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Analysis and Design of AI and AR-Based Applications with a UIUX Approach to support Inclusive Learning for students with Disabilities

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Abstract— The integration of Artificial Intelligence (AI) and Augmented Reality (AR) in education holds transformative potential, particularly in fostering inclusive learning environments for students with disabilities. This study investigates the integration of Artificial Intelligence and Augmented Reality to advance inclusive education. This research examines the analysis and design of AI and AR-based applications, employing a User Interface and User Experience (UI/UX) approach to cater to the diverse needs of students with physical, sensory, or cognitive impairments. By emphasizing inclusive design principles, the study aims to develop adaptive and accessible educational tools that promote engagement, deepen understanding, and improve learning outcomes. The research adopts a multidisciplinary methodology, combining insights from accessibility standards, UI/UX design frameworks, and educational technologies. Key objectives include identifying accessibility barriers, designing user-centric interfaces, and evaluating the effectiveness of AI-driven personalization and AR-enhanced interactivity in real-world learning scenarios. Preliminary findings highlight the importance of responsive and adaptive interfaces in facilitating equitable access and promoting active participation among students with disabilities. The study underscores the role of innovative technologies in bridging gaps in traditional education systems, ultimately promoting an inclusive and empowering learning experience. This research contributes to the broader discourse on leveraging technology to ensure educational equity and inclusion in the digital age.

Keywords—SignSyncAI; Wireframe; Mock-up; Mobile Application; Flutter Framework; Virtual Reality.

I. INTRODUCTION

Mobile apps designed for people with disabilities are innovative solutions that enhance accessibility and inclusion in everyday life. These apps utilize technology to deliver features such as voice-based learning, automated texting, image recognition, and alternative communication, which can be tailored to individual needs [1]–[3]. With a focus on ease of use, these apps aim to reduce physical and social barriers, enabling users to be more independent in their activities, communication, and access to information, as noted in [4]. Through them, mobile apps for people with disabilities not only support empowerment but also help create a more inclusive society for individuals with disabilities [5][6]. The research utilizes a mobile application with AI capabilities.

UI/UX is essential to designing an app that is truly on target in its use. For individuals with disabilities, it is essential to create the right digital experience, as in [7]. References [8]–[10] indicate that the approach enables users with diverse abilities to interact effectively with technology, thereby enhancing the overall experience. Accessibility in UI/UX design is not just an add-on; it is a fundamental aspect of the design process that requires careful consideration and empathy for the diverse needs of users.

Accessibility in mobile apps is essential because it enables individuals with disabilities to access the same functionality as their peers without disabilities [11]–[13]. This inclusivity not only promotes equality but also enriches the user experience for everyone. By prioritizing accessibility, designers can create apps that cater to a wider audience, ensuring that no one is left behind in the digital age.

A user-centered design approach is essential when developing mobile apps for individuals with disabilities. This involves engaging users with disabilities throughout the design process to gather insights into their unique challenges and preferences, as in [14]. By understanding their needs, designers can create more effective and user-friendly interfaces that increase usability and satisfaction.

Several key principles guide the creation of accessible mobile apps. Deploy applications with valid sources for students with disabilities. These include providing clear navigation, using high-contrast colours for improved readability, ensuring compatibility with assistive technologies, and providing alternative text for images. By adhering to these principles, designers can create apps that are not only functional but also enjoyable for all users.

Mobile apps for individuals with disabilities also benefit from advancements in emerging technologies such as artificial intelligence (AI), machine learning (ML), and augmented reality (AR), as in [15]. AI and ML can enable features like predictive text input, speech-to-text conversion, and real-time translation, which are highly beneficial for users with hearing or speech impairments [16]–[18]. Meanwhile, AR can create immersive experiences for individuals with cognitive

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disabilities, providing interactive tools to support learning, navigation, and daily activities. These technologies expand the scope of what accessible apps can achieve, making them more versatile and personalized for diverse needs, as in [19].

Collaboration with accessibility experts and advocacy groups is another critical component in the development of inclusive mobile apps. By collaborating with organizations that specialize in supporting individuals with disabilities, developers can gain valuable insights and feedback. This collaboration ensures that the app not only meets accessibility standards, such as the Web Content Accessibility Guidelines (WCAG), but also addresses real-world usability issues faced by its target audience. Additionally, such partnerships demonstrate a commitment to inclusivity and can foster trust among users and stakeholders.

Finally, the impact of accessible mobile apps extends beyond individual users, influencing societal attitudes toward inclusion and equality. By making technology more accessible, these apps help normalize the presence and participation of people with disabilities in all aspects of life, from education and employment to social interactions, as noted in [20]. This cultural shift encourages the adoption of universal design principles in other sectors, creating a ripple effect of inclusivity. As technology continues to evolve, the commitment to accessibility in mobile apps will play a vital role in shaping a more equitable and inclusive digital future.

II. Research Methodology

This section provides a detailed explanation of the research conducted. The research work is illustrated in Fig.1.

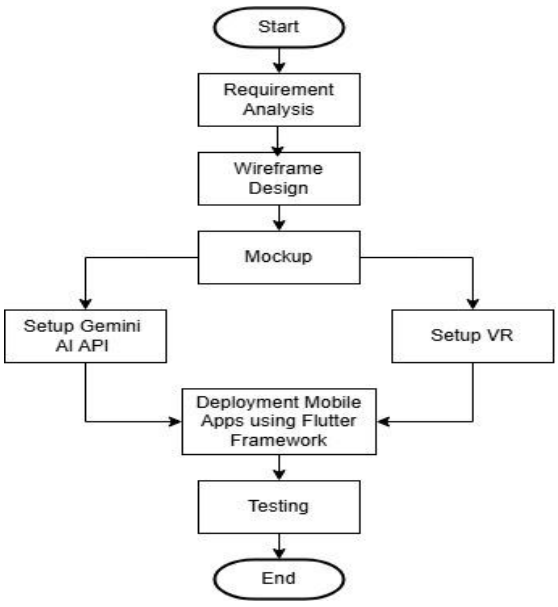

Fig.1. Workflow

The process begins with the initiation of the project. The Requirement Analysis step involves identifying and gathering the functional and technical requirements necessary for the application. A wireframe or prototype is created to visualize the application's user interface and structure without delving into detailed design. A more detailed version of the Wireframe, including design elements such as colours, typography, and branding, is developed to represent the final look of the app. The application integrates artificial intelligence, APIs like Gemini AI are conFig.d to handle AI-related functionalities. The application includes virtual reality features. The VR environment and tools are set up. The mobile application is developed and deployed using the Flutter framework, which enables cross-platform compatibility. The last step is rigorously tested to ensure it meets quality standards and is free of bugs.

A. Software Lifecycle Design

The author uses Agile to deploy the application. Agile Software Development Life Cycle (SDLC) is ideal for this project because it emphasizes adaptability, collaboration, and iterative progress—key factors in designing inclusive applications. The dynamic nature of AI and AR technologies, combined with the diverse needs of students with disabilities, necessitates a flexible approach that incorporates continuous feedback from stakeholders, including educators, students, and accessibility experts. Agile allows for incremental development, enabling the team to prioritize and deliver high-value features, such as accessibility enhancements or adaptive interfaces, early in the process. This iterative approach ensures that the application evolves effectively to meet real-world requirements, reduces risks, and fosters a user-centred design that aligns with the principles of inclusivity.

B. UI/UX Wireframe

The UI/UX wireframe for SignSync AI is designed to provide a seamless and intuitive user experience, focusing on accessibility and ease of navigation for both sign language users and interpreters. The layout features a clean and organized interface that prominently displays the main functionalities, including video upload, real-time sign language interpretation, and customization settings. Key elements include a user-friendly dashboard with clear icons for uploading content, selecting sign language options, and accessing analytics. The Wireframe incorporates visual cues and tooltips to guide users through the process, ensuring that even those with limited technical skills can effectively engage with the platform. Additionally, the design prioritizes responsiveness across devices, allowing users to access SignSync AI on desktops, tablets, and smartphones, thereby enhancing its usability in various contexts.

C. SignSync AI Mock-up

The SignSync AI research methodology employs a multifaceted approach to enhance the synchronization of sign language interpretation with visual media. It begins with comprehensive data collection, including diverse sign language videos and corresponding audio-visual content, to create a robust training dataset. Advanced machine learning algorithms, such as deep learning and natural language processing, are then employed to analyze patterns and improve the accuracy of sign language recognition and translation. User-centered design principles guide the iterative development process,

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incorporating feedback from sign language users and interpreters to ensure the system is intuitive and effective. Finally, rigorous testing and evaluation against established benchmarks ensure the reliability and usability of the SignSync AI system in real-world applications.

D. Flutter Framework

The Flutter framework is a powerful open-source toolkit developed by Google, designed for creating natively compiled applications for mobile, web, and desktop from a single codebase. It utilizes the Dart programming language and offers a comprehensive set of pre-designed widgets, allowing developers to create highly customizable and visually appealing user interfaces. Flutter's unique architecture, including its reactive programming model and widget-based approach, facilitates rapid development and testing. Its cross-platform nature and "hot reload" feature have made it a popular choice for modern application development. This framework has been adopted across diverse industries due to its ability to deliver seamless and performant apps efficiently.

In research methodology, a study on Flutter would involve a systematic investigation into its technical capabilities, usability, and performance across different platforms. Researchers may employ a mixed-methods approach, combining quantitative metrics, such as build times, app size, and performance benchmarks, with qualitative assessments, including developer satisfaction and user experience feedback. Comparative studies with other frameworks, such as React Native or Swift, may highlight Flutter's strengths and weaknesses, providing deeper insights into its utility for diverse development scenarios. Additionally, examining real-world case studies where Flutter has been implemented can enrich the understanding of its practical applications and limitations.

III. Result and Discussion

The study's results led to the creation of an application for mobile devices. The author uses several tests, including needs Analysis, Prototyping testing, UX Testing with Target Users, and statistical testing. The research product is an Application based on mobile. The flow for SignSync AI is illustrated in Fig.2.

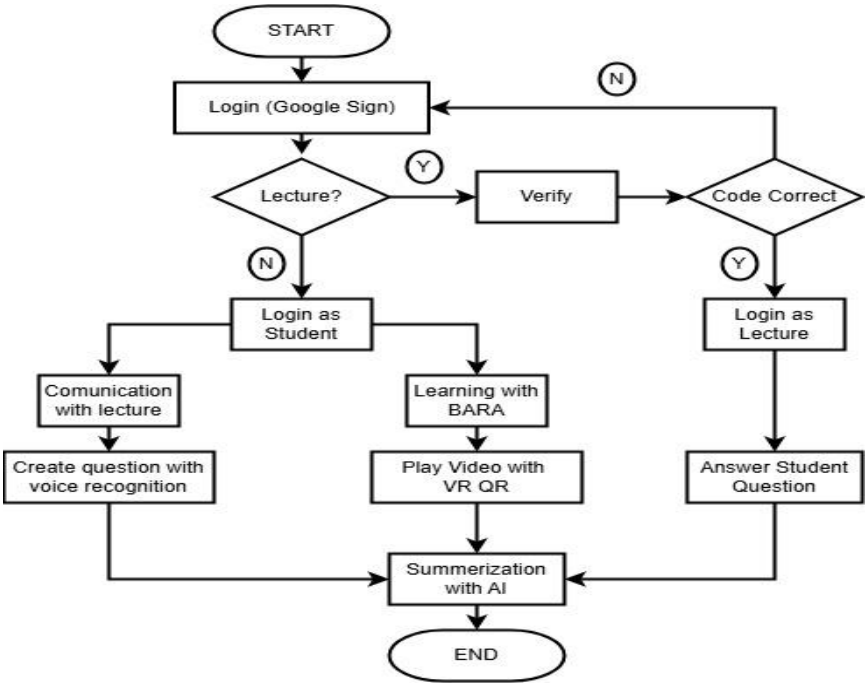

Fig.2. Research Flow

A. User

Users log in with Google using their email. Users can log in to the app using either Google Sign-In or their email credentials. The app supports two primary user roles: Students and Lecturers. During registration, the system automatically assigns the user type based on the email provided, simplifying the process for both user groups.

For Students, entering an email with a valid Student ID number ensures their account is categorized correctly without additional steps. This automation enhances the user experience by minimizing manual input and ensuring a seamless onboarding process tailored to each user's role. Lecturers, on the other hand, can sign up without this requirement, enabling a straightforward registration process for all users.

B. UI UX Design Wireframe

The UI/UX design starts from the design Wireframe. The Wireframe for the Signsync AI mobile app outlines a user-friendly interface designed to facilitate seamless interaction. The home screen features a clean header with the app logo and a search bar for quick access to content. Fig.3 explains the Wireframe from our research.

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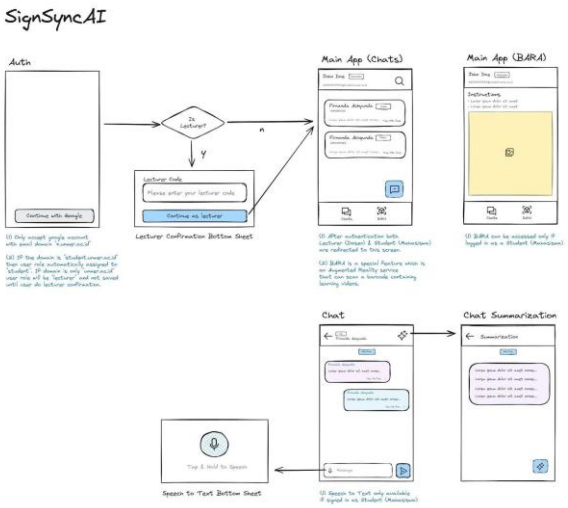

Fig.3. Wireframe

C. *UI/IX Mock-up*

The UI/UX design mock-up for the Signsync AI mobile application focuses on inclusivity, particularly for students with diverse needs. The interface is designed to be intuitive, featuring clear navigation, large buttons, and accessible colour contrasts that accommodate users with visual impairments or cognitive differences. Key features include an interactive "Learn Signs" module with step-by-step tutorials. This "Translate" tool converts text or speech into sign language animations, and a "Practice" area for skill reinforcement. The design incorporates a customizable user profile, allowing students to tailor their experience with options such as preferred sign language dialects or font sizes. By prioritizing simplicity and adaptability, the mock-up ensures all students can effectively engage with the app.

The Home Page is the login page that is used. Fig.4 explains the login process for both lecturer and student users using Google Sign-in. From the lecturer's display, a discussion schedule proposed by students will be available. Fig.5 explains the communication process between lecturers and students. Students can use the voice-to-text menu in the communication process.

Fig.4. Login Page SignSync AI

Fig.5. Discussion Page For The Lecturer

Fig.6 explains the use of AR technology to view learning videos that students with disabilities will utilize. Fig.7 explains the role of AI in summarising all conversations between students and lecturers. Application of AI to summarise conversations held by students and lecturers.

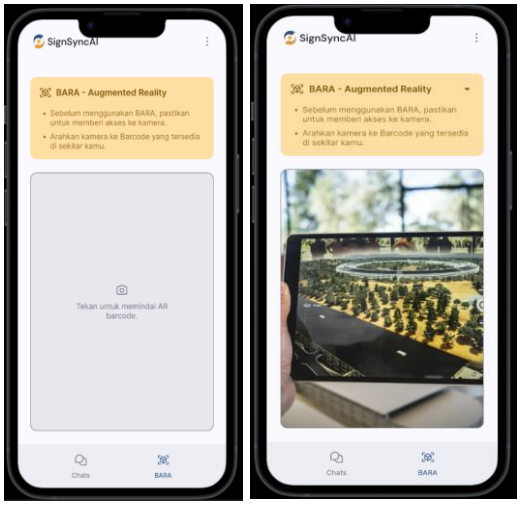

Fig.6. Using AR for play Learning Video

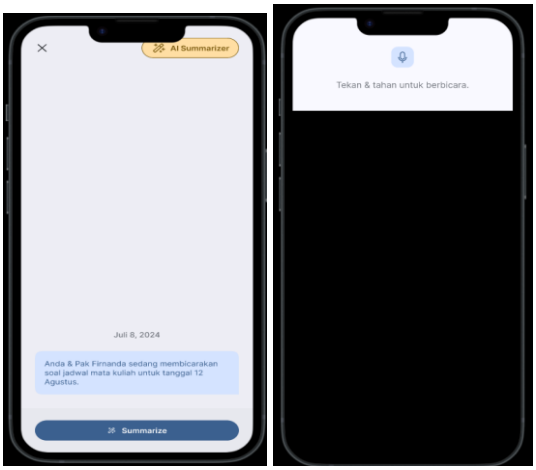

Fig.7. Summarise Using AI

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D. Mobile Application Implementation

Signsync AI is a mobile application designed to bridge communication barriers by leveraging advanced AI technology for sign language translation. The app provides users with tools to learn and practice sign language interactively, as shown in Fig. 8, making it an invaluable resource for individuals in educational settings, workplaces, or social environments where inclusive communication is essential. We test the application directly with students with disabilities in class, allowing us to monitor the results and receive direct feedback from them.

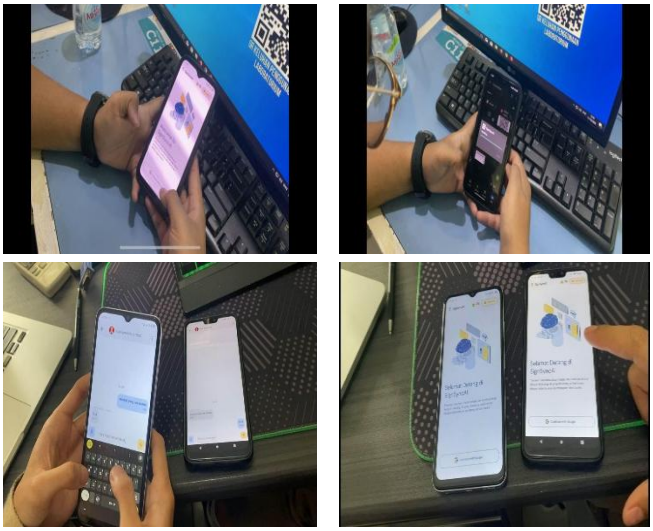

Fig.8. Implementation of Mobile Application SignSyncAI

The application is installed on a mobile phone, and the author tries to test all features. These features might include a home screen for navigation, a learning section, a practice mode for real-time feedback, and a history section to track progress. The main feature of this application is BARA and Chat with the lecturer. The polished design not only ensures usability but also reflects the Apps focus on accessibility, with features such as adjustable text sizes and high-contrast modes tailored to meet the needs of users with varying requirements. Signsync AI represents a significant step forward in promoting inclusivity, helping students, educators, and the community communicate effectively through sign language.

E. QR Code Generator

The QR code generator uses https://www.qr-code-generator.com/. Our generator code is described in Fig. 9. The QR Code Generator offers a comprehensive platform for creating, designing, managing, and tracking QR codes. Key features include customizable designs, the ability to embed various types of content such as URLs, contact information, and multimedia, as well as analytics tools to monitor scan rates and user engagement. Additionally, it supports dynamic QR codes that can be updated after creation, ensuring flexibility for marketing campaigns. The platform is user-friendly, requiring no design expertise, and provides high-resolution downloads in multiple formats. With options for team collaboration and campaign management, the QR Code Generator is ideal for businesses and individuals looking to enhance their marketing strategies through effective QR code utilization.

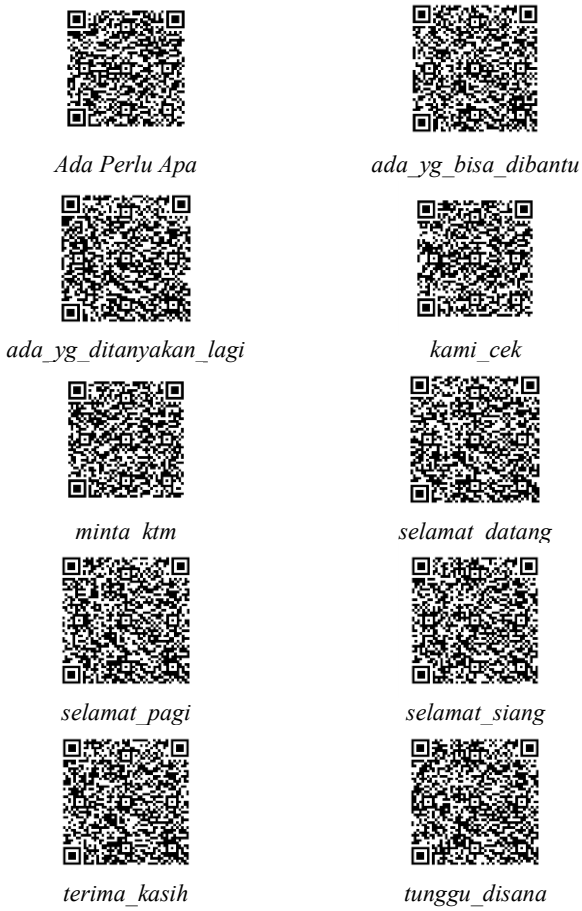

Fig.9. QR Code

F. Discussion

This research employs various types of analysis to ensure the optimal development of applications. The retention rate is also measured to determine the application's ability to maintain user engagement over time, providing insights into its long-term usability and relevance. The author conducts various tests, including needs analysis, to understand user specifications and expectations for the application. Prototype testing is then carried out to evaluate the initial design and core functionalities before further implementation. Additionally, UX testing with target users is applied to assess usability, ease of use, and user satisfaction with the application's interface. Finally, statistical testing is used to analyze the test data, ensuring the validity and reliability of the results before the application is released.

G. Needs Analysis

This study employs qualitative methods, including in-depth interviews and focus group discussions, with students, educators, and inclusion experts to gain comprehensive insights into the specific challenges and expectations in inclusive education. At the same time, structured questionnaires are employed to capture user interface and user experience systematically (UI/UX) requirements tailored to the diverse

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needs of learners with disabilities. The interviews or focus group discussions with students, teachers, or inclusion experts. Questionnaire to capture UI/UX needs in Table I.

TABLE I
NEEDS ANALYSIS SIGNSYNC AI

Aspect	Needs	Proposed Solutions
Primary Users	Easy access to inclusive, technology-based learning tools	An application with simple interactive features that supports various types of users
Problems Encountered	A learning platform that facilitates two-way communication using sign language	Sign language learning modules, text/voice-to-sign translation features, and a community for collaboration.
Main Goals	A user-friendly application that supports the cognitive and social development of students	Features like "Learn Sign Language," "Translation," and "Practice" are specifically designed for inclusive students.
Technical Requirements	Accessible and responsive design for all devices	Inclusive UI/UX design with options to adjust text size, colours, and language preferences
Data Sources	Accurate data on user needs	Targeted user surveys, focus groups with inclusion experts, and literature research.
Key Features	Ease of access, interactive learning experience, and flexibility in use	Automatic login, module-based interface, and interactive videos and animations for practice

H. Wireframe Prototyping testing

The author uses two types of analysis to confirm the fixed prototype and can deploy it to the next process. The author uses Usability testing and Heuristic testing. Heuristic using the think-aloud protocol when users try out prototypes and analyze. Heuristic testing involves the author asking UI/UX experts to evaluate designs based on usability principles. The analyze task completion rate, error rate, or task completion time in Table II.

TABLE II
PROTOTYPE TESTING

Aspect	Usability Testing	Heuristic Evaluation
Purpose	Observe how real users interact with Signsync AI to ensure the design is intuitive and user-friendly.	Evaluate whether the Signsync AI wireframe follows best practices for usability and design standards.
Method	Users are asked to complete tasks (e.g., translating text to sign language or learning signs) while verbalizing their thoughts aloud.	UI/UX experts review the Wireframe based on established heuristics such as simplicity, feedback, and error prevention.
Metrics Analyzed	a) Task Completion Rate: Users complete key tasks such as translating text or signing a word. b) Error Rate: The Wireframe is clear and intuitive. c) Task Completion Time: The Wireframe is streamlined and intuitive.	a) Consistency: The design is consistent in terms of navigation and layout. b) Feedback: Users should receive clear, timely feedback for their actions c) Error Prevention: The Wireframe should prevent common user errors
Results with Good Wireframe Design	a) Task Completion Rate: A high success rate, indicating that the wireframe design effectively supports users in completing tasks. b) Error Rate: Minimal errors, indicating that the Wireframe is clear, intuitive, and easy to navigate. c) Task Completion Time: Shorter times for completing tasks, showing that the wireframe design allows users to perform tasks efficiently.	a) Consistency: The Wireframe is consistent, making navigation and use predictable. b) Feedback: The Wireframe provides clear feedback, such as visual cues, when actions are completed c) Error Prevention: Users experience minimal errors, and if they do occur, they can recover easily through well-designed error messages or guidance.

I. Black Box Testing

After the testing process is carried out under valid and invalid conditions based on the expected results, it is confirmed that all functions are functioning properly. The test results are presented in Table III.

TABLE III
VALIDITY ANALYSIS

ID	Descriptions
FL1	Valid
FL2	Valid
FC1	Valid
FC2	Valid
FB1	Valid
FB2	Valid
FS1	Valid
FS2	Valid

Table III provides results from black box testing conducted on various functionalities of the application, identified by their IDs (e.g., FL1, FC1, FB1). Black box testing focuses on evaluating a system's functionality without examining its internal code or implementation details. Instead, it tests the application by providing inputs and validating the outputs against expected results.

In this case, each ID (e.g., FL1, FL2, FC1) represents a specific functionality or feature within the application, and the result for each is marked as "Valid". This indicates that all tested functionalities operated correctly and produced the expected outcomes during the testing process. For example, FL1 and FL2 might refer to login functionalities, FC1 and FC2 could represent core features like content display, and FB1, FB2, FS1, and FS2 might refer to buttons or specific operations within the application. The consistent "Valid" status confirms that the application's features function as intended and meet the defined requirements.

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IV. CONCLUSION

The conclusion of this research is to develop a mobile application using the Flutter framework. It begins with requirements Analysis and designing the application's structure through wireframes and mock-up, ensuring a clear vision of the final product. The inclusion of optional steps, such as setting up AI (Gemini AI API) and VR, highlights the flexibility to incorporate advanced functionalities based on project needs. After configuring these features, the app is developed and deployed using Flutter, leveraging its cross-platform capabilities. SignSync AI enhances accessibility by offering real-time sign language recognition and translation, facilitating more inclusive communication and learning experiences for individuals with hearing impairments. The testing phase ensures the app's quality, functionality, and user satisfaction before release. Overall, the process emphasizes planning, adaptability, and rigorous testing, ensuring an efficient and high-quality mobile app development lifecycle. The future application can be deployed with a combination of AI to provide more accurate summaries.

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