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A Project Report

On

"AI tool for Indian Sign language (ISL) generator from audio-visual content in English to ISL content and vice-versa"

Batch Details

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1.Introduction about project:

Background: Indian Sign Language (ISL) is a visual-gestural language used by deaf and hard-of-hearing individuals across India. It encompasses a rich vocabulary of hand movements, facial expressions and body postures to convey messaging. ISL facilitates communication and fosters community among deaf individuals, enabling them to express emotions, share ideas and engage in every day interactions.

Description: The need for audio to Indian Sign Language (ISL) conversion arises from the communication barrier between the deaf community, which primarily uses ISL, and individuals who do not know sign language but communicate through spoken language. This barrier hinder effective communication in various settings, including education, healthcare and various interactions. Without a mean to convert audio into ISL, deaf individual faces challenging in accessing information and participating fully in society.
Expected Solution: The expected solution entails developing technology-such as software or devices-capable of accurately converting spoken language to Indian Sign Language (ISL). This technology should use speech recognition, natural level processing, and computer vision to transcribe and interpret audio input, generating corresponding ISL gestures in real-time. It should prioritize accuracy, user-friendliness, and adaptability to regional variation of ISL, thereby facilitating seamless communication between deaf individual and those who do not know sign language.
For example:
1. Development of application by which announcement/ text display in railway platform Display Unit Converted to Indian Sign Language, so that deaf people can see it and understand the announcement.

2. Development of Mobile app through by which using Mobile Camera, normal person can understand sign language used by dead individuals.

2.Literature Review:

S.NO	Year	Author(s)	Title	Outcomes	Advantages	Limitations
1	2024	Yadav, P., Sharma, P., Khanna, P., Chawla, M., Jain, R., & Noor	Harnessing AI to generate Indian Sign Language from natural speech and text for digital inclusion and accessibility	AI converts speech and text into ISL, improving accessibility.	Bridges communication gaps for the deaf community	Accuracy may vary with dialects and context

2	2024	Nagaraju, R., Asha, A., Vinay, A., Varun, A., Preetham, A., & Harshitha	Audio to sign language translation using AI	Converts spoken language into Indian Sign Language (ISL) for better accessibility	Helps bridge communication gaps for the deaf community	Accuracy may vary due to speech recognition errors
3	2021	Kulkarni, S., & Kariyal, S.	Speech to Indian Sign Language translator	Converts spoken language into Indian Sign Language (ISL) for better accessibility	Enhances communication between the deaf and non-sign language users	Accuracy depends on speech recognition and sign database limitations
4	2021	Sonawane, P., Shah, K., Patel, P., Shah, S., & Shah, J	Speech to Indian Sign Language (ISL) translation system	Converts spoken language into (ISL) for better accessibility	Helps bridge communication gaps for the deaf community	Limited accuracy due to speech recognition and sign language variations.
5	2021	Tewari, Y., Soni, P., Singh, S., Turlapati, M. S., & Bhuva, A	Real-time sign language recognition framework for two-way communication	Enables seamless real-time communication between sign language users	Enhances accessibility and inclusion for the deaf community	Accuracy may be affected by varying signing styles and occlusions
6	2019	Kunjumon, J., & Megalingam, R.	Hand gesture recognition system for translating Indian Sign Language into text and speech	Converts Indian Sign Language gestures into text and speech for better communication	Bridges the communication gap between the deaf and non-sign language users	Accuracy may vary due to variations in hand gestures and lighting conditions

7	2020	Gangadia, D., Chamaria, V., Doshi, V., & Gandhi, J	Indian Sign Language interpretation and sentence formation	The system translates speech into Indian Sign Language (ISL) and forms meaningful sentences	It improves communication between the deaf community and non-sign language users	Accuracy may be affected by complex sentences and regional language variations
8	2012	Shangeetha, R. K., Valliammai, V., & Padmavathi, S	Computer vision-based approach for Indiansign language character recognition	The system accurately recognizes and translates Indian Sign Language characters using computer vision	It enhances communication accessibility for the deaf and hard-of-hearing community	Accuracy may be affected by variations in hand gestures and lighting conditions
9	2014	Sawant, S. N., & Kumbhar, M.	Real-time sign language recognition using PCA	Improves real-time sign language recognition using PCA for faster processing	Reduces dimensionality, enhancing recognition speed and accuracy	PCA may lose some critical sign language features, affecting precision
10	2021	Sonare, B., Padgal, A., Gaikwad, Y., & Patil, A	Video-based sign language translation system using machine learning	The system translates video-based sign language into text or speech using machine learning	Improves communication between the deaf community and non-sign language users.	Requires large datasets and high processing power for accurate translation

3.Objectives:

1. **Bridging the Communication Gap:**
   The primary objective is to create a solution that bridges the communication gap between deaf individuals, who primarily use Indian Sign Language (ISL), and the general population, who typically communicate using spoken language. This can be achieved by developing technology that converts audio input into ISL gestures.

2. **Real-Time Audio-to-ISL Conversion:**
   Develop a software solution capable of converting spoken language into ISL in real time using a combination of speech recognition, natural language processing, and computer vision technologies. This allows for seamless and instant communication in various settings, such as education, healthcare, and social interactions.
3. **User-Friendly Interface:**
   Ensure that the developed application is intuitive and easy to use, making it accessible to a wide range of users, including both deaf individuals and non-sign language users. This can be done by designing a simple and functional user interface using tools like Tkinter and EasyGUI.
4. **Regional Adaptability:**
   Since ISL may have regional variations, the solution must be adaptable to different regional dialects and nuances, ensuring accurate representation of ISL gestures in different regions of India.
5. **Enhancing Accessibility in Public Spaces:**
   Implement solutions that enhance accessibility in public spaces, like railway stations, airports, and hospitals, by converting announcements or textual content into ISL gestures, thus allowing deaf individuals to receive important information.
6. **Mobile Application for ISL Understanding:**
   Develop a mobile application that uses a camera to recognize ISL gestures performed by deaf individuals and converts them into text or speech for a hearing person to understand, improving two-way communication.
7. **Accurate Speech Recognition:**
   Implement a reliable speech-to-text system using the Google Speech API to accurately transcribe spoken words into text, which will then be converted into corresponding ISL gestures.

Experimental Details:

1. Programming Language:
   •Python 3.x: Ensure you have the latest version of Python 3 installed.
2. Libraries & Dependencies:
   •speech_recognition: For converting speech to text using Google API.
   •tkinter: For GUI development (usually comes pre-installed with Python).
   •easygui: For simple pop-up dialogs in the GUI.
   •Pillow (PIL): For handling image files.
   •opencv-python (cv2): For image processing and computer vision tasks.
   •numpy: For numerical computing and matrix manipulation.
   •matplotlib: For creating visualizations.
   •os: For interacting with the operating system and file management.
   •string: For string manipulation tasks.
3. IDE & Code Editors:
   •VS Code or PyCharm: Popular Integrated Development Environments (IDEs) for Python development.
4. Database (if required):

•SQLite or Firebase: If you plan on storing user data or app configurations.

5. Other Tools:
   •Google Cloud API credentials: For using the Speech-to-Text functionality from Google Cloud.
6. Operating System:
   •Windows: Python and the listed libraries are cross-platform, but you might need to install certain dependencies specific to your OS.
7. Package Management:
   •pip: For installing Python libraries.

Architecture Overview:

Speech Recognition: The spoken input is captured and processed by a speech recognition module (e.g., Google Speech-to-Text API).

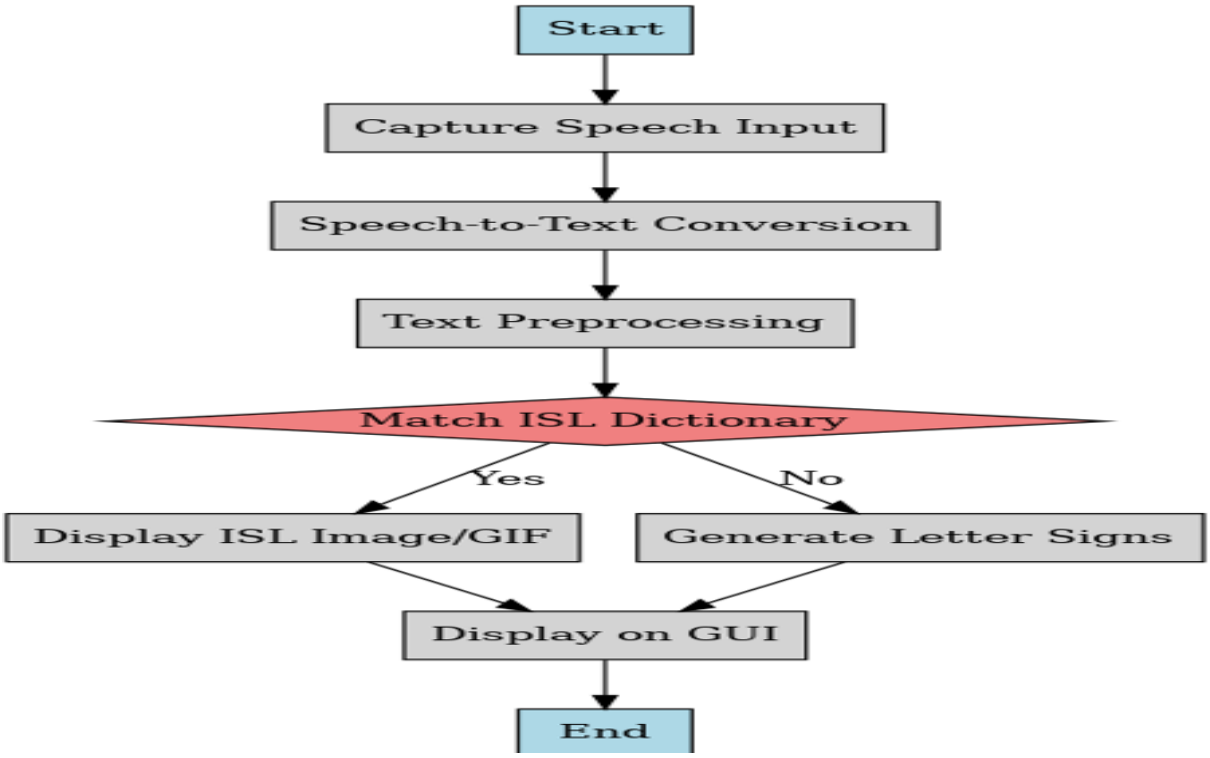
Natural Language Processing (NLP): The recognized speech is processed using NLP techniques to understand the context and intent of the message.

ISL Gesture Generation: Based on the NLP output, a set of corresponding ISL gestures is generated using AI and machine learning models trained to recognize and produce ISL.

Computer Vision: Computer vision techniques (using OpenCV or similar libraries) can be applied to interpret gestures made by the user or to display animated ISL gestures on a screen.

Mobile App Interface: A mobile application or GUI (built with Tkinter, easygui) serves as the interface, allowing users to interact with the system.

Feedback Loop: Real-time feedback is provided to the user through the app interface, displaying generated gestures or translating the user's ISL input.



4.Methodology:

The methodology for the development of a system that converts spoken language into Indian Sign Language (ISL) involves several key steps and technologies. Below is the detailed process for implementing the project:

1. Problem Understanding and Requirements Gathering

Objective: Understand the challenges faced by the deaf community in communication and identify the specific needs of users (e.g., real-time translation of spoken language to ISL).

Tools: Surveys, interviews with the deaf community, consultation with experts in ISL and accessibility.

2. Design and Architecture Development

System Design: Create a flow diagram that includes components like Speech Recognition, NLP, ISL Gesture Generation, Computer Vision, and a user interface (GUI). This helps visualize how data flows and how the components interact.

Tools: Diagram tools (e.g., Lucidchart, draw.io).

3. Speech Recognition Integration

Speech-to-Text: Use the Google Speech Recognition API to convert spoken language (audio input) into text.

Process:

Capture audio through a microphone.

Convert the audio into text using the speech_recognition library.

Tools: Google Speech API, speech_recognition (Python), microphone.

4. Natural Language Processing (NLP)

Text Processing: The recognized text is processed using Natural Language Processing (NLP) to understand the context and the structure of the speech. This ensures that the system can generate accurate ISL gestures that align with the meaning of the speech.

Process:

Tokenization: Break down the text into manageable units (words, phrases).

Context Understanding: Identify the overall meaning of the sentences for correct gesture generation.

Tools: spaCy, NLTK (Python libraries).

5. ISL Gesture Generation

Mapping Text to ISL: The processed text is mapped to its corresponding ISL gesture. This step involves creating a dictionary of common words/phrases and their corresponding ISL gestures.

Process:

Use machine learning models or pre-defined rule-based systems to generate gestures based on text.

Train models (if necessary) using datasets of ISL gestures for accuracy.

Tools: Custom dataset, deep learning frameworks (e.g., TensorFlow, Keras), gesture libraries.

6. Computer Vision for Gesture Display

ISL Gesture Animation: The generated ISL gestures can be displayed using a visual avatar or through pre-recorded gesture animations.

Process:

Use OpenCV or Pillow (Python libraries) to display gestures or manipulate video frames to present animations.

Tools: OpenCV, Pillow, matplotlib for visualization.

7. Mobile Application / GUI Development

User Interface: Develop a mobile app or a GUI for the user to interact with the system. This can be a simple interface where users input speech (through a microphone) or view gestures on-screen.

Process:

Design intuitive and accessible UI/UX to ensure easy navigation for both deaf and hearing individuals.

Integrate speech recognition, NLP, and gesture display into the app.

Tools: Tkinter (for GUI), easygui, Kivy (for mobile apps), Android/iOS development tools.

8. Real-Time Feedback and Adaptability

Real-time Translation: Ensure the system provides real-time feedback to users by continuously processing speech and generating corresponding ISL gestures.

Process:

Continuous audio input via a microphone.

Real-time processing of audio to text and translation into gestures.

Tools: Threading in Python for real-time operations, mobile app background processing.

9. Testing and Validation

User Testing: Conduct tests with both deaf and hearing individuals to evaluate the system's effectiveness, usability, and accuracy.

Process:

Test the system for various speech scenarios and check the accuracy of gesture representation.

Collect feedback from users to improve system performance, especially for regional ISL variations.

Tools: Test cases, feedback collection forms.

10. Deployment and Maintenance

Deployment: Deploy the system as a mobile application or desktop software to allow widespread use by the deaf community.

Process:

Package the application for deployment (e.g., Android/iOS store, Windows/Mac).

Regularly update the system for improvements based on user feedback and evolving technology.

Tools: Android Studio, Xcode (for mobile app), PyInstaller (for desktop apps).

Design Procedure:

1. **Requirements Gathering**: Identify the needs of the deaf community.

2. **System Architecture**: Create a high-level view of the system.
3. **Module Design**: Break down the system into components such as Speech Recognition, NLP, Gesture Generation.
4. **UI/UX**: Design an accessible, user-friendly interface.
5. **Algorithm Design**: Develop algorithms for speech-to-ISL translation.
6. **Database Design**: Plan data storage for gesture mappings.
7. **Integration**: Design how all modules work together.
8. **Testing**: Design a robust testing and validation strategy.
9. **Security**: Ensure privacy and data protection.
10. **Deployment**: Plan for deployment and updates.

This procedure ensures a methodical approach to building the system, from understanding user needs to delivering a fully functional, real-time ISL translation system.

5.Expected Outcomes:

1. Enhanced Communication Accessibility

The primary outcome is the ability for deaf individuals to access spoken language information in real-time, facilitating communication in public spaces, healthcare settings, education, and workplaces.

2. Real-time Indian Sign Language Translation

The system will be able to convert spoken language into ISL gestures immediately, ensuring that deaf individuals can follow conversations, announcements, or other audio-based content without delays.

3. Improved Inclusion in Public Spaces

For example, announcements at railway platforms or in airports will be displayed as ISL gestures, ensuring that deaf individuals can understand important information such as delays or safety instructions.

4. Increased Awareness and Understanding of ISL

The mobile app component will allow hearing individuals to understand ISL used by deaf individuals, promoting mutual understanding and interaction between both communities.

5. Enhanced Educational Access

Deaf students will be able to access classroom materials, online content, and educational lectures in ISL, helping to bridge the gap in education accessibility and promoting equality in learning opportunities.

6. User-friendly Interface

The technology will be designed to be easy to use, making it accessible to a wide range of users, both deaf and hearing, without requiring technical expertise.

7. Cross-Regional Adaptability

The system will support regional variations of ISL, ensuring that it is useful across different parts of India, improving its accuracy and effectiveness in diverse cultural and linguistic contexts.

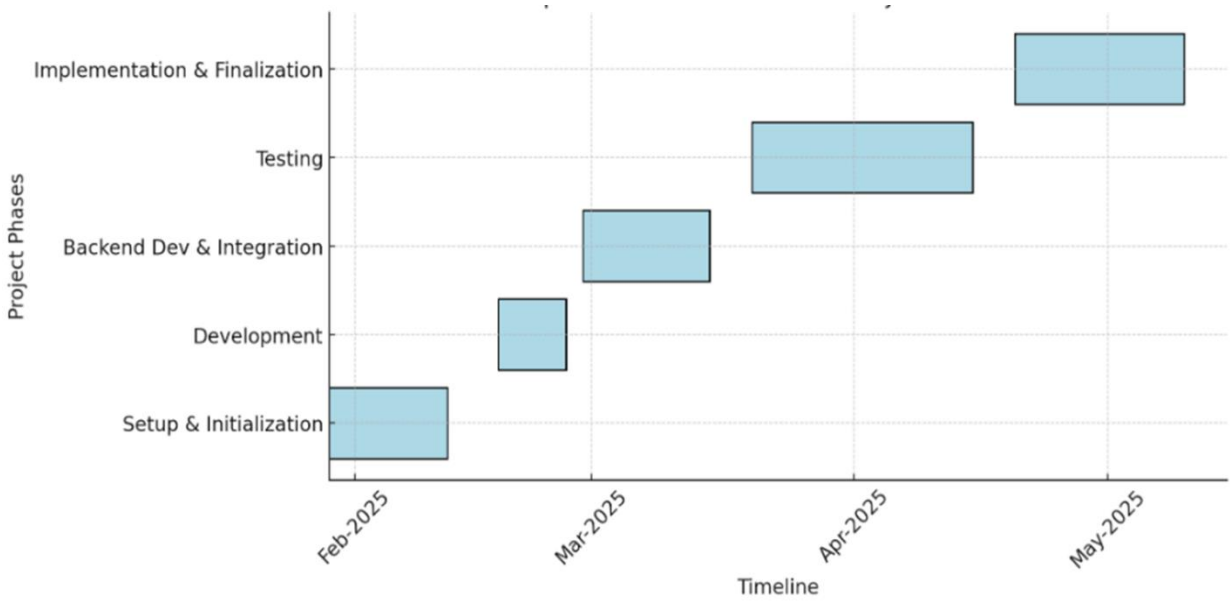
8. Fostering Social Inclusion

By reducing communication barriers, the project will foster better social integration for deaf individuals, helping them participate more fully in daily life, and encouraging their inclusion in social, professional, and governmental settings.

9. Technological Advancement in Accessibility

The project will contribute to the development of AI, machine learning, and computer vision techniques in the field of accessibility, advancing both the state of the art in these technologies and their practical application to real-world challenges.

6.Time Line of the project/Project Execution plan:



7.Conclusion:

This project is designed to bridge the communication gap between the deaf and hearing communities in India by developing technology that converts spoken language into Indian Sign Language (ISL) in real-time. Utilizing advanced technologies like speech recognition, natural language processing, and computer vision, the system will allow deaf individuals to understand spoken language and interact more seamlessly with the hearing population.

In practical terms, this could be especially beneficial in public spaces such as railway stations, airports, or hospitals, where announcements can be converted into ISL gestures, ensuring that deaf individuals

can access important information without barriers. Moreover, the mobile application will empower hearing individuals to understand ISL gestures from the deaf community, fostering two-way communication and deeper mutual understanding.

The solution's adaptability to regional variations in ISL ensures that the system remains accurate and relevant across different areas of India. Its user-friendly interface will make it accessible to a wide range of users, regardless of technical skill.

By improving communication in everyday settings—whether in education, healthcare, or public spaces—this project will significantly enhance the quality of life for deaf individuals, promoting inclusivity and ensuring equal access to information and opportunities. Ultimately, it will contribute to a more accessible and inclusive society, empowering deaf individuals to fully engage with the world around them and reduce the social divide.

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Project work mapping with SDG:

SDG 3: Good Health and Well-Being

The system helps deaf individuals access important healthcare information, improving communication in medical settings.

SDG 4: Quality Education

The project promotes inclusive education by ensuring deaf individuals can access educational content through ISL, breaking barriers for students with hearing impairments.

SDG 8: Decent Work and Economic Growth

By improving communication, the project helps deaf individuals access employment and career opportunities, fostering economic inclusion.

SDG 9: Industry, Innovation, and Infrastructure

The development of AI-based ISL translation contributes to technological innovation and advances digital accessibility solutions.

SDG 10: Reduced Inequality

By enabling communication between deaf individuals and the broader community, the project fosters social and economic inclusion for people with disabilities.

SDG 11: Sustainable Cities and Communities

The system ensures deaf individuals have access to important public information in spaces like railway stations and airports, promoting inclusion in public life.

SDG 16: Peace, Justice, and Strong Institutions

The project enables deaf individuals to actively participate in societal decisions, supporting inclusive and representative decision-making.

SDG 17: Partnerships for the Goals

The project encourages collaboration between developers, educators, and civil society to enhance accessibility and reach more people.

GitHub Link:

https://github.com/katejaswini/PIP_4004