A mobile learning application for Malaysian sign language education

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Abstract. Malaysian Sign language is the primary means of communication among the deaf-mute community in Malaysia for many years since it was first created in 1998 when the Malaysian Federation of Deaf was first established. Although Malaysian Sign Language is widely used among the deaf-mute community, hearing individuals often have little or no exposure to the usage of sign language due to the lack of pervasive environment for the usage of sign language. There is also a lack of effective mobile learning application that encourages and facilitates the learning of sign language. This creates a communication gap among the deaf-mute community and the hearing individuals. The objective of the project is to design a mobile application that can facilitate the learning of sign language and ultimately bridging the gap between deaf-mute communities and hearing individuals. A survey was carried out to elicit the requirements of potential users. The sample population was drawn from Bahasa Isyarat Malaysia (BIMMF) Facebook group and Universiti Tenaga Nasional (UNITEN) students. The questionnaire consists of multiple-choice questions, open-ended questions and dichotomous questions which can be logically divided into demographic questions, questions on the experience of a participant on sign language, preferred learning methods and the preferred features of the application. The findings show that there is a need for an effective and interactive mobile application for learning sign language. Most of the respondents agreed that video tutorials are their preferred learning method as it is more dynamic than learning via images or books. A majority of the respondents also have no experience in using a sign language learning application due to the lack of availability on the market. Moreover, most of the participants also show interest in using a mobile application in learning Malaysian Sign Language. Some respondents also requested the feature of a built-in dictionary. Thus, the findings validate that SLEM has its demand and potential to provide a more accessible and user-friendly means to learn Malaysian Sign Language. The application has the potential to be commercialized to industries and communities such as sign language learning institutions, the public and individuals who are related to deaf or verbally challenged individuals. This paper provides directions and guidance for further development of this educational mobile application.

1. Introduction

Sign language is defined as a communication system which is commonly expressed using hand movements rather than verbal expression [1]. Both manual gestures and non-manual signals are used to express or communicate using sign language. Manual gestures refer to gestures that make use of the orientation and movement of hands and arms to convey meaning whereas non-manual signals consist of features other than hands and arms such as head movement, facial expression, body shifting or others. Sign language serves as a primary means of communication for people who are hearing impaired or verbally challenged.

The United Nations Conventions on the Rights of Persons with Disabilities advises the state parties to accept and facilitate the use of sign languages, as well as recognizing and promoting the use of sign languages. It also encourages the state parties to facilitate the learning of sign language and the promotion of the linguistic identity of the deaf community [2]. The United Nations Convention on the Rights of Persons with Disabilities (CPRD) was ratified by Malaysia on 19 July 2010 to protect the right of the disabled people.

Sign languages vary across different nations around the world. When the Malaysian Federation of the Deaf was...
established in 1998, Malaysian Sign Language was created and has since been used as the standard means of communication among the deaf community in Malaysia. However, it might be difficult for speech or hearing-impaired people to communicate with typical individuals using sign language, as most of them are not familiar with sign language. According to the Department of Social Welfare Malaysia, the number of hearing-impaired people in Malaysia in 2016 was reported to be 31,937 whereas the number of speech-impaired people was reported to be 2,104 people [3].

One of the means to learn Malaysian Sign Language is by attending sign language classes. There are currently a few places for the public to learn Malaysian Sign Language regardless if they are deaf or hearing such as YMCA KL Sign Language Courses and Malaysian Federation of the Deaf. It requires the learners to commute to the places where the classes are held. People who live in rural areas may not have access to sign language classes. Another medium of learning Malaysian Sign Language is by reading books. Video tutorial is another popular means of learning sign language in Malaysia as it allows users to learn at a comfortable pace. However, books and video tutorials are not able to provide feedback to learners. Thus, most hearing people are not familiar with using sign language as there is a lack of effective learning support provided to them. Moreover, it is crucial to evaluate and provide feedback to the learners, especially the beginners so that the mistake will not be permanent [4].

Hearing-impaired and verbally challenged individuals often face difficulty in their daily communication with the other individuals as the usage of sign language is not prevalent in Malaysian society. There is also a lack of mobile application that efficiently supports the learning of sign language. Although there are a few applications which are designed to help sign language learners to learn sign language, the user interface of the applications is not very interactive. Sign language users must be able to both recognize and generate the sign during a duplex communication. However, most of the applications only assess the learners’ ability to recognize sign language, but not the ability for them to reproduce or generate the sign.

Early childhood is a critical period of language acquisition for children. Thus, it is very crucial for children who are deaf to have early immersion and exposure to sign language for their linguistic development. However, most deaf children are born to hearing parents [5]. They might encounter difficulty in providing their children with a linguistic model if they are not familiar with using sign language. The first exposure of children to signing is usually at school. This might lead to a delay in the language acquisition of children which then affects their ability to fully learn the nuances of the first language and increases their difficulty in learning other languages throughout their life [6].

This proposed application aims to enhance the learning interest of deaf-mute children as beginners in sign language as well as act as a valuable educational resource to teach and support people to learn the sign-language alphabet enjoyably and effectively by providing feedback and evaluation in the learning process of the learners. Since not everyone can comprehend sign language, this application is expected to help the beginners to learn Malaysian Sign Language to ease the communication of deaf community.

2. Literature Review

2.1. Review on Existing Systems

This section reviews the sign language self-learning applications that are currently available to the public. The section includes descriptions about the features, as well as the advantages and limitations of each application.

2.1.1. Eddy. Eddy is an interactive self-learning app developed by BAXS Technology to facilitate the learning of Malaysian Sign Language. The application includes features such as interactive game scenes, 3D animated Malaysian Sign Language dictionary and Malaysian Sign Language Spelling features that ease the learning of Malaysian Sign Language. The application also embraces a gamified approach to the learning of Malaysian Sign Language to enhance the learning efficacy of the sign language learners.

2.1.2. MyBIM. MyBIM is an iOS application developed by Veggie Express that uses multiple interactive methods to teach sign language. The application demonstrates gestures for Malaysian Sign Language through videos and flashcards. It also includes a step-by-step guide to perform the gesture which eases the learning of sign language. Moreover, it incorporates 36 categories of gestures and about 500 vocabularies in both Malay and English language.

2.1.3. KotBAM. KotBAM is an Android application developed by Creative Multimedia Team. It is developed based on the syllabus of Kod Tangan Bahasa Melayu. The target user of the application is teachers who are new to sign language. The application uses video tutorials as the main material of teaching sign language.
2.1.4. **ASL American Sign Language.** ASL American Sign Language is an Android application that serves as a learning platform of American Sign Language. It uses videos tutorials, picture matching games and images to teach some basic signs of American Sign Language such as alphabets, numbers and commonly used phrases and vocabulary in daily conversation.

2.1.5. **SignSchool.** SignSchool is an Android application that provides a platform for learners to learn American Sign Language at their own pace. The application has a sign language dictionary which allows the user to search for a sign of a word. It also divides signs into various categories which are related to certain topics. It also includes multiple-choice games to reinforce the learning of sign language and SignBuilder feature that uses randomized sign generators to strengthen the learners’ vocabularies.

2.2. **Comparison of Features between the Existing Sign Language Applications**

All the applications reviewed divides signs into clear categories for users to be able to learn by category easily. However, KotBAM and ASL do not have a feature that allows the user to search for a specific sign. From all the applications, only Eddy allowed its user to view the fingerspelling of an input word. Eddy, ASL and SignSchool have features that evaluate and give feedback to the user on the users’ ability to recognize signs. None of these applications evaluates or provide feedback to the users on their ability to perform signs. Moreover, SignSchool is the only application that allows the user to control the speed of the video. Both Eddy and ASL took a gamification approach to the teaching of sign language. Only ASL includes sign language stories for its users to view. KotBAM is the only application that includes signs in the form of a sentence that illustrates real-life conversation or scenario.

3. **Requirement Analysis**

3.1. **Requirement Elicitation**

Requirement elicitation is the application of various techniques to discover and gather requirements from various sources such as the stakeholders of the project, existing systems and documentation of similar systems. Requirement elicitation is a significant component of software development as it ensures that the application that is being developed fulfils users’ need and expectation.

3.1.1. **Questionnaire.** The use of a questionnaire is the main requirement elicitation technique chosen as it enables many potential stakeholders of the proposed application to participate. Generally, the goal of this questionnaire is to elicit the requirements of the potential stakeholders of SLEM application. It is expected to discover the features that are desired in a sign language application. It also aims to discover the preferred learning method of the participants, as well as the pain points or problems that the participants have while using other sign language learning applications. The development of the proposed application necessitates elicitation of requirements from a diverse group of people as the project aims to enable Malaysian Sign Language to be accessible to as many people as possible to build a more inclusive communication environment. Thus, to elicit the requirements of the proposed application at large scale, Microsoft Form is used to gather the requirements from the public, and the response is then analyzed to gain insights from the responses gathered. To better understand the need for deaf and verbally challenged community, the questionnaire is posted on Bahasa Isyarat Malaysia (BIMMFD) Facebook group which has about 3,000 members who are actively exchanging sign language learning content. The questionnaire is also spread among UNITEN students to better understand the requirement of hearing users. Quantitative and qualitative data obtained from the questionnaire is collected and analyzed to elicit the requirements for the proposed learning application.

The population that participates in the questionnaire is 44 UNITEN students and the members of Bahasa Isyarat Malaysia (BIMMFD) Facebook group. It is found that participants between the age of 18 to 24 make up the largest portion of the entire population of the survey. About 15.9% of the participants are deaf or related to someone who is deaf. It is also discovered that about 52.3% of the participants do not know sign language. This necessitates the existence of Malaysian Sign Language learning app like the proposed application so that more people can gain exposure to the use of sign language. Most of the participants of this questionnaire (88.7%) identify themselves as ‘poor’ or ‘very poor’ as their proficiency level of sign language. This might be due to the lack of accessible Malaysian Sign Language learning platform that assists them in learning sign language. It is also found that the most preferred learning method for sign language is watching video tutorials (39.4%) followed by learning from mobile application as the second most preferred method. Thus, the proposed application can incorporate learning content in the form of video tutorials as it is the favourite method for learning sign language as compared to other methods. Method such
reading may not be efficient for the participants as the graphics are static, so they might need to interpret the correct movement themselves. Taking sign language courses also demands regular commitments to commute to the learning centre. Thus, a mobile application might be the most accessible way to learn sign language. It is discovered that 88.6% of the participants have no prior experience of using a sign language learning application. About 46.7% of the participants also think that the application they have previously used does not help learn sign language. This might imply that there is a limited number of applications for learning sign language with the desired quality and functionality. There are problems which the user encounters while using a mobile application to learn sign languages such as inconsistency and inaccurate learning content. There is also a lack of functionality which the user expects such as a built-in sign language dictionary. Thus, the development of the proposed application should focus on these problem areas and address the users’ needs. About 95.5% of participants also show interest in using a mobile application in learning Malaysian Sign Language. The desired features suggested by the participants of the questionnaire are recorded.

Based on the findings of the questionnaire, it is discovered that the participants are interested in using a mobile application to learn Malaysian Sign Language. Therefore, the proposed application has great potential to provide a more accessible and efficient platform to learn Malaysian Sign Language.

4. Proposed Solution
This paper presents the Sign Language Education Malaysia (SLEM) mobile self-learning application. This section aims to give the reader an overview of the system specifications. In this chapter, system design is broken down into three parts, namely system architecture and interface design to give the reader a clearer view on the modules, interfaces, specifications, and architectures of the proposed application.

4.1. System Architecture
The system architecture of SLEM application is illustrated in Figure 1. The application mainly consists of the user interface, Firebase services, Google Cloud services and the Internet connection. The main users of the application are comprised of the learners. The learner will interact with the user interface of the application to perform functions such as answering practice questions, searching for a sign and learning sign language. The client will constantly make requests and receive responses from Firebase. A few Firebase services will be utilized to implement the functionality of the application, namely Firebase Authentication, Cloud Firestore and Firebase Storage. Firebase Authentication will be used to authenticate the application user conveniently and securely. Firebase Firestore will be utilized to store and synchronize the application and content information whereas Firebase Storage will be used to store the learning content in the form of videos and images. Cloud AutoML Vision will be used to train, host and deploy the machine learning model used for sign recognition in the application. Communication between the application and Firebase and Google Cloud services is established via the Internet connection so an active Internet connection is required for using some of the features of the application.
4.2. **User Interface Design**

4.2.1. **Home Screen.** Figure 2 illustrates the home page of SLEM application. The home icon is highlighted in blue to indicate that the user is currently at the home page. Users can access the user profile page by tapping on their profile pictures at the upper right of the screen. Users can also search for a sign by entering a word using the search bar. The featured categories are listed on the home page neatly to enable users to quickly dive into one of the categories to start learning. A navigation bar is also provided at the bottom of the screen to enable users to go to different tabs such as categories, dictionary, fingerspelling and practice.
4.2.2. **Categories Page.** Figure 3 shows the categories page of the application. The category icon on the navigation bar is highlighted in blue to indicate that the user is currently at the categories page. The categories are sorted according to the importance of the category. All the signs are classified into meaningful categories so that it is convenient for users to start browsing and learning different signs. Users can tap into any one of the categories in this page to start learning.

4.2.3. **Learning Content Page.** Figure 4 shows the learning content which is displayed once users tap into one of the categories. The word shown in Figure 4 is ‘Hello’, which is one of the signs in the Greeting categories. The progress bar will show the current user’s progress in the category as users progress through words in the categories. The content is shown in the form of images or videos. Tapping on the next icon allows users to go to the next sign in the
category. In contrast, tapping on the previous icon allows users to go to the previous sign. Users can also tap on the back icon on the upper left of the screen to return to the list of categories.

**Figure 4. Learning Content Page**

4.2.4. **Dictionary Page.** Figure 5 shows the dictionary page which enables users to quickly search for a sign without the need to browse through each category to look for a specific sign. The dictionary icon on the navigation bar is highlighted in blue to indicate that the user is currently at the dictionary tab. Users can look for a sign by entering a word on the search bar and tap on the search icon. The ‘Recently Searched’ section of the page enables the user to view the recently searched items and quickly tap on one of the words to look for a sign if the user forgets the sign.

**Figure 5. Dictionary Page**

4.2.5. **Fingerspelling Page.** Figure 6 illustrates the fingerspelling section of the application. The dictionary icon on the navigation bar is highlighted in blue to indicate that the user is currently at the dictionary tab. The two main tabs on the fingerspelling page are alphabets and numbers. Users can tap on either of the tabs to start learning on fingerspelling.
4.2.6. Sign of Alphabets. Figure 7 shows the sign of the letter ‘G’. The progress bar on top of the screen shows the user’s progress as the user progresses through the alphabet. The sign of the alphabets is displayed to the user. Tapping on the previous button brings users to the previous letter, whereas the next button brings the user to the next letter. User can tap on the capture icon to capture the image of the user performing the sign.

4.2.7. Check User’s Sign. Figure 8 shows an example of the camera screen shown once the user taps on the capture icon in Figure 7. Users can then try to capture the image of them performing the sign by tapping on the camera icon. Alternatively, users can return to the previous screen by tapping on the close icon. Once the user captures his photo, the photo will be sent to the cloud for inference.
4.2.8. Check Result. Figure 9 illustrates the screen that will be displayed to the user if the user performs a sign correctly. Users can continue to learn the other numbers or alphabets by tapping on the continue button. Alternatively, users can tap on the back button on the upper left of the screen to return to the previous screen.

4.2.9. Practice Page. Figure 10 shows the Practice page. The Practice icon on the navigation icon is highlighted in blue to indicate that the user is currently at the practice tab. Users can tap into any one of the categories to start practising the sign in the category.
4.2.10. Practice Question. Figure 11 shows one of the multiple-choice questions in the ‘Greetings’ category. The question tests the user’s ability to recognize a sign. Users can view the sign which is being displayed to the user, and choose by tapping on one of the options listed below the sign. If the user picks the correct answer, the answer will be highlighted with a tick. The progress bar on top of the screen will show the user’s current progress as the user progresses through each question.

4.2.11. User Profile Page. Figure 12 illustrates the user profile page which the user can access by tapping on the user profile picture on the home page of the application. The user profile page provides an overview of the user information such as the profile image, username, and user’s email address. To motivate users to use the application for learning, the user profile page also shows the streak, which is the number of consecutive days the user uses the application. The user profile page also shows the best record of the user.
5. Conclusion

The idea of the project initiated from the observation of various problems which hinders the existence of an inclusive communication environment for the deaf and verbally challenged community. This project aims to provide an effective solution to the lack of Malaysian Sign Language learning platform within the Malaysian community by developing a mobile learning application. It serves as a means to bridge the communication gap between hearing individuals and hearing-impaired individuals. The project is expected to contribute to providing a more pervasive environment for the usage of Malaysian Sign Language within the Malaysian community. In this report, a design for a Malaysian Sign Language learning application has been presented.

As part of the requirement elicitation activities, various mobile applications which are currently available are studied to gain insights on the strength and weaknesses of the applications. A questionnaire is used to elicit requirements among hearing individuals and hearing-impaired individuals to better understand their needs and expectations. The requirements are then analysed to create the specifications of the application. In the requirement specification phased, the scope of the project is determined. The architecture and features of the application are planned in the system design phase of this project. The user interface of the application which is the means of communication between the user and the application is designed by following a minimalist approach to increase the understandability of the users.

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