Step-by-Step: Learning Japanese Writing on Android for Beginners

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Abstract **– This research focuses on developing an Android-based mobile application to facilitate the process of learning to write in Japanese for beginners. This application is designed to effectively teach the two main Japanese writing systems, namely Hiragana and Katakana, through an interactive and easy-to-follow method. By utilizing digital image processing technology, handwriting pattern recognition is carried out in real time by applying the Local Binary Patterns (LBP) and Euclidean distance methods. The app provides instant feedback allowing users to correct their mistakes in real-time. This research describes the application development process, the methodology used, and evaluation of application performance based on user testing. The research results show that this application is effective in improving Japanese writing skills for beginners, as well as offering a flexible and accessible way to learn Japanese. This study provides valuable insights into language learning applications that can be adapted to various learners needs and offers recommendations for the future development of similar applications.**

Keywords **– Hiragana, Japanese, Katakana, mobile application.**

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1. Introduction

In 2022, Japan hosted 231,146 international students, a number that actually decreased by 4.7% from the previous year [1]. Despite the decrease, this figure still shows that Japan remains one of the most desirable destinations for higher education. Japan's success in attracting international students is inseparable from its quality academic reputation and promising career opportunities after graduation [2]. However, on the other hand, international students face significant challenges, especially in terms of language and cultural adaptation. These barriers often hinder their adaptation to the academic and social environment in Japan [3].

One of the major challenges faced by international students is mastering the Japanese language, especially its unique, complicated, and complex writing system. Japanese uses three different writing systems: hiragana, katakana, and kanji. Hiragana and katakana each have 46 characters, while kanji (characters adopted from Chinese) number in the thousands [4]. Hiragana is used to write native Japanese words, while katakana is used for foreign words. These two writing systems are very important in daily communication [5]. Therefore, a deep understanding of hiragana and katakana is very important, especially for international students who plan to study in Japan.

Given the importance of accessibility and flexibility in language learning, mobile learning applications are an ideal solution [6] for learning Japanese. Mobile-based applications allow users to learn anywhere and anytime, giving learners the opportunity to practice consistently and efficiently [7]. Currently, there are various Japanese learning apps available on the Play Store; however, most of them do not include a handwriting pattern recognition feature. This is a drawback, given the importance of writing practice in learning a language [8], especially Japanese, which uses three different handwriting systems.

To overcome this problem, this research aims to develop a mobile application that not only facilitates the recognition and mastery of hiragana and katakana but also provides real-time handwriting pattern recognition features by utilizing digital image processing technology for beginners. One of the feature extraction methods, local binary patterns (LBP) [9], [10], [11], will be combined with a distance calculation method, Euclidean distance [12], to recognize letter patterns written in real-time on the application. This application is expected to be an effective tool for international students preparing to study in Japan, reducing the language barrier and easing their adaptation process.

Based on this description, research that develops Android-based mobile applications to facilitate the learning process of writing in Japanese for beginners is expected to produce an innovative learning medium. This research is also expected to produce an application that is able to recognize hiragana and katakana letter patterns. The developed application is also expected to not only facilitate the basic learning process of hiragana and katakana but also contribute to increasing the effectiveness of digital learning for international students.

2. Methodology

The fishbone diagram [13], [14] , shown in Figure 1, displays the methodological structure of this research. The diagram illustrates the systematic process used in the research to develop a mobile application that supports learning the hiragana and katakana alphabets.

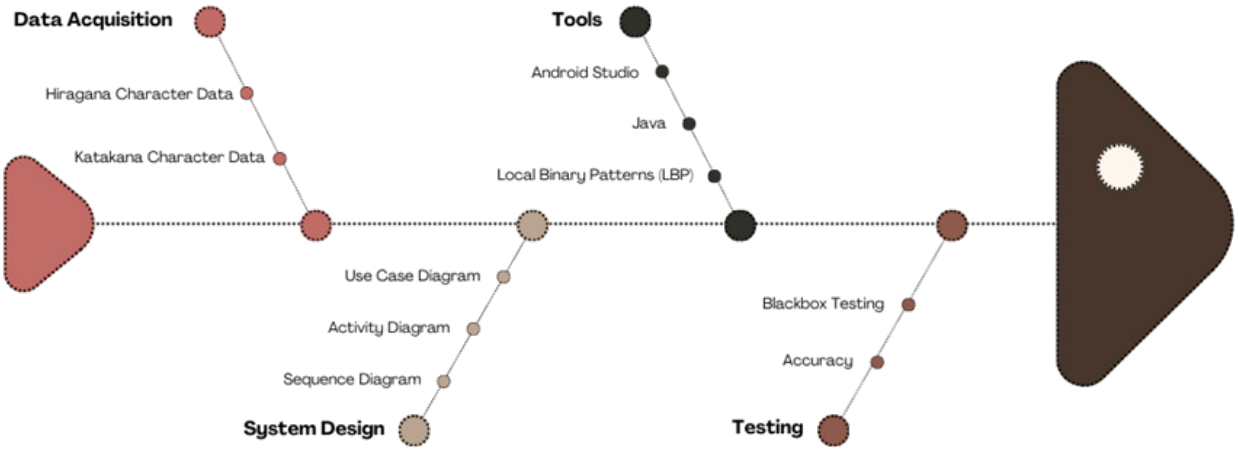


Figure 1. Fishbone diagram

The initial phase of this research is data acquisition, which is a fundamental element in the process of developing this application. In this phase, primary data consisting of two important letters in the Japanese language, namely hiragana and katakana, were collected. The data in this acquisition phase is also needed to implement the LBP method in the developed application. Next is the system design stage. The system design in this study uses diagrams in the unified modelling language (UML) [15], [16], [17]. Case diagrams, activity diagrams, and sequence diagrams are used as tools to determine functional requirements, user activity flows, and interactions between application elements.

The tools stage is an explanation of the tools and technologies chosen to implement and test the application. Android studio is the official integrated development environment (IDE) for Android application development. Java is the most commonly used programming language in Android application development [18].

LBP was chosen as the pattern recognition method to be evaluated in this study for its effectiveness in identifying character writing by users [6], [9], [19], [20].

Finally, in the testing stage, Blackbox testing is part of the research method used to test the application [21]. The next test is threshold testing [21] using Equations 1 and 2 [22]. For d_{ij} is the distance value, n is the vector length, x_{ik} is the input feature vector, and x_{jk} is the comparison feature vector. After getting the threshold value, the accuracy calculation is carried out. The use of accuracy calculations aims to measure the success rate of a test. By dividing the quantity of correctly tested data by the total quantity of tested data, and then multiplying the result by 100, one can calculate this success rate. Mathematically, this accuracy calculation formula can be seen in Equation 3 [23].

$$d_{ij} = \sqrt{\sum_{k=1}^{n} (x_{ik} - x_{jk})^2} \quad (1)$$

$$Similarity = (1 - distance) * 100\% \quad (2)$$

$$Accuracy = \frac{\sum Correct}{\sum Test\ Data}\ x\ 100\% \quad (3)$$

3. Result

The section explains the system design, which consists of use case diagrams, activity diagrams, sequence diagrams, and application interfaces as well as the results of application testing carried out in this research.

3.1. System Design

In this research, the unified modelling language (UML) framework was adopted to design the system architecture. This approach consists of several interrelated diagrams, including use case diagrams that identify user interactions with the system, sequence diagrams that describe the sequence of operations between objects, and activity diagrams that describe the workflow of business processes.

3.1.1. Use Case Diagram

The diagram in Figure 2 visualizes the use-case diagram of the learning application designed to teach the letters hiragana and katakana. The user actor, placed at the center of the diagram, is the main entity that interacts with the application. The actor has access to the four menus of hiragana and katakana, which are the menus for learning how to write the letters hiragana and katakana. Then on the practice entity, there is an interactive component where the actor can practice writing the letters hiragana and katakana. To help validate and provide feedback on the character writing by the user, pattern recognition using the LBP method is performed. The app also has an "about" menu. This menu gives all the details about the app, such as what it is for, how to use it, and developer information.

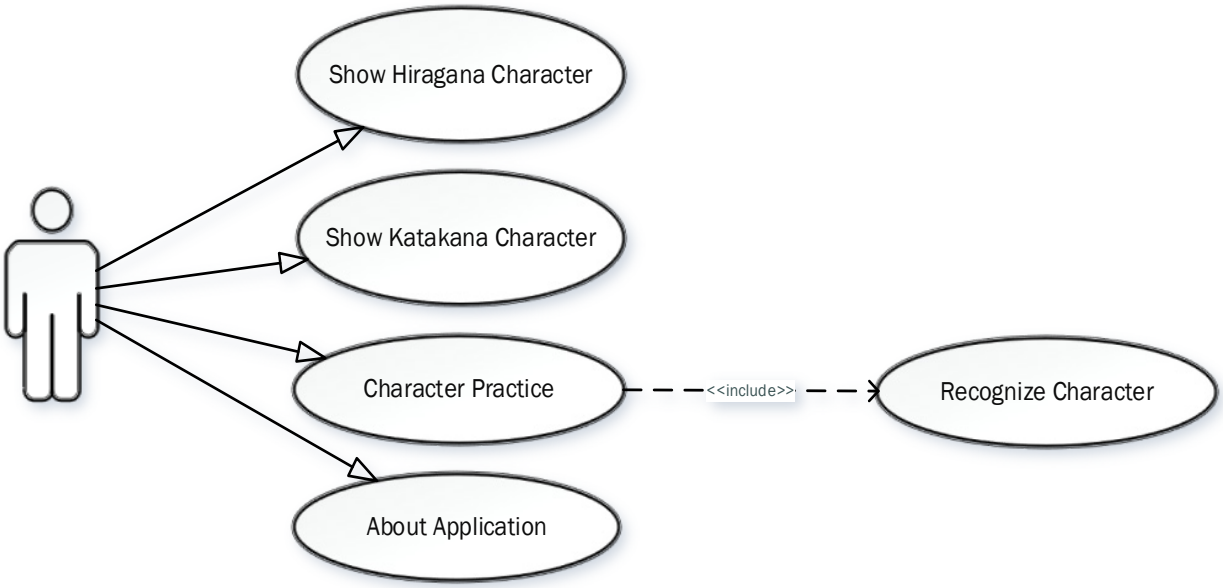
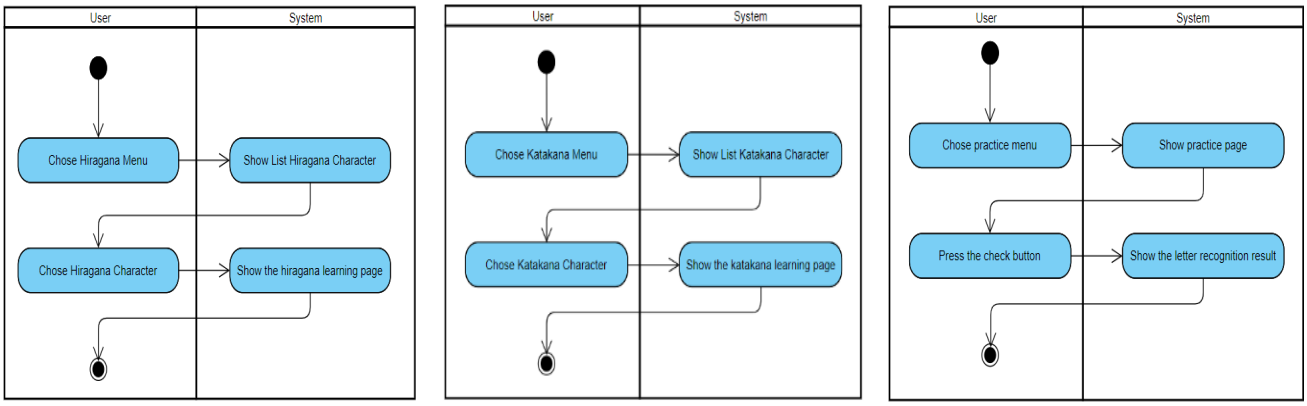


Figure 2. Use case diagram of the application

3.1.2. Activity Diagram

In the diagram shown in Figure 3a, the interactive process for learning the hiragana script is shown. It begins when the user selects the hiragana option from the main menu, to which the system responds by displaying a collection of hiragana letters. The user can then select a specific letter to learn how it is written, and in response, the system presents a learning page for the selected hiragana letter. A similar process is described in Figure 3b, where a user who wants to learn katakana will start by selecting the katakana menu. The system will then provide a list of katakana letters, and once the user selects a particular letter, the system will display the corresponding learning page for the katakana script.



(a) (b) (c)

Figure 3. Activity diagram of Hiragana menu (a), Katakana menu (b), Practice menu (c)

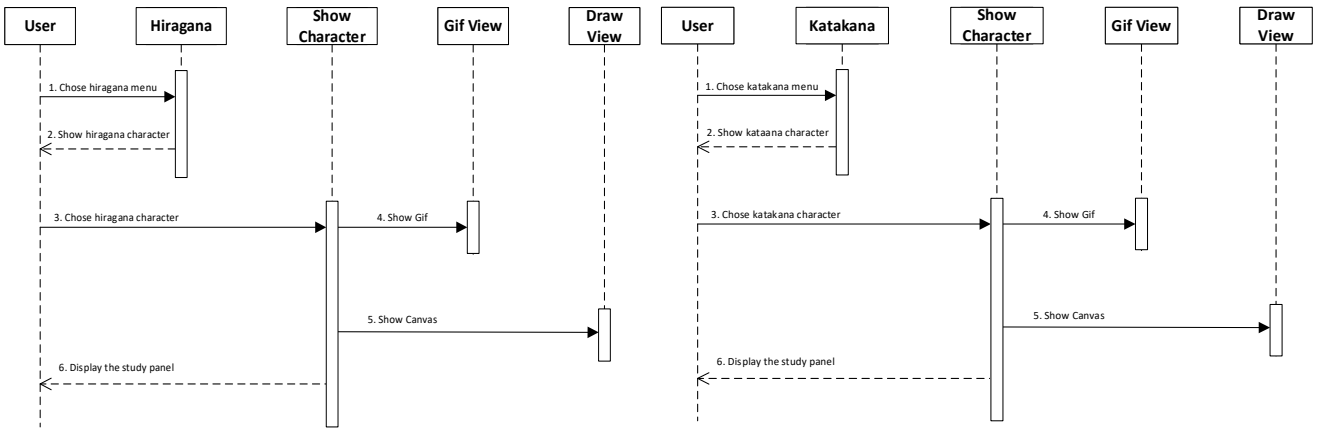
Furthermore, Figure 3c displays the activity on the exercise page, where letter pattern recognition technology is applied using the LBP method. The user is expected to start by selecting the exercise menu, then proceed to write letters, and finally press the 'check' button to get feedback on the letter recognition results that have been written.

3.1.3. Sequence Diagram

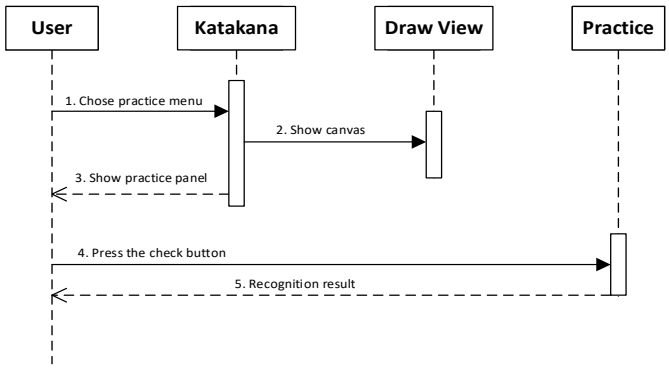
Figure 4a displays the sequence diagram relating to the hiragana module, providing a step-by-step overview of the process of user interaction with the system when accessing and learning hiragana letters. Meanwhile, Figure 4a illustrates the sequence diagram for learning katakana letters, focusing on the sequence of interactions that occur as the user moves through the various functions offered by the system for katakana letter recognition. Furthermore, Figure 4b shows the sequence diagram for the practice menu, outlining the series of actions and events initiated by the user in the writing practice menu using the pattern recognition system.

This application also includes an interactive practice menu, where users can practice writing hiragana and katakana letters directly on their mobile devices. This feature uses LBP-based pattern recognition technology to assess and provide feedback on letter writing. The last menu is about the application; this menu provides all information related to the application that has been developed. ***Application Interface***

In this research, a mobile-based Japanese language learning application was built. As shown in Figure 5, this application has four main menus designed to facilitate an interactive learning experience. First, the hiragana menu presents a complete catalogue of the hiragana script. The purpose of this menu is for users to see and learn the basic characters of the Japanese language. Second is the katakana menu, which functions the same as the hiragana menu but is more specific to the letter katakana.



(a) (b)



(c)

Figure 4. Application sequence diagram

(a) (b) (c)

(d) (e) (f)

Figure 4. Application interface

This application also includes an interactive practice menu, where users can practice writing hiragana and katakana letters directly on their mobile devices. This feature uses LBP-based pattern recognition technology to assess and provide feedback on letter writing. The last menu is about the application; this menu provides all information related to the application that has been developed.

3.2. Testing

At this stage, we will test the application on three smartphones that have different specifications, namely the Xiaomi Redmi Note 10 5G, Samsung Galaxy S23 FE, and Samsung Galaxy A8 which are explained in Table 1.

Table 1. Smartphones used for testing

Type	Xiaomi Redmi Note 10 5G	Samsung Galaxy S23 FE	Samsung Galaxy A8
Display			
Type	IPS LCD, 90Hz, 400 nits (typ), 500 nits (HBM)	Dynamic AMOLED 2X, 120Hz, HDR10+, 1450 nits (peak)	Super AMOLED
Size	6.5 inches, 102.0 cm2 (~83.7% screen-to-body ratio)	6.4 inches, 100.5 cm2 (~83.2% screen-to-body ratio)	5.6 inches, 79.6 cm2 (~75.6% screen-to-body ratio)
Resolution	1080 x 2400 pixels, 20:9 ratio (~405 ppi density)	1080 x 2340 pixels, 19.5:9 ratio (~403 ppi density)	1080 x 2220 pixels, 18.5:9 ratio (~441 ppi density)
Platform			
OS	Android 11, MIUI 12	Android 13, upgradable to Android 14, One UI 6	Android 7.1.1 (Nougat), upgradable to Android 9.0 (Pie), One UI
CPU	Octa-core (2x2.2 GHz Cortex-A76 & 6x2.0 GHz Cortex-A55)	Octa-core (1x3.00 GHz Cortex-X2 & 3x2.50 GHz Cortex-A710 & 4x1.80 GHz Cortex-A510) - USA	Octa-core (2x2.2 GHz Cortex-A73 & 6x1.6 GHz Cortex-A53)
GPU	Mali-G57 MC2	Xclipse 920 - International	Mali-G71
Memory			
Internal	128GB	256GB	64GB
RAM	6GB	8GB	4GB

In the Blackbox testing data presented in Tables 1 and 2, it can be proven that the developed application is compatible with a variety of smartphone devices operating on the Android operating system, with variations in processor type and RAM capacity. This indicates that the app has high flexibility in terms of device specifications. Furthermore, Table 2 provides further data on the app's performance, stating that optimal performance was achieved on a Samsung Galaxy A8 device. Despite having relatively low specifications among the smartphone devices tested, including an Octa-core 1.6 GHz processor, 4 GB of RAM, a screen with a resolution of 1080 x 2220 pixels at 5.6 inches, and running Android version 7.1.1 Nougat.

Table 2. Results of testing on smartphones

No	Display	*Smartphone*		
		Xiaomi Redmi Note 10 5G	Samsung Galaxy S23 FE	Samsung Galaxy A8
1	Main Menu	Good	Good	Good
2	Hiragana Menu	Good	Good	Enough
3	Katakana Menu	Good	Good	Enough
4	Practice Menu	Enough	Good	Enough
5	About Menu	Good	Good	Good

The next test of this research is to evaluate the accuracy of the pattern recognition system in the application. There are two stages of testing carried out: first, testing the threshold. This test is to get the threshold value of the similarity of each hiragana and katakana letter. The threshold value uses the maximum value of the similarity value in the five trials. The threshold value will be used as a determinant of the letter pattern recognition results in the second test. The results of test 1 are shown in Figure 5. From Figures 5a and 5b, it is known that the average similarity for the letters hiragana is 79.28% and katakana is 81.98%. So, when averaged, all letters get a threshold value of 80.4%.

(a) (b)

Figure 4. Average threshold value

Next, end-users were tested. We selected 3 users, where user-1 is a student who has no prior knowledge of Japanese, user-2 is a Japanese teacher at a school in Kendari City, and user-3 is a student who has learned to write Japanese. In this test, users were asked to write directly on their smartphone screen, and the application then gave a score based on the similarity of their handwriting with the correct hiragana and katakana letters. A total of 20 letters were randomly presented to each user, and each user tested three times. The diagram displays the accuracy score for each testing session for each user.

The results of these tests are summarized in Figure 6, which shows: user-1 scored 40% on the first test, which increased rapidly to 78% on the second test, and then reached 83% on the third test, showing a significant improvement in accuracy over time. As for user-2, who started with a score of 80% in the first test, showed an increase to 90% in the second test, and reached the highest score of 93% in the third test, showing consistent and substantial progress, Finally, user-3 had a score of 58% on the first test, which increased to 77% on the second test, and again increased to 83% on the third test, showing steady improvement in proficiency.

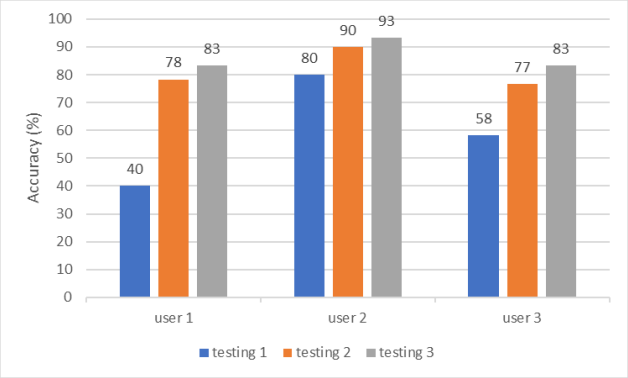


Figure 5. Test results of pattern recognition accuracy of the application

4. Conclusion

This research produces a Japanese language learning application that is efficient in recognising hiragana and katakana characters through handwriting. Testing of the Japanese writing learning application showed that the application is effective in improving the ability to write hiragana and katakana characters through interactive exercises on the smartphone screen. Each user showed consistent improvement from the first test to the next, indicating that the app is able to support the learning process effectively. Coupled with the Blackbox testing data, it was evident that the app has wide compatibility with a variety of Android smartphone devices, signaling the app's high flexibility across a wide range of technical specifications. This proves that the app was designed with inclusive use in mind, ensuring that users with different devices can access and utilize the app to improve their Japanese writing skills.

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