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Android-Based Detection Application of Indonesian Sign Language System (SIBI) Using Rapid Application Development Method

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Abstract

Deaf individuals face communication challenges with the general public due to their limited hearing, which necessitates the use of sign language. The gap in sign language understanding between deaf individuals and the general public often hinders their social interactions. This research develops the SIBI sign object detection model into an Android-based application that can detect and translate the Indonesian Sign Language System (SIBI) features into spoken language. The development of this application employs the Rapid Application Development (RAD) method, which includes the stages of requirements planning, user design, construction, and completion. The application was built using the Kotlin programming language and a TensorFlow Lite-based gesture detection model with three main features: real-time SIBI gesture detection, SIBI information, and Indonesian to SIBI translation. Testing involved 30 respondents with normal hearing and utilized the Blackbox Testing method. Usability testing results reached 85.6%, indicating the feasibility and effectiveness of the application. Blackbox Testing achieved a score of 100%, confirming the system's very high functionality. The Indonesian Sign Language (SIBI) Detection Application was successfully developed using the RAD method. This application has proven to be effective as a communication tool that bridges deaf individuals with the wider community in Indonesia

Keywords:
Indonesian Sign Language System Application (SIBI), Real-Time Object Detection, Tensorflow Lite, Sign Language Translator, RAD.

1. Introduction

Deaf people are people who experience limitations in their hearing so deaf people have certain sign language in their communication [1]. The number of people with disabilities registered in the Permanent Voter List (DPT) in the 2024 election reached 1,101,178 people. These disabilities are divided into four main categories, namely, physical disabilities, sensory disabilities, mental disabilities, and intellectual disabilities. Of this total, 482,414 people are registered as voters with physical disabilities, which includes various conditions that limit their mobility or physical abilities. Meanwhile, 298,749 voters were included in the sensory disability category, which includes disorders of the five senses, such as deafness and blindness. Mental disabilities, which include psychological, emotional and anxiety disorders, were recorded as 264,594 voters. In addition, there are 55,421 voters with intellectual disabilities, who experience limitations in intellectual functions, down syndrome, and autism [2]. Verbal communication is often found in society in daily communication**.** The most effective communication for deaf people is non-verbal communication. Sign language communication is used for communication by deaf people. This communication uses sign language either in the form of hand gestures or body gestures and facial expressions [3]. Based on the regulation of the Minister of Education of

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the Republic of Indonesia Number 0161/U/1994, the Government standardized the Indonesian Sign Language System Dictionary (SIBI) so that SIBI became the official sign language used by all Special Schools (SLB) under the auspices of the Ministry of Education and Culture, the sign language that is often used and has been established is the Indonesian Sign Language System (SIBI) [4].

Application development on the Android platform was chosen due to the high number of Android users in Indonesia, which allows this application to be accessible to more users, including deaf people. Recent data shows that Android dominates the mobile operating system market sales in Indonesia with the most sales until July 2024, Android controls about 87.84% of the total mobile phone users in Indonesia [5].

This research is a continuation of research conducted by [6] This research uses the MobileNet V2 FPNLite SSD PreTrained Model Architecture and the TensorFlow Object Detection Framework to detect 15 SIBI gestures (Vowels A, I, U, E, O, and 10 words, namely Baik, Bangk, Bangk, O, and 10 words). Detect 15 SIBI gestures (Vowels A, I, U, E, O and 10 words namely Baik, Bangku, Bell, He, Table, Scout, Sick, Me, Friend, and Task). The model is trained for 40,000 steps with batch size 16. The evaluation results show that the model successfully detects 15 gestures. The SIBI with the MAP model accuracy value @ 0.5:0.05:0.95 of 89.93% and the value of loss of 0.1434. The applications developed in this research include the development of Android-based applications to detect SIBI, the implementation of a detection model using TensorFlow Lite that allows real-time gesture recognition, and the addition of Indonesian and SIBI translation features.

The Rapid Application Development (RAD) method was chosen for this study for several reasons: Iterative Process: RAD allows for fast and flexible iterative development cycles, thus allowing for rapid customization based on feedback from users or changing needs. This is especially important for gesture recognition systems. Suitability for Mobile Applications: The iterative customization process of RAD is well suited to the dynamic nature of mobile application development, especially for applications with real-time detection features such as this study. Performance Optimization: Development was done using the Kotlin programming language, which supports native Android development, thus ensuring the app performs optimally. Alignment with Research Objectives: The structured yet flexible RAD approach aligns with the objective of this research, which is to produce an accessible, accurate, and user-friendly Indonesian Sign Language (SIBI) detection application [7].

The main focus of this application is to be a communication bridge between deaf people and people who do not understand sign language. With a mobile application that can detect and recognize SIBI gestures, users can communicate with deaf people more easily. This research is important in efforts to improve the accessibility of communication technology for deaf people and the general public.

2. Related Works

Research that makes applications for deaf people has been done by[3],[6] Their research focuses on designing building and implementing android-based sign language learning media This application is designed to help deaf people overcome communication difficulties through interactive sign language learning. This application can be used by people who are deaf to communicate with normal hearing. This research is an additional learning media for SIBI sign language for deaf people. This research is limited to the introduction of alphabet letters and words in Indonesian and is intended for people with hearing impairments aged 7-10 years [9].

Further research conducted by [10], and [11] Uses the same method, namely the same system development method, namely Rapid Application Development (RAD). Jurianto and Kurniadin emphasize that RAD allows the development of applications in a short time. The

results obtained show that RAD can help small and medium-sized businesses record sales transactions more easily and regularly.

A study stated the success of RAD in creating effective online learning so it can be concluded that the RAD method is a very effective approach in developing mobile applications in various applications. [12]. Conducted research focusing on developing an Indonesian sign language translator application into voice using TensorFlow Lite. This research shows that the use of TensorFlow Lite on Android devices allows the recognition of gestures accurately and in real-time, thus speeding up the process of translating sign language into voice. [13].

Developed in agriculture, education, and communications, TensorFlow Lite enables applications to process data in real time with accurate results. The applications discussed in these studies demonstrate the success of TensorFlow Lite in solving the challenges associated with data processing on resource-constrained mobile devices. [14]. Based on several previous studies that discuss object detection models using TensorFlow Lite and the Rapid Application Development (RAD) method, it is known that research related to Android-based Indonesian Sign Language (SIBI) detection applications is still very limited. Therefore, this research aims to develop an Android-based application that utilizes the object detection model to detect sign language hand gestures, by applying the RAD method as an application development framework.

3. Proposed Method

This research uses the Rapid Application Development (RAD) method, which consists of four main stages, Requirements Planning, User Design, Construction, and Cutover. RAD is an adaption of the waterfall model, using waterfall principles to develop each software component [15]. The RAD method can be shown in Figure 1.

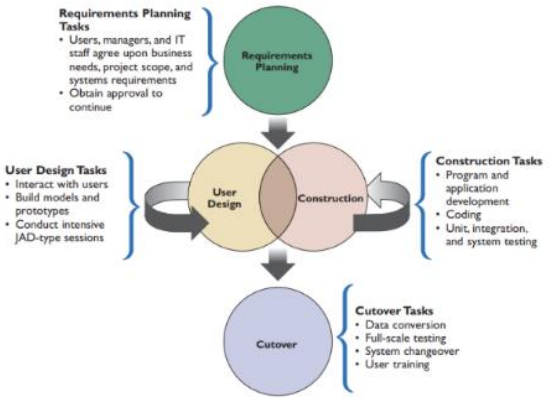


Fig. 1 RAD Model

The RAD method allows the development process to be carried out iteratively through the stages of needs planning, user design, construction, and completion. The following are the stages of the RAD Method. [7]. Requirements Planning Determines the purpose and identification of the objectives of application development and identification of information needs. User Design. In this research, the user design uses Figma, and the system design is described using the Unified Modeling Language (UML). Construction At this stage the RAD Method includes the development of programs and applications based on prototypes. Cutover Testing of this application uses the Black box method and Usability Testing which focuses on system functionality testing and user satisfaction testing.

4. Experimental Setup

Experiments were conducted involving 30 respondents who used the application to test three main features, namely real-time motion detection, information about SIBI, and Indonesian to SIBI translator. After trying the application, respondents were asked to fill out a usability questionnaire with a Likert scale to evaluate four main aspects, namely, Learnability, Flexibility, Effectiveness, and Attitude. The collected data was analyzed to assess the quality of the application and meet the research objectives.

4.1 Data Collection

Data collection is done through two main methods, namely application function testing using the Blackbox Testing method and evaluating user satisfaction using usability testing. The following are the steps in data collection:

1. Blackbox Testing
   This test is carried out to ensure that each feature in the application functions correctly. The features tested were *real-time* detection of SIBI gestures, information about SIBI, and translation of Indonesian text to SIBI sign language. The data was tested using 15 gestures, including five vowels and 10 specific words.
2. *Usability Testing*
   This test involved 30 respondents with the criteria, people aged 18-25 years and people with normal hearing. Respondents were asked to answer a questionnaire covering four main aspects of usability: Learnability, Flexibility, Effectiveness, and Attitude. Data was obtained in the form of Likert scale values from 1 (*Strongly Disagree*) to 5 (*Strongly Agree)*.

4.2 Data Analysis

The data that has been collected is analyzed to assess the performance and effectiveness of the application. The analysis procedure was carried out as follows:

1. Blackbox Testing Analysis

$$Nilai\ Akurasi = \frac{\text{Jumlah Deteksi Benar}}{\text{Jumlah Total Pengujian}}\ x\ 100\% = 100\% \quad (1)$$

2. Usability Testing Analysis

$$Usability\ (\%) = \frac{A + B + C + D}{4}\ x\ 100\% \quad (2)$$

U*sability* calculation where:

A: percentage value of learnability aspect, B: percentage value of flexibility aspect, C: percentage value of effectiveness aspect, D: percentage value of attitude aspect.

5. Result and Analysis

The RAD method has proven effective in this project due to its ability to accommodate user feedback during each phase. In the Construction phase, iterative prototyping allows for real-time adjustments to the gesture recognition model. Based on black box testing, the final application achieved an accuracy level of 89.93% in detecting SIBI gestures, demonstrating the robustness of this approach. Usability testing conducted with 30 respondents showed a satisfaction score of 85.6%, indicating that the RAD approach efficiently meets user expectations.

5. 1 RAD Model

Requirement Planning

The development of the SIBI Detection application has several planned functional and non-functional requirements that must be met. Functional requirements include the main features that must be present in the application. Below are the functional and non-functional requirements.

Table 1. Requirement Planning

Number	Functional Requirement	Non-Functional Requirement
1.	An application can detect and recognize hand signals based on SIBI guidelines.	ASUS-K513EA laptop with processor 11th Gen Intel(R) Core (TM) i3-1115G4 RAM 8 GB, and System type 64-bit operating system, x64-based processor
2.	An application can translate hand gestures into language text in Indonesia in real time.	
3.	The app can translate the results corresponding to 15 class cues and 10 words.	Windows 11 64-bit, Web browser (Microsoft Edge), Figma, Android Studio, Draw.io, Jetpack Compose
4.	The application provides information about SIBI.	

Design

The user Design stage, UI/UX design, Use Case Diagram, Activity Diagram, and Sequence Diagram have been successfully developed based on the results of the needs analysis in the previous stage. Testing shows that the main features such as SIBI Movement Detection function properly according to the scenario described in the Sequence Diagram.

Construction

At this stage, the application is developed using the Kotlin programming language with the integration of the Model converted to TensorFlow Lite and integrated into the Android application to detect 15 classes of SIBI movements. There are three main menu features, namely, SIBI Movement Detection, Information about SIBI, and Indonesian to SIBI Translator.

SIBI Gesture Detection Feature.

This feature can detect 15 SIBI gestures with hand gestures in real time.

Fig. 2 Main menu

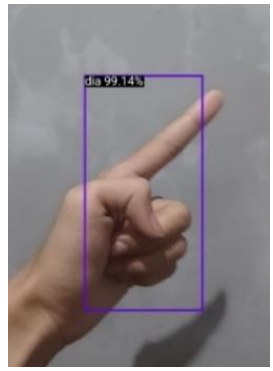
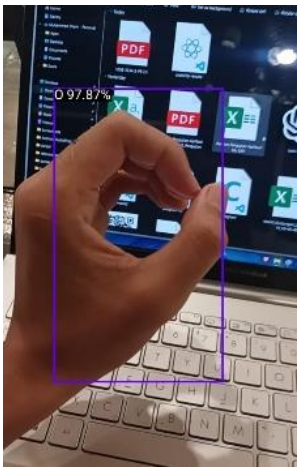


Fig. 3 "HE" word gesture detection



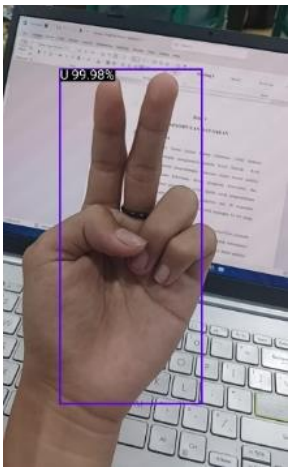


Fig. 4 “O” word gesture detection (a)

Fig. 5 “U” word gesture detection (b).

Information About SIBI

This page presents articles that provide information related to SIBI. Each article explains various aspects of using SIBI.

Fig. 6 Information About SIBI

Fig. 7 Information About SIBI

Indonesian to SIBI Translator Menu: Users can string together words, with no maximum limit on the number of words. The purpose of stringing words is to help individuals with normal hearing understand the SIBI sign language movements in the MySIBI Application.

Fig. 8 Stringing words

Fig. 9 Translator Assembling Result

Cutover

The cutover process includes final testing activities. The stage of each application feature, such as real-time SIBI sign detection, information about SIBI, and Indonesian to SIBI translator. Testing is done using Blackbox Testing and *Usability* Testing.

1. Black Box Testing Results

The black box testing method focuses on checking the functionality of the three main features of the application without examining its internal code. The functionality of the MySIBI app, specifically regarding real-time SIBI gesture detection and information about SIBI features, was evaluated through a thorough black box test. The app accurately detected 15 SIBI gestures and displayed the corresponding text labels in real time. Additionally, the app successfully presented numerous complete articles on SIBI that matched the expected information. The results indicate that all features function properly.

$$Nilai\ Akurasi = \frac{30}{30}\ x\ 100\% = 100\%$$

The results of the calculation of the system accuracy value show that the system test is very high with an accuracy value of 100%.

2. Usability Testing Results

The analysis technique used in this study is the respondent's frequency analysis method on a Likert scale, which involves calculating the proportion of "strongly agree" and "agree" responses from respondents for each question. This research involved 30 respondents to test the MySIBI application.

Table 2. Usability Questionnaire Results

Aspects	Questionnaire Statement Total	Total
Learnability	The app display is easy to understand.	128
	The buttons used are easy to understand.	130
	The menu location in the application is easy to understand.	128
Flexibility	The menu on the application is easy to run.	128
	All features can be used.	131
	The translator feature is easy to understand and use.	131
Effectiveness	The app can detect motion and the result is correct.	125
	The detection feature accurately detects motion.	128
	The app can help as a translator.	123
Attitude	This app fulfills a need to learn sign language.	131
	Features Information about SIBI by the provisions of the definition of SIBI at large	128

The results of usability testing using questionnaires on each aspect are shown in Table 3.

Table 3. Average Results of *Usability Testing*

Learnability	*Flexibility*	*Effectiveness*	*Attitude*
85.8%	83.6%	86.7%	86.3%/

Learnability is an aspect that relates to ease of use. The flexibility aspect pertains to the availability of features in the system. The effectiveness aspect relates to the success of achieving goals while using the application, and the attitude aspect pertains to the level of user satisfaction. The usability value can be measured using the usability equation (1). From the data obtained in Table 3, the overall percentage of the usability level of the MySIBI application is described in the following calculation results:

$$Usability(\%) = \frac{85.8\% + 83.6\% + 86.7\% + 86.3\%}{4}\ x\ 100\%$$

Usability (%) = 85.6%

6. Conclusion

Based on the research conducted, the MySIBI application was successfully developed using the RAD method and the Kotlin programming language, featuring three main components: real-time gesture detection, SIBI information, and Indonesian to SIBI translation. This application can detect 15 classes of SIBI signs, which include 5 vowels and 10 words, in real time. Usability testing results from 30 respondents reached 85.6%, and Black Box Testing showed 100% accuracy, demonstrating that this application is both feasible and effective as a communication aid to bridge the gap between deaf individuals and the general public in Indonesia. This study highlighted the suitability of RAD for developing a real-time SIBI detection application, as it supports iterative testing and customization. The flexibility of RAD allowed for rapid adjustments to the TensorFlow Lite model, ensuring high recognition accuracy while maintaining an efficient development timeline.

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References

[1] D. Permana and J. Sutopo, "Indonesian Language Sign System (SIBI) Alphabet Recognition Application with YOLOv5 Algorithm," *J. Simantec*, vol. 11, no. 2, pp. 231–240, Jul. 2023, doi: 10.21107/simantec.v11i2.19783.

[2] Databoks, "Number of Persons with Disabilities in the Permanent Voters List (DPT) for the 2024 Election," Available: [Online]. https://databoks.katadata.co.id/datapublish/2023/07/04/11-juta-penyandang-disabilitas-sudah-tercatat-di-dpt-pemilu-2024

[3] M. Rofiandaru, "Sign Language Learning System (SIBI) Using Total Communication Method for the Deaf at SLBN Semarang," 2022.

[4] Ministry of Education and Culture, "Indonesian Sign Language System Research and Development Institute," Available. Accessed: Sep. 16, 2024.

[5] G. S. Stats, "Exploring the Development of Smartphone Usage in Indonesia," *Good Stats*. Accessed: Aug. 20, 2024.

[6] N. T. Adam, Z. A. Tyas, and T. Hardiani, "Indonesian Sign Language System Gesture Detection Using SSD MobileNetV2 FPNLite Deep Learning Method," *Sainteks*, vol. 21, no. 2, p. 129, Oct. 2024.

[7] G. B. Shelly and H. J. Rosenblatt, *Systems Analysis and Design*, 9th ed. Boston: Course Technology Cengage Learning, 2012.

[8] R. Nanda, "Designing Applications for the Speech and Hearing Impaired Using the Android-Based Waterfall Method," *JEKIN - J. Tek. Inform.*, vol. 3, no. 1, pp. 20–30, Jan. 2023.

[9] A. Aditya and D. W. S. Susanto, "Design and Development of Learning Media Applications for Deaf Students Based on Android," *Techno.Com*, vol. 20, no. 4, pp. 540–551, Nov. 2021.

[10] E. Junirianto and N. Kurniadin, "Android-Based Point of Sale Application Development Using the Rapid Application Development Method," *JOINTECS J. Inf. Technol. Comput. Sci.*, vol. 5, no. 3, p. 211, Sep. 2020, doi: 10.31328/jointecs.v5i3.1564.

[11] I. Agustina and A. Ratnasari, "Use of Rapid Application Development (RAD) Method in Creating Marine Safety and Security Reporting Applications," *CESS J. Comput. Eng. Syst. Sci.*, vol. 5, no. 1, p. 124, Jan. 2020, doi: 10.24114/cess.v5i1.14442.

[12] A. Rahman, "Rapid Application Development of Android-Based Online Learning System," *INTECH*, vol. 1, no. 2, pp. 20–25, Nov. 2020, doi: 10.54895/intech.v1i2.639.

[13] N. H. A. E. and M. I. Zul, "Indonesian Sign Language Translator Application to Android-Based Voice Using TensorFlow," *J. Komput. Terap.*, vol. 7, no. 1, pp. 74–83, Jun. 2021, doi: 10.35143/jkt.v7i1.4629.

[14] Y. H. Natbais and A. B. S. Umbu, "Android-Based Tomato Leaf Disease Detection Application Using TensorFlow Lite Trained Model," *TEKNOTAN*, vol. 17, no. 2, p. 83, Aug. 2023, doi: 10.24198/jt.vol17n2.1.

[15] W. Warjiyono, A. N. Rais, Fandhilah, and F. R. Febrianti, *Information System Analysis and Design (Case Study of Public Service Applications)*. Tegal: TEKNOSAIN, 2021.