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Speech Recognition to Aid Hanyu Pinyin Pronunciation as Part of Mandarin Language Education

Henry[1], Eryc[2]
Email of author correspondence : 2031119.henry@uib.edu[1]

[1]Faculty of Computer Science, Universitas Internasional Batam, Batam, Indonesia
[2]Faculty of Computer Science, Universitas Internasional Batam, Batam, Indonesia

Abstract

International language skills are increasingly more relevant in the globalization era. One of these international languages is Mandarin. Speech Recognition can be used to recognize speech to design an application to train mandarin pronunciation skills.This research examines the design and evaluation of an application that uses speech recognition to assist mandarin language students. Waterfall-type SDLC method is used during the development of the application. Testing is done using a black-box testing method. Questionnaire data of 33 users are collected to assess the application. Results showed "Very Effective" in terms of operation, appearance, and content.

Keywords: Mandarin, Speech Recognition, Mobile Learning, System Development Life Cycle.

Introduction

Language is a tool that we use to communicate in our everyday activities. Communication is a way of sharing information or opinions in written or oral form (Puspitasari & Putra Danaya, 2022). When communicating, there are several things that must be considered so that the communication process runs smoothly. One of them is the use of correct spelling in written communication (Nadaiah Fitrah et al., 2021). Meanwhile, things to pay attention to in oral communication are pronunciation and intonation (Prasetiyo, 2021).

As one of the languages used at the United Nations, Mandarin is one of the languages frequently used in the world (Sakti, 2021). Thus making Mandarin the second international language after English. Mandarin is an important tool in entering the workplace, with Mandarin language skills being an important factor in determining income in work (Wang & Dai, 2021).

Several countries, including Indonesia, realize how important it is to learn Mandarin. This is demonstrated by the inclusion of Mandarin as a mandatory subject in Indonesian educational institutions (Elyana, 2021).

Mandarin has different characteristics from Indonesian. Where Mandarin is an isolative language and Indonesian is an agglutinative language. Words in isolative languages do not use affixations, and use word order and function words to indicate syntactic changes (Du & Chen, 2021). This is different from Indonesian which uses additions, compounding and combining words to change words (Wijana, 2022). With the large amount of characters and the addition of a tone system, Mandarin is regarded to be one of the hardest language to learn (Aklani & Junifer, 2022) .

Hanyu pinyin in Mandarin has a 4 tone system, namely tone 1 (—), tone 2 (/), tone 3 (v), and tone 4 (\). With this system, Mandarin has words that have the same pronunciation but with different tones. The tone component in Mandarin is important to pay attention to because the meaning of a word can change depending on the tone used by the speaker. Meanwhile, the tone system does not exist in Indonesian. This makes it difficult for Indonesian students to learn Mandarin (Lianisyah & Sugiarti, 2022).

The differences in consonants found in Mandarin can also make it hard for Indonesian students to learn Mandarin. The pronunciation errors in Mandarin that are often made by students from Indonesia are in the consonants "zh, ch, sh". This is because the Indonesian language does not have the consonants "zh, ch, sh" so students pronounce them as "z, c, s". Students also tend to make more frequent pronunciation and tone errors when pronouncing sentences than when pronouncing words (Lianisyah & Sugiarti, 2022).

Machines in modern times can now simulate human activities. This technology is called Artificial Intelligence (AI). The goal of AI is to create a machine that can imitate human intelligence such as listening, predicting, learning, and so on (Xu et al., 2021). One branch of AI that can identify words with the aim of imitating the human ability to hear is called Speech recognition (Wahyuni et al., 2021). Speech recognition technology can be used in mobile applications. With the implementation of a speech recognition based mobile application, students can learn languages based on the specific needs of the student in terms of availability and individuality (Chrstian & Denissa, 2022).

Teachers play a big role in learning Mandarin by identifying and correcting errors in pronunciation and tone of students. However, teachers can only teach during school time so that student learning outside of school time is less effective if they are not accompanied by a teacher (Watanabe et al., 2020). With speech recognition, the system can recognize students' voices. Using a speech recognition system that is capable of recognizing Mandarin can hear and provide input regarding Mandarin pronunciation and tone.

With the increasing importance of Mandarin language skills in the fields of business and studies (Rindawati & Thamrin, 2022) and difficulties experienced by Mandarin students, especially in pronunciation (Fajarisman et al., 2021) there is an immediate need for ways to practice Mandarin pronunciation for beginner students. which can be accessed at any time without the help of a Mandarin teacher .

Based on the explanation above, the Mandarin pronunciation and tone training application using speech recognition can replace the role of the teacher during non-school time and help students to further develop Mandarin pronunciation skills.

Therefore, the author wants to conduct research entitled "Speech Recognition to Aid Hanyu Pinyin Pronunciation as Part of Mandarin Language Education". This research was carried out by designing an application using speech recognition that recognizes Mandarin. The system design was carried out by following the waterfall type SDLC (System Development Life Cycle). After the application has been designed, a quantitative test will be carried out by distributing questionnaires to Mandarin language students who use the application designed to measure the effectiveness of the application. This application aims to help Mandarin students to practice pronunciation and tones in Mandarin without the help of a teacher with speech recognition.

Literature Review

The following is previous research which is the basis of this research which discusses "Speech Recognition to Aid Hanyu Pinyin Pronunciation as Part of Mandarin Language Education":

Research conducted by (Afrianto et al., 2019) which examined the implementation of chatbot technology to assist in English language education. This research is about designing and evaluating chatbot applications as English learning materials. The chatbot application design in this research uses the Dialogflow API, Languagetool API and uses the Google Speech Recognition library to capture user voice input. The results of testing using the beta test method which was carried out by distributing questionnaires to 25 people received an agreement score with the average final answer to the questionnaire reaching 63.96%.

Next is research conducted by (Watanabe et al., 2020) which examined the use of Information and Communication Technology (ICT) in online Mandarin language learning. This research is about the use of various ICT tools for communication and as learning materials to increase the effectiveness of distance learning. One of these learning materials is the "ST Lab" software designed by researchers using speech recognition technology to train pronunciation in Mandarin. and the research found that the application of ICT in distance learning can increase learning motivation.

Next is research conducted by (Agrawal et al., 2020) which examines designing an exam platform that can help visually impaired people. This research was carried out by designing a mobile-based exam platform application using Flutter. The application imports the Text-to-Speech and Speech-to-Text packages from Flutter and uses the Firebase database system. The results of this research are applications that can be used with voice input and application users can hear voice instructions from the system.

The next research implemented speech recognition to design an interactive English e-learning application by (Nurkholis & Bimantara, 2022). This research was carried out by designing an Android-based application for English language learners with the aim of practicing English reading, listening and speaking skills. This application is designed using the System Development Life Cycle (SDLC) and uses the Google Cloud Speech-To-Text API to capture voice input from users. The results of this research are applications that can be used to practice English language skills.

Furthermore, research conducted by (Faisol et al., 2021) examined the implementation of mobile-based speech recognition to help improve English reading skills. This research was

carried out by designing an early reading assistant application on a mobile platform. This design uses the Dart programming language and uses the Flutter framework. The result of this research is a reading assistant application that can help improve English reading and pronunciation skills.

Next is research conducted by (Nuraini et al., 2022) which examined the use of speech recognition technology to create English learning applications. This research began with designing an online English learning application using the IBM Watson library, then conducting a feasibility test of the application using quantitative methods in the form of distributing questionnaires and experiments with a sample of students from SMPN 17 Bengkulu. The results of this study show that the application of speech recognition can influence English language comprehension.

Next is research conducted by (Salamun et al., 2022) which examines the design and implementation of Artificial Intelligence to design web applications to display information about verses in the Al-Qu'ran. The application is designed using the Python programming language and the Django framework. The test results show that the system can convert voice input data into output data in the form of text.

Table 1. Literature Review Summary

Year	Author	Summary
2019	Afrianto et al.	The Likert scale assessment can be used to test whether the designed application is effective or not in solving a problem
2020	Watanabe et al.	The use of information and communication technology, one of which is the implementation of speech recognition for Mandarin pronunciation training, can add motivation to online distance learning.
2020	Agrawal et al.	Applications that use the text-to-speech and speech-to-text packages from Flutter can be used to receive voice input and provide instructions to application users.
2021	Faisol et al.	A mobile application designed with the Flutter framework using speech recognition has been successful in improving children's English speaking skills.
2022	Nurkholis & Bimantara	Interactive e-learning media using speech recognition using the Speech-to-Text API designed using the waterfall type SDLC method can help in learning English.
2022	Nuraini et al.	Quantitative methods in the form of spreading and analysis of questionnaire answers can be used to determine the level of application feasibility in terms of appearance and application function.
2022	Salamun et al.	Artificial Intelligence can be applied to design an Automatic Speech Recognition system that can capture voice data into text that is displayed on a computer

Based on the research above, research will be carried out on the implementation of speech recognition. This application uses the Dart programming language using the Flutter framework as in research conducted by (Faisol et al., 2021) and was designed using the SDLC method as carried out by (Nurkholis & Bimantara, 2022). The application will use text-to-speech and speech-to-text packages to receive input and provide voice instructions as done by (Agrawal et al., 2020). Data collection was carried out quantitatively by distributing questionnaires to students who used the application and then analyzing the answers as done by (Nuraini et al., 2022) and (Afrianto et al., 2019). Research focuses on implementing speech recognition to

train Mandarin pronunciation and tones as done by (Watanabe et al., 2020). The sample population in this study were students who used an application designed to practice Mandarin pronunciation.

Research Methods

The following is a flow that acts as a guide so that the implementation of research activities can run smoothly.

Figure 1. Research Flowchart

The literature review stage begins by searching for related literature sources on topics relevant to this research. This literature review was carried out to obtain information and knowledge about the basic theory and knowledge used in the research. The next stage in this research is the research problem formulation stage. This stage formulates the problem discussed by this research.

At this application development stage, the waterfall type SDLC (System Development Life Cycle) method will be used to design a mobile-based Mandarin pronunciation and tone learning application. The designed application uses a speech-to-text package to capture voice input from the user and text-to-speech to provide instructions to the user. This application is designed using the Dart programming language with the Flutter framework. Next is the application testing stage which is carried out using the black box method.

After that, it will continue with the quantitative data collection stage in the form of distributing system feasibility test questionnaires to 33 users of the Mandarin pronunciation trainer application. Next, it will be followed by the data analysis stage carried out on the questionnaire data carried out in the previous stage. The analysis method uses a 4-point Likert scale calculation to draw conclusions regarding the feasibility of the system being designed.

After the other stages have been completed, the research enters the final stage, namely the report writing stage where the author will record the theory and results obtained in the previous stage.

This research was carried out using the Waterfall type SDLC method to design a mobile application using speech recognition technology with the following stages:

A. Planning

At this stage data collection is carried out by studying literature related to the research topic. This stage aims to find what materials and features can meet user needs.

B. Analysis

At this stage a system requirements analysis is carried out which consists of a functional analysis of the application where functions such as what menus are available in the application will be explained. Next there is mobile input analysis where the user

input flow is explained at this stage. The next analysis is material analysis, this analysis explains the material used as questions in the application, namely 107 words from the HSK 1 vocabulary. The next analysis is business function analysis which explains the flow that runs in the application.

C. Design

At the design stage, unified modeling language (UML) diagrams are created which consist of use case diagrams and activity diagrams to describe how the application works in order to facilitate the design process.

D. System Coding

The following are the hardware specifications used in this research when coding the system:

1.Operating System: Windows 10 Pro 64-bit
2.Processor: AMD Ryzen 5 1600 Six-Core Processor, 3.20 GHz, 6 Core(s), 12 Logical Processor(s)
3.Ram: RAM: 8.00 GB

This research also uses several tools used in system design, namely:

1.Flutter framework with the Dart programming language for designing mobile applications
2.Visual Studio Code version 1.73.1 as IDE (Integrated development environment)
3.Package speech_to_text version 6.1.1 from pub.dev to receive input in the form of sound
4.Package flutter_tts version 3.6.3 from pub.dev to provide pronunciation instructions

E. System Testing

At this stage the application is tested using the black box method. where it will be tested whether the designed application runs or not. This research also collects quantitative data to measure the feasibility value of the application. The population in this study were application users who were beginner Mandarin students. This research uses purposive sampling where the research sample is taken under the condition that beginner Mandarin students can use the microphone feature on a smartphone. Data collection was carried out quantitatively by distributing feasibility test questionnaires to 33 users of the designed application. The determination of the number of respondents in this research was based on research conducted by (Rahmantara et al., 2018) which stated that 30 respondents was the minimum number of respondents suitable for quantitative research. Data collection is carried out to measure the effectiveness of the application in terms of application operation, appearance and completeness of the material.

The following are questions from the system feasibility test questionnaire in terms of application operation, application appearance and material content of the application used based on research conducted by (Nuraini et al., 2022).

Table 2. Questionnaire Questions

Variables	Indicators
Application Operation(V1)	-Able to open and access the Mandarin pronunciation training application menu -Able to understand the function of the command buttons of the Mandarin pronunciation training application
Appearance (V2)	-The writing in the Mandarin pronunciation training application is easy to read and understand -The audio sounds contained in the Mandarin pronunciation training application are easy to hear and understand -The pronunciation guide and microphone commands in the Mandarin pronunciation training application are clearly visible -There is a good color selection in the Mandarin pronunciation training application -The information on the Mandarin pronunciation training application has been conveyed well
Application Content (V3)	-HSK 1 material application in the Mandarin pronunciation training application is comprehensive -Material in Mandarin pronunciation training application is suitable for learning HSK 1 -The content of the material and practice questions are clear in the Mandarin pronunciation training application

Source: (Nuraini et al., 2022)

The questionnaire responses were assessed using a 4-point Likert scale to determine the feasibility of the Mandarin pronunciation practice app. The calculation considered ease of operation, application appearance, and content. The average results show the suitability of the application for Mandarin pronunciation and tone practice.

The average answer results for each questionnaire category will be categorized based on a 4 point Likert scale interval, namely 0.75. The categories of average questionnaire answers can be seen from the following table:

Table 3. 4-Point Likert Scale Category Table

Mean	Category
3.25 - 4.0	Very Effective
2.5 - 3.25	Effective
1.75 – 2.5	Ineffective
1.0 – 1.75	Very Ineffective

Results and Discussion

1. Planning

   The tools used in this research were determined based on the results of a literature study. The application design will use the Dart programming language with the Flutter framework as done by (Faisol et al., 2021) and use the speech_to_text and flutter_tts packages (Agrawal et al., 2020).

The material used in this application is a collection of HSK 1 vocabulary on the digmandarin.com website.

2. Analysis
   a. Application functional analysis

      The results of the functional analysis of the Mandarin pronunciation training application include:

      1. Vocabulary page with Mandarin words, hanyu pinyin, and translation.
      2. Pronunciation practice feature with voice evaluation.
      3. Word pronunciation sound button for pronunciation guide.

   b. Mobile Input Analysis

      The analysis results in this section explain the flow process from input to output production in the application.

Figure 2. Mobile Diagram Block

At user input, the answer is received using the smartphone microphone, validated with the answer key, and produces a true or false evaluation result.

   c. Application Process Analysis

      The following is the flow of the application. Users can choose between answering practice questions, accessing vocabulary pages, or application info. In practice questions, the user reads the word, and the system checks the pronunciation. If incorrect, the user is asked to repeat until the exercise is complete.

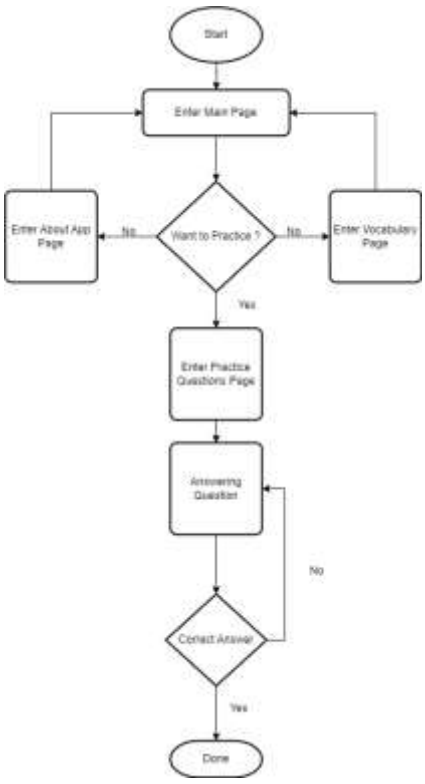
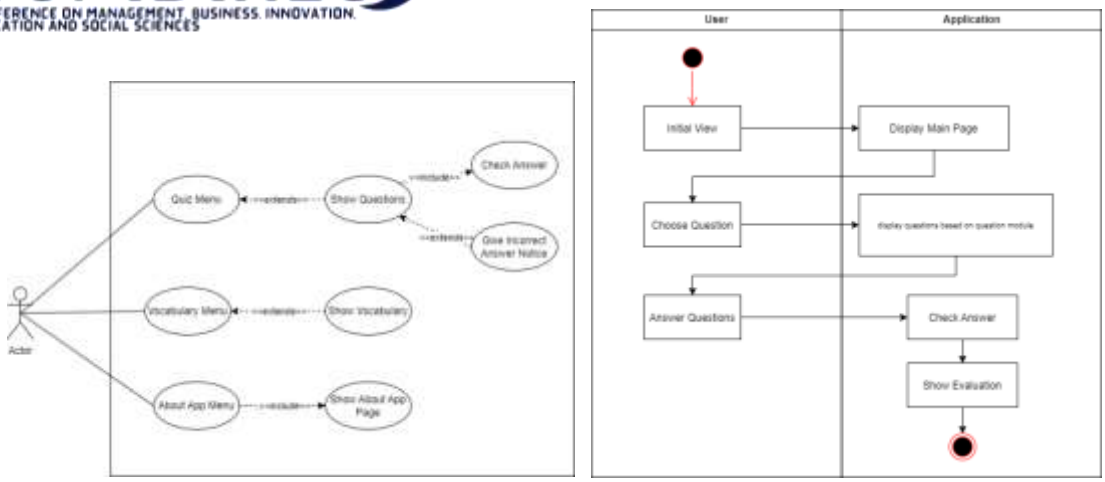


Figure 3. Application Flowchart

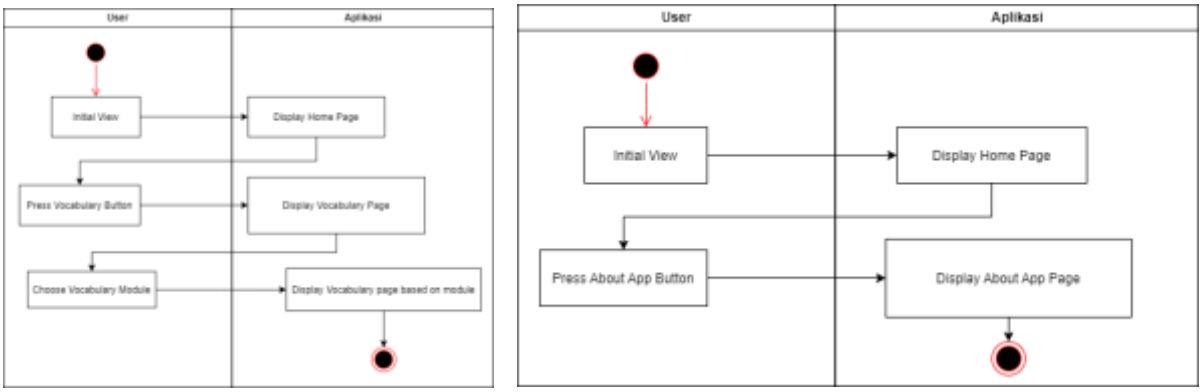
3. Design

The results of the architectural specification design for the Mandarin pronunciation application are UML (Unified Modeling Language) in the form of Use Case Diagram and Activity Diagram of the application. The following are the results of the UML design made at the design stage:



(a) **(b)**

Figure 4. (a) Use Case Diagram (b) Home Activity Diagram



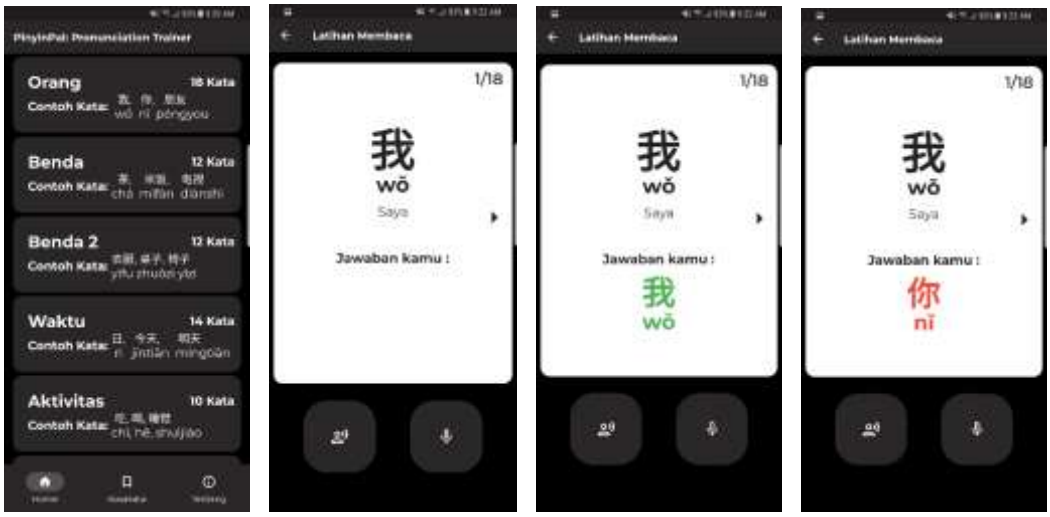
(a) **(b)**

Figure 5. (a) Vocabulary Activity Diagram (b) About Application Activity Diagram

4. Implementation
   a. Application Main Menu

      In this menu, users can access the practice questions menu, vocabulary menu and "about" page of the application
   b. Application Quiz Menu

      On this page, users can answer by reading the words displayed in the question by pressing the microphone button.



(a) (b) (c) (d)

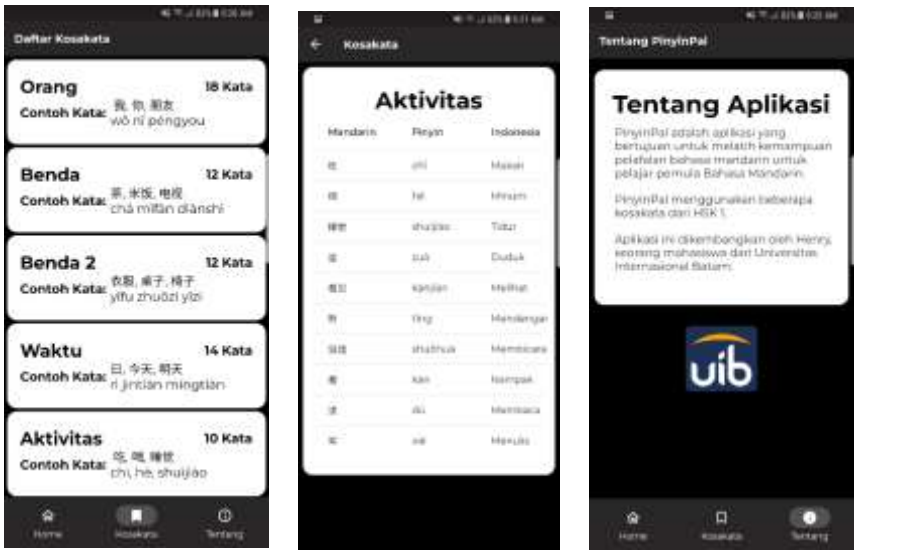
Figure 6. Page (a) Main Menu (b) Quiz (c) Correct Answer (d) Incorrect Answer

c. Application Vocabulary Menu

This menu can be accessed by users by pressing the vocabulary button in the application navigation bar.

d. About Application Menu

This page contains information about the application.



(a) (b) (c)

Figure 7. Halaman (a) vocabulary menu, (b) vocabulary page (c) about application

5. Testing

The testing method carried out in this research uses a black-box testing approach. Test results can be seen in the following table:

Table 4. Black-box testing result

Scenario	Case	Expected Result	Test Result
Opening Application	Pressing the app *icon*	Enters the application main menu	Success
Opening Questions Page	Pressing one of the question buttons	Enters the chosen questions menu	Success
Using Microphone	Pressing the microphone icon	Receive voice input	Success
Requesting Pronunciation Hint	Pressing the hint button	Gives pronunciation hint	Success
Giving Correct Answer	Inputting the correct answer	User answers are displayed in green	Success
Giving Incorrect Answer	Inputting the incorrect answer	User answers are displayed in red	Success

6. System Assessment

The following are the results of the system assessment carried out by distributing questionnaires to 33 respondents who used the Mandarin pronunciation training application:

Table 5. Application operation asessment result

No	Application Operation (V1)	M (Mean)	Frequency			
			SD	D	A	SA
1	Able to open and access the Mandarin pronunciation training application menu	3.393939394	1	3	11	18
2	Able to understand the function of the command buttons of the Mandarin pronunciation training application	3.424242424	2	2	9	20
Total frequency			3	5	20	38
Frequency percentage total			4.54%	7.57%	30.30%	57.57%
Total mean			3.409090909			
Category			Very Effective			

Table 6. Application appearance asessment result

No	Appearance (V2)	M (Mean)	Frequency			
			SD	D	A	SA
1	The writing in the Mandarin pronunciation training application is easy to read and understand	3.333333333	0	4	14	15
2	The audio sounds contained in the Mandarin pronunciation training application are easy to hear and understand	3.303030303	1	2	16	14
3	The pronunciation guide and microphone commands in the Mandarin pronunciation training application are clearly visible	3.424242424	0	3	13	17
4	There is a good color selection in the Mandarin pronunciation training application	3.242424242	1	2	18	12
5	The information on the Mandarin pronunciation training application has been conveyed well	3.424242424	0	2	15	16
Total frequency			2	13	76	74
Frequency percentage total			1.21%	7.87%	46.06%	44.84%
Total mean			3.345454545			
Category			Very Effective			

Table 7. Application content asessment result

No	Application Content	M (Mean)	Frequency			
			SD	D	A	SA
1	HSK 1 material application in the Mandarin pronunciation training application is comprehensive	3.393939394	0	3	14	16
2	Material in Mandarin pronunciation training application is suitable for learning HSK 1	3.393939394	1	1	15	16
3	The content of the material and practice questions are clear in the Mandarin pronunciation training application	3.515151515	0	2	12	19
Total frequency			1	6	41	51
Frequency percentage total			1.01%	6.06%	41.41%	51.51%
Total mean			3.434343434			
Category			Very Effective			

Based on the results of the assessment using the Likert scale assessment above, it can be concluded that the Mandarin pronunciation training application designed is very effective in terms of application operation, appearance and application content.

The results of this research namely the Mandarin pronunciation application, is in accordance with research done by (Salamun et al., 2022) and (Agrawal et al., 2020),

This application was built using Flutter, supports speech recognition and text-to-speech as per research done by (Faisol et al., 2021), was designed using the SDLC method as done by (Nurkholis & Bimantara, 2022) and was assessed as suitable by 33 respondents in the questionnaire similar to the research done by (Nuraini et al., 2022), (Rahmantara et al., 2018), and (Afrianto et al., 2019).

This application is successful in training Mandarin students outside school hours as shown in research by (Watanabe et al., 2020).

Conclusions

This research demonstrates the suitability of the waterfall SDLC method for developing mobile apps using Dart and Flutter. Black box testing validates the app's performance. Quantitative assessments place the app in the "Very Effective" category in terms of application operation, appearance, and content therefore indicating the success of using speech recognition technology to train Hanyu Pinyin pronunciation skills in Mandarin. Future

research could focus on developing an app for higher-level HSK vocabulary and sentence pronunciation training in Mandarin.

References

Afrianto, I., Irfan, M. F., & Atin, S. (2019). Aplikasi Chatbot Speak English Media Pembelajaran Bahasa Inggris Berbasis Android. *Komputika : Jurnal Sistem Komputer*, *8*(2), 99–109. https://doi.org/10.34010/komputika.v8i2.2273

Agrawal, S., Agrawal, M., & Padiya, S. (2020). Android Application with Platform Based On Voice Recognition For Competitive Exam. *International Journal of Advanced Research in Science & Technology (IJARST)*, *5*(5). www.ijarsct.co.in

Aklani, S. A., & Junifer, J. (2022). Perancangan Aplikasi Media Pembelajaran Kosakata Bahasa Mandarin untuk Anak Usia Dini. *Computer Based Information System Journal*, *10*(1), 36–45. https://doi.org/10.33884/cbis.v10i1.5448

Chrstian, Y., & Denissa, D. (2022). Analysis of Hangman Game Implementation for Hsk Test Participants Using Flutter. *JIKO (Jurnal Informatika Dan Komputer)*, *6*(1), 6. https://doi.org/10.26798/jiko.v6i1.506

Du, D., & Chen, W. (2021). A study of modern chinese typological characteristics from the perspective of linguistic typology. *Theory and Practice in Language Studies*, *11*(7), 853–857. https://doi.org/10.17507/tpls.1107.12

Elyana. (2021). *Analisis Kebutuhan Pembelajaran Mandarin Dasar di SMPN 163 Jakarta*. *3*(2), 43–50. https://doi.org/10.53744/bambuti.v3i2.31

Faisol, M. A. M., Ramlan, S. A., Saod, A. H. M., Mozi, A. M., & Zakaria, F. F. (2021). Mobile-based Speech Recognition for Early Reading Assistant. *Journal of Physics: Conference Series*, *1962*(1). https://doi.org/10.1088/1742-6596/1962/1/012044

Fajarisman, Widiatsih, A., & Kustiowati. (2021). Pengembangan Media Pembelajaran Berbasis Adobe Flash CS6 Pada Mata Pelajaran Bahasa Mandarin Untuk SMP/MTs. *Education Journal : Journal Education Research and Development*, *5*(1), 1–16.

Lianisyah, U. Y., & Sugiarti, T. (2022). *Analisis Motivasi dan Kesulitan Belajar Bahasa Mandarin Mahasiswa Indonesia non-Keturunan Tionghoa di Universitas Sebelas Maret Indonesia Abstrak*. *6*(2), 48–55.

Nadaiah Fitrah, D., Resnani, & Agusdianita, N. (2021). Analisis Kesalahan Penggunaan Huruf Kapital dan Tanda Baca pada Hasil Menulis Siswa Kelas V Sekolah Dasar Negeri 67 Kota Bengkulu. *JURIDIKDAS (Jurnal Riset Pendididkan Dasar)*, *4*(3), 329–338. https://doi.org/https://doi.org/10.33369/juridikdas.4.3.%25p

Nuraini, Andreswari, D., & Farady C, F. (2022). Aplikasi Belajar Daring Bahasa Inggris Kelas VII Smp Menggunakan Teknologi Voice Recognition Berbasis Android (Studi Kasus: SMP Negeri 17 Bengkulu). *Rekursif: Jurnal Informatika*, *10*(1), 81–95. https://doi.org/10.33369/rekursif.v10i1.17257

Nurkholis, A., & Bimantara, R. (2022). Interactive English E-Learning Based on Cloud Speech-to-Text. *Jurnal Ilmiah Edutic*, *9*(1), 1–9.

Prasetiyo, A. B. (2021). Gangguan Pelafalan Fonem Bahasa Jawa (Studi Kasus Anak Usia 5 Tahun). *Kajian Linguistik Dan Sastra*, *6*(2), 141–148. https://doi.org/10.23917/kls.v6i2.13580

Puspitasari, D., & Putra Danaya, B. (2022). Pentingnya Peranan Komunikasi Dalam Organisasi: Lisan, Non Verbal, Dan Tertulis (Literature Review Manajemen). *Jurnal*

Ekonomi, Manajemen Sistem Informasi, *3*(3), 257–268. https://doi.org/10.31933/jemsi.v3i3.817

Rahmantara, D. S., Wardhani, K. D. K., & Saf, M. R. A. (2018). Aplikasi Pengenalan Nama Surah pada Juz ke 30 Kitab Suci Al-Qur'an Menggunakan Speech Recognition. *Jurnal RESTI (Rekayasa Sistem Dan Teknologi Informasi)*, *2*(1), 345–353. https://doi.org/10.29207/resti.v2i1.285

Rindawati, T., & Thamrin, L. L. (2022). Penggunaan Media Audio Visual Film Kartun Dalam Pembelajaran Kosakata Bahasa Mandarin Pada Siswa SD Lkia. *Journal Tunas Bangsa*, *9*(1), 2022–2023. https://ejournal.bbg.ac.id/tunasbangsa

Sakti, K. F. L. (2021). Pelatihan HSK Sebagai Upaya Meningkatkan Kemahiran Berbahasa Mandarin Bagi Guru-Guru Bahasa Mandarin Se-Malang Raya. *SELAPARANG Jurnal Pengabdian Masyarakat Berkemajuan*, *Vol 5*, *No*, 4. https://doi.org/DOI: https://doi.org/10.31764/jpmb.v5i1.6222

Salamun, Sukri, Amin, K., Elvitaria, L., & Trisnawati, L. (2022). Artificial Intelligence Automatic Speech Recognition (ASR) untuk pencarian potongan ayat Al-Qu'ran. *Jurnal Komputer Terapan*, *8*(Vol. 8 No. 1 (2022)), 36–45. https://doi.org/10.35143/jkt.v8i1.5299

Wahyuni, S., Sambo Layuk, N., Hesron Loly, R., Nandito Daud, A., Dipa Makassar, universitas, Perintis Kemerdekaan Km, J., & Makassar Sulawesi Selatan, T. (2021). Desain Sistem Speech Recognition Penerjemah Bahasa Toraja Menggunakan Hidden Markov Model Design System Speech Recognition Tranlator Toraja Language Using Hidden Markov Modelling. *Jppi*, *11*(2), 107–119. https://doi.org/10.17933/jppi.v11i2.286

Wang, L., & Dai, J. (2021). Economic Effect of Language Ability on Income and Employment: The Evidence from China. *International Journal of Business and Management*, *16*(2), 54. https://doi.org/10.5539/ijbm.v16n2p54

Watanabe, Y., Omae, T., & Odo, S. (2020). *Teaching Online Chinese Pronunciation with Pronunciation Training Software: An Empirical Study*.

Wijana, I. D. P. (2022). Adverb in Indonesian. *Ranah: Jurnal Kajian Bahasa*, *11*(1), 26. https://doi.org/10.26499/rnh.v11i1.2454

Xu, Y., Liu, X., Cao, X., Huang, C., Liu, E., Qian, S., Liu, X., Wu, Y., Dong, F., Qiu, C. W., Qiu, J., Hua, K., Su, W., Wu, J., Xu, H., Han, Y., Fu, C., Yin, Z., Liu, M., … Zhang, J. (2021). Artificial intelligence: A powerful paradigm for scientific research. *The Innovation*, *2*(4). https://doi.org/10.1016/j.xinn.2021.100179