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# Text to English and Text to Filipino Sign Language Translator: An Android-based Mobile Application with Text Analysis Using Knuth-Morris-Pratt Naive Algorithm

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**Abstract**.The inability of an individual to hear sounds causes trouble in communicating among other individuals. Sign language helps the deaf community express what they want to say through different hand gestures, facial expressions and body movement. However, not everyone is knowledgeable of sign language. This study aims to develop an android based mobile application translator system which translates text into sign language. The system is called SiTa: Sign Talker. It accepts English and Filipino words or phrases then translates to American Sign Language (ASL) and Filipino Sign Language (FSL). The text analysis algorithm used by the proponents is the Knuth-Morris-Pratt Naïve Algorithm which searches the corresponding sign language animation stored in the application that matches to the entered words or phrase by the user. Besides that, the developed application was evaluated through survey for the performance in term of functionality, reliability, usability, efficiency, maintainability, and portability. The survey results obtained showed that most participants were satisfied with the overall performance of the development system application.

**Keywords:**Hearing Impairment; Filipino Sign Language; Language Translator; Sign Language Interpreter

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## INTRODUCTION

A sign language is a body language that is used to convey meaning and the person's thoughts in contrast with expressing through voice's sound patterns [1, 2]. It involves movement of the hands, arms or body, a series of hand shapes, facial expressions, and hand gestures to eloquently express the meaning [3].Sign language varies in different regions or country. No forms of sign language are universal [4]. Similar to any spoken language, it has its own unique rules of syntax and grammar. The American Sign Language (ASL) is the most widely used by Americans specifically deaf North Americans [4]. ASL differs notably to Filipino Sign Language (FSL). Filipino Sign Language has a unique gestures and way of expressing their thoughts through hand and body movements compared with any other sign language [5]. Another fact about sign languages is that sign language is translated through a concept or idea not words. Unlike translating English to Filipino spoken languages, there is no direct translation of its words and grammar [6]. Communication takes a large part of our life. Deaf refers to a person who has a hearing and speaking disability such people communicate using sign language.

Based on the study led by the World Health Organization in the year 2015, there are about 5% or equivalent to70 million of the world's population is deaf and mute. Hence, they use non- verbal form of communication [7]. Not everyone knows sign language especially the hearing community which creates a communication barrier between them [8]. Approximately 28 million Americans have some degree of hearing impairment according to National Center for Statistics and 2 million of them are considered as deaf [9]. Most deaf people in the United States use American Sign Language or ASL [4]. On the other hand, according to the Philippines National Statistics Office (PNSO), there are 3 out of 1000 Filipinos are Deaf.

Applying this to the current approximate population of 100,000,000 there are an estimated 300,000 Deaf people. As of year 2009 there are 54% Filipino sign language users in the Philippines [5]. According to Alfi, Basuon, and Atawy, who developed an intelligent translation system, one of the problems they encounter in the process of the development is that the number of words in the Arabic sign dictionary is fewer than the words in Arabic language dictionaries [10].Knuth - Morris – Pratt algorithm is a string matching algorithm conceptualized by Vaughan Pratt and Donald Knuth and independently by James H. Morris in 1977. It searches a given pattern of string in a text and avoids going back to the initial position of the text during iteration which lessens the total number of comparisons of the variables [11,12].

This study intends to develop an android mobile application translator that will translate English text to ASL or Filipino text to FSL.Through the use of technology, specifically an android mobile application, it will be more accessible and convenient for users whenever they need to communicate with deaf people. Most of the people nowadays use android mobile phone. There is also a shortage of human sign language interpreters in the Philippines because only few people are interested in learning sign languages. This will serves as an interpreter to converse with them proficiently. It will be a huge help to Filipino's deaf community. Also to those who speak English and wants to communicate with Filipino deaf. This study also implemented the Knuth-Morris-Pratt Naïve Algorithm. It is a string searching algorithm that searches for the occurrence of a certain word or text in a main text string or group [11]. This algorithm will be implemented in the structure of project development.

## METHODOLOGY

This study employed both qualitative and quantitative method. To be able to design the application, a series of focus group discussion were conducted with the teachers of deaf students as well as in-depth interview to ensure that exact details were captured during the design of the application. The focus group discussion allowed the teachers who are expert in teaching both ASL and FSL sign languages to share their ideas that will help in the development of the application.

The designed mobile application passed through a series of testing to ensure that the language translations are accurate and within the language context. To ensure that the software passed a certain standard, the study also employed ISO 9126 to evaluate the system in terms of functionality, efficiency, usability, reliability, and portability.

### Framework of the Study

Figure 1 illustrates the research framework applied in the study. This study using the data gathered to discern the needed requirements; this would be the source of information to develop the application according to user requirements. This study used Android studio as its platform as well as Maya to create 3D animations.

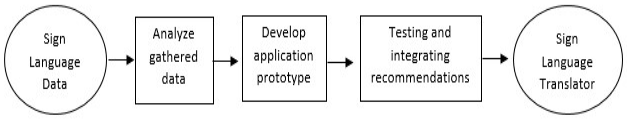


**Figure 1**.*Research Framework*

### Algorithm

The Knuth-Morris-Pratt Naïve Algorithm was used in developing the translator mobile application [11]. The algorithm performs a searching and matching method to translate a text to a corresponding sign language gesture. When the user inputs a phrase, the algorithm will analyze the text and searches for a word pattern that have a corresponding sign language animation name. It will searches from left to right of the inputted text and get all the word patterns which have a similar name that match in the stored sign language animation name. When a mismatch occurs, it will not go back from the beginning but continue to the next word from where the mismatch occurs until the end of the phrase is met. The pseudo code of the KMP algorithm is shown in Figure 2.

```
function brute_force(text[], pattern[])
{
  // let n be the size of the text and m the size of the
  // pattern

  for(i = 0; i < n; i++) {
    for(j = 0; j < m && i + j < n; j++)
      if(text[i + j] != pattern[j]) break;
      // mismatch found, break the inner loop
    if(j == m) // match found
  }
}
```

**Figure 2**. *Pseudo code of the KMP algorithm*

**System Architecture**

Figure 3 shows the process of the system developed in the study. The user must input a word or phrase by using either a speech recognition or text input. Then, the inputted word or phrase will be analyzed in the translation program and then will be validated in the SmarterASP.NET cloud storage and database. Upon validating, if a match is found in the list of animated words, it will generate and display the corresponding sign language output in the application.

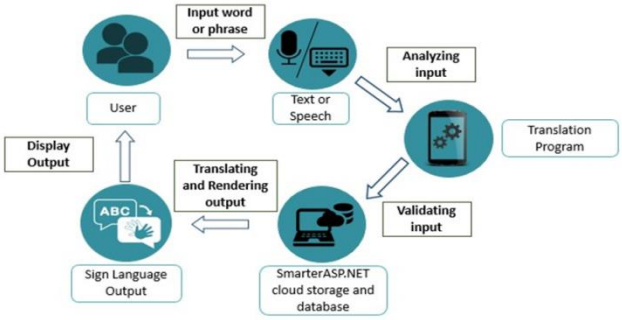


**Figure 3**.*System Architecture*

The designed system allows users to choose a language between English and Filipino then input text that will be then translated into sign language and can be viewed as animation. Viewing of history, help, adjusting of settings and dictionary are also included as features of this system.

**Hardware**

In this study, the developed application will be launched in android operated smartphones.

**Software**

The software used in the development of the mobile application consists of Android Studio, Photoshop, Maya and SmarterASP.NET.
The Android Studio is an android platform which provides integrated development environment and tools needed to develop the mobile application. Photoshop is the application that is used to design and create icons and logo for the application. Maya is a 3d computer graphics software used to animate sign language animations. SmarterASP.NET. in an online web hosting used to store the gif animations in the cloud storage and create a database to store the list of words connected to it.

## RESULT AND DISCUSSION

**System Features**

The developed system is a mobile application that will translate English text to American Sign Language (ASL) and Filipino text to Filipino Sign Language (FSL).
Figure 4 indicates the splash screen shows first when the user launch the application. It shows the logo and name of the application. It notifies the users that the application is in the process of loading and indicates the loading progress. Figure 5 demonstrates the navigation drawer slides from the left side of the application. It contains a navigation list of destination. These are the home, about and settings.

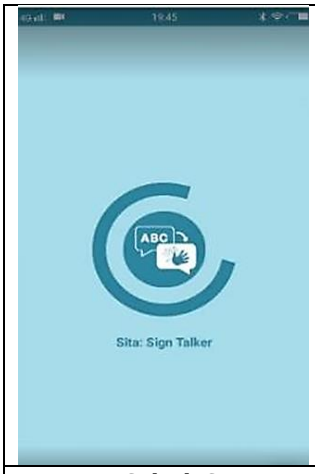


Figure 4. Splash Screen

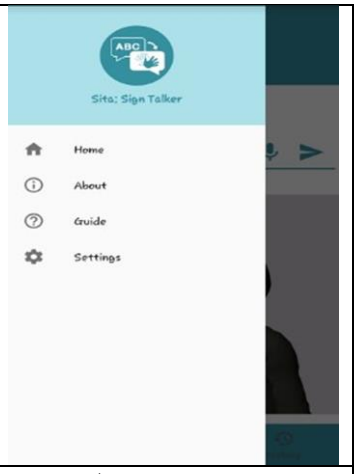


Figure 5. Navigation Drawer

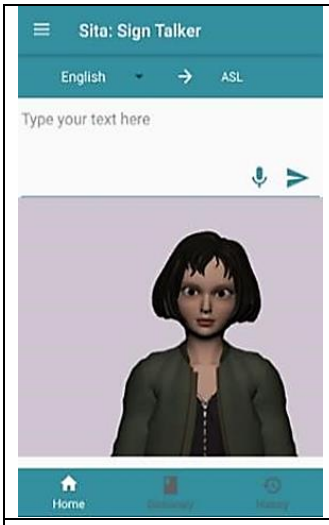


Figure 6.Translate Page (Text input)

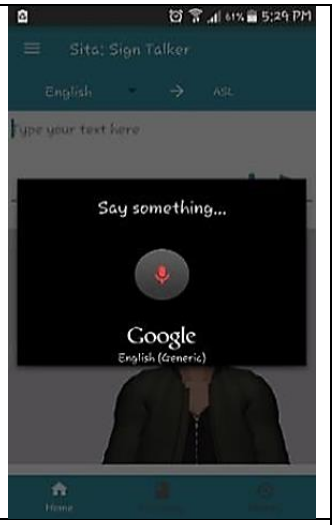


Figure 7. Translate Page (Voice input)

Figure 6 shows a text field where the user can input the word or phrases that want to be translated and the sign language. The user has an option on how to input the text. It can be through typing on the keyboard or speech recognition which shown in Figure 7. At the bottom of the page is the other feature. These are history and dictionary.


Figure 8. Dictionary


Figure 9. Speech feature

Figure 8 illustrates the dictionary includes all the words that can be translated and stored in the application. The words are grouped by ASL and FSL. When a word is clicked from the list it will be redirected to screen that view the corresponding sign language. The user has an option to choose if wanted to have a text speech while viewing the sign language and also a repeat animation function (Figure 9).


Figure 10. History Page


Figure 11. About Page

Figure 10 demonstrates the History page; a history list of translation the user made is shown. The history can be deleted by long pressing and selecting an item that want to be deleted and pressing yes in the dialog shown. Figure 11 displays about option in the application, the information about the application and the developers it is shown.

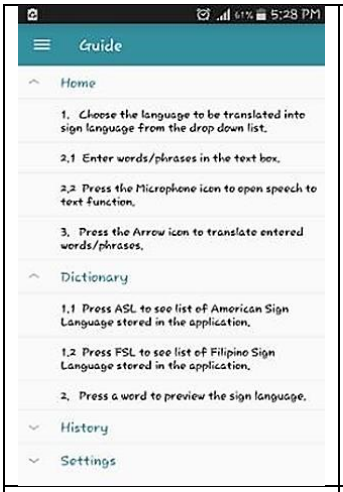


Figure 12. Guide

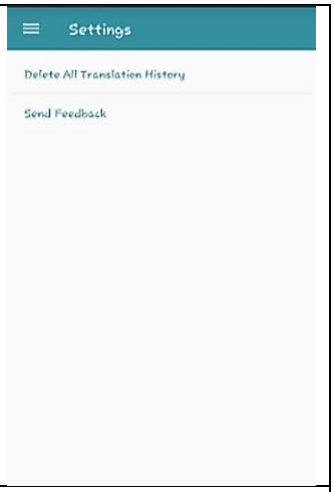


Figure 13. Settings

Figure 12 shows a step-by-step guide on how to use the application is shown in this feature. Figure 13 illustrates the settings option; the user can configure the actions in the application such as deleting all the history and sending feedback thru email.

## System application evaluation

The developed mobile application was evaluated based on the feedback of the survey which conducted in Lyceum of the Philippines University Manila. There are 44 students (IT and non-IT) had participated in the questionnaires survey. The obtained results are presented chronologically. Table 1 tabulates the overall evaluation of the mobile application from the survey.

**Table 1**. *Overall Evaluation of the Mobile Application*

| **Criteria** | □ | **Verbal Interpretation** |
|---|---|---|
| Functionality | 4.69 | Excellent |
| Reliability | 4.5 | Very Good |
| Usability | 4.77 | Excellent |
| Efficiency | 4.66 | Excellent |
| Maintainability | 4.57 | Very Good |
| Portability | 4.69 | Excellent |
| **TOTAL** | **4.65** | **Excellent** |

Table 1 shows the summary of the respondents' evaluation of the Text to English and Text to Filipino Sign Language Translator mobile application system. The functionality, usability, efficiency and portability have an overall rating of 4.69, 4.77, 4.66 and 4.69 respectively with "Excellent" verbal interpretation. While two of the criteria which are the reliability and maintainability remarked as "Very Good" with weighted mean of 4.50 and 4.57, respectively. Generally, the overall computed weighted mean of 4.65 were interpreted by the respondents as "Excellent".

## CONCLUSION

This study has successfully developed an Android application translator: English text to American Sign Language (ASL) and Filipino text to Filipino Sign Language using Knuth-Morris-Pratt Naïve Algorithm. After numerous testing and revisions, there are some problems encountered in storing animations. Yet, the overall performance of the application is compatible, and the system application developer and the several volunteers who tested the application still believed that it is good enough to be implemented for a limited use.

After conducting survey evaluation of the performance of the application, the result shows that the overall evaluation was interpreted by the respondents as "Excellent". The required functions are implemented, and accuracy and interoperability is also provided. The application is considered as reliable as it is rated "Very Good". Its usability is excellent because it provides a user interface that allows easy operation management and easy to remember. The application has also an excellent efficiency; it translates text to sign language and shows results fast and efficient. Its maintainability is good, it has less bugs and very easy to fix and modify. As for its portability, it is excellent and provides easy installation.

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