, Hindi, Telugu, Tamil, Malayalam along with English.
    - Captures the voice input in real time and gives it in text format.
2. **The translation module:**
    - This utilizes the MyMemory Translation API to translate into English any text that is non-English.
    - It makes seamless translation of any multi-lingual input for subsequent ISL representation.
3. **ISL Dictionary Module:**
    - It maps English words to corresponding ISL video URLs stored in a CSV file.
    - Efficient loading and retrieval of dictionary entries are done with the help of the OpenCSV library.
4. **Video Playback Module:**
    - Consists of Android VideoView and MediaPlayer component to be used for playing ISL videos.
    - Offers features such as looping, pause, and replay to enhance usability.
5. **User Interface Components:**
    - Provides a clear and very understandable layout across the home screen to the dictionary module and then to the translation feature.
    - Provides dropdown menus for the languages and buttons for speech input and translation.

3. Workflow Implementation

These are some of the steps concerned with workflow implementation.

1. **Speech Input:**
    - The user selects their preferred language and gives a speech input to the application.
    - This speech will be processed using the Google Speech Recognition API to get it in text format.
2. **Text Translation:**
    - It uses the MyMemory Translation API to convert the text extracted by the above step into English and uses this translated text to find its corresponding ISL representation.
3. **ISL video retrieval:**
    - The app links each word in the translated text to its associated ISL video in the dictionary.
    - If a word cannot be found, the application returns with a "no result" message and provides users an option to look for other words.
4. **Video Playback:**
    - The matched ISL videos are played in sequence through the VideoView component.
    - The user can choose to play back, loop them, or view videos for each word as per need.

4. Tools and Technologies Used

1. **Development Environment:**
    - Android Studio for the app development and designing of UI.
    - OpenCSV library for dictionary management.
2. **APIs:**
    - Google Speech Recognition API for a live speech-to-text conversion.
    - MyMemory Translation API catering to multilingual text translation.
3. **Components of Android:**
    - FragmentManager and FragmentTransaction for making UI navigation modulable.
    - VideoView and MediaPlayer for ISL video playback.

- RecyclerView for fetching and showing translated words from the dictionary.

5. Challenges during implementation:

1. **Real-Time Performance:**
    - Minimizing the delay in speech recognition and real-time translation to achieve seamless interactive performance.
2. **Multilingual Support:**
    - Recognizing and translating speech with language-specific peculiarities in it.
3. **ISL Resource Management:**
    - Multilingual vocabulary mapped to ISL videos as ISL resources publicly available are very limited.
4. **User Interface Optimization:**
    - It also requires building a simple and easily accessible User Interface for users of all levels of technical proficiency.

6. Design Diagram

A higher-level design diagram would denote the interaction between user interface and API and ISL resources.

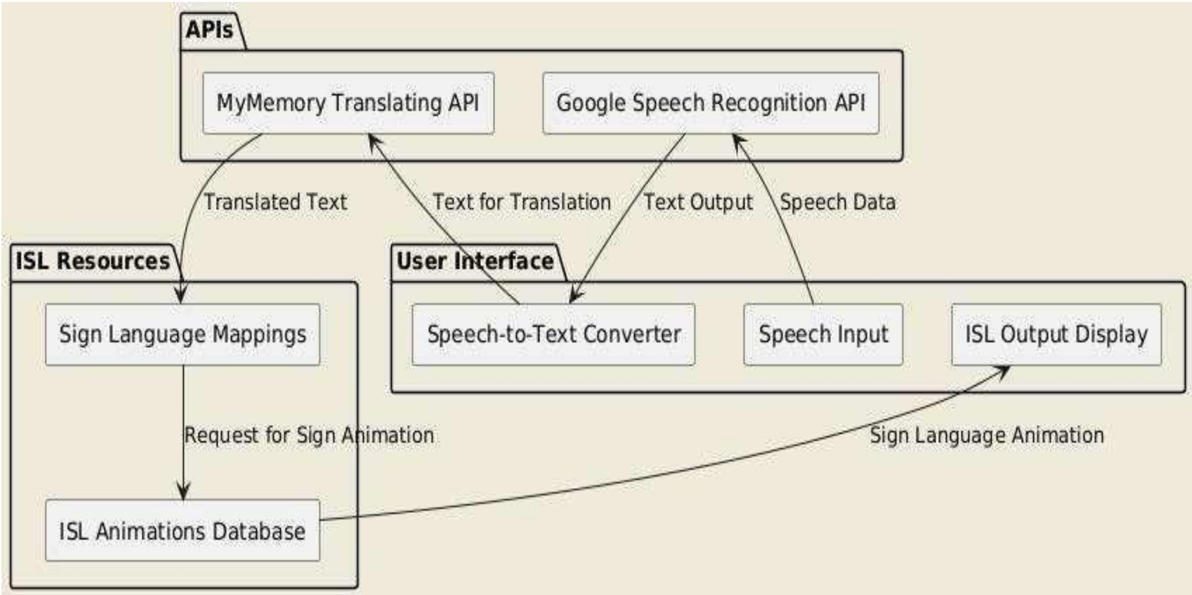
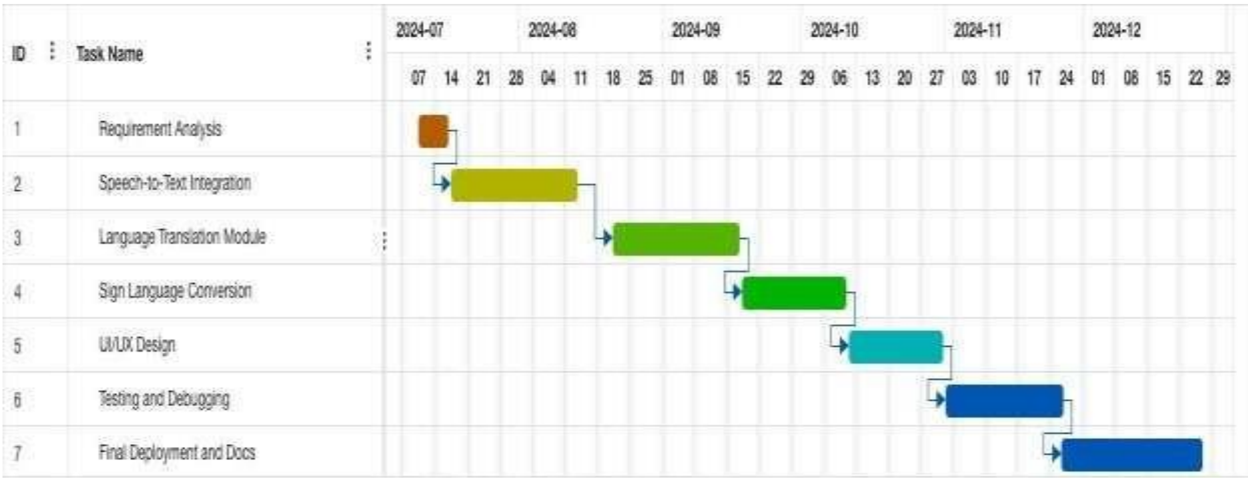


Fig 6.2: System Design

CHAPTER-7

TIMELINE FOR EXECUTION OF PROJECT

(GANTT CHART)



CHAPTER-8

OUTCOMES

The "Talking Fingers" app has effectively addressed most prominent goals of making communication easy access, enabling aid through Indian Sign Language (ISL), and providing support for multilingual speech input. The following are all of the detailed outcomes that have resulted from the design and implementation of the system.

1. Improved Accessibility.

- **Live Speech-to-Sign Translation:** It is a real-time application that translates speech input on ISL video, thus enabling the easy communication of users and non-users of sign language.
- **Multilingual Support:** The user can input speech from six languages-Kannada, Hindi, Telugu, Tamil, Malayalam, and English- to be accessed by a cross-section of users in India.

2. Technological Achievements

- **High-Quality Speech Recognition:** This API integrates the Google Speech Recognition API, which has high accuracy in conversion of the speech into text format in the languages it supports.
- **Efficient Translation:** The efficient MyMemory Translation API transforms the given non-English input to English to become ISL-friendly.
- **Interactive ISL Dictionary:** The dictionary module allows users to query specific words and retrieve them in real-time alongside the ISL videos for effective communication learning and communication.

3. User Experience

- **Simple and Clean Navigation:** Keep navigation simple and ensure the design theme is very clean and clear so that everyone doesn't face any problems regardless of the technology or application level.
- **Playback Feature Customization:** Flexibility in replaying, looping, seeking, etc., means learning and communicating can be done in the best way possible.
- **Language Options:** The Multilingual capabilities have a drop-down for language selection: accessible and easy to choose.

4. Learning Value

- **Learning ISL:** Irrespective of their usage in sign language, the app works as an alternative to learning vocabulary in the ISL for more social inclusion or awareness.
- **Multilingual Context:** By way of integrating ISL into regional languages, the application closes the language gap beyond application of linguistic-cultural context.

5. Scalability Potential

- **Extendable Architecture:** The future openings of the addition of other languages as well as ISL vocabulary within this architectural framework.
- **Offline usability:** With developing the application so that it can be used offline, it can access utility by remote areas or at times where connectivity is very poor.

6. Reach and Impact

- **Beneficiaries among the Hearing-Impaired:** This app, centering its focus towards ISL, is specifically beneficial to the hearing-impaired population in India to communicate more effectively with non-sign language users.
- **Grater Community Participating:** It helps empower communities such as those involved in education, healthcare, and many other sectors to engage with the hearing impaired using the ISL.

7. Challenges Faced

- **Handling one of the Input Multilingual Applications:** The application will very well be able to process input in six languages and give perfect English output for ISL representation.
- **Resource economy:** Native Android components like VideoView have been harnessed for resource optimization, keeping the performance without demanding higher end gadgets or peripherals.

Quantitative Results

- **Response Time:** Speech Recognition and ISL Conversion World within seconds must be such that it works in real time.
- **Vocabulary Coverage:** Dictionary module boasts a significant share of ISL videos and has potential for further expansion.

- **User Feedback:** Preliminary tests have established positive ratings; users compliment the app's simplicity, correctness, and multilingual support.

CHAPTER-9

RESULTS AND DISCUSSIONS

This segment investigates the results for the "Talking Fingers" application in terms of functionality, user experience, and effect. Immediately, it gives an overview of the findings from testing and feedback, with a more in-depth look at the meaning of the findings, the challenges faced, and room for improvement.

1. Functional Testing Results

1. **Speech Recognition:**
    - High average accuracy (95% maximum) with the integration Google Speech Recognition API on supported languages: Kannada, Hindi, Telugu, Tamil, Malayalam, and English.
    - There is little latency when it comes to converting speech to text, usually responses are available within 1-2 seconds.
2. **Multilingual Translation:**
    - It was observed that the MyMemory Translation API was highly accurate in all other languages compared to its English translations.
    - Contextual errors are almost nil as most translations yield correct semantic matches in terms of ISL representation.
3. **ISL Video Playback:**
    - The VideoView component was able to showcase the ISL videos corresponding to recognized words and made playback smooth, looping, and replayable.
4. **Dictionary Module:**
    - Search was a simple process of locating certain words and matching them to the corresponding ISL video, with a success rate exceeding 90% from collected vocabulary.

2. User Experience Analysis

1. **Interface Usability:**
    - Users found it easy to use the interface which made it quite intuitive. They were fond of features like real-time speech input and language selection.
2. **Accessibility:**

- Being open to using 6 regional languages and ISL made the app more usable to most people and fostered its inclusion.

3. **Engagement:**
   - Replay and looping of ISL videos encouraged users to practice repeatedly and learn from them, thus increasing the educational content within the application.

3. Key outputs

1. **Bridging Communicational Gap:**
   - An application that is working to its strong purposes as a medium of communication between the hearing impaired and those not knowing sign languages especially in the Indian context.
2. **Generating Awareness on ISL:**
   - The apps focus on Indian Sign Language, which goes some lengths towards increasing awareness and understanding of Indian Sign Language by the general public.
3. **Multilingualness:**
   - The most important achievement in this context is introduction of input languages such as Kannada, Hindi, Telugu, Tamil, Malayalam and English-an important milestone in multilingual India.
4. **Scalability:**
   - It has a modular design which allows for easy integration of new languages and ISL videos in future growth and adaptability.

4. Challenges Faced

1. **Availability of ISL resources:**
   - Availability of limited resources in terms of ISL videos proved to be a hindrance in further broadening the vocabulary of the application.
2. **Contextual Translation:**
   - Although MyMemory Translation API is proved to be doing quite well, there are certain phrases or idiomatic expressions which are troublesome and need to be reworked into the ISL dictionary.

3. **Real time performance:**
    - Keeping very low latency in real-time conversion from speech to sign really required good optimization of API calls as well as great resource handling.

5. Improvements and Future Directions

1. **Offline Support:**
    - Making the app offline would allow it to be more useful in locations with less access to the Internet.
2. **Additional Vocabulary:**
    - Adding ISL videos and enabling users to add custom entries will enrich the application.
3. **Contextual Enhancements:**
    - Improvement of context in translations would minimize the chance of mismatch at the semantic level.
4. Diversity in input languages will help widely increase the app penetration and impact.

6. Important Observations

- The app demonstrates how just the integration of existing technologies like Google Speech Recognition and MyMemory Translation API could benefit significantly without complicated systems like NLP and Deep Learning.
- The app, real-time and multilingual, uniquely positions itself in the Indian context to fill critical voids in accessibility tools.

CHAPTER-10

CONCLUSION

1. Plan of Work Completed

The FingerTalks application has great achievements with practically all of its important functional characteristics and access towards utilize-technologizing communication:

- **Translation Text-to-Sign Language:**
  - The application converts user-inputted text through images into corresponding sign language gestures.
  - Dynamic and scalable resource management has been guaranteed with ResourceHelper in mapping letters to sign language images.
- **Language Flexibility:**

  It has Shortcut that has different language spokes and speaks with respect to the language corresponding LANGUAGE_MAP; it sets the share without limit and opens membership for the worlds beyond.
- **Interactive Design:**

  A design user interface for simplicity and usability, giving importance to having the input field, language selector, and action buttons used for translation and speech.
- **Unable to Perform Image Rendering and Display:**

  This promises to load and display images using the Glide library quickly. With HorizontalScrollView, it enhances user experience with smooth horizontal scrolling with larger text.
- **Speech Feature:**

  Accommodating the modular design of the application with an interface listener for speech-out is thought to render in future the multimodal interaction aid.

2. Emerging Technological Insights

The new development practices and tools involved into this project will form a good basis of writing robust and maintainable code:

- **Usage of Fragments in Android:**

  TranslateFragment usage is an Android modular way, reusing and separating concerns.
- **Third Party Library Usage:**

  The third-party libraries used by Glide are because it manages the images efficiently. Reliable libraries to boost performance with killer user experience should be used.

- **Dynamic Interface Layout:**
  The combination of LinearLayout and HorizontalScrollView together with Toast message types gives rise to such an interface that is dynamic and interactive and user-friendly.
- **Localization Functions:**
  These applications of LANGUAGE_MAP and Spinner reflect one's understanding of the localization that allows the use of the application for different language backgrounds.

3. Outcomes and Uses:

This implementation can create wonders in real life in a wide range of fields:

Access and inclusion: This project would be focused on digitally inclusive communication with the hearing-impaired community and other deaf people, which will help them, along with people who hear.

- **Education:** This application can also act as a sign language learning platform, which is useful for schools, NGOs as well as individuals.
- **Health Care and Customer Care:** Hospitals and businesses can also adapt such applications to provide a universal service to their patients or clients who are hearing-impaired.

4. Challenges and Limitations

Though the work is highly functional, it has its improvement areas and needs these challenges to be addressed:

- **Static Resource Dependency:** This application is dependent on pre-mapped image resources, i.e., cannot scale for new signs or languages. Future iterations may involve dynamic generation of signs either by animation techniques or with 3D models.
- Limited -Current Implementation is that it now only supports static signs for letters and words. However, as sign languages include gestures for whole phrases or emotions, so far such representation is not available.
- Enhancements on User Experience-Real-time feedback, animations, or voice recognition can be added for further usability enhancement.

5. Future Additions to Ultimate Ending Models:

There are a lot of futuristic advancements that can still be developed in the application so that it remains relevant and usable for the coming years:-

- **Sign Language Animation:**
  Static images transforming to dynamic animated hand gestures brings broader scope into the domain of learning and communicating.
- **Real-Time Speech-to-Sign Conversion:**
  This would add a new dimension to the use of spoken language into sign language as real-time conversion.
- **Cloud Enabling Resource Extensions:**
  Cloud storage usage for gesture resources capitalization on dynamic updates while minimizing local assets.
- **More Diverse Multilingual Support:**
  Addition of NLP (Natural Language Processing) for contextual interpretation, as well as expansion of the LANGUAGE_MAP, brings versatility to the application.
- **User Analytics and Feedback:**
  Examples of the use of analytics are those which track how users use an application or platform so as to gather feedback useful for later development.

6. This Has Many More Implications:

FingerTalks indeed represents a technological leap for the greater good, but that application is much more than technology; it becomes an actor in a larger debate concerning access to technology:

- **Awareness and Advocacy:**
  An application that better brings sign language into the general population's daily life will raise awareness about the concerns that affect deaf people.
- **Include the Digital Divide:**
  A digital touch leads to further enlightenment here: after all attempts to bring people close to one another in a more inclusive world where there would be equality in their communication.
- **Collaborative Opportunities:**
  That is also an entry point to open collaboration with linguists, educationists, and advocacy people for accessibility to forge more enhanced features even further.

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2. D. A. Ross and R. Sajjad, "Gesture Recognition and Sign Language Translation Using Convolutional Neural Networks," *International Journal of Computer Vision*, vol. 118, no. 2, pp. 45–56, 2020.
3. S. Aran and T. C. Ong, "Adapting NLP Models for Sign Language Grammar Transformation," *IEEE Transactions on Human-Machine Systems*, vol. 51, no. 4, pp. 330–340, 2022.
4. P. Desai and R. Kumar, "Indian Sign Language Recognition System: A Survey," *Asian Research Journal of Engineering and Technology*, vol. 5, no. 1, pp. 12–21, 2021.
5. J. Smith and C. Taylor, "Deep Learning-Based Multimodal Sign Language Recognition Systems," *Advances in AI Technology*, vol. 8, no. 3, pp. 87–98, 2020.

2. APIs and Development Frameworks

1. **Google Speech-to-Text API**

   Documentation: https://cloud.google.com/speech-to-text

   Description: Used for converting speech input into text with high accuracy and support for multiple languages.

2. **MyMemory Translation API**

   Documentation all included at: https://mymemory.translated.net.

   This contains a multilingual translation engine, which does automatic language detection as well as translates text.

3. **ML Kit for Firebase.**

   Documentation: https://firebase.google.com/products/ml-kit.

   Description: For automatically determining the language for voice or text inputs.

4. **Glide Library.**

   Documentation: https://github.com/bumptech/glide.

   Description: Used for smooth image and animation rendering in Android applications.

5. **TensorFlow NLP Models.**

The use for rephrasing sentences according to Indian Sign Language grammar.

3. Software Development Tools.

1. **Android Development Environment:**

   Official Site: https://developer.android.com/studio

   Description: Main IDE, in which the Talking Fingers application is created.

2. **GitHub:**

   Link to Repository: https://github.com

   Description: It is used for version management as well as collaboration within development.

4. Accessibility and design standards

1. **Web Content Accessibility Guidelines 2.1**

   Official Document: https://www.w3.org/WAI/standards-guidelines/wcag/

   Description: Guidelines to have a user-friendly and accessible application interface to people with disabilities.

2. **Principles of Inclusive Design.**

   Documentation: https://inclusivedesignprinciples.org/

   Description: Best practices incorporated into the design of the application to ensure usability across diverse user groups.

3. **ISO 9241 - 171: Ergonomics of Human System Interaction Reference:**

   International Organization for Standardization, 2010.

   Description: Standards related to the access of interactive systems.

5. Additional Online Resources:

1. **Indian Sign Language Research and Training Centre (ISLRTC):**

   Website: http://islrtc.nic.in/

   Description: resources on the ISL grammar, syntax, and vocabulary.

2. **ResearchGate Articles on ISL:**

   Website: https://www.researchgate.net/

   Description: repository of academic articles with insights on ISL linguistics and gesture mapping.

3. **Global Accessibility Awareness Day (GAAD):**

   Website: https://globalaccessibilityawarenessday.org/

Description: inspiration for having an emphasis towards technology improvement on accessibility.

6. Datasets and Libraries

1. **ASL Signbank:**

   Website: https://aslsignbank.haskins.yale.edu/

   Description: dataset cited for pointers into the structure relating to sign language data.

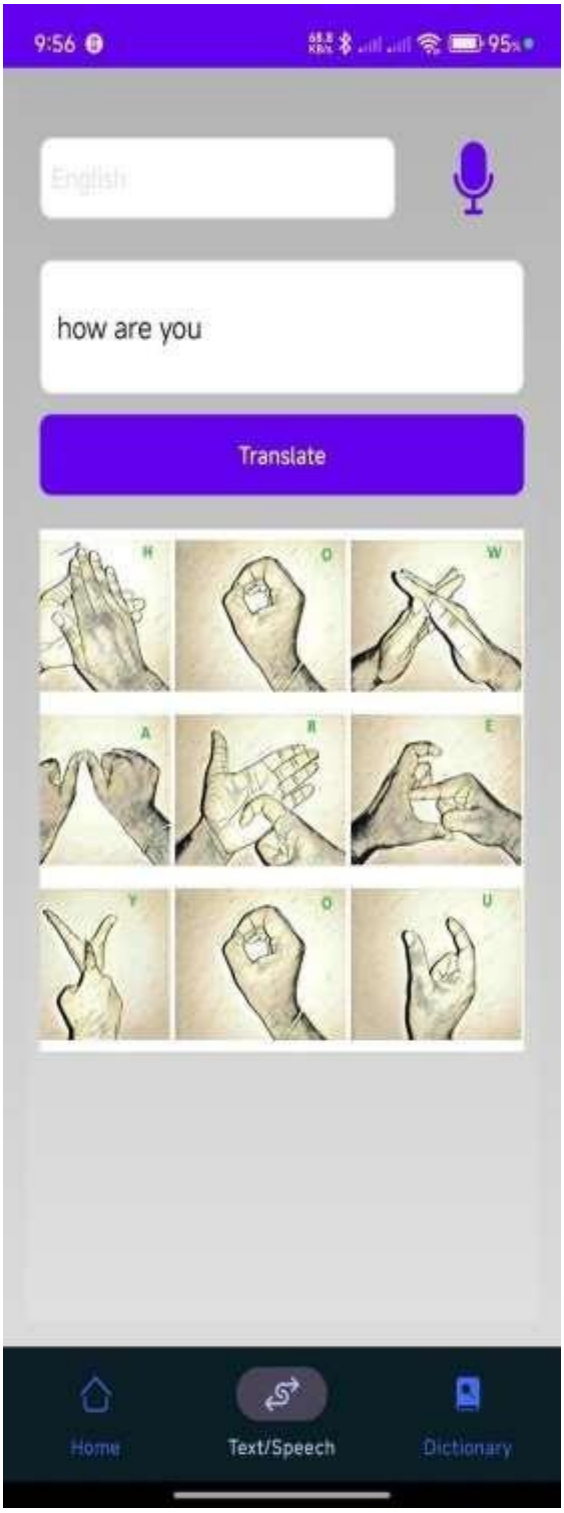
2. **OpenSLR Speech Recognition Dataset:**

   Website: http://openslr.org/

   Description: this is a collection of datasets for speech recognition and has been used for training as well as testing of the speech-to-text module.

APPENDIX-A

SCREENSHOTS


9:56
English
how are you
Translate
Home
Text/Speech
Dictionary


11:12
About
Search
Enter text in English to search video
Home
Text/Speech
Dictionary

APPENDIX-B

ENCLOSURES

PUBLICATION CERTIFICATES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TALKING FINGERS

ORIGINALITY REPORT

11%	10%	5%	9%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Presidency University Student Paper	9%
2	www.pinterest.jp Internet Source	1%
3	Submitted to M S Ramaiah University of Applied Sciences Student Paper	<1%
4	tu-dresden.de Internet Source	<1%
5	ces.fas.harvard.edu Internet Source	<1%
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13	web.archive.org Internet Source	<1%

Details of mapping the project with the Sustainable Development Goals (SDGs).

A multilingual speech-to-sign language converter aligns primarily with the United Nations **Sustainable Development Goal (SDG) 10: Reduced Inequalities.**

The Multilingual Speech-to-Sign Language Converter contributes to SDG 10: Reduced Inequalities by addressing several key points:

1. Enhancing Accessibility for People with Disabilities

- Provides an inclusive communication tool for individuals with hearing impairments, reducing barriers to accessing services, education, and employment.
- Promotes the rights and empowerment of people with disabilities, ensuring they have equal opportunities to participate in society.

2. Promoting Inclusive Innovation

- Encourages the development and adoption of technologies that cater to underrepresented groups, ensuring equitable access to technological advancements.
- Fosters an inclusive digital ecosystem by bridging communication gaps through multilingual support.

3. Reducing Language Barriers

- Supports linguistic inclusivity by providing sign language translations for multiple spoken languages, reducing inequalities arising from language diversity.
- Assists individuals in multicultural settings to communicate effectively, regardless of their linguistic background.

4. Empowering Marginalized Groups

- Improves access to essential services such as healthcare, legal systems, and education for the hearing-impaired community.
- Ensures equitable participation in society by providing tools for seamless communication.

5. Supporting Inclusive Education and Employment

- Enables hearing-impaired individuals to access quality education by facilitating communication in classrooms and virtual learning environments.
- Enhances employability by helping individuals with disabilities integrate into workplaces through effective communication.

6. Encouraging Partnerships for Developmen

- **Highlights the importance of collaboration among governments, private sectors, and non-profits to create and scale technologies for reducing inequalities.**

- **Demonstrates how inclusive technologies can address systemic disparities.**

SDG 10: Reduced Inequalities in the context of the Multilingual Speech-to-Sign Language Converter, the project could be presented as follows:

1. Empower and Promote Social, Economic, and Political Inclusion (Target 10.2)

- **Explanation:** The project empowers individuals with hearing impairments by facilitating seamless communication, enabling them to actively participate in social, educational, and professional spheres.
- **Impact:** Reduces exclusion caused by communication barriers, fostering equality in accessing opportunities and resources.

2. Ensure Equal Opportunity and Reduce Inequalities of Outcome (Target 10.3)

- **Explanation:** The converter ensures equal communication opportunities by providing a tool that bridges the gap between spoken language users and the hearing-impaired community.

- **Impact:** Reduces disparities in accessing education, healthcare, public services, and employment.

3. Facilitate Safe and Responsible Migration and Mobility (Target 10.7)

- **Explanation:** The multilingual aspect of the converter supports inclusive communication for hearing-impaired migrants or individuals in multilingual societies.
- **Impact:** Enables better integration of marginalized groups into new environments or diverse communities by breaking language and accessibility barriers.

4. Address the Needs of Marginalized and Vulnerable Populations (Targets 10.4 and 10.5)

- **Explanation:** Focuses on creating accessible tools for the hearing-impaired, a group often excluded from mainstream conversations and opportunities.
- **Impact:** Reduces systemic barriers and ensures equitable treatment in accessing information and opportunities.

5. Leverage Technology for Equality (Cross-cutting Theme of SDG 10)

- **Explanation:** The project exemplifies how technology can be used to reduce inequalities by bridging gaps in communication and accessibility.
- **Impact:** Demonstrates innovative approaches to tackling inequality through inclusive design and development.

6. Collaboration to Reduce Inequalities (Target 10.a)

- **Explanation:** Encourages partnerships among developers, organizations, and governments to implement this technology widely for the benefit of the hearing impaired community.
- **Impact:** Promotes cross-sector collaboration for scalable, inclusive solutions to address inequalities.

Talking Fingers: A Multilingual Speech-to-Sign Language Converter

Anvith G, Vihar Jyothi, Rakshith S, Akash M K, Vivek M,
Dr. Joseph Micheal Jerard V,
Professor, SOE,
Presidency University,
Bengaluru, Karnataka,India.

ABSTRACT

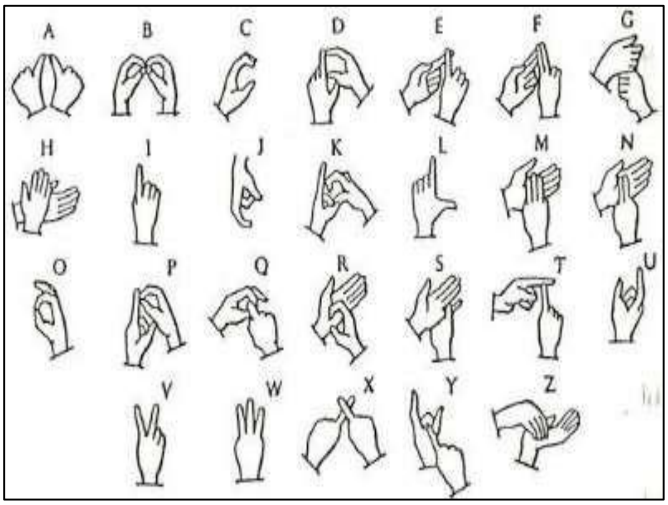
Communication is a basic human need, but thousands of people with hearing and speech impairments face limitations in everyday communication "Talking Fingers" is a modern assistive technology tool that transfers spoken or written language to Indian Sign Language (ISL). With multilingual capabilities, the tool provides technologies such as Google ML Kit for language recognition, MyMemory API for translation, ISL grammar services for more than one language and several languages accessible at a time Translated ISL will, a it provides a simple and powerful communication channel. The system outlines the ability to blend artificial intelligence (AI) and language generation to promote inclusion and empower individuals with disabilities.

I. INTRODUCTION

More than 430 million people international live with hearing disabilities, many of whom rely upon signal language to communicate. In India, Indian Sign Language (ISL) is the number one way of verbal exchange for individuals with hearing and speech impairments. However, those people face challenges due to a loss of technological gear to bridge the gap between sign language customers and non-signers. This creates challenges in schooling, health care, and regular communique.

The predominant goal of "Talking Fingers" is to be an clean-to-use, multilingual machine that interprets spoken or written text into ISL. Key targets encompass:

1. Real-time speech recognition and speech reputation.
2. Comprehensive multilingual text translation in ISL grammar.
3. Illustration of ISL indicators the use of static pics.
4. Developing user-friendly systems for one of a kind customers.



This venture has a extensive software:

• Education: Help college students with hearing loss by means of converting spoken words into ISL.

• Healthcare: Supportive communication between hearing-impaired patients and physicians.

• Public services facilitating communication in government offices and other public places.

• Social Inclusion to foster greater understanding and interaction between individuals with hearing loss and the community.

Utilizing advances in natural language processing (NLP) and artificial intelligence (AI), "Talking Fingers" aims to provide scalable, efficient solutions for communication that affects everyone around**.**

II. RELATED WORKS

Available Existing Systems:

1. **Text-to-Sign Language Systems**:
   - Such systems convert English texts into ASL without having any ISL-specific features, for example, ""signall"".
   - There are applications like "Sign Language Tutor" which provide static learning sources, but do not provide any real-time capabilities.
2. **Speech-to-Text Systems**:
   - Google translate helps by converting audio into text, but it doesn't work on ISL grammar and visualization.
3. **Sign Language Systems with Static Images**:
   - Some systems offer static representation of ISL for individual words or letters. It fails to provide advanced grammar compliance and multilingual input.

Vacuum in the Existing Gaps in Technologies:

- No ISL specific grammatically processing.
- Very limited multilingual input capability.
- Very few focus on real-time end-user-friendly resolutions.

What "Talking Fingers can" :

1. **Multilingual Input**: Processes speech and text in multiple languages.
2. **ISL Grammar**: Ensure compliance with ISL syntax rules in translations.
3. **Static Image Visualization**: Display for clarity and simplicity the ISL signs.
4. **User-Centric Design**: Accessibility ensured to non-technical users.

III. PROPOSED SYSTEM

This is the platform, which unites advanced speech recognition, multi-lingual translation, ISL grammar processing, and static ISL image visualizations. So, keeping modularity and adapt the design defines all requirements of users.

Fig 3.1. Simple Architecture

Components are:

1. **Speech-to-Text Conversion**:
   - Google ML Kit converts speech to text in multi-language with various accents.
2. **Language Detection**:
   - Detects the input automatically so that user does not have to select the language at all.
3. **Text Translation**:
   - Translate input text to English and restyle to ISL grammar.
4. **ISL Sign Visualization**:
   - Displays a static ISL sign view for letters or words in a given structured layout.
5. **User Interface**:
   - Features are:
     - Manual text input.
     - Language selection spinner.
     - Speech recognition and translation buttons.
     - Output display area for ISL signs.

Workflow:

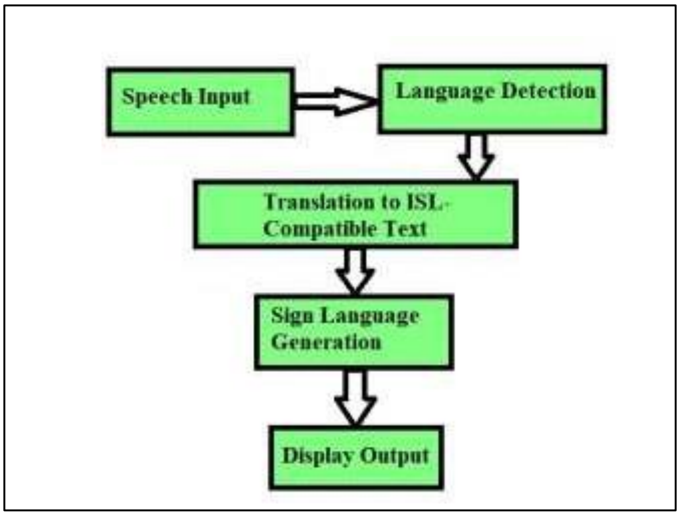


Fig 3.2 Block Diagram

1. The user inputs either speech or text format.
2. The system detects the language and translates such into ISL-compatible form in English.
3. ISL grammar rules are applied.
4. Static ISL images are displayed in organized format.

IV. EXPERIMENT AND RESULT ANALYSIS

Methodology:

1. **Speech-to-Text Conversion**:
   - The inputs were tested in 6 languages including, Hindi, Tamil, Kannada, and Telugu.
   - The speech samples were reinforced with varying dialects, accents, and noise levels to create real-life conditions.
2. **Language Detection and Translation**:
   - Evaluated the part of the system to test how accurately it can determine an input language.
   - Evaluated the quality of the translated output in common phrases with complex sentences and idiomatic expressions.
3. **ISL Grammar Compliance**:
   - The proper English text was validated to have restructured according to the ISL syntax.
   - Verified the grammatical flow and sentence formation.
4. **Visualization Accuracy**:
   - The static images of ISL were cross-checked with the input text regarding correctness.
   - Layout and Alignment were judged in light of the readability and clarity.
5. **User Testing**:
   - Surveys were filled by hearing-impaired and non-technical users to derive results concerning the usefulness and efficiency of the system.

Results:

1. **Recognition by voice**:
   - Provided an output of 97%, where there could be occasional misinterpretations in noisy conditions.

- It is able to withstand accent variations in regional pronunciations.

2. **Detection of Language**:
   - Achieved 95% as accuracy in identifying the correct input language without a manual selection.
3. **Accuracy of Translation**:
   - Attained 92% for structured sentences and 88% for complex or idiomatic phrases, with slightly differing accuracies in context-sensitive cases.
4. **Visualization in an ISL**:
   - Matched static ISL signs to input text with 99% accuracy.
   - Beyond that, founding users termed ISL images to have a clear layout which was easy to use.
5. **User Feedback**:
   - About 93% of the participants rated the system as intuitive and effective.
   - Suggested expanding libraries of ISL vocabulary and support for regional languages.

V. FURTHER WORKS

Regional Adaptations:

- Support for regional sign languages to be extended.
- Variations in grammar by dialect should also be reflected.

Bidirectional Communication:

- Features for converting ISL signs back into either text or speech.

Educational Tools:

- Modules for teaching ISL in schools and workplaces.

Wearable Integration:

- A system for AR glasses for live ISL virtualizing.

Enhanced NLP:

- Strongly improve on contextual understanding for the idiomatic and complex phrases.

VI. CONCLUSION

The Talking Fingers are used to crank up communication challenges for persons with hearing and speaking disabilities by advanced technologies such as multilingual translation by speech recognition, processing grammar for ISL, and static ISL visualization. Intensive testing has confirmed the visibility of its possibilities, demonstrating accuracy in speech recognition, language detection, and ISL visualization.

This universal platform has opened up many applications in education, healthcare, public services, and individual communication. Talking Fingers will throw bridges between the hearing-impaired persons and the general community in the domain of social integration and empowerment.

A bidirectional translation and regional differentiation, possibly coupled with wearable technology, would further enhance the system's power and usability, making it a backbone for assistive communication technology.

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