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CMPE 491 – High Level Design Report

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1. Introduction

1.1. Purpose of the System

The objective of developing the SignLinga project originated from our observations of a noticeable language barrier existing between individuals with hearing impairments and those who rely on voice-based languages. This language barrier inspired the creation of SignLinga, a comprehensive initiative aimed at overcoming this barrier and fostering communication. The project is designed to address the specific challenges faced by people unfamiliar with sign language, offering translation solutions through voice, text, and video translation options. Our goal is to cultivate an application that not only eliminates communication barriers but also ensures ease of use, swift accessibility, and guaranteed accuracy. SignLinga aspires to be more than just a translation tool; it envisions becoming a seamless, efficient, and user-friendly platform, readily available to users with the same simplicity as making a phone call, thus empowering individuals to communicate effortlessly and inclusively.

1.2. Design Goals

We want our product to be as efficient, fast as it can be while not compromising on accuracy, to make this a reality our design goals for SignLinga are:

- Reliability: We need our system to be reliable as people are going to have full blown conversations there. So, we need people to be able to trust us also the number of errors should also be minimal.
- Maintainability: Our system should be open to changes. As we are thinking of later adding multiple language support and other features.
- Reusability: Our app should be able to operate on multiple platforms. Be it android ios and such.
- High Performance: Due to the nature of the the thing our app does. We need the app to operate in high speeds with high efficiency.
- User-Friendliness: Learning how to use SignLinga's should be incredibly easy. So, its interface should be basic and minimalistic. Accessing the features must be easy as well.
- Cost efficient: The app must be cost efficient. It needs to be easy to develop and maintain.

1.3. Definitions, Acronyms, and Abbreviations

App: An application that in this context will be used mainly on mobile devices

OTP: An authentication code to help us check whether users are real persons.

Admin: An application manager that has more authority then normal users(not a developer).

User: Any human that wants to talk to an audio impaired person

Registration: The action that will make you a registered user. Which will later help in pairing your data with you, like when creating a translation history for you to see.

1.4. Overview

Encountering people with auditory impairments in your daily life may pose challenges. However, SignLinga emerges as a solution yo that exact challenge. This innovative application lets users to capture videos of individuals conversing in sign language, offering a easy and accessible way to communicate. SignLinga's translation capabilities provide users with accurate output options, allowing them to receive translations in written or spoken formats based on their preferences.

Following the translation process, users can input their responses either in written or spoken forms, and SignLinga will accurately transform these responses into sign language, ensuring a two-way conversation experience. The application's design prioritizes the fluidity and completeness of communication interactions.

SignLinga's functionality extends beyond real-time conversations, as it can also the translate pre-recorded videos. This feature enhances the applicability of the app, enabling users to translate and understand sign language expressions in a variety of context, or it can also help audio impaired people watch videos that doesnt have subtitles.

In essence, SignLinga not only eases communication with audio-impaired individuals but it also goes beyond the limits of a translation app by providing options for both real-time and pre-existing video content. Its thoughtful design and innovative features position SignLinga as a valuable tool for anyone that might need its features someday.

2. Current System

Attached herewith are images showcasing the latest iteration of our current system. It is imperative to underscore that none of the visuals displayed in these images represent the final version of our project/product. The ultimate rendition will be unveiled upon the culmination of the entire project.

 It is essential to note that our current system is designed as a web-based platform for visibility purposes, even though the eventual goal is to transform it into an application-based interface. This strategic decision is a temporary measure to present a tangible representation during the developmental phase. As we progress toward the final stages, our project will be fully optimized for application-based presentation and utilization.
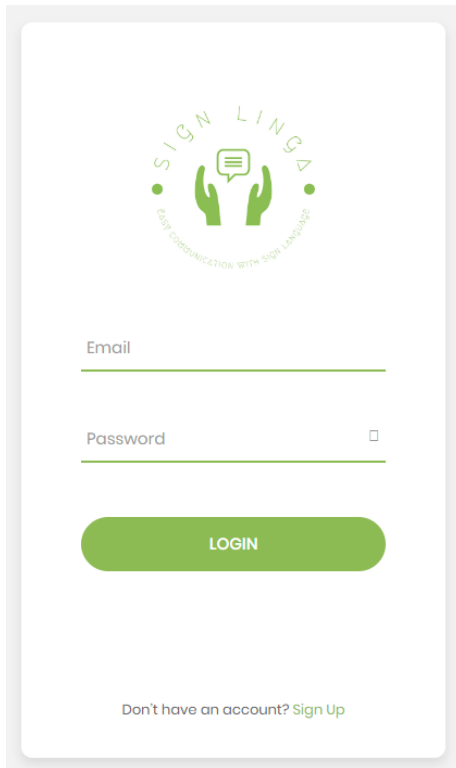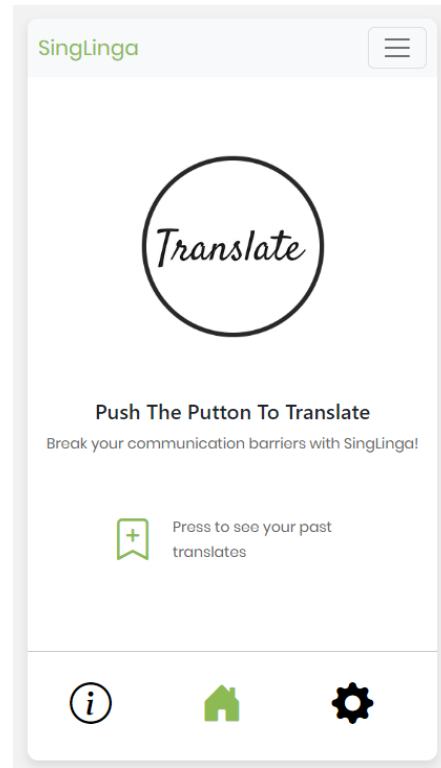
Figure 1 *Login Page of SignLinga*
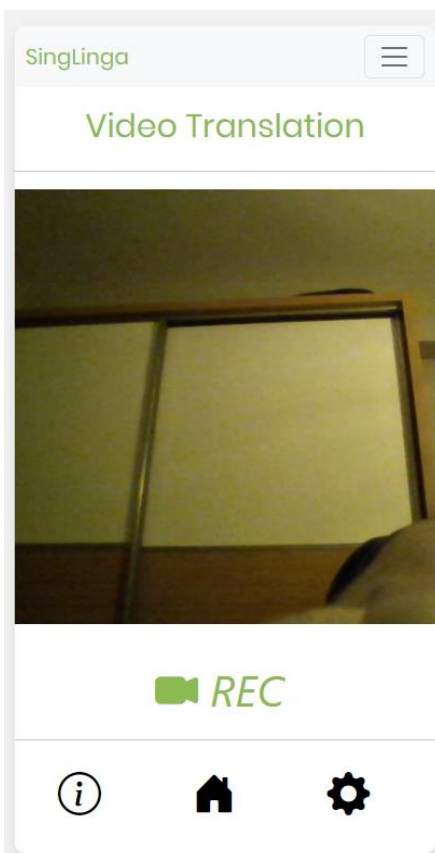

Figure 2 *Home Page of SignLinga*

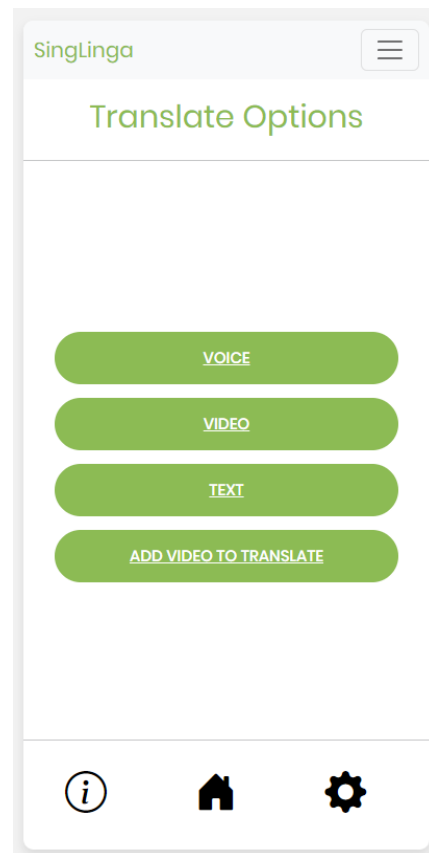*Figure 3* *Translate Options page of SignLinga.*

Figure 4 Video Translation page of SignLinga

3. Proposed Software Architecture

3.1. Overview

The proposed software architecture is designed to facilitate effective communication between individuals who can speak sign language and those who cannot. The solution's focus is on overcoming barriers for those who are unfamiliar with sign language. The application offers different integrated translation options such as voice, text, and video ensuring quick and simple comprehension. The main goal is to create an environment where individuals communicate with each other in sign language effortlessly and thro.

The login screen greets the user when they launch the application. If the user uses the application for the first time or has not created an account already, the user must register in the application. The user should provide name, surname, date of birth, phone number, email, username, password, information about their ability to speak/sign in sign language, and any disability status information. When the user completes the registration step an OTP code will be sent to the entered phone number for verification purposes. The user will easily create a new account by entering this code on the screen that pops up with the "Enter Code" button. Subsequently, the user's information will be saved to the real-time database and the real-time database will be updated. This allows users to easily log in to the application by only providing e-mail and password information and then clicking the "Log In" button. After registering the application one time, users can access their main page after logging in from the screen that appears when they launch the application.

Upon accessing the main page, users are greeted with a main screen featuring essential buttons, guiding them to key functionalities. The user interface is designed to be intuitive; it allows users to access translation options, view translation history, adjust settings, view their created profile, and find guidance on using the application effectively. The "Translate" button takes away the user to the "Translate Options" page and expects the user to select the translate type he/she desires to use. The "+" button takes away user to the page where the list of translation histories is displayed. The three essential buttons guide the user to other pages than the main page located at the bottom of the screen and always remain there. The leftmost "i" button directs the user to the "How To" page and presents a guideline to the user in the name of how to use the applications' features. The middle button with the home symbol turns back the user to the main page. The rightmost button with the cogwheel symbol takes the user to the "Settings Page" where he/she can arrange custom and general settings for the application. The last essential button is placed at the right top of the page. It is designed to have three lines one under the other when the user clicks this button it takes the user to the profile page where the user can arrange profile settings or display details about his/her profile.

The "Translate" module is the central feature, offering voice, text, and video translation options. Users can record sign language expressions through video or use existing or captured videos. The expressions desired to translate to sign language can be uploaded to

the application through a microphone or input text. On the main page when the user clicks on the "Translate" button and opens the "Translate Options" page, these options are listed. The user selects the desired translation option from these options which they listed as individual buttons. If the user clicks the "Voice" button, the "Voice Translation" page opens and waits for voice input in order to make the translation. When it gets the input, it makes the translation and displays the translated sign language on the screen as a video. If the user clicks the "Video" button, the "Video Translation" page is open, and the system waits for video input which includes sign language expressions. The video input can be recorded at the moment by clicking the "Record" button and opening the device camera or can load the existing video by clicking the "Upload" button which opens the gallery of the user and waits for the user to select a video. When it gets the input, it makes the translation and displays the translated text on the screen. If the user clicks on the "Text" button, the "Text Translation" page is open and waits for text input. On the "Text Translation" page text area is found and the user should enter the text he/she wants to translate here. When the user clicks on the "Translate" button, the system gets the text input and translates the entered text into sign language, the translated video includes sign language expressions displayed on the screen as a video. All the translated contents can be saved or shared, promoting flexible communication.

The admin Panel is available for the users who registered in the administrator list. The Admin Panel offers a range of powerful functionalities to streamline the oversight and management of user activities. Administrators can access an overview of registered users, providing details such as names, surnames, phone numbers, and email addresses. Real-time online status tracking ensures administrators can monitor user engagement efficiently. One key functionality of the Admin Panel is the ability to delve into users' detailed translation histories, allowing administrators to gain insights into individual user interactions with the application. Moreover, administrators can manage user roles, defining specific permissions and access levels for different users within the system. Additionally, the Admin Panel provides the capability to disable selected users temporarily, thereby blocking their entry to the application. These features empower administrators to maintain a secure and controlled environment while efficiently overseeing user activities. Admins have access to functionalities similar to the user interface, allowing for efficient monitoring and management of user activities.

Data security and privacy are paramount in the architecture. User data, stored in a real-time database, is handled securely. The account deletion process ensures the permanent removal of user data from the database, aligning with strict data protection measures. Scalability is a key consideration in the architecture, accommodating potential growth in user base and future feature enhancements. The real-time database enables seamless scaling, ensuring optimal performance as the application evolves.

In conclusion, the proposed software architecture stands out for its commitment to breaking down communication barriers and fostering inclusive communication. The user-centric design ensures that individuals, whether proficient in sign language or not, can interact seamlessly. The integration of voice, text, and video translation options provides a versatile and inclusive platform for effective communication. The intuitive user interface, coupled with the specialized Admin Panel, enhances user experience and facilitates efficient administration. Key strengths lie in the emphasis on data security and privacy, with stringent measures in place for user information handling. Scalability features ensure the application can adapt to the evolving needs of a growing user base. In essence, this architecture is poised to deliver a robust, scalable, and user-friendly communication facilitation application, promoting inclusivity and accessibility for all.

3.2. Subsystem Decomposition

The subsystem decomposition breaks down the proposed software architecture into distinct components or subsystems, each responsible for specific functionalities. To consider all system functionalities as a whole the admin system and user system functionalities have been unified and then divided into subsystems. The subsystems and according functionalities are listed below.

3.2.1. User Management Subsystem

This subsystem is responsible for handling user registration, authentication, and profile management.

The components of this subsystem are:

- User Registration
- User Authentication
- Profile Management
- OTP Generation and Verification
- Database Interface

3.2.2. Translation Subsystem

This subsystem is the core subsystem for translating sign language expressions using various input modes.

The components of this subsystem are:

- Voice Translation
- Text Translation
- Video Translation
- Translation History
- Save and Share
- Database Interface

3.2.3. User Interface Subsystem

This subsystem encloses the overall user interface, providing a seamless and intuitive interaction experience.

The components of this subsystem are:

- Main Page
- Navigation Buttons (Help – Main Page – Settings – Profile buttons)
- Translation Options
- Settings Interface
- How to Use Interface
- Pop-up Interfaces (for errors and warnings)
- Database Interface

3.2.4. Admin Panel Subsystem

This subsystem facilitates administrative functionalities and oversight and gives the admin control over users.

The components of this subsystem are:

- User Overview
- Online Status Monitoring
- Translation History Viewer
- User Management
- Settings Access
- Database Interface

3.2.5. Security and Privacy Subsystem

This subsystem ensures data security and manages privacy-related operations.

The components of this subsystem are:

- Data Encryption
- Account Deletion Process
- Privacy Policy Management
- Database Security

3.2.6. Scalability Subsystem

This subsystem addresses the scalability of the application for potential growth.

The components of this subsystem are:

- Database Scaling
- Infrastructure Scaling
- Feature Enhancement Integration

3.3. Hardware/Software Mapping

The hardware/software mapping establishes the relationship between the various software components of the proposed architecture and their corresponding hardware resources. In the context the of SignLinga application, the allocation of software components to specific hardware environments is designed to enhance user experience, maintain data security, and streamline administrative functionalities. The breakdown of subsystems (as listed in 3.2 Subsystem Decomposition) guides the distribution of software components across the user devices and the database server. The mapping provides visual information about the distribution.
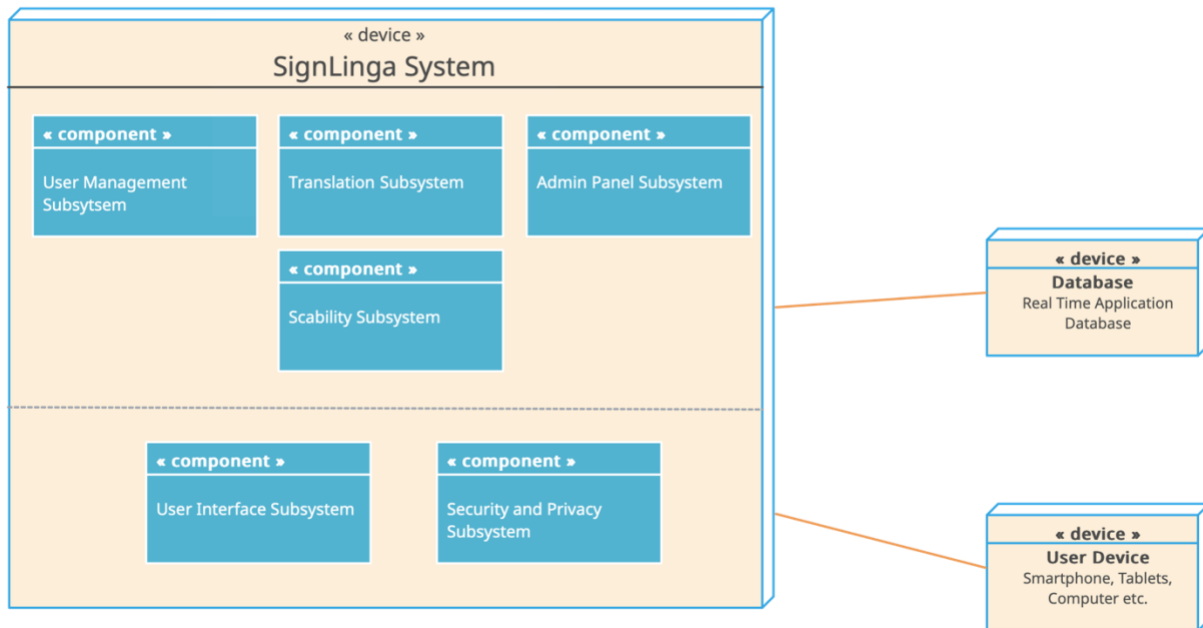
Figure 5 *Hardware-Software mapping of SignLinga application*

3.3.1. User Management Subsystem
- Deployed on database.
- Database Interface communicates with Database Server for user data storage and retrieval.

3.3.2. Translation Subsystem
- Deployed on database.
- Database Interface communicates with Database Server for translation history and data storage.

3.3.3. User Interface Subsystem
- Deployed on user devices.
- Communicates with Application Server for data retrieval and updates.

3.3.4. Admin Panel Subsystem
- Deployed on database.
- Database Interface communicates with Database Server for user and activity data storage.

3.3.5. Security and Privacy Subsystem
- Encryption processing on user devices
- Account deletion and security processes on Application Server and Database Server

3.3.6. Scalability Subsystem
- Database Scaling Component on Database Server
- Feature Enhancement Integration on Application Server

3.4. Persistent Data Management

The persistent data management of the proposed software architecture is a critical aspect ensuring the reliability and integrity of the system's data. The system will employ a robust database management system (DBMS) to handle data storage and retrieval. The chosen DBMS will be designed to support the specific requirements of the application, such as scalability, data consistency, and fault tolerance.

Data will be organized into well-defined tables, and relationships between entities will be established to maintain data integrity. Additionally, data normalization techniques will be applied to eliminate redundancy and optimize storage efficiency. Backup and recovery mechanisms will be implemented to safeguard against data loss and ensure business continuity.

To safeguard against data breaches and unauthorized access, the system will incorporate encryption-at-rest mechanisms within the database. Additionally, secure coding practices will be enforced to prevent SQL injection, cross-site scripting (XSS), and other common vulnerabilities.

3.5. Access Control and Security

Access control and security mechanisms are integral components of the proposed software architecture to safeguard sensitive information and ensure that only authorized users can interact with the system.

Furthermore, data encryption will be employed during transmission and storage to prevent unauthorized access. Authentication mechanisms, including multi factor authentication. Regular security audits and monitoring will be conducted to identify and mitigate potential vulnerabilities, ensuring the overall security posture of the system.

Access control and security measures will be paramount to the application's defense against unauthorized access and malicious activities. The architecture will enforce strong authentication mechanisms, including the use of multi factor authentication, will be implemented to verify the identity of users. Authentication something user know and something user have to verify the identity of users. Role-based access control will be implemented, defining granular permissions based on job roles and responsibilities such as user role, privileged user, admin user. Defining roles and associated permissions to regulate user access at different levels.

Security headers and protocols, such as HTTPS, will be employed to secure data in transit. Continuous monitoring tools will be in place to detect and respond to any anomalous activities. Regular security training for development and operational teams will ensure a proactive approach to security, fostering a culture of awareness and responsibility. Proactive defense aims to preparing defense against threat before attack.

3.6. Global Software Control

Global software control refers to the mechanisms in place to manage and coordinate the overall behavior of the distributed software system. The proposed architecture will implement a centralized control module responsible for orchestrating communication between subsystems. This central control mechanism will facilitate system-wide coordination, ensuring seamless interaction and collaboration between different components.

Version control systems will be employed to manage the evolution of the SignLinga, allowing for systematic updates and bug fixes. Additionally, a logging and monitoring system will be implemented to track system activities, aiding in debugging, performance optimization, and ensuring compliance with predefined standards.

3.7. Boundary Conditions

The boundary conditions of the SignLinga software architecture define the limits and constraints within which the system must operate effectively. This includes considerations for external interfaces, interoperability with other systems, and environmental constraints. The system will be designed to handle variations in data input, user load, and network conditions gracefully.

Compatibility with different operating systems and browsers will be ensured to enhance the system's accessibility. The architecture will incorporate mechanisms for graceful degradation and fault tolerance to handle unexpected scenarios. The defined boundary conditions will guide the system's behavior in diverse situations, ensuring a robust and reliable performance in real-world environments.

4. Subsystem Services

The SignLinga project's subsystem services include a wide range of features designed to provide regular users and administrators with an easy-to-use and seamless experience. These services are aimed at meeting the various demands of the target audience (hearing impaired people and people who will communicate with them), especially the hearing impaired. Admin System and User System are the two main parts of subsystem services.

4.1. Admin System Services

4.1.1. User Management

- Admins can log in to the application securely with their own login information.
- People using the application can create and control various user roles (Admins, User and Disabled User).
- Information such as name, e-mail, etc. of users registered to the application can be listed.
- Users can be deactivated as desired.
- User permissions and responsibilities can be changed.

4.1.2. System Monitoring and Control

- Users' general information (name, surname, phone number, etc.) can be displayed.
- Users' online or not status can be viewed in the application.
- Desired notifications can be sent to users.

4.1.3. Security and Authentication

- Ensuring that admins' e-mails and passwords are securely protected so that they can log in safely.
- Only people identified as administrators in the database can access the admin panel.

4.1.4. Logging and Reporting

- Data such as what was done in the application, which users logged in/out, and transaction histories can be kept and examined like a diary.

4.2. User System Services

4.2.1. User Registration and Authentication

- People who want to use the application can register by entering the basic information required for registration such as their name, surname, e-mail and password.
- Providing verification with OTP code whether users are real people or due to fraud problems.
- Allowing users to change themes according to their own tastes, update their personal information, log out and delete their accounts.

4.2.2. Translation Services

- Users can choose translation options such as voice, text, and video translations.
- Converting body movements in sign language into text.
- Ability to convert written text into sign language body movements.
- Ability to convert recorded voice into sign language body movements.

4.2.3. User Interface Services

- Ability to find and use options such as translations, translation history, how to use and settings.
- Accessing the translation history button so that users can view their past translations.
- Settings menu so users can access and change settings.
- Accessing user profile details.

4.2.4. Accessibility and Usability

- Preparing the application in a simple and user-friendly manner.
- Availability of facilities for disabled individuals to use them easily.
- Finding error messages so that problems can be resolved.

4.2.5. System Performance and Reliability

- Minimum latency for fast translation services.
- Ensuring both security and accuracy to ensure an accurate and reliable translation.

4.2.6. Security and Compatibility

- Translations that may be deemed sensitive can be safely deleted.
- It can be used on various devices if the equipment required by the application is available.

- The application can be used at any time.

The above-mentioned subsystem services collectively contribute to SingLinga's ability to facilitate effective and easy communication for both hearing-impaired and non-disabled individuals. Especially thanks to the user security, background check and easy use provided by the application, it makes it both understandable, easy to use and easy to use.

5. Glossary

In this part of the report, we can easily examine different commonly used words and their meanings. In this way, we can better understand what our project and report want to say.

1. **SignLinga Project**: A system called the Sign Language Project was created to make communication with the deaf and hard of hearing easier.
2. **Subsystem Services**: Subsystem Services has features that are intended to make a variety of users and administrators, particularly those with hearing impairments, have a smooth and simple-to-use experience.
3. **Admin System:** The administrative responsibilities and duties inside the system are contained in the Admin System subsystem.
4. **User System**: The subsystem known as the User System handles tasks including logging in, updating personal data, and enrolling people inside the system.
5. **OTP (One-Time-Password) Code:** Verification code used to check whether users are real persons or to prevent fraud problems.
6. **Translation Services**: Include audio, text and video translation options for the needs of hearing impaired and other users.
7. **User Interface Services**: Include features that provide users with access to options such as translation history, usage instructions, and settings.
8. **Translation History**: A function within the translation program that maintains track of previous translations a user has completed. It offers a list of translation activities arranged chronologically.
9. **Disable User:** The process of deactivating a user account in a translation application, either temporarily or permanently. Until their accounts are reactivated, disabled users are unable to access the application.
10. **User List:** A compiled list within the admin system displaying information about registered users. This list typically includes details such as usernames, email addresses, and other relevant user attributes.
11. **Use Management:** The group of features in the admin system that give administrators control over things associated to users, such as changing user roles, and disable user accounts.
12. **Database**: A set of data that has been structured and arranged to make efficient management and retrieval possible. It keeps user accounts, translation data, and other important data relevant to the report.

13. **Accessibility and Usability**: Designing the application in a simple and user-friendly way so that disabled individuals can use it easily.
14. **System Performance and Reliability:** Minimum delay for fast translation services and security measures for an accurate, reliable translation.
15. **Security Headers and Protocols:** Security measures used to secure data transmission, such as HTTPS.
16. **Persistent Data Management**: Database management system (DBMS) used to ensure the reliability and integrity of system data.
17. **Encryption-at-Rest**: Encrypting data in the database protects against data leaks and unauthorized access.
18. **Web-based Platform**: Web-based platform is the interface where the existing system is designed on the web for visibility purposes.
19. **Application-based Interface**: Interface that will be optimized in the final stages of the project and will allow users to access it through the application.

6. References

[1] Creately.Diagram Maker. Retrieved January 6, 2024, from

https://app.creately.com/

[2] High-Level Solution Design Documents: What Is It and When Do You Need One. (2021, July 23). Operational Excellence in Software Development. Retrieved January 2, 2024, from

https://softwaredominos.com/home/software-design-development-articles/high-level-solution-design-documents-what-is-it-and-when-do-you-need-one/

[3] Sign Language Recognition Generation, and Translation: An Interdisciplinary Perspective (2019, October 24). Retrieved January 2, 2024, from

https://dl.acm.org/doi/abs/10.1145/3308561.3353774