VOICE SIGNAL TO VISUAL INDIAN SIGN LANGUAGE (ISL) CONVERTER

A PROJECT REPORT
for
Mini Project-I (K24MCA18P)
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Submitted by

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CERTIFICATE

Certified that Ankit Kumar Shahi**,** 202410116100028 has carried out the project work having "**Voice signal to visual Indian sign language (ISL) converter**" (**Mini Project-I, K24MCA18P**) for **Master of Computer Application** from Dr. A.P.J. Abdul Kalam Technical University (AKTU**)** (formerly UPTU), Lucknow under my supervision. The project report embodies original work, and studies are carried out by the student himself, and the contents of the project report do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

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ABSTRACT

The "Converting Voice Signal to Visual Indian Sign Language (ISL) Converter" project is an innovative solution aimed at bridging the communication gap between the hearing and the deaf or hard-of-hearing communities. By translating spoken language or text into Indian Sign Language animations, this system enhances accessibility and inclusivity. Leveraging a combination of speech recognition technologies, text processing, and animation libraries, the project converts voice inputs into corresponding ISL gestures in real time. The primary objective is to address a significant challenge faced by individuals with hearing impairments in daily communication, education, and public services. This solution empowers the community by fostering smoother interactions, enabling better access to information, and supporting inclusive learning environments. The system is designed to be user-friendly, ensuring that individuals with limited technical expertise can also benefit from it. Applications of this project span various domains, including educational platforms, government services, healthcare systems, and customer service interfaces. By integrating Indian Sign Language into digital platforms, the project contributes to building an equitable society where communication barriers are significantly reduced. This project not only showcases the potential of technology to drive social change but also paves the way for future developments in assistive communication systems. With its scalable design, the ISL converter can be further enhanced to accommodate multiple languages and regional dialects, ensuring widespread impact and usability across diverse communities.

Keywords:

ISL, Voice-to-Sign Translation, Speech Recognition, Real-Time Gesture Conversion

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Ankit Kumar Shahi

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The "Converting Voice Signal to Visual Indian Sign Language (ISL) Converter" project introduces an innovative solution to the long-standing communication challenges faced by the deaf and hard-of-hearing communities. By integrating speech recognition technology and pre-saved Indian Sign Language animations, this system aims to provide seamless and real-time translation of spoken words into visual ISL representations. This addresses critical communication gaps in education, healthcare, workplaces, and everyday interactions, fostering inclusion and accessibility.

The importance of sign language as a means of communication cannot be overstated. Indian Sign Language (ISL), while widely used among the deaf community in India, remains underrepresented in technological advancements. The proposed system leverages advancements in speech recognition and visual rendering to create a reliable tool for communication.

1.2 BACKGROUND AND MOTIVATION

The inability of individuals with hearing impairments to effectively communicate with the hearing population has been a persistent issue. Sign language bridges this gap, but there remains a lack of awareness, tools, and support for its implementation.

1.2.1 Existing Challenges

1. **Lack of Technological Tools:**
   Existing solutions for sign language translation are limited in functionality, often focusing on written translations instead of voice inputs.

2. **Educational Barriers:**

   Students with hearing impairments often struggle in classrooms where lessons are delivered orally without supportive tools for ISL representation.

3. **Public Services:**

   In places like hospitals, police stations, and government offices, communication barriers can result in exclusion or a lack of critical assistance.

1.2.2 Motivation for the Project

This project is motivated by the need to address these challenges and create a transformative tool that:

- Provides real-time and user-friendly speech-to-ISL translation.
- Promotes the adoption of Indian Sign Language as a standardized form of communication.
- Empowers individuals with hearing impairments to achieve independence and inclusion in society.

1.3 Objectives

The main objectives of the project are:

1. To develop a speech recognition system that converts spoken words into text using WebKit.
2. To map recognized text to ISL animations to visually represent communication for deaf individuals.
3. To allow text input as an alternative mode for individuals who may not rely on voice inputs.
4. To create a scalable solution that can be further enhanced with additional animations, languages, and features.
5. To deploy the system on an accessible platform, ensuring ease of use for all stakeholders.
6. To contribute towards inclusivity, empowering the deaf and hard-of-hearing communities.

1.4 Scope of the Project

The scope of this project includes:

1. **Real-Time Voice and Text Conversion:**
    - Implementation of speech-to-text conversion using WebKit Speech Recognition.
    - Text-based inputs for instances where voice recognition is unnecessary or impractical.

2. **Integration of Pre-Saved ISL Animations:**
    - Utilizing a dataset of ISL gestures/animations (sourced from Kaggle) to provide accurate translations.

3. **User-Friendly Interface:**
    - Designing a simple interface using HTML, CSS, and JavaScript that can be used on web browsers.

4. **Scalability:**
    - Building the system architecture to allow integration of new animations, languages, and input methods in the future.

CHAPTER 2

FEASIBILITY STUDY

2.1 Technical Feasibility

The technical feasibility assesses whether the project can be successfully implemented using the available technology, tools, and frameworks.

- Speech Recognition: Tools like Google Speech API and WebKit Speech Recognition provide accurate voice-to-text conversion. These technologies offer real-time capabilities, ensuring smooth processing.
- Animation Rendering: Pre-saved animations of Indian Sign Language (ISL) sourced from platforms like Kaggle can be displayed seamlessly using frontend technologies such as HTML5, CSS3, and JavaScript.

2.2 Economic Feasibility

This subsection evaluates whether the project is cost-effective:

- Cost of Development: The use of open-source tools like Django, Python, HTML, and free APIs minimizes development costs.
- Resource Allocation: Pre-built ISL animations reduce the need for animation development, saving both time and costs.
- Return on Investment: While the project's primary focus is social impact, it can also be monetized in the education and public service sectors.

2.3 Existing Solutions and Literature

Existing systems primarily include text-to-sign language converters and video-based tools for teaching sign language. For instance, early works used static image libraries to display basic sign language gestures, but these solutions lacked real-time functionality and failed to accommodate voice inputs.

Advancements in speech recognition technologies and natural language processing (NLP) have opened new possibilities for dynamic voice-to-sign systems, improving communication efficiency.

Research on American Sign Language (ASL) and other global sign languages has led to interactive tools and mobile applications that leverage animation and machine learning models. However, ISL has not received comparable attention, leading to fewer technological solutions tailored to its unique structure and gestures. Some studies explore computer vision and animation techniques to create real-time sign language interpreters, but scalability and accuracy remain challenges.

2.4 Gaps in Existing Systems

Despite advancements in speech recognition and animation technologies, several gaps remain:

- Limited ISL Integration: Most existing tools focus on American Sign Language (ASL) and lack datasets for Indian Sign Language.
- Real-Time Translation: Many systems focus on text-based inputs rather than real-time voice recognition.
- Accessibility: Few tools are designed for user-friendly deployment on commonly used devices (e.g., smartphones or laptops).

This project addresses these gaps by:

- Leveraging pre-saved ISL animations for quick deployment.
- Using cost-effective, software-based tools (WebKit, APIs).
- Ensuring accessibility through web-based platforms.

2.5 Social and Practical Feasibility

The project's social and practical feasibility examines its real-world applicability and benefits:

1. Impact on Deaf Communities:

- Enables individuals with hearing impairments to communicate effectively using ISL animations.
- Reduces dependency on human interpreters.

2. Educational Applications:

- Can be integrated into classrooms to assist deaf students in understanding spoken lessons through ISL.

3. Public Services:

- Improves communication in hospitals, courts, and government offices where interpreters are unavailable.

4. Scalability:

- The system can be enhanced further with new features such as real-time camera-based ISL recognition or integration with additional languages.

CHAPTER 3

PROJECT OBJECTIVE

The primary objective of the "Voice Signal to Visual Indian Sign Language Converter" project is to create an innovative, reliable, and accessible solution that addresses communication barriers faced by individuals with hearing impairments. The project aspires to bridge the communication gap between the hearing community and the deaf or hard-of-hearing population by combining advanced technologies such as speech recognition, text processing, and sign language animation.

3.1. Key Objectives

1. Accurate Voice Recognition
   - Implement a robust and real-time speech recognition system using technologies such as the WebKit.
   - Ensure high accuracy in converting spoken language into text, even with varying accents, speeds, and pronunciations.
   - Optimize the system for both short phrases and longer paragraphs to accommodate diverse user requirements.

2. Indian Sign Language Animation Display
   - Develop an ISL-compatible animation system that visually represents spoken or typed words using pre-saved ISL animations.
   - Utilize a structured animation mapping approach to align parsed text inputs with corresponding sign language gestures.
   - Ensure that the animations are clear, smooth, and visually appealing to enhance user comprehension and engagement

3. User-Friendly Web Interface
    - Design an interactive, responsive, and intuitive user interface suitable for users of all age groups and technical backgrounds.
    - Integrate voice input, text input, and animation display modules into a single platform for seamless communication.
    - Focus on ensuring ease of navigation, accessibility, and real-time feedback for a smooth user experience.

4. Accessibility and Inclusivity
    - Build a platform accessible across multiple devices, including laptops, tablets, and smartphones.
    - Leverage web-based solutions to eliminate installation complexities, ensuring universal access for users in diverse environments.
    - Provide multi-language support for text input and ensure that the tool can be customized to meet the specific needs of users.

5. Educational Integration
    - Facilitate the integration of the tool into educational settings to assist deaf or hard-of-hearing students.
    - Enable real-time conversion of spoken lessons into Indian Sign Language animations, enhancing learning outcomes and engagement in classrooms.

6. Cost-Effective and Scalable Solution
    - Utilize open-source libraries and pre-existing ISL datasets to minimize development and operational costs.
    - Build a scalable architecture that allows for easy integration of future features such as regional sign languages, new animations, or real-time gesture recognition.
    - Ensure that the solution can be expanded to accommodate advancements in speech recognition and animation rendering technologies.

7. Social Impact and Awareness
   - Raise awareness about the importance of Indian Sign Language (ISL) as a critical communication tool for the deaf community.
   - Empower individuals with hearing impairments by providing a platform that fosters independence, confidence, and inclusion.
   - Promote societal understanding of the challenges faced by the deaf community, contributing to the creation of a more equitable and inclusive environment.

3.2 Broader Objectives:

1. Innovation in Assistive Technology:
   - Leverage cutting-edge technologies to develop a transformative solution that enhances accessibility for people with disabilities.

2. Reduction in Communication Barriers:
   - Facilitate smoother communication between the deaf community and the hearing population by offering real-time voice-to-sign translation.

3. Scalable and Sustainable Solution:
   - Ensure long-term usability and adaptability of the platform with provisions for future upgrades and technological advancements.

4. Inclusivity in Public and Private Sectors:
   - Create opportunities for deaf individuals to actively participate in educational, professional, and social environments.

5. Real-World Impact:
   - Develop a practical solution that improves everyday communication in areas such as public services, healthcare, education, and personal interactions.

3.3 Measurable Outcomes:

1. Accuracy Metrics:
   - Achieve high accuracy in speech-to-text conversion with optimized recognition for various dialects.

2. User Adoption:
   - Measure usability and effectiveness through user feedback and real-world testing.

3. Animation Clarity:
   - Ensure clarity and fluency in sign language animations to effectively convey messages.

4. Platform Accessibility:
   - Ensure the platform runs seamlessly on various devices with minimal technical constraints.

5. Inclusivity Index:
   - Evaluate the tool's social impact by measuring its adoption rate in educational institutions and public domains.

➢ CHAPTER 4

HARDWARE AND SOFTWARE REQUIREMENTS

4.1 Hardware Requirement

To develop, test, and deploy the "Voice Signal to Visual Indian Sign Language Converter" project, the following hardware components are required:

1. Processor (CPU):

➢ A system with at least an Intel Core i5 processor (or its equivalent) is necessary to efficiently perform tasks such as real-time speech recognition, text parsing, and animation playback.

2. Memory (RAM):

➢ A minimum of 8 GB of RAM is recommended to handle multiple processes simultaneously, including running the application, accessing animation files, and rendering outputs.

3. Storage:

➢ At least 256 GB of SSD storage is required for storing ISL animations, datasets, libraries, and application resources. Fast storage ensures quick access and retrieval of animation files.

4. Microphone:

➢ A built-in or external microphone is essential to capture the user's voice input accurately for the speech recognition module.

5. Display:

➢ A screen with at least a 1920x1080 resolution ensures clear and sharp visuals of the sign language animations for better user experience.

6. Internet Connection:

➢ A stable internet connection is necessary to interact with online speech recognition APIs and to fetch resources dynamically when needed.

7. Input Devices:

➢ Basic peripherals such as a keyboard and mouse are required for user interaction and input when using text-based options.

4.2 Software Requirements

The following software tools and frameworks are necessary for the successful implementation of the project:

1. Operating System:
   - Windows 10/11, Ubuntu Linux, or macOS
   - A versatile and stable operating system is required to run development tools, libraries, and test the project.

2. Backend Framework:
   - Python (3.7 or higher): Python serves as the primary backend programming language.
   - Django Framework: Used for handling the backend logic, database integration, and server-side scripting.

3. Frontend Development Tools:
   - HTML5, CSS3, and JavaScript: Core technologies to design a user-friendly and responsive user interface.
   - Bootstrap: A front-end framework to ensure a clean and responsive design.

4. Speech Recognition Library:
   - WebKit Speech Recognition: This library processes and converts voice input into text in real time.

5. Animation and Media Management:
   - Kaggle ISL Dataset: Pre-saved ISL animations are integrated to display corresponding sign language visuals.
   - Media Tools: Libraries such as HTML5 Video Player or JavaScript for rendering animations.

6. Database:
   - SQLite: A lightweight relational database for storing user credentials, ISL animation mappings, and application data.

7. Development Environment:
   - Visual Studio Code (VS Code): A versatile code editor for development.

8. APIs and Libraries:
   - NLTK (Natural Language Toolkit): Used for text tokenization and parsing.
   - Speech Recognition Library: Processes and integrates speech input.

9. Browser Support:
   - Google Chrome, Mozilla Firefox, or any modern web browser for running and testing the frontend application.

CHAPTER 5

PROJECT FLOW

The "Voice Signal to Visual Indian Sign Language Converter" project follows a structured workflow to ensure seamless translation of voice and text inputs into visual sign language. The methodology is divided into multiple interconnected stages, described as follows:

5.1 User Authentication Stage

- Before accessing the application's functionalities, the user must authenticate through the Login.
- Input Credentials: The user provides their username/email and password via the login interface.
- Authentication Process: The credentials are validated against the stored user data in the SQLite database using Django's authentication system.
- Session Management: Secure sessions are initiated to maintain user access until logout or timeout.
- Access Granted:
    - If the credentials are valid, the user is redirected to the main interface.
    - If invalid, an error message is displayed, and the user is prompted to retry.

5.2 User Input Stage

- After successful login, the user interacts with the application through two input modes:

1. Voice Input:
    - The user provides spoken input via a microphone.
    - The system utilizes a speech recognition library (WebKit) to convert the speech signal into a text format.

2. Text Input:
    - The user directly types a word, phrase, or sentence into the provided input field within the application interface.

5.3 Input Parser Stage

Once the input is received (from either voice or text):

- The Input Parser Module tokenizes the input paragraph into individual sentences using the Natural Language Toolkit (NLTK) library.
- Each sentence is further broken down into words to map corresponding sign language animations.

5.4 Sign Language Mapping Stage

- The Sign Language Generation Module searches for each word in the Indian Sign Language (ISL) animation database:
- Pre-saved animations stored in local storage are mapped to individual words.
- If a word has no direct sign animation, a default "letter-by-letter" ISL representation is generated.

5.5 Animation Playback Stage

- The system retrieves the corresponding ISL animations for the processed input:
    - Each animation is sequentially displayed using media rendering tools.
    - Smooth transitions between animations ensure a clear and coherent representation of the original input.

5.6 Output Stage

- The processed input is displayed as Indian Sign Language animations on the user interface:
    - For voice input, the converted speech (text) and sign language animations are shown simultaneously.
    - A clean and responsive user interface ensures accessibility for all users, with options to replay, pause, or restart the animations.

5.7 DFD

DFD is the abbreviation for Data Flow Diagram. The flow of data of a system or a process is represented by DFD. It also gives insight into the inputs and outputs of each entity and the process itself. DFD does not have control flow, and no loops or decision rules are present. Specific operations depending on the type of data can be explained by a flowchart. It is a graphical tool, useful for communicating with users, managers and other personnel. it is useful for analysing existing as well as proposed system.

- **0-LEVEL**

  The 0-Level diagram represents the high-level overview of the ISL (Indian Sign Language) converter system. It shows a direct interaction between the user and the ISL Converter Website. The user accesses the system through a signup/login process, where their input (voice or text) is converted into ISL.

Fig 5.1 0-level DFD

- **1-LEVEL**

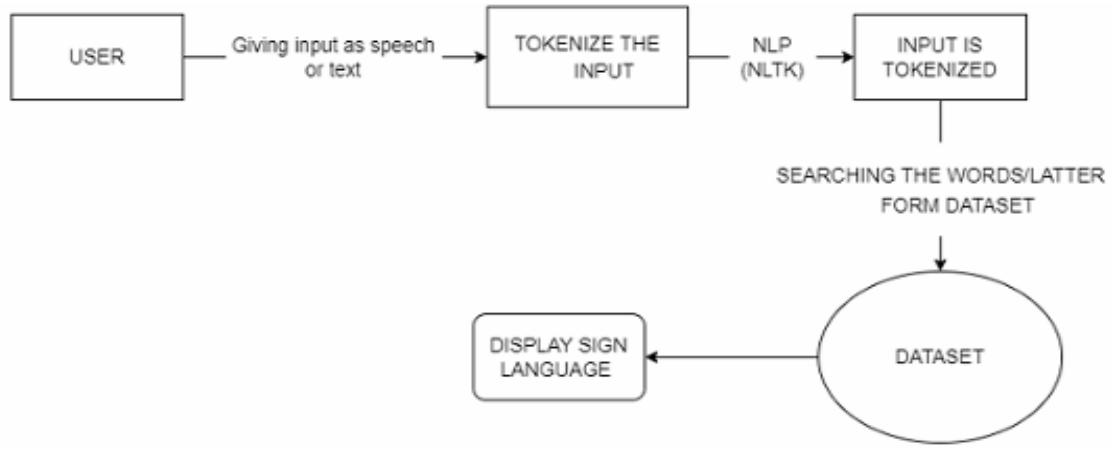


Fig 5.2 1-level DFD

- User Input: The user gives input in the form of speech or text.
- Tokenization: The input is processed and tokenized using NLP tools like NLTK.
- Dataset Search: The system searches for the corresponding words or letters in the dataset.
- Display: Finally, the system displays the output in sign language format.

5.8 USECASE DIAGRAM:

A Use Case Diagram is a vital tool in system design, it provides a visual representation of how users interact with a system. It serves as a blueprint for understanding the functional requirements of a system from a user's perspective,

aiding in the communication between stakeholders and guiding the development process.

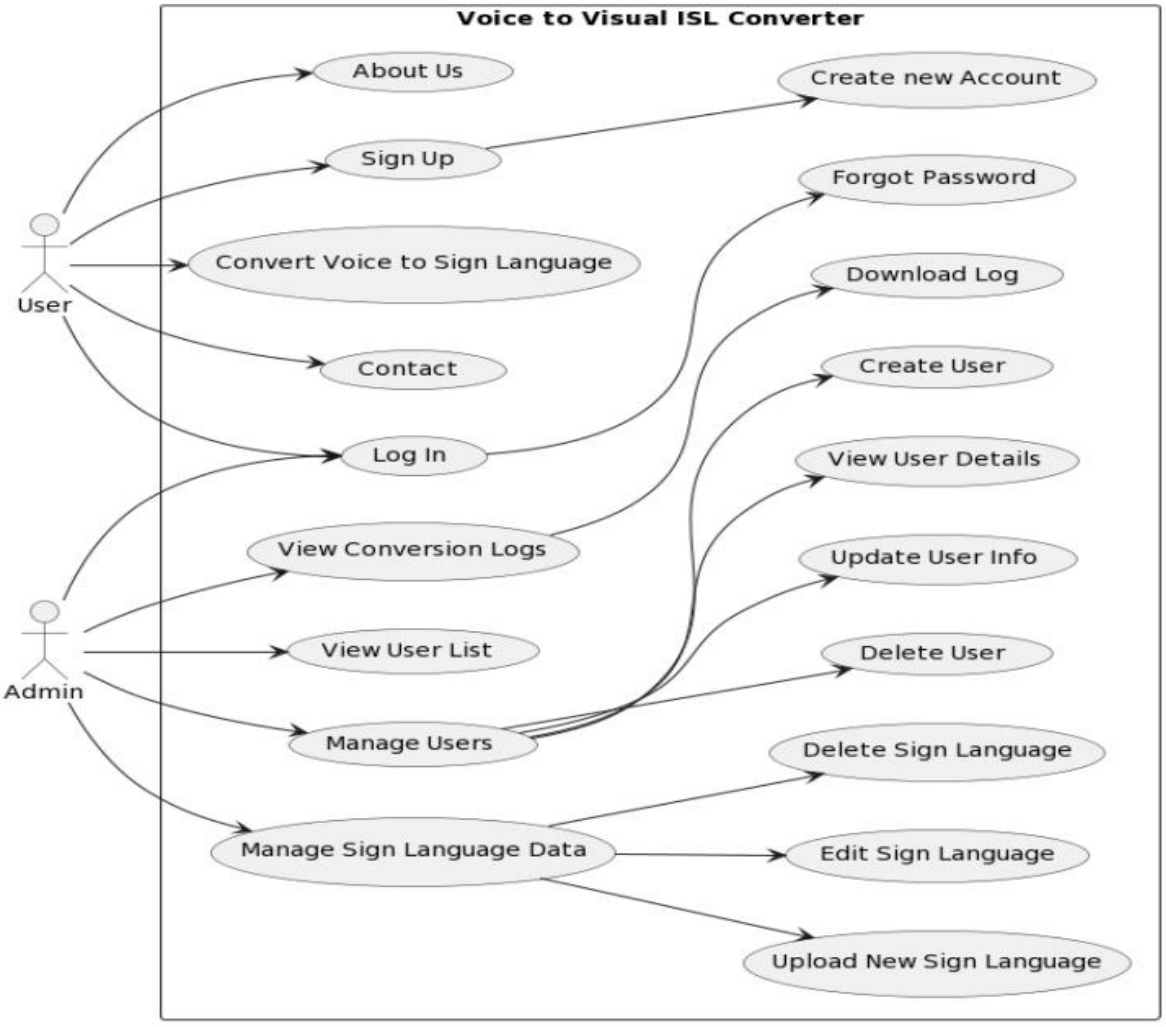


Fig 5.3 USE-CASE Diagram

- This diagram represents a Use Case Diagram for the Voice to Visual ISL Converter system. It shows how two types of users interact with the system: User and Admin. The functionalities are divided between these two roles.

5.9 Flowchart & Algorithm

- **Flowchart**

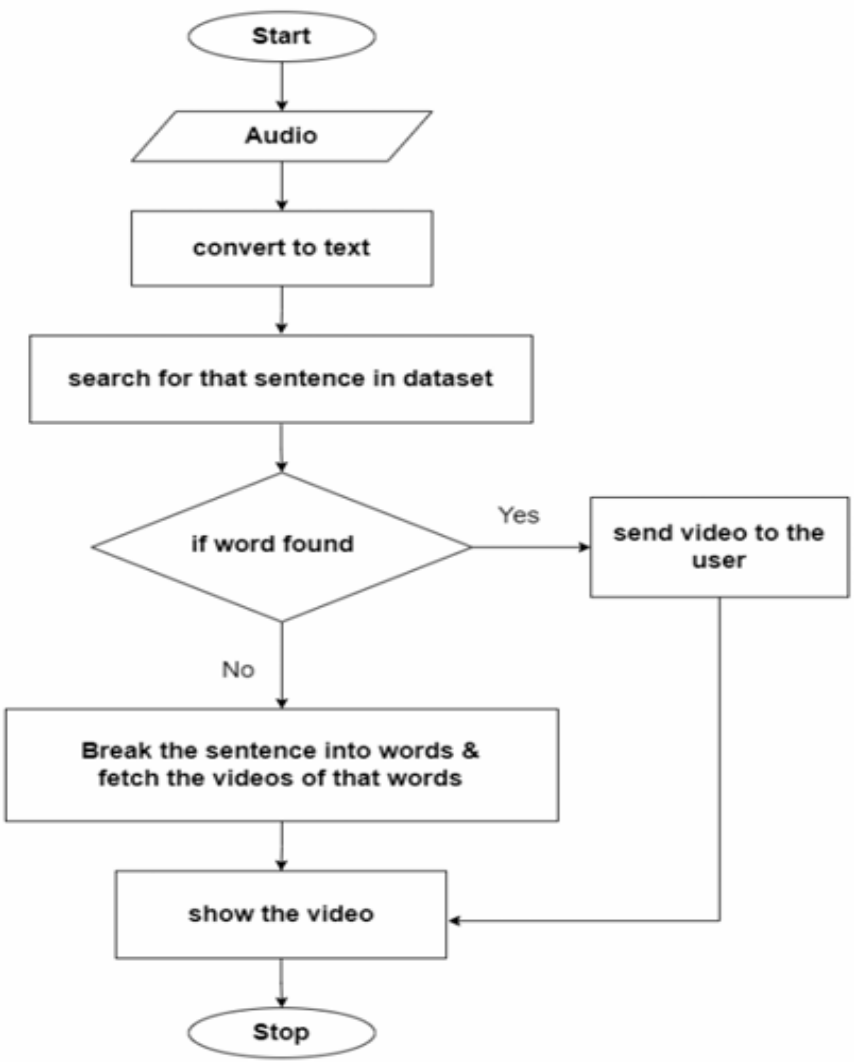


Fig 5.4 Flow chart

- **Algorithm**

1. Open Web Application.
2. Signup or login.
3. Input the text or click on microphone to speak.
4. Click on submit.
5. Input is process by system.
6. Start button for display of animation.
7. Shows the Required result.
8. Close.

CHAPTER 6

PROJECT OUTCOME

The "Voice Signal to Visual Indian Sign Language Converter" project delivers significant outcomes that directly address communication barriers faced by the deaf and hard-of-hearing communities. By leveraging speech recognition and sign language animations, the project provides a seamless and transformative communication tool.

6.1. Key Outcomes:

6.1.1 Enhanced Accessibility:

- The system bridges the communication gap by converting spoken or typed language into Indian Sign Language (ISL) animations.
- It empowers individuals with hearing impairments to understand and respond in real-time interactions.

6.1.2 Improved Inclusivity:

- The project promotes inclusivity in various sectors, including education, public services, and personal communication.
- It creates equal opportunities for individuals with hearing disabilities to engage meaningfully in society.

6.1.3 User-Friendly Experience:

- The intuitive user interface ensures smooth interaction for users of all technical backgrounds.
- Features like voice input, text input, and animation playback provide multiple modes of accessibility.

6.1.4 Reliable Performance:

- By utilizing advanced speech recognition tools (e.g., Google Speech API) and pre-saved ISL animations, the system ensures accurate and efficient results.
- Input parsing and tokenization guarantee clarity in processing longer paragraphs or complex sentences.

6.1.5. Scalability and Flexibility:

- The system can be scaled further to include additional sign language animations or languages to accommodate diverse user needs.

6.2. Social Impact:

- The project empowers deaf and hard-of-hearing individuals, contributing to a more equitable and inclusive society.
- It facilitates better communication in educational institutions, workplaces, healthcare, and daily life, thus improving the quality of life for marginalized communities.

6.3. Technological Advancement:

- The integration of speech recognition, text parsing, and ISL animation generation showcases the potential of combining modern technologies for accessibility-focused applications.
- The project serves as a foundation for further research into AI-based real-time communication tools and assistive technologies.

6.4 USER INTERFACE

- **Home Page**

  The Landing Page of the "Voice to Visual ISL Converter" project is its entry point to the application, made simple, engaging, and user-friendly. Its clean layout includes a bold header featuring the title of the project, "Voice to Visual ISL Converter," and a language selection dropdown by Google Translate to use application in multiple language. A short navigation bar on top with links to the Home page (which is the landing page), Converter, Log-in, Sign-up, Contact, About, and Manual makes for easy use. On the middle of the page, there is a greeting in big bold text - "Welcome to Voice to Visual ISL Converter," with a "Click to Start" button pointing users to the actual functionality of the tool.

6.1 Home Page

- **Sign-up Page**

The Signup Page of the "Voice to Visual ISL Converter" project allows new users to create an account, ensuring secure and personalized access to the platform. The page includes a clean and intuitive design with user-friendly input fields for essential information:

1. Username: A text input field where users can enter their desired username. This serves as the unique identifier for the user.
2. Password: A secure input field where users enter a strong password. The input is masked to ensure privacy.
3. Confirm Password: Another input field to re-enter the password, ensuring accuracy and preventing typos.

To enhance user experience, the form validates the input, ensuring that:

- The username is not left blank.
- The password meets security standards (e.g., minimum character length & use of special character).
- The "Password" and "Confirm Password" fields match.

  At the bottom of the page, a "Sign Up" button allows users to submit their information and create an account. If the passwords do not match, the user is prompted with an error message.

6.2 Sign-up Page

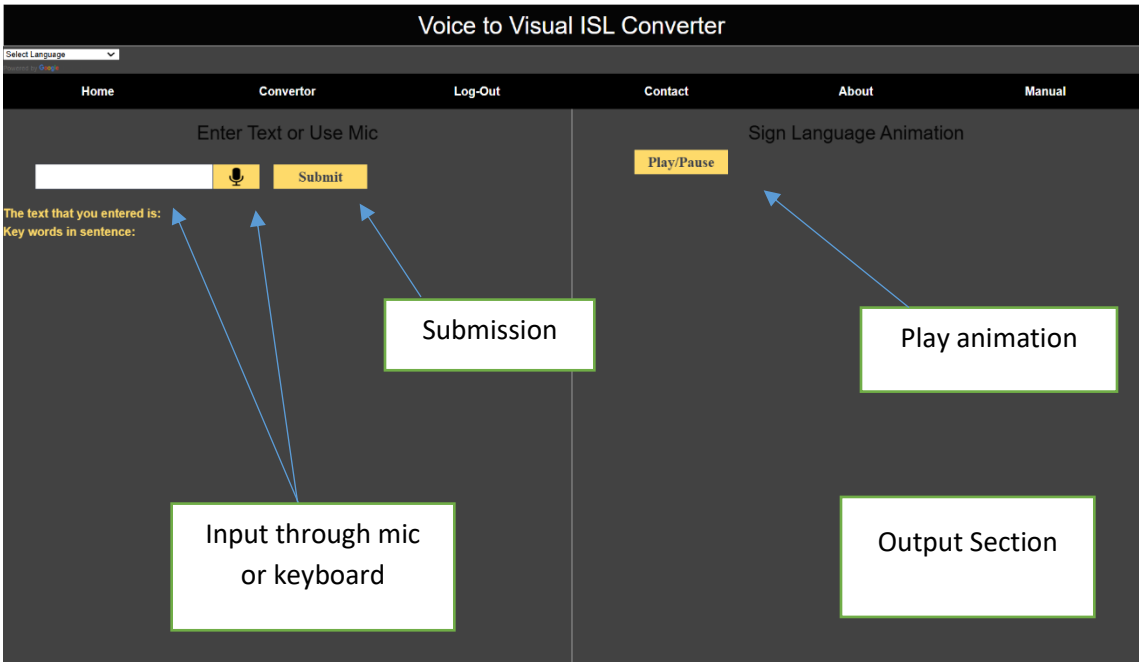
- **Log-in**

  Before accessing the main service, which is the Converter Page, users must log in with their credentials. This ensures that the platform remains secure and only accessible to authorized users. As soon as an unauthorized user attempts to open the page through a Hyperlink or the Converter Tab, they are automatically redirected to the Login Page. The Login Page is designed with a simple, clean, and user-friendly interface to ensure a seamless experience.

6.3 Login Page

- **ISL converter page**

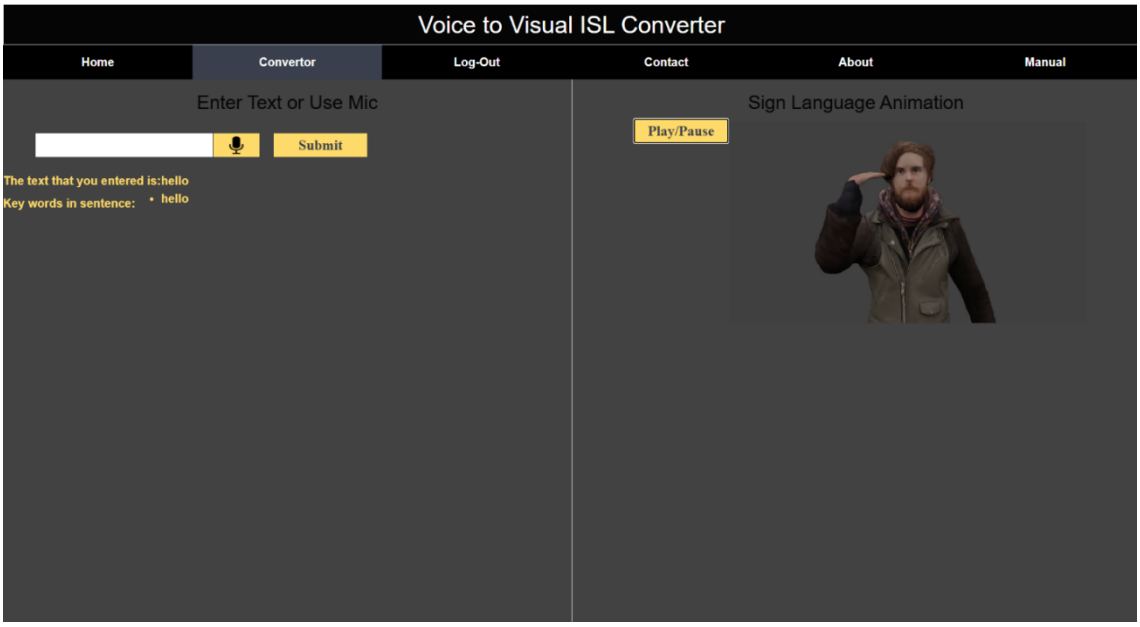
  Now after getting into the Converter Page, the page is divided into 2 halves:
  The left is the input part, and the right one is for the output part. Input part mainly consists of the placeholder where the user can type the input text or activate the mic button to start the Speech Recognition module which gets input text from the mic in English Format. Just right to it is the Submit button to submit the input into the system for the processing and desired output. Below it there is the space to reconfirm the spoken input by getting the output from the Speech Recognition module only.



6.4 Converter Page

- **Output**

  The Output Page is the final stage of the application where the results of the voice or text input are displayed in the form of Indian Sign Language (ISL) animations. This page is designed to provide a user-friendly and intuitive interface, ensuring the generated ISL gestures are clear and easy to understand. The input word is mapped with dataset and Alongside the ISL animations, the original input text is displayed for reference, helping users correlate the gestures with their corresponding words.



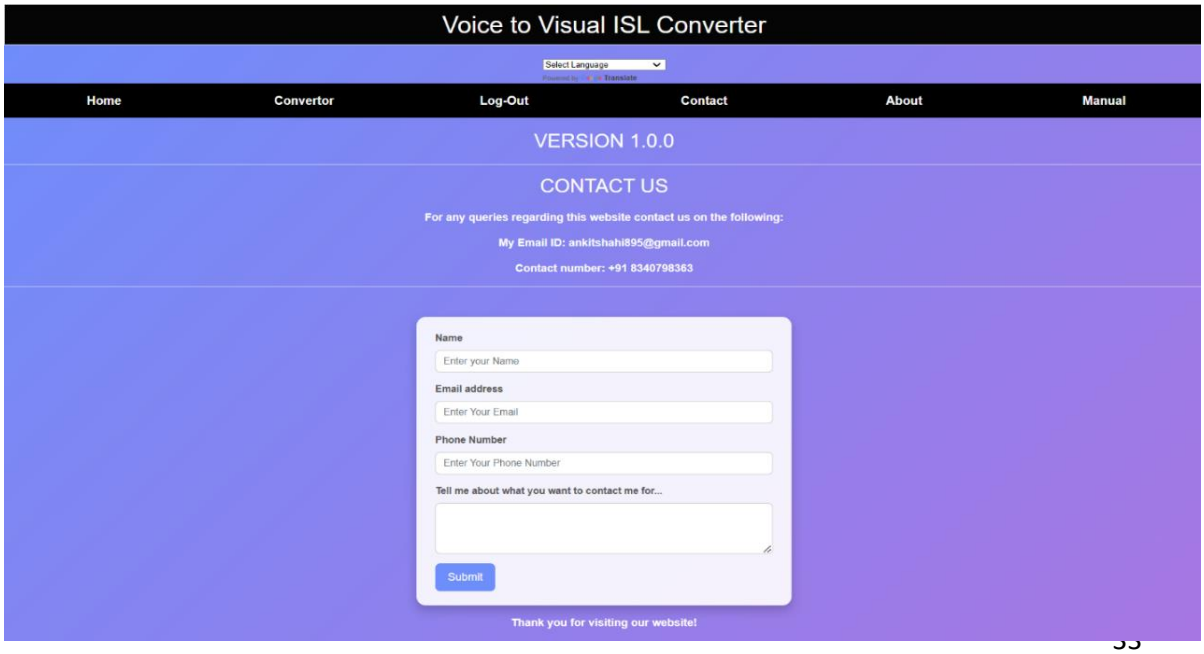
6.5 Output Page

- **Log-out**

  The Logout feature ensures the security and privacy of user accounts within the application. After successfully using the service, users can securely exit their session by clicking the Logout button, which is prominently placed on the navigation bar for easy access. Upon clicking, the system terminates the active session and redirects the user to the login page, preventing unauthorized access to the application. This functionality is crucial for protecting user data, especially in multi-user environments or shared devices. It also enhances the user experience by providing a clear and secure way to exit the application.

- **Contact**

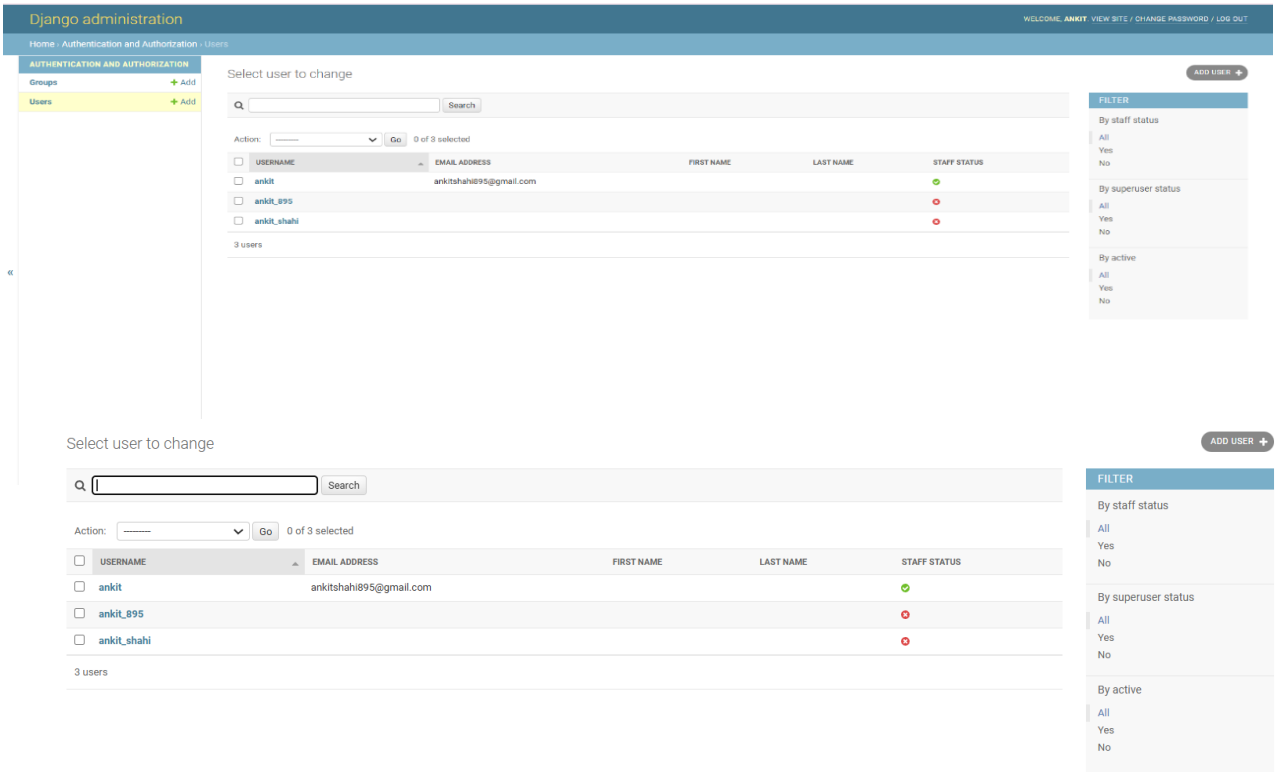
  The Contact has all the necessary Contact information. I have also included a contact form where user can contact me for any query or suggestions.



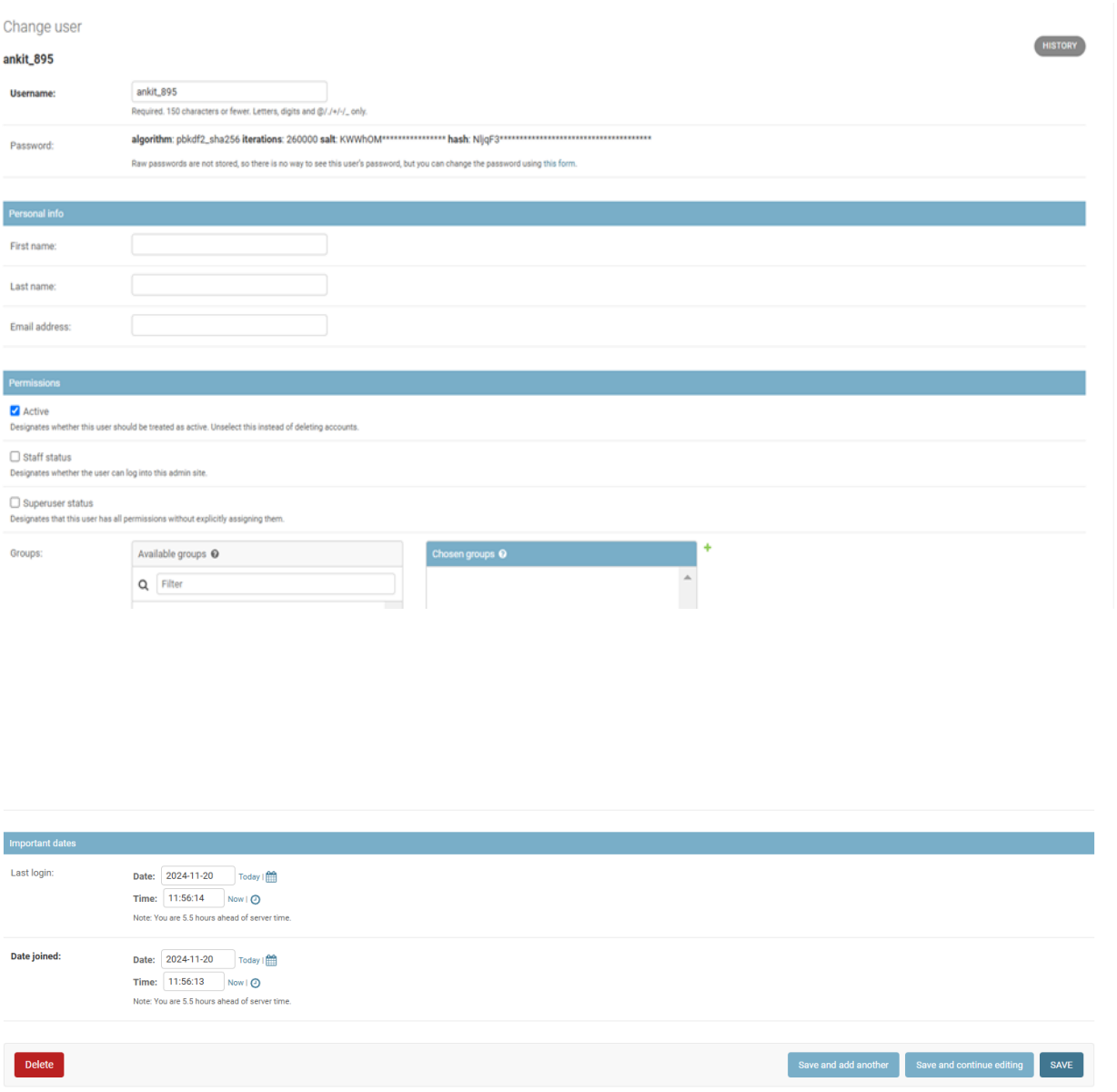
6.6 Contact Page

- **Backend Admin Page**

  For backend I used the Django admin panel, the Django admin panel makes server maintenance easier. All user log in and sign-up details are stored in Django server. Admin can access and modify the user login and sign-up. Its data simplifies development and gives developers the ability to manage websites more effectively. It provides reliable and adaptable server administration that meets a range of needs thanks to its integrated security and customization features.



6.7 Admin Page



6.8 User details on admin Page

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