Development of English-to-Sign-Language Translation System on Android

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ABSTRACT
Sign-language uses gestures as signals in communication. Various kinds of sign languages can be used, one of which is American Sign Language (ASL). Sign language is one of the communication media that can be used while having a conversation with deaf people. Every single person who wants to communicate with deaf people often experiences difficulties because of limited knowledge about sign language. Learning media for ordinary people to learn sign language is also limited, which only consists of conventional learning media such as books with very limited numbers. An application that can make the process of translating into a sign language movement can be a solution as a learning medium for the people to help communicate with deaf people on a wider scale.

Keywords: Android Application, Sign Language, Deaf People, Translator, English, American Sign Language.

1. INTRODUCTION
Humans are social beings where their activities cannot be separated from communication between one another. Communication is a process of exchanging information between individuals through a system of symbols, signs or gestures. Communication in an organization, group or association has a very important role to avoid misinterpretation of information between members so that the goal can be achieved. Communication can be done by using words (verbal) or not (non-verbal). Non-verbal communication uses gestures, physical appearance, sound, and touch as signals in communication. Various languages can be used, one of which is sign language. Sign language is one of the communication media carried out by friends, parents, and people around with deaf people [1].

According to data from Survei Penduduk Antar Sensus (SUPAS) Biro Pusat Statistik in 2015 the population of deaf people in Indonesia was 2.7% of the population of 255,182,144 people or as many as 6,952,797 people [2]. Deaf and deaf people often experience difficulties in the level of Education. The small number of teaching staff who can use sign language has caused difficulties in getting an education. Learning media for ordinary people to learn sign language is also limited which only consists of conventional learning media such as books. Teachers certainly use sign language in learning activities at the school, such as translating books or documents to students with hearing impairments. Translating books or documents which generally have several words which are many obstacles for teaching staff.

People in their daily lives use spoken languages in communicating with others. Spoken communication is done because it is considered easier to convey things to others. Spoken communication cannot be carried out by deaf people. This causes people to experience difficulties in communicating with deaf people. Along with technological developments, especially mobile devices that are increasingly rapidly opening opportunities in all fields. Mobile devices that were originally used only for communication media, developed and made it possible to use a variety of applications. This opens up the opportunity to create a media that can help the community to communicate with deaf people in sign language.

Standard sign language used in Indonesian is different from the standard used in English. The Indonesian language applies BSINDO standards which are standards set by the government in terms of movements in sign language. BSINDO standards have been used in the level of primary education or Special Schools (SLB) for deaf people. The difference in the standard of sign language used in Indonesian (BSINDO) with English (ASL) makes communication that can be done by deaf people or people who want to communicate with people with speech impairments will be limited to the national scope only.

Based on all these problems, to facilitate the learning of sign language it is necessary to create an application that allows to do translation of text or sentences in English into gestures in sign language using the standard
American Sign Language as a learning medium to help people with hearing impairments or people who want to communicate with deaf people to help communicate on a broader scale. The American sign language (ASL) is a sign language that uses hand movements and other limbs such as the facial mimic and body gestures to convey information. ASL is the first sign language used in the state of North America and is the most widely used sign language especially in English-speaking countries. Even though ASL is used in countries with the majority using English, grammar in ASL is not the same as English. ASL has its own rules such as the placement of words and their meanings [3].

<table>
<thead>
<tr>
<th>English</th>
<th>English in ASL</th>
</tr>
</thead>
<tbody>
<tr>
<td>He walked yesterday</td>
<td>Yesterday he walk</td>
</tr>
<tr>
<td>How are you?</td>
<td>How you?</td>
</tr>
<tr>
<td>I'm hungry. Why? I didn't eat lunch</td>
<td>I hungry. Why? Eat lunch not</td>
</tr>
<tr>
<td>I can't go</td>
<td>Me go can’t</td>
</tr>
</tbody>
</table>

ASL Sign Language simplifies grammar in English as if only words were left without being accompanied by to be or conjunctions. The passive sentence in ASL is also slightly different when compared with English sentences with good grammar as in Table 1 above. The sentence 'I can't go' is simplified to become “Me go can’t”. People's pronouns 'I' are changed to ‘Me’, while the words ‘can’t go’ are exchanged to 'go can’t'. Simplifying grammar on ASL will make it easier for users to practice gestures. The table above shows one example of a movement that represents the sentence 'How are you?' Which is simplified to 'How you?'. Especially for abbreviations or words that do not have a sign language equivalent, can be translated by spelling each letter of the word. The following is a hand gesture that represents letters in sign language.

2. RELATED WORKS

The language most often used in communicating in Indonesia is Indonesian and English. Communication can also be classified as verbal (verbal) and non-verbal communication. One type of non-verbal communication is sign language that is usually used by deaf people. The Indonesian language applies BSINDO standards which are standards set by the government in terms of movements in sign language. BSINDO standards have been used in the level of primary education or Special Schools (SLB) for deaf people. The difference in the standard of sign language used in Indonesian (BSINDO) with English (ASL) makes communication that can be done by deaf people or people who want to communicate with people with speech impairments will be limited to the national scope only.

The design of an android application about sign language has been done with a variety of purposes and case studies used. The design is in the form of an android application as a medium of introduction and learning with various standard sign languages used.

Yuniati et al. proposed a learning media that introduce letters and numbers for deaf people. The application designed the movement of each letter and number by displaying the image of the sign language and can display gesture language videos on the vocabulary of names of objects, animals and commonly used verbs [4].

Sutanto et al. proposed a web-based American Sign Language learning media for deaf people that displaying a picture of sign language of words, letters, and numbers [5].

Fauzia et al. proposed a web-based sign language dictionaries using Indonesian standard of sign language that displaying sign language as a picture or video. The proposed web-based dictionaries contain images of sign language for each character and number that shown using a web service to store data [6].

Nofarina L et al. proposed a learning media application for desktop which utilizes computer-delivered tutorials that contain a letter, number and gesture in sign language about common objects. The application also contains games to exercise user to memorize the sign languages [7].

Nuriyanti et al. proposed an application for sign language recognition using Android-based devices. The application introduction sign languages of letters, number, animals, days, colors and other common daily-used words [8].

Based on all the research that has been done related to the use of sign language, there is still no research on how to translate text into sign language, especially on mobile devices. All of these studies are limited to translation and/or the introduction of sign language for each letter and number as well as some commonly used terms. Therefore, by designing an application for translating text-based files into sign language it can make it easier to process sign language in the future.

3. METHODOLOGIES

English to Sign Language Translation System on Android requires data and information as well as designing algorithms that are done in stages. The analysis begins with data collection consisting of collecting primary data, secondary data and interviews to get all the data needed in the design of the application. The collected data is then analyzed and the translation process algorithm is designed. Algorithms that have been designed are then applied to the application at the application design stage. Testing is done after the design stage is complete so that the
conclusions and suggestions used in writing the results of the study are completed.

The algorithms used in the stemming process is the Porter Stemmer Algorithm. Porter Stemmer itself is a common morphological and inflectional suffix algorithm of English. This algorithm consists of a set of conditions or action rules. The set of conditions used in this algorithm can be seen in the following flowchart [9, 10].

Porter's stemming algorithm has five main steps, each of which has its own rules. Before the stemming process begins, it is necessary to calculate the value of the variable m which is the number of repetitions of vowels and consonants in a word. The variable m will then be used as a condition for replacing suffixes in the process of stemming steps 2 through 5.

4. PROPOSED SYSTEM

The design of the application utilizes the Android platform and uses the API to handle the translation process. The application designed receives input in the form of English-language text with output in the form of sign language motion videos.

English words or sentences entered into the application are sent to the API on the server for translation. The translation process involves a database that stores the classes of words in English that are used in word mapping. The translation process uses the Apache-based API with the PHP programming language. The API can be divided into two main processes, namely the stemming process and the translation process. The stemming process serves to simplify each word in the sentence into a basic word. Sentences that have gone through the stemming process, will then go through a translation process with an algorithm that has been designed. The final response from the API will be in the form of English text that has been adjusted to the rules of translation on sign language. Text from the translation is received by the Android device and a sign language motion video playback is performed in the application asset storage section.

Every single word in the input sentence will be carried out by checking the word classes based on existing databases and stored in the temporary variable for each word class. When all words in a sentence have been checked, each word in the temporary variable for each word classes will be combined with the merging rules in sequence noun + verb + adjective + adverb. The new sentence from the merger will be used as the result of the translation process. For example, the phrase 'the train is late' can be identified that the sentence consists of a noun 'train' and an adjective 'late'. Based on the flowchart above, the translation results will be arranged as a noun + verb + adjective + adverb, so the translation results for that sentence will be 'train late' which consists of noun + adjective.

Another example, as in the phrase "the elevator is stuck" consists of a noun "elevator" with a determinant "the" and an adjective "stuck". So, the results of the translation process will produce the phrase "elevator stuck" by removing the words "the" and "is".

The process carried out in question sentences in English (what, where, which, how, who, whom, when and why). Each question sentence will be carried out in the sentence retrieval process. Question words that have been obtained, then placed at the very end of the sentence. The results of this process are in the form of sentences ending with question words and without question marks. For example, in the question sentence 'what is the temperature?' It can be separated into noun 'temperature' and the question word 'what'. Based on the translation sentence of the question sentence, the question word will be placed at the end of the sentence. So, the results of the translation in that sentence are 'temperature what' which consists of noun + question words.

The sentence with other conditions such as in the phrase "are you married?" Translated without going through this process. This is because it does not meet the specified sentence conditions, so this process will be skipped.
The process carried out in negative sentences in English (none, never, sans, no, nobody, not, without, nowhere, nothing, neither, minus, nor, don't, not, isn't, doesn't, can't, don't, won't, can't, aren't, haven't and didn't). The process begins by recognizing whether the sentence used is a negative sentence or not. If the sentence is a negative sentence, then a negative word will be taken from the sentence and placed at the end of the sentence. The result of this process is a new sentence with a negative word at the end of the sentence.

For example, the phrase “the flower is not growing” can be identified that the sentence consists of a noun “flower”, verb “growing” and negation “not”. Based on the flowchart above, the translation results for that sentence will be 'flower grow not' which consists of noun + verb + negation.

The process carried out in sentences with pronouns (i, me, my, you, your, he, him, his, she, her, it, its, we, us, our, they, them, and them). The process begins by determining whether the sentence used as a pronoun in that sentence. If the sentence has a pronoun, the process is continued by taking the pronoun in the sentence and putting it at the end of the sentence. The result of this process is a new sentence with the pronoun person at the end of the sentence.

For example, the phrase “I like to study” can be identified that the sentence consists of a verb “study”, an adjective “like” and pronoun “I”. Based on the flowchart above, the translation results for that sentence will be “study like I” which consists of noun + adjective + pronoun.

The process carried out in sentences that have special conjunctions (and, when, while, on, in, at, as and of). The process is divided into 2 (two) main parts, namely for sentences that have 'and' conjunctions and sentences that have the remaining special conjunctions. The process in sentences with conjunctions begins by cutting the sentence into two new sentences with separators based on the conjunctions found. Sentences separated by ‘and’ words are sorted from the first sentence and the second sentence and separated by commas, while the sentence fragments separated by other conjunctions are sorted from the second sentence and the first sentence.

5. EVALUATION

Testing the translation process is done by inputting 402 sentences from the book to determine whether the translation results produced are under the translation results in the book. The results of the tests that have been carried out can be seen in the following chart.
The diagram above shows a summary of test data that has been done with data totaling 402 sentences. Based on the diagram above, there were 26 sentences with correct or "Correct" translation results, 365 sentences with almost correct or "Almost Correct" translation results and 11 sentences with incorrect results or "Incorrect".

The number of tests that are almost correct or almost Correct is caused by several factors, including the changing patterns of translation, the addition of words to the results of the translation and the change in the words of the translation results.

<table>
<thead>
<tr>
<th>No</th>
<th>English</th>
<th>Correct Translation</th>
<th>Translation Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>do you have your ticket</td>
<td>ticket have</td>
<td>ticket have you</td>
</tr>
<tr>
<td>2</td>
<td>can you drive</td>
<td>drive can you</td>
<td>drive can you</td>
</tr>
</tbody>
</table>

The table above displays data samples in the test as examples of changing patterns. In the phrase 'do you have your ticket', the correct translation sentence is 'ticket have' by removing the pronoun and the question word at the beginning of the sentence. But in the sentence "can you drive", the pronoun is displayed again on the translation results. This also occurs in several other examples of test results data.

<table>
<thead>
<tr>
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<th>English</th>
<th>Correct Translation</th>
<th>Translation Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>the flower is growing</td>
<td>flower grow</td>
<td>flower grow</td>
</tr>
<tr>
<td>2</td>
<td>you sign fast</td>
<td>sign rapid you</td>
<td>sign fast you</td>
</tr>
<tr>
<td>3</td>
<td>where is the waiter</td>
<td>server agent</td>
<td>waiter where</td>
</tr>
</tbody>
</table>

Word changes also occur in some data used. As in the table above, in the phrase "you sign fast" there is a change in the word noun "sign" to "rapid" in translation. The translation system that has been designed cannot handle changes to the word because there is no clear reference to any type of word and in what conditions a word must be changed. Another example is the phrase "where is the waiter" has changed the word from noun ‘waiter’ to ‘agent server’. If interpreted, words that experience change still has the same meaning.

<table>
<thead>
<tr>
<th>No</th>
<th>English</th>
<th>Correct Translation</th>
<th>Translation Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I am a doctor</td>
<td>I doctor</td>
<td>doctor i</td>
</tr>
<tr>
<td>2</td>
<td>I am broke</td>
<td>broke i</td>
<td>broke i</td>
</tr>
<tr>
<td>3</td>
<td>she is a missionary</td>
<td>missionary she</td>
<td>missionary she</td>
</tr>
</tbody>
</table>

Other conditions that cause uncertainty in the pattern of translation are the placement of pronouns. The sentence "I am a doctor" has the translation of "I doctor" by placing the pronoun at the beginning of the sentence, while in the phrase "I am broke" and the sentence "she is a missionary" pronoun is placed at the end of the sentence.

6. CONCLUSIONS

Development of English-to-Sign-Language Translation System on Android uses translation algorithms for sentences with noun, verb, adjective and adverb, question sentences, negative sentences, sentences with person pronouns and sentences with special words and using a stemming porter algorithm. Tests were carried out on 402 sentences which produced as many as 26 (about 6%) sentences which were tested as having 'Correct' translation, 365 sentences (about 91%) having translation results 'Almost Correct', and 11 sentences (about 3%) having translation results 'Incorrect'. The number of results of the translation with the Almost Correct result was caused by several factors including the changing pattern of translation, the addition of words to the results of the translation and changes in the words of the translation results. To increase the number of translations that are 'Correct', it is necessary to add a literature study to be able to design a better translation algorithm in the future.

REFERENCES


