



Sign For Everyjuan: An Interactive Android Application That Teaches Filipino Sign Language Using Hand Gesture Recognition

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Abstract. Sign for EveryJUAN is an Android application for Filipinos who want to learn alphabet, numbers, WH questions, greetings, phrases, days, family members, adjectives, and verbs in Filipino Sign Language. The application will display images and play videos of signs in Filipino Sign Language which includes facial expression and hand gestures. Users can use their front-facing camera to perform and practice the learned sign and the application will detect if the user performed the correct sign. MediaPipe is used to track and extract key point coordinates from the user's hands and face. The extracted key point coordinates are used as an input for the Long Short-Term Memory neural network to identify what sign was performed. The LSTM network achieved accuracy ratings of above 90%. The application received an average rating of 4.53 from end users, which is considered to be highly acceptable, and an average rating of 4.18 from IT professionals, which is considered to be very acceptable. **Keywords:** Filipino Sign Language, Long Short-Term Memory Network, MediaPipe 1.0 Introduction Communication helps humans to interact and understand one another. People may not be able to communicate verbally in another culture's language, but they can utilize gestures, visual cues, body language, and other nonverbal communication strategies (Naar, 2021). Sign language is a mode of communication that uses hand motions, body movements, and facial expressions. It is used by people around the globe who face difficulty with hearing and speaking to express and communicate. But there.

Keywords: Android, Sign Language, Hand Gesture, Recognition, Interactive

1 Introduction

Communication helps humans to interact and understand one another. People may not be able to communicate verbally in another culture's language, but they can utilize gestures, visual cues, body language, and other nonverbal communication strategies [1]. Sign language is a mode of communication that uses hand motions, body movements, and facial expressions. It is used by people around the globe who face

difficulty with hearing and speaking to express and communicate. But there is no universal sign language. There are different sign languages just as there are a variety of spoken languages. As of March 2022, Ethnologue listed 157 listed sign languages that include deaf community sign language and shared sign language. In the Philippines, the sign languages used are American Sign Language, Signing in Exact English, Samar Sign Language, and Filipino Sign Language. However, Filipino Sign Language, or FSL is the national sign language of the Filipino deaf [2]. In 2000, the National Statistics Office reported that there are over 121,000 Filipinos who are deaf and hard of hearing. In an interview done by Imperial (2015) with Liwanag Caldito, one of the founding members of the Philippine National Association of Sign Language Interpreters (PNASLI), the latter stated that 70 percent of the Filipino Deaf community uses FSL as their main sign language. Still, there are many deaf, mute, and people with the ability to hear who are not familiar with the national sign language.

There are several new inventions and advancements in technology nowadays like gloves that aim to help the Deaf community. However, wearable technology that interprets sign language ignores the complexities of sign language [3]. But mobile technology improves the way we interact and is becoming an important teaching tool [4]. Also, according to Loveless (n.d), the educational application is a method to pique students' interest in subjects they may otherwise overlook.

The main objective of this study is to develop an educational interactive Android application for Filipinos who want to learn basic Filipino Sign Language, and applying the Long Short-Term Memory (LSTM) algorithm for sign language recognition.

1.1 Specific Objectives

1. To create a system that recognizes the basic Filipino Sign Language;
2. To develop an Android-based application;
3. To apply LSTM algorithm in sign language recognition

1.2 Scope and Limitation

The scope of this project is that it only teaches basic Filipino Sign Language which includes alphabet, numbers, common basic/WH questions, common greetings, common phrases, days, family members, adjectives, and verbs. The categories chosen are based on the most commonly used by people to communicate with one another.

1. Alphabet: A, B, C, D, E, F, G, H, I, J, K, L, M, N, Ñ, NG, O, P, Q, R, S, T, U, V, W, X, Y, Z
2. Numbers: 1-25, 30, 40, 50, 60, 70, 80, 90, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000
3. Ordinal Numbers: 1 st , 2 nd , 3 rd , 4 th , 5 th , 6 th , 7 th , 8 th , 9 th , 10th .
4. Basic/WH Questions: Who (Sino), Why (Bakit), When (Kailan), Where (Saan), How (Paano), What (Ano), How much (Magkano), How many (Ilan)

5. Greetings: Good morning (Magandang umaga), Good midday (Magandang tanghali), Good afternoon (Magandang hapon), Good evening (magandang gabi), Hi, Hello, How are you (Kumusta ka), Thank you (Salamat), Nice to meet you (Masaya akong makilala ka), Goodbye (Paalam)
6. Phrases: What is your name (Anong pangalan mo?), I am- (Ako si-), Sorry (Patawad), Please (Pakiusap), Yes (Oo), No (Hindi), I am fine (Ayos lang ako)
7. Days of the Week: Monday (Lunes), Tuesday (Martes), Wednesday (Miyerkules), Thursday (Huwebes), Friday (Biyernes), Saturday (Sabado), Sunday (Linggo)
8. Family members: Father (Tatay), Mother (Nanay), Sister (Ate), Brother (Kuya), Grandfather (Lolo), Grandmother (Lola)
9. Adjective and Verbs: See (Tingnan), Eat (Kain), Drink (Inom), Like (Gusto), Wait (Sandali), Want (Gusto), Beautiful (Maganda), Handsome (Gwapo), Ugly (Panget), Cute (Kyut)

2 Method

The researchers will use quantitative research approach and will utilize descriptive design for the entire study. Quantitative approach uses survey questionnaires to collect data and the data will be shown through statistics. Descriptive study is a scientific approach that observe and describe a subject's behavior without altering it in any manner. The researchers chose this design because it was the most likely to produce the necessary data, leading to a precise result and a successful study overall.

The study will be conducted during the second semester of the academic year 2021-2022, and first semester of academic year 2022-2023. The researchers will gather respondents from Marikina City as the chosen beneficiary is located in the mentioned city. The respondents will be surveyed online and at a comfortable place that the respondent will choose to.

Population and Sampling In this study, the researchers will gather ten (10) Filipino Sign Language interpreters, five (5) people with family member who is Deaf, and five (5) IT experts. The sample size is twenty (20) as this is the sample size that the researchers believe that is attainable as people may still decline to participate even if participation is confidential. Also, population size is an important factor in determining sample size, since the population is more specific, the sample size is small. The researchers also believe that this sample size is adequate for collecting data to answer the study's objective. The researchers will use non- probability sampling specifically snowball sampling technique in choosing the respondents. Snowball sampling allows the researchers to quickly gather respondents through the suggestion of an individual that meets the criteria. The criteria of the respondents are:

For the Filipino Sign Language Interpreter:

1. Filipino Sign Language Interpreter;
2. At least 18 years old;
3. Residing or working in Marikina;
4. Willing to install and test an application; and

5. Has an Android OS smartphone.

For the family member of the Deaf:

1. Have a Deaf family member;
2. At least 18 years old;
3. Residing or working in Marikina;
4. Willing to install and test an application; and
5. Has an Android OS smartphone.

Those from outside Marikina, a minor, and have other operating system like iOS will be automatically excluded in the survey.

2.1 Data Gathering Procedure

The researchers will use an online survey form with the use of Google Forms and informed consent using Jotform, and will be sent to the respondents through Facebook Messenger. The survey and informed consent include all the necessary details that the respondents needed to know. The testing and survey will be done just once and will only take around 1 to 2 hours. As the respondents finish the survey, the researchers will be able to collect all information and analyze the response. All the data will be kept in Google Drive for confidentiality and will be deleted after a year once the study is finished. Once the researcher reached the quota number of respondents, data analysis will take place

2.2 Research Instrument

The research instrument used is a survey evaluation for end- users and IT experts. The survey that was used to evaluate the application follows the ISO 25010 standard. The researchers conducted a survey to convey the aim of the study that has been carefully interpreted and analyzed. The questionnaire given consists of questions that will be answered by stating if it is unacceptable, moderately acceptable, acceptable, very acceptable, or highly acceptable

2.3 Testing Procedure

Beta testing is a type of testing carried out by actual users or end users to make sure the application can work in a real environment. It helps the developers in figuring out whether the application functions correctly and if there are any problems or defects. The beta testing method used for Sign for EveryJUAN is traditional beta testing, in which the target users are given the application and asked to provide feedback via a beta testing questionnaire [5]. Questions for beta testing questionnaire consist of questions regarding the application's installation, user interface, functionality, responsiveness, contents, and outputs. The questions were based on the mobile application testing

criteria provided in the 2012 book "The Art of Software Testing" by Myers, Sandler, and Badgett.

2.4 Evaluation Procedure

The data collected from the respondents will be subjected to the following statistical analysis: Frequency and percentage distribution. This was used to interpret and analyze the profile of the respondents. Weighted arithmetic mean. This will be used to analyze the respondent's answers per statement. The computed weighted arithmetic mean will be interpreted based on the 5-point Likert scale with the descriptive meaning of (1) unacceptable, (2) moderately acceptable, (3) acceptable, (4) very acceptable, and (5) highly acceptable. The formula for weighted mean is: $\sum_{i=1}^n W_i X_i / \sum_{i=1}^n W_i$ where n = number of terms, W_i = weight applied to x value, X_i = data values to be averaged. Table 1 shows the descriptive meaning of the scale and interval of weighted arithmetic mean.

Scale Interval	Descriptive Meaning
5.00 - 4.21	Highly Acceptable
4.21 - 3.41	Very Acceptable
3.41 - 2.61	Acceptable
2.61 - 1.81	Moderately Acceptable
1.81 - 1.00	Unacceptable

3 Results and Discussion

Sign Language Applications in Google Play Store and Apple App Store Figure 12: Categories of Sign Language Applications in Google Play Store and Apple App Store Figure 12 shows the categories of sign language applications in Google Play store and Apple App store. The proponents looked for applications in Google Play Store and Apple App Store about sign language that is similar or related to the study. Using the keywords "sign language recognition", "sign language", "sign language app", "sign language education", "learning sign language", "sign language translator", and "learn sign language", the proponents found 136 mobile applications. The applications found are separated into different categories based on their similarities. The first category is videos. 60 out of 136 applications are compilation of short videos demonstrating sign language for alphabets, numbers, greetings, common phrases, and others. Some applications under the videos category have added features like tracking the progress of the user, history of the sign language and description for each word, simple games where a video of sign language is displayed and the user will identify what word is being showed, the ability to add signs to a favorites list, voice/text to sign language where a corresponding video demonstration of the sign language will be displayed as a result, and voice to text and text to voice feature. Some applications under this category is only focused on one category of words like banking words, sexual health words, animals, and school related words instead of a more general scope like alphabet, numbers, greetings, phrases, days, etc. The second category is images. 34 out of 136 applications are compilation of sign language images, mostly for alphabet and numbers only, but some application also includes greetings and common phrases. Some of the applications have added features like simple games where an image of sign language is displayed and the user will identify what word is being displayed, text to sign language where user will

enter a word and the image for the sign language will be displayed, and sign language to text where the keyboard is composed of sign language images and when selected the appropriate word will be displayed.

The third category is a combination of images and videos. Images are used for alphabet and numbers sign language, and videos are used for other sign language like greetings, common phrases, and others. 16 out of 136 applications are under this category. Some applications have added features like having an online community where users can post and interact with other users, games that is the same as the two categories above where an image or video is displayed, and the user will identify what is the correct word for that sign, and text to sign language where the user will enter a word and an image or video demonstrating the sign language for that word will be displayed. The fourth category uses an avatar in 3D or 2D form to demonstrate sign language for each word instead of using video or image. 9 out of 136 applications are under this category. Some of them have added features like text or voice to sign language where the avatar will demonstrate the appropriate sign language for the word, and games where sign language by the avatar is showed and the user will identify what is the correct word for that sign. The fifth category is games. The approach of applications under this category is more on games, unlike the four previous categories where their approach is more of a library or compilation of sign language through images, videos, and avatar. 7 out of 136 applications are under this category. All of them are games where an image or video is displayed, and the user will identify what is the correct word for that sign. The scope of these applications varies, some only alphabets and numbers, while others include other sign language for greetings, common phrases, etc. The sixth category is bible, stories, and nursery rhymes. Unlike the five previous categories, applications under this category are not focused on learning sign language but making the bible and stories accessible to sign language users. 8 out of 136 applications are under this category.

Their features include videos showing the contents of the bible per chapter through sign language, converting story books for children into sign language, and nursery rhymes in sign language for children. The seventh category is hand sign recognition. 2 out of 136 applications are under this category. This scope of this applications under this category is alphabets while others also include numbers from 1 to 10. A video demonstrating how to do the sign language is displayed first and then an assessment will follow where the application will access the phone camera and the user will demonstrate the sign language to check if the user is doing it right. In summary, based on the applications discussed above, some similarities found for this study are video demonstration of sign languages and the hand sign recognition. Despite these similarities, the unique feature for this study is the ability to recognize sign language with series of movements. Note that in the seventh category, it also has a sign language recognition feature, but that feature can only detect one movement or sign and only takes one frame, the reason why the scope of that application is only numbers and letters.

In this study, series of movements are recognized for more complex sign language that requires several actions. Multiple frames at a time are captured to get the key points

for each sign language. Also, most of the sign language applications available online are in foreign sign languages not in Filipino Sign Language

Project Description the Sign for EveryJUAN: An Interactive Android Application that teaches Filipino Sign Language using Hand Gesture Recognition was developed to aide hearing and deaf Filipinos in learning FSL. This application is designed to help and assist the communication between members of the hearing and Deaf communities through the use of Filipino Sign Language. Furthermore, the interactive feature of this application will help new signers to grow their sign language vocabulary and develop their signing skill. **4.3 Long-Short Term Algorithm in the Application** The said algorithm is used when users turn on their camera and perform a specific Filipino sign language. With the help of MediaPipe, key points from hands and face mesh landmarks are collected. The x, y, and z coordinates of these key points provide information on the location of each landmark. As the user performs a specific Filipino sign language, a series of key points from hands and face mesh are collected. This series of key points will be used by the LSTM neural network as in input to predict what Filipino Sign Language is performed. The result from the LSTM neural network will be used to check whether the user performed the Filipino sign language correctly.

Project Structure of Sign for EveryJUAN System Description System Overview Sign for EveryJUAN is a mobile app for Filipinos who want to learn numbers, alphabet, basic words, phrases, and greetings in Filipino Sign Language.

The application will show images and play recorded videos of hand gestures and facial expressions, and the user will sign using the smartphone's selfie camera. The application could then detect and display if the user is making the proper gesture with the use of LSTM algorithm. It also has a primer that contains information about Filipino Sign Language, and an exercise mode where they can test their signing. This program is intended to aid communication between members of the hearing and Deaf communities by using FSL. Furthermore, the interactive element of this software will assist new signers in expanding their sign language vocabulary and honing their signing skills. To provide an efficient and successful user experience, the program includes a user-friendly interface. **System Functionality** Three options will be presented to users when the application first launches: Filipino Sign Language Primer, Learn Filipino Sign Language, and FSL Exercise. The first option is the Filipino Sign Language Primer. The history of sign language and Filipino sign language are covered in this primer, along with a detailed explanation of Filipino sign language's nuances and components. It also offers advice for those just learning FSL.

The introduction also includes tips for communicating with a deaf person and facts about the Deaf community, who use sign language most commonly. The information written in this primer are from FSL books, related studies, and Filipino Deaf advocates. The next option is Learn Filipino Sign Language where users will be able to view the tutorials for FSL and practice them. The FSL tutorials can be found in various categories, such as alphabets, numbers, ordinal, greetings, phrases, basic questions, family, days of the week, and adjectives and verbs. Following the tutorial, users can use the camera to practice the FSL they learned. When the camera is turned on, MediaPipe Library is used to capture data points from the face and hands. Each landmark on the

hands and face is identified by its x, y, and z coordinates. MediaPipe will continue to gather data points as the user performs the FSL until it has gathered enough data points to make predictions. The LSTM neural network will input the collected sequence of data points to make a prediction. The user's execution of the proper sign will be evaluated using the prediction from the LSTM neural network. The last option is FSL Exercise. Here, users can put their newly acquired sign languages into practice and put them to the test. Users of the app can choose the category they want to practice in the exercise section. Consider a scenario in which the user selects the alphabet category; a randomly generated letter will then appear, and the user must do the FSL for it without the aid of the tutorial in the span of 60 seconds. If the user does not yet know or cannot recall the FSL for the created letter, they also have the option to generate another random letter. Interface The user interface of Sign for EveryJUAN was designed to be user-friendly. There are no unnecessary elements that could cause confusion, and different font sizes were utilized to the texts to increase legibility. Colors used also has to do with optimization of the application. The colors blue and green were used to represent trust and security, and its the easiest color for the eyes to process.

The primary objective of this study was to develop an accessible interactive Android-based application that teaches Filipino Sign Language using hand gesture recognition with the use of LSTM algorithm. This paper also evaluated the mobile application based on the functionality, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability for the IT professionals, and usability, security, functionality, compatibility, and portability for the end-users. End-user's evaluation result shows that the application's overall usability score is 4.60 which is classified as Highly Acceptable, security score is 4.53 which is classified as Highly Acceptable, functionality score is 4.64 which is classified as Highly Acceptable, compatibility score is 4.22 which is classified as Highly Acceptable, and portability score is 4.64 which is classified as Highly Acceptable. The result of the evaluation by the IT Experts produced a mean score of 4.33 for functionality which is interpreted as Highly Acceptable, mean score of 3.87 for performance efficiency which is interpreted as Very Acceptable, mean score of 4.10 for compatibility which is interpreted as Very Acceptable, mean score of 4.33 for usability which is interpreted as Highly Acceptable, mean score of 4.20 for reliability which is interpreted as Very Acceptable, mean score of 4.35 for security which is interpreted as Highly Acceptable, mean score of 4.20 for maintainability which is interpreted as Very Acceptable, and mean score of 4.07 for portability which is interpreted as Very Acceptable. The application's overall evaluation score by the end-users obtained a highly acceptable rate with an overall weighted mean of 4.53, and a very acceptable rate with an overall weighted mean of 4.18 by the IT experts. This result reveals that Sign for EveryJUAN accomplishes what was stated in the objectives. It implies that the program works well on Android smartphones, simple to adapt and use, and has effectively integrated the unique hand gesture recognition feature in teaching fundamental Filipino sign language.

4 Conclusion

In this paper, the researchers created an educational interactive Filipino Sign Language application using LSTM algorithm. The significant finding is that Sign for EveryJUAN: An Interactive Android Application that teaches Filipino Sign Language using Hand Gesture Recognition is a useful tool in helping the Filipinos to learn FSL. Sign for EveryJUAN's overall evaluation score by end-users was highly acceptable, with an overall weighted mean of 4.53, and a very acceptable rate by IT experts, with an overall weighted mean of 4.18. It means that the program works well on Android devices, is easy to adapt and use, and has successfully integrated the unique hand gesture recognition in teaching basic Filipino sign language. It concludes that the mobile application is functional, performance efficient, compatible, usable, reliable, secured, maintainable, and portable. Overall, respondents were pleased with the execution of the application. They voiced support for the study's contribution to the education of Filipinos, both deaf and hearing, in the country's national sign language which is Filipino Sign Language.

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