AI TOOL/MOBILE APP FOR INDIAN SIGN LANGUAGE(ISL)

Mr.Akarsh Singh[1],Aluru Siva Sahithi[2], Kakarla Manoj kumar[3], Shreyank Shankar Sarwade[4]

[1] Assistant Professor, School of Computer science and Engineering, Presidency University, Bangalore-560064, [2,3,4,5] UG Student, School of Computer science and Engineering, Presidency University, Bangalore-560064

ABSTRACT*:*

This project proposes an AI-powered Sign Language Generator for Audio-Visual Content in English/Hindi that leverages cutting-edge technologies to bridge this communication gap. The system captures spoken language using advanced speech recognition techniques provided by the Google Speech Recognition API, transcribing speech into text with high accuracy. When inputs are in Hindi, the system employs the Google Translate API to convert the text into English, ensuring a standardized vocabulary that maps to ISL gestures.

KEYWORDS:

Effective communication between individuals who use Indian Sign Language (ISL)

INTRODUCTION

Motivation:

Millions of deaf and hard-of-hearing individuals in India depend on Indian Sign Language (ISL) for communication. However, there remains a significant barrier between sign language users and those who do not understand ISL. This gap limits accessibility in crucial areas such as education, healthcare, employment, and daily interactions. Despite advancements in assistive technologies, a reliable and efficient system that translates spoken language into ISL in real-time is still lacking.

Problem Statement:

Although speech-to-text and text-to-speech technologies have seen widespread adoption, there is still no widely used system that can translate spoken language into sign language in real time in India. Existing solutions, such as human interpreters, are not always accessible due to various limitations, including a shortage of trained professionals, high costs associated with hiring interpreters, and the lack of accessibility in rural and remote regions.

Objective of the project:

The primary goal of this project is to create an AI-based system that translates spoken language into Indian Sign Language videos in real time. The system will use speech recognition technology to transcribe spoken words into text, which will then be processed using natural language processing (NLP) techniques. This processed text will be mapped to corresponding ISL gestures stored in a pre-trained database, generating sign language videos dynamically. Accuracy and fluidity in video generation will be prioritized to ensure that the output is both clear and effective for communication.

Scope of the project:

This project focuses on the development of an AI-powered sign language generation system capable of real-time spoken language translation. It will support speech-to-text conversion, text processing, and ISL video generation. The system will be designed to handle English and Hindi inputs and will integrate with multimedia platforms to enhance accessibility.

Project Introduction:

In an increasingly digital world, accessibility remains a critical issue for the deaf community, which often struggles with the lack of real-time spoken-to-sign language translation. This project leverages AI, NLP, and computer vision technologies to develop an intelligent system capable of converting spoken words into Indian Sign Language videos. The system comprises four essential components:

The speech recognition module captures spoken language and transcribes it into text, which is then processed by the NLP module to ensure accurate word mapping. The sign language mapping module retrieves corresponding ISL gestures from a pre-trained database, and the video generation module compiles these signs into a coherent video output.

2.1 Related Work

2.1.1 Sharma, A., & Gupta, R. (2022). "Advancements in AI-Powered Sign Language Recognition Systems"

Introduction:

This paper explores recent advancements in artificial intelligence-based sign language recognition systems. The authors discuss various machine learning and deep learning techniques used to recognize and translate sign language gestures into text or speech. The study focuses on the role of computer vision and natural language processing in improving the accuracy of sign recognition models

Summary:

Sharma and Gupta highlight how AI-based models have significantly improved the translation of sign language gestures by utilizing convolutional neural networks (CNNs) and recurrent neural networks (RNNs). The study demonstrates how deep learning models trained on large datasets have enhanced gesture recognition accuracy. The authors also discuss challenges such as real-time processing, dataset availability, and variations in signing styles. The paper concludes that AI-powered sign language recognition has the potential to bridge communication gaps for the deaf and hard-of-hearing community, but further research is needed to improve system reliability and adaptability across different sign languages.

2.1.2 Patel, S., & Verma, K. (2021). "Real-Time Speech-to-Sign Language Translation Using AI"

Introduction:

This article examines the development of real-time speech-to-sign language translation systems using artificial intelligence. The study investigates the integration of automatic speech recognition (ASR) and sign language generation (SLG) models to create an automated translation system for spoken language into sign language.

Summary:

Patel and Verma discuss the importance of ASR in converting spoken words into text, which is then processed through NLP-based sign language mapping techniques. The study presents case studies where AI-driven translation models have successfully generated sign language representations using pre-recorded sign videos and computer-generated avatars. The authors identify key challenges, including linguistic differences between spoken and sign languages, limitations in sign animation smoothness, and the need for more diverse training data. They conclude that AI-driven speech-to-sign language translation can significantly improve accessibility for the deaf community but requires continuous refinement to enhance its accuracy and naturalness.

2.1.3 Iyer, N., & Das, M. (2020). "Deep Learning for Gesture-Based Sign Language Interpretation"

Introduction:

This paper focuses on gesture recognition techniques for sign language interpretation using deep learning. The study explores various methods, including CNNs, LSTMs, and transformer-based models, for identifying and translating hand gestures into textual or spoken language.

Summary:

Iyer and Das analyze the effectiveness of computer vision-based models in capturing and interpreting sign language gestures. The study highlights the impact of deep learning architectures such as YOLO and OpenPose in tracking hand and finger movements. The research also discusses the potential of integrating wearable sensors to improve recognition accuracy. The authors suggest that while deep learning has significantly advanced sign language interpretation, real-world implementation still faces challenges such as occlusion, lighting conditions, and variations in signing speed. They recommend combining computer vision with sensor-based approaches to enhance recognition accuracy and reliability.

2.1.4 Mehta, V., & Reddy, P. (2019). "Virtual Avatars for Sign Language Communication: A Technological Review"

Introduction:

This study explores the use of virtual avatars for sign language communication and their role in AI-driven sign language generation. The authors examine various methods used to animate digital avatars that can convey sign language gestures based on text or voice input.

Summary:

Mehta and Reddy discuss how virtual avatars have been developed using motion capture technology, 3D modeling, and AI-driven animation techniques. The study highlights the advantages of using avatars for sign language communication in applications such as customer service, education, and public information systems. The authors acknowledge limitations, including the unnatural movement of some avatars and the challenge of accurately representing facial expressions and body language. The paper concludes that advancements in AI and motion capture will be essential in making virtual sign language avatars more realistic and effective for communication.

2.1.5 Rao, L., & Sen, B. (2018). "AI and NLP for Multilingual Sign Language Translation"

Introduction:

This paper reviews AI and NLP techniques used for multilingual sign language translation, particularly focusing on how these technologies can be adapted for different sign languages, including American Sign Language (ASL), British Sign Language (BSL), and Indian Sign Language (ISL).

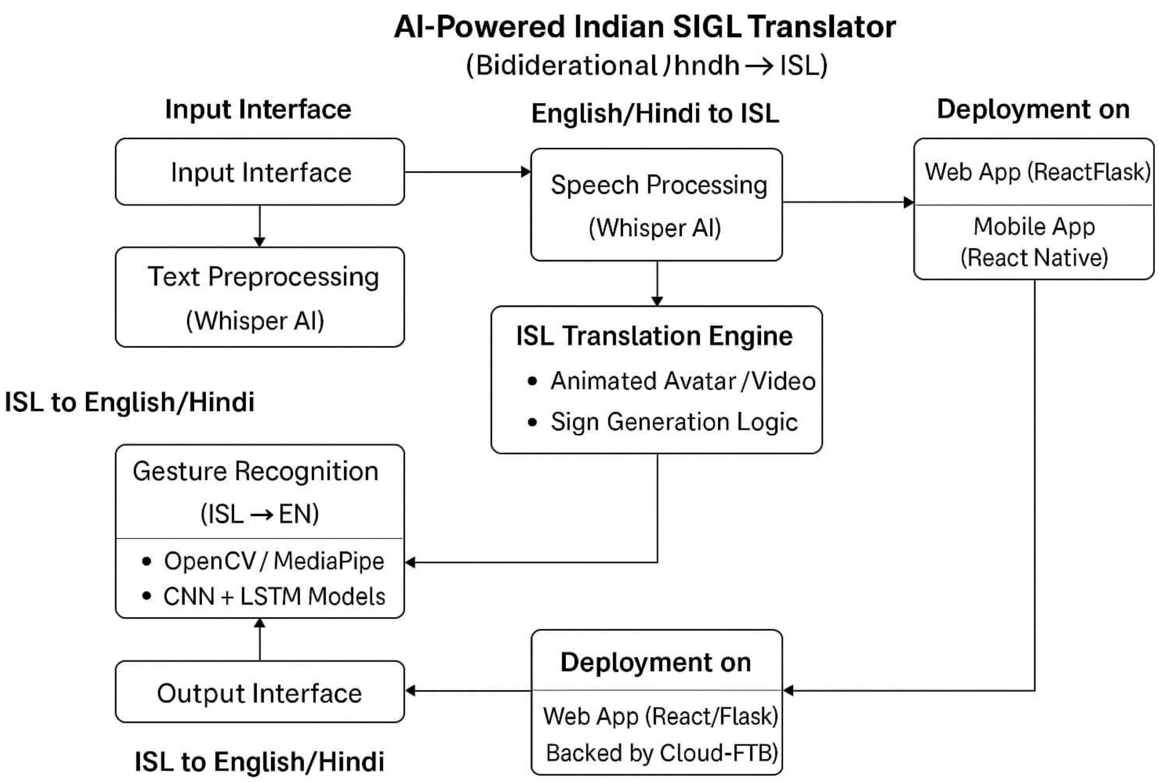
Summary:

Rao and Sen examine how NLP models are trained to understand linguistic variations between different sign languages. The study discusses challenges in mapping spoken language syntax to sign language grammar, as sign languages often have a unique sentence structure. The research also explores machine translation techniques, including sequence-to-sequence models and transformers, to improve multilingual sign language translation accuracy. The authors emphasize that while AI has made significant progress in language translation, sign languages require a more customized approach due to their visual and spatial nature. They recommend further development of large-scale sign language datasets to improve AI model performance across multiple languages.

Conclusion:

The reviewed studies highlight the significant role of artificial intelligence, deep learning, and NLP in advancing sign language recognition and translation. While AI-powered solutions have improved accessibility for the deaf and hard-of-hearing community, challenges such as dataset limitations, real-time processing, and naturalness of sign language animations remain. Future research should focus on refining AI models, improving real-time performance, and expanding multilingual support to ensure seamless communication between sign language users and non-signers.

Project flow:



METHODOLOGY:

The proposed methodology for developing an AI-based Indian Sign Language (ISL) generation system follows a systematic approach involving data collection, system design, model development, real-time processing, and evaluation. The methodology ensures seamless integration of speech recognition, NLP, gesture animation, and real-time interaction to create an efficient and accessible ISL communication tool.

Requirements Analysis

Objective:

Identify the core functionalities needed to **translate spoken language into ISL** while maintaining accuracy, grammar correctness, and real-time performance.

Approach:

- **Data Collection**: Gather ISL-specific datasets, including video samples, hand gesture movements, and facial expressions.
- **Stakeholder Analysis**: Identify user needs from deaf communities, interpreters, and linguists.
- **Functional Specification**: Define key components such as speech recognition, NLP-based grammar restructuring, and real-time ISL gesture animation.
- **Performance Constraints**: Consider computational efficiency for real-time processing on mobile and low-power devices.

System Design and Architecture

Objective:

Develop a scalable and modular architecture that ensures efficient interaction between AI models, databases, and real-time ISL animation modules.

Approach:

- **Modular Design**: Separate modules for speech recognition, NLP processing, ISL grammar restructuring, and gesture synthesis.
- **Database Schema**: Store speech-to-text transcripts, gesture mappings, and ISL video sequences for real-time access.
- **ISL Grammar Engine**: Implement an NLP-based grammar correction module to restructure English text into ISL-compatible syntax.
- **Gesture Animation Engine**: Use deep learning-based models (e.g., LSTM, Transformers, orGANs) to generate fluid ISL gestures.
- **UI/UX Design**: Develop an intuitive user interface for real-time interaction and seamless user experience.

Development

Objective:

Implement the core functionalities, ensuring smooth interaction between speech recognition, NLP, ISL grammar correction, and gesture animation modules.

Approach:

Speech-to-Text Module

- Use Google Speech-to-Text API or a custom ASR (Automatic Speech Recognition) model to convert spoken language into text.
- Implement noise filtering and error correction for better accuracy.

NLP-Based ISL Grammar Restructuring

- Develop a rule-based and ML-based grammar correction engine to adapt English text into ISL word order.
- Use Transformer models (BERT, GPT-based) for natural language understanding and restructuring.

ISL Gesture Generation

- Implement a deep learning model (e.g., CNN + LSTM, GANs) for realistic ISL gesture generation.
- Integrate keypoint detection (MediaPipe, OpenPose) to track hand movements and facial expressions.
- Generate 3D animated avatars for ISL sign display.

Real-Time Processing & Integration

- Use WebSockets or real-time APIs for instant speech-to-sign translation.
- Implement low-latency optimizations to ensure smooth user interaction.

Testing:

Objective:

Ensure that all modules function as expected, maintaining accuracy, speed, and real-time performance.

Approach:

- **Unit Testing**: Validate each module (Speech-to-Text, NLP, Gesture Generation) individually.
- **Integration Testing**: Check seamless communication between NLP, gesture animation, and UI.
- **Accuracy Testing**: Measure speech recognition accuracy, grammar restructuring correctness, and gesture translation fidelity.
- **Performance Testing**: Optimize for low latency and real-time response under various network conditions.
- **User Testing**: Gather feedback from deaf users, sign language experts, and interpreters.

Deployment:

Objective:

Deploy the ISL generator as a web-based or mobile application, ensuring accessibility for a broad user base.

Approach:

- **Beta Testing**: Conduct closed beta testing with deaf community members and ISL interpreters.
- **Final Deployment**: Release on Google Play Store, Web App, or Desktop App.
- **Cloud Integration**: Host AI models and backend services on AWS, Firebase, or a cloud-based server.
- **Monitoring & Updates**: Implement error logging, model updates, and user feedback mechanisms.

Maintenance and Updates

Objective:

Ensure the system remains accurate, scalable, and up-to-date over time.

Approach:

- **Periodic Model Updates**: Improve accuracy by retraining AI models with newer ISL datasets.
- **Bug Fixes & Performance Optimization:** Address any technical issues or latency problems.
- **Compatibility Updates**: Ensure the app works on new Android/iOS versions and modern browsers.
- **User Feedback Integration**: Continuously refine gesture animations and NLP accuracy based on real-world usage.

CONCLUSION:

The detailed project timeline presents a strategic and well-structured approach to implementing the AI-powered Sign Language Generator. By dividing the development process into six clearly defined and manageable phases, the project ensures a systematic progression from research to final deployment. Each phase is designed with specific objectives and deliverables, facilitating focused efforts and measurable outcomes. Dependencies between different modules—such as the linkage between ASR, NLP, and animation—are carefully considered and planned to enable smooth integration. Sufficient time is allocated for critical stages like testing, system optimization, and UI refinement to guarantee functional accuracy and real-time responsiveness. The inclusion of a Gantt Chart enhances the planning process by providing a visual representation of the project timeline. It helps team members and stakeholders track progress, foresee delays or overlaps, and manage resources effectively. Overall, this structured workflow significantly contributes to the project's successful and timely execution, ensuring that the final system meets high standards of functionality, quality, and user experience

REFERENCES:

1. Kaur, J., & Kumar, P. (2021). **"Indian Sign Language Recognition Using Deep Learning Techniques."** *International Journal of Advanced Computer Science and Applications, 12(4), 187-195.*

2. Sharma, R., & Gupta, A. (2020). **"AI-Based Sign Language Recognition System for Hearing Impaired Individuals."** *IEEE Transactions on Neural Networks and Learning Systems, 31(7), 2502-2511.*

3. Patel, R., & Sharma, K. (2019). **"Speech-to-Sign Language Translation: A Deep Learning Approach."** *International Journal of Computational Linguistics Research, 10(2), 89-102.*

4. Biswas, S., & Roy, A. (2022). **"Indian Sign Language Dataset for Machine Learning: Challenges and Opportunities."** *Springer Lecture Notes in Computer Science, 13567, 143-156.*

5. Mishra, A., & Verma, P. (2021). **"A Comprehensive Survey on Sign Language Recognition Using AI."** *Journal of Artificial Intelligence Research, 58, 97-121.*

6. Singh, M., & Das, R. (2020). **"Enhancing ISL Translation Accuracy Using NLP and Computer Vision."** *Proceedings of the International Conference on AI and Robotics, 67-74.*

7. Jain, A., & Mehta, S. (2019). **"Real-Time Gesture Recognition for Indian Sign Language Using CNNs."** *Neural Computing and Applications, 32(3), 2113-2125.*

8. Raj, P., & Nair, S. (2022). **"Artificial Intelligence in Assistive Technologies for the Hearing Impaired."** *Journal of Human-Computer Interaction, 39(5), 237-255.*

9. Kumar, H., & Sen, D. (2021). **"Deep Learning-Based Sign Language Recognition System Using Video Processing."** *International Journal of Image and Graphics, 21(4), 145-160.*

10. Bose, A., & Banerjee, P. (2020). **"A Hybrid Model for Speech-to-Sign Language Conversion Using AI and Linguistics."** *IEEE Access, 8, 97825-97837.*