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Translating an Aesop's Fable to Filipino Sign Language through 3D Animation

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Abstract

According to the National Statistics Office (2003) in the 2000 Population Census, the deaf community in the Philippines numbered to about 121,000 deaf and hard of hearing Filipinos. Deaf and hard of hearing Filipinos in these communities use the Filipino Sign Language (FSL) as the main method of manual communication. Deaf and hard of hearing children experience difficulty in developing reading and writing skills through traditional methods of teaching used primarily for hearing children. This study aims to translate an Aesop's fable to Filipino Sign Language with the use of 3D animation resulting to a video output. The video created contains a 3D animated avatar performing the sign translations to FSL (mainly focusing on hand gestures which includes hand shape, palm orientation, location, and movement) on screen beside their English text equivalent and related images. The final output was then evaluated by FSL deaf signers. Evaluation results showed that the final output can potentially be used as a learning material. In order to make it more effective as a learning material, it is very important to consider the animation's appearance, speed, naturalness, and accuracy. In this paper, the common action units were also listed for easier construction of animations of the signs.

Keywords: Filipino Sign Language, text to sign language, 3D animation

1. Introduction

In the 2000 Population Consensus, the National Statistics Office (2003) indicated in their report that there are 121,000 deaf and hard of hearing Filipinos. With the use of sign language, it became a possibility for them to communicate and, in a way, express themselves to other people. According to Mendoza (2018), these deaf and hearing Filipinos use various languages to communicate such as American Sign Language (ASL), Signing Exact English (SEE), and Filipino Sign Language (FSL). Among these methods, FSL is the most widely used at a percentage of 70% of Filipino signers using it as their main sign language (Imperial, 2015).

A wide range of deaf and hard of hearing individuals have difficulties in reading. This is because written text follows different grammatical structures from that of FSL, causing confusion especially to deaf and hard of hearing children who are only starting to read (Flores, 2012). As stated by Imperial (2015), signers first learn FSL for communication, a visual-spatial language different from an auditory-vocal language like Filipino (and its written transcripts).

Deaf and hard of hearing children experience difficulty in developing reading and writing skills through traditional methods of teaching used primarily for hearing children (Mich et al., 2013). A reason for this is because they cannot hear and distinguish the phonemic sound system or what the spoken language sounds like (Magee, 2014). Another reason is the method of teaching that is given to them, in which the learning method teaches them how to understand single words and single sentences instead of learning the full text. Thus, specialized methods catered specifically to their needs must be utilized to aid in the development of reading skills (Mich et al., 2013).

In order to help with the development of vocabulary and reading skills in young signers, supervision from an adult signer can provide a significant improvement. According to Huff (2012), older signers who can provide translations from the text into FSL could aid in the child's understanding of the text and in the long run, would help in the development of reading skills.

An example of text that children enjoys are stories. These are one of the most prevalent sources of knowledge. They help children learn and make sense of the world (Lonneker and Meister, 2005). Fables are stories that teach important life lessons using animals as characters (Ang et.al, 2010). By using animals instead of human characters, readers would less likely be biased when reading the story. It allows readers to go through the story without thinking of comparing themselves with the character. A famous set of fables are Aesop's fables, which is used for this study.

To teach the meaning of the story text, it must be translated to sign language first. An example of application that has already been developed for such purpose is MMSSign produced by Jemni, Ghoul, Yahia, and Boulares (2007) to aid in the use of cellular phones by those of the Deaf Community. It turns messages into a 3D animated video with the corresponding sign language, removing the need to read the contents of the message. This serves as a better system of communication for the signers.

In the Philippines, however, there is very minimal research that focuses on such technology that translates English text to FSL. According to Martinez and Cabalfin (2008), there are only few researchers that conduct studies for the Filipino deaf community.

The use of 3D animation in the delivering of translated passages (whether from spoken or written sources) is very widespread. Along with the use of videos depicting real people performing signs, it is the most commonly used in translation systems. Thus, 3D animation was utilized for the translation in this study.

This study aims to translate an Aesop's fable to FSL with the use of a 3D animation software resulting to an animated video output. Among the 5 components of FSL, which includes the hand shape, location, palm orientation, movement, and non-manual signals, the animation mainly focused on the hand gestures (includes hand shape, location, palm orientation, and movement).

The contributions of this paper are:

- a 3D animated version of a translated Aesop's fable to FSL which can serve as a learning material,
- a proposed layout for an FSL learning material that allows new signers to learn FSL signs by

associating the images with the FSL signs and to slowly learn the English text equivalent at the same time, and

- a list of the common hand gestures in FSL which can help in constructing 3D animated FSL signs.

2. Review of Related Literature

Multiple application and software have been developed in order to ease the communication between signers and non-signers. Addressing the gap in communication between the two communities are made easier through the use of technology. Through these technological methods, the need for an interpreter decreases as the translating power of devices increases. These applications can vary from translating text to Sign Language, or speech to Sign Language, or Sign Language to text. In the process of translating oral or written text into sign language, the transcript must first be transformed into the grammatical structure used in sign language before finding gestures to form the same message in sign language. These gestures are obtained from a database and most commonly presented in one of two ways: (1) a pre-recorded video of a person performing that sign stitched together to form a video, or; (2) a 3D animated model. For the reverse (Sign Language to Text), the use of motion capture devices is necessary to read the gesture performed before being translated into text.

2.1 Translation system by Halawani

In the study by Halawani (2008), the process of translation systems would be primarily divided into two parts, the conversion and the translation. Conversion refers to the process in which the written syntax of a language is dissected and arranged into the syntax of the signs, and translation changes the words into animated rendering of the sign language equivalent which is shown to the user on the screen of their device. The conversion process is a common challenge in producing translation systems, as most sign languages are not yet thoroughly studied in the area of its syntax and grammatical structure.

2.2 LODE-2

In the study of Mich, Pianta, and Mana (2013), they have developed a tool called LODE-2 which is an improved version of LODE-1. It is a system with interactive stories and exercises for deaf children. The system has dynamic feedback for improving the reading comprehension skills of deaf children. After reading a whole story, the children are instructed to solve some three exercises for assessment : a global comprehension of the story, a comprehension of local-temporal relations, and a comprehension based on pure text. They have concluded that simplified stories with illustrations is the most effective way in teaching and aiding deaf children's reading comprehension.

2.3 ATLASLang MTS 1

Brour and Benabbou (2018) created a machine translation system Arabic Sign Language (ArSL) which allows the input of Arabic text by a non-deaf user to be converted into ArSL and displayed using GIF Images. They developed ATLASLang MTS 1, an example-based and rule-based Interlingua approach system. The example-based is used when the given sentence exists in the database, otherwise, it uses rule-based Interlingua. For the animation, they translated sentences using a database of 200 words that are taken from the Moroccan Dictionary. However, if the given word is a proper noun or does not exist in the database, it will spell it out letter by letter (finger spelling). The researchers did an experiment using the ATLASLang MTS 1. In the experiment they conducted, not all sentences given were accurately translated. There were also cases that no results were given. Specific results were not shown. After their experimentation, the researchers concluded that to improve the current version of the system, they must expand their database and implement more rules. They also recommend to use 3D Human Avatar instead of GIF Images.

2.4 VGuido (eSIGN 3D Avatar)

Another translation system was that of San-Segundo et al. (2011) which translates spoken Spanish into Spanish Sign Language. According to San-Segundo et al. (2011), at least 92% of the Spanish deaf community have a hard time comprehending and conveying themselves in Spanish. Verb conjugations, abstract concept explanations, and gender concordance are just some of the problems that the Spanish deaf community is having. Another problem is that the accepted Spanish Sign Language is not spread well enough to other people resulting to a communication barrier between the Spanish signers and non-signers.

The objective of the study is to introduce the first system of translating Spanish speech into the Spanish sign language in assisting a deaf person in a kind of service like the renewing process of a driver's license. The system is composed of different parts for the system to work. The speech recognizer that converts the speech into a sequence of words, the natural language translator that translates the sequence of words into Spanish sign language, and the 3D avatar animation module that shows the sign language on the screen (San-Segundo et al., 2011).

In the system made by San-Segundo et al. (2011), three technological proposals for the natural language translator were utilized: (1) example-based strategy; (2) statistical translation, and; (3) rule-based translation. From a 0-5 scale, the user is asked if the signs are correct, if they understand the sequence of signs, if the signing is natural, and if they would use the system instead of a human. In the test, the system executed the task very well in speech recognition, only having a 4.8%-word error rate, and in language translation, only having an 8.9% sign error rate. Although the system executed the task very well, the people who used the system did not rate it with a very good score in the questionnaires with reasons being the avatar signs unnaturally and there were discrepancies. The researchers concluded that improvement is needed in the system, especially in the area of the 3D animation.

3. Methodology

Based on the related literature for sign language translation from text to sign, 3D animation is the most commonly used method of visualizing the translated passages. First, the 3D animation tool was selected. Second, the reference video for the signs was annotated. Third, the avatar was animated in accordance to the reference video. Fourth, the video elements (i.e. video of avatar signing, text equivalent, and other supplements) was compiled to one video.

3.1 Selection of 3D Animation Tool

A selection of 3D animation software was chosen and was tested and evaluated based on criteria needed for the research output. The criteria were based on the presence of features that were needed in making the animation which are detailed in Table 1.

SmartBody (Shapiro, 2015) lacked the drag and drop capabilities that could help ease the animation process. The complicated interface and the lack of avatar customization also made SmartBody unlikely to be chosen as the animation software for the project.

Alice (Alice, 2017) has a built-in character customization screen that can change specific parts of the avatar. The avatar included with the software is also pre-rigged, although, for example, the pinky finger in both hands does not have their own rigs and only moves based on the movement of rigs that are near or adjacent. This creates inaccuracies in the performed signs.

Blender (Blender Foundation, n.d.) does not provide a built-in character model but has an online community wherein royalty-free, rigged models are available for download. The animation capabilities of the software were also vast as it can animate up until the fingertips which is very important for FSL.

Through the testing process, Blender was chosen as the 3D animation software that will be utilized.

Tool	Ease Of Use	Simple Interface	Avatar Customization	Detailed Animation
Smart Body	No	No	Yes	Yes
Alice	Yes	Yes	Yes	No
Blender	**Yes**	**No**	**Yes**	**Yes**

Table 1: Features in the tested 3D animation software

3.2 Annotation of the Reference Video

The reference video used for this research is a publicly available video containing the FSL translation of the chosen story, "The Tortoise and the Hare" (Landayan, 2017). The video was annotated using EUDICO Linguistic Annotator (E-LAN) (Tacchetti, 2018).

There were three types of annotations made which are the common hand action units, glosses (i.e. words or phrases), and English sentences.

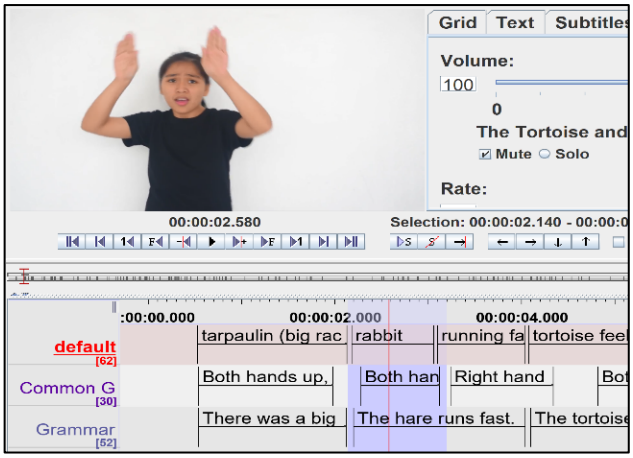

Figure 1: ELAN Annotation Interface.

3.2.1 Common Action Units

The hand action units were described in the annotation. Then, the reference video was analyzed to enumerate the common hand action units, and the unique hand action units. See Figure 1. For the word 'Rabbit', the person in the video raised both of her hands till her mid-body and her palm was facing outwards. Thus, what was entered in the tab was, "Both hands raised to mid-body, palms face outward". The list of the common hand gestures derived from the story is shown in Table 2. These may be used in animating a different story.

Hand Shape	Location	Palm Orientation	Movement
Both hands, open-A shape	Chest	Downward	Pointing to self
Both hands, X shape	Eyes	Inward	Circular motion
Both hands, 5 shape	Eyes	Inward	Fingers fluttering
Both hands, open-B shape	Chest	Center Line	Clapping
Both hands, S shape	Chest	Downward	Making an arc shaped motion forward
Both hands, open-B shape	Temples	Outward	
Right hand, 1 shape	Chest	Inward	Pointing to self/other
Both hands, L shape	Chest	Right hand, inward and Left hand, outward	Shifts to open-G shape
Right hand, open-A shape	Chest	Outward	Thumbs down
Right hand, B shape	Stomach	Inward/ Outward	Handshake
Right hand, open-B shape	Mouth	Inward	
Both hands, bent-5-claw shape	Chest	Upward	
Both hands, R shape	Forehead	Outward	Slight shake
Both hands, 5 shape	Arm sides	Center Line	Circular motion backwards
Both hands, open-B shape	Chest	Downward	Crawling
Both hands, S shape	Chest	Center Line	Circular Motion
Both hands, 1 shape	Chest	Center Line	
Left hand's thumb and index finger pinch together	Cheeks	Outward	Straight line motion outwards
Right hand, open-A shape and Left hand open-B shape resting at back of right hand	Chest	Right hand, center line and Left hand, downward	Slight shake for right thumb

Both hands, 5 shape	Right hand, nose and Left hand, chest	Right hand, center line and Left hand, downward	Slight shake for right hand
Both hands, 5 shape	Back of head	Outward	
Left hand, 1 shape	Chest	Outward	
Left hand, 5 shape	Face	Inward	Shifts to flat-O shape
Both hands, S shape	Chest	Downward	
Both hands, bent-5-claw shape	Neck	Inward	Fingers fluttering
Right hand, 4 shape	Face	Inward	
Both hands, C shape	Above head/ Chest	Center line	
Both hands, 5 shape	Chest	Inward	Brushing against body

Table 2: List of Common Gestures (left and right hand based on the person in the video)

3.2.2 Glosses

The gloss labels (i.e. words or phrases) were annotated by an FSL deaf signer for matching the performed signs to its corresponding English text as they are more knowledgeable. The FSL deaf signer is 22 years old with almost 5 years of experience in signing FSL.

However, the researchers searched for another annotator because the previous annotations made were mostly phrases or sentences which are made up of many different signs. This makes it difficult for the researchers to annotate its exact word or phrases. The other annotator is 25 years old and comes from a family of FSL deaf signers.

The annotation was done by first, selecting a (group of) sign performed in the video and entering the corresponding English text in the tab. For instance, since the sign performed in the selection corresponds to the word 'rabbit', the word 'rabbit' was entered in the tab (as shown in Figure 1). This step is important because not all English words have corresponding signs in FSL, as FSL has its own grammatical structure that focuses only on the main points of a sentence.

3.2.3 English sentences

After annotating the video to match the corresponding signs to its English equivalent, the reconstruction of words, phrases, and sentences was done as well to follow the English grammar. This was done by the researchers. For instance, in Figure 1, the words in the tab are "rabbit" and "running fast". Thus, following the English grammar, it was reconstructed to "The hare runs fast". This is an important step because FSL and English have a very different grammatical structure.

3.3 Animation of the Video

Using the annotated video as reference, the avatar was animated using Blender. The avatar used was a default model that Blender offers. The animation focused on the hand gestures only.

The animation is separated by, searching for common hand action units first. The researchers analyzed the video and categorized the common action units into hand shape, location, palm orientation, and movement. See Table 1 for the list of common hand gestures. Animations were done for the common hand action units. These were saved into separate files so researchers can use these to animate by connecting each one to another creating words or phrases. This allowed researchers to simply use those animations, and stitch them together to form a gloss. There were signs that were unique which made them must be animated independently.

After connecting the common hand action units, and the unique hand action units to form the glosses, the resulting animations of glosses are used to construct the English sentences.

3.4 Compilation of the Video Elements

Using a video editing software, the different elements of the final output was compiled together into one video. Elements include the animation of the performed signs, the text equivalent in English, and related images.

The text will be synced with the signs using the annotated video as reference. In the text portion of the video, the sentence equivalent will be shown. While the avatar is signing a word, its corresponding exact text translation will be highlighted to allow the viewer to learn the meaning of the sign. Related images are shown as well since it can retain more information thus improve learning (Gutierrez, 2014). Images of the word being translated were drawn by the researchers.

Figure 2: Final Output.

3.5 Evaluation of the output

The evaluation of the final output was done by 5 FSL deaf signers who are 22 years old to 24. They have 5-18 years of experience in signing.

The evaluation sheet was created based on the criteria presented in previous related studies (San-Segundo et al, 2011). The evaluation sheet made was rephrased to simpler English because the evaluators' mode of communication is different from written English. Thus, using simpler English

will be more understandable. The final output was evaluated using a Likert scale in two major categories: animation and performance, wherein each contains subcategories such as the naturalness of the animation, the understandability of the sign, and the usability of the output as a learning material. The evaluation sheet also contains a portion for the evaluator's comments and suggestions.

Rate from 1-6 with 1 (lowest) and 6 (highest).	1	2	3	4	5	6
Animation						
1.The animation is accurate.						
2.The animation is natural looking.						
3.I understand the performed signs.						
4.The avatar is eye-catching and child friendly.						
Performance						
1.Layout of video is organized.						
2.I would use this as a learning reference material.						
Overall Rating						
Comments						

Table 3: Final Output Evaluation Sheet

4. Results and Discussion

The evaluation was done by 5 FSL deaf signers with 5-18 years of experience in signing. The results are as follows.

The first statement, "The animation is accurate.", received an average score of 3.4 out of 6. This may be due to animation errors. There are some signs that the avatar performed incorrectly such as the "Boastful" sign. The sign of "Boastful" is palm rolled with your thumb pointing at yourself. However, the avatar's thumb wasn't in a pointing position. It was mentioned by the evaluators that different FSL schools teaches sign language differently. Another instance was the sign of "Hare". It was mentioned by the evaluator that, in hand sign of "Hare", the fingers were supposed to be bending halfway instead of fully folded. One of the evaluators stated that the signing in the reference video is different from what they are currently signing. It appears that different schools teach sign language differently.

The second statement, "The animation is natural looking.", received a 3.4 out of 6 as well. The low score may be caused by the avatar having no facial expressions. Facial expressions are essential for sign language to express their emotions. If facial expressions and body movements were added, it can possibly increase the score. By adding these, it can make the avatar possess human-like characteristics. An evaluator mentioned that children can't understand if there are no facial expressions involve in the character who is signing.

The third statement, "I understand the performed signs.", received the lowest rating 3 out of 6. This can be due to unclear animations. There were parts of the animation moving too quick or was distorted. One example was from the sign of "Ready". The arm of the avatar during this sign was raised weirdly. Most of the evaluators also commented that the hand movements were unclear and confusing.

The fourth statement, "The avatar is eye-catching and child friendly,", received a relatively low score of 3.2 out of 6. Although the avatar looks pleasant, majority of the evaluators suggested to use characters that looks younger (preferably child) and Filipino to make the children relate to the avatar more. According to one of the FSL deaf signer, since this was meant to be a learning material, it might be better if the signing speed of the avatar is slowed down by 50-60% to ensure that each sign is fully seen.

The fifth statement, "Layout of video is organized.", received an average rating of 3.6 out of 6. There were mixed comments about the layout of the output. Some people suggested to enlarge the avatar to make the hand motions more obvious for the children. There were also comments about slowing down the captions as well for smoother learning and enlarging and adding more color and life to the illustrations. Lastly, there was a comment suggesting to simply just remove the captions because it was very distracting. He added that some deaf children ignore the texts and focus only on the sign language. However, he also added that the vocabulary words can be added either at the start or at the end of the video.

Lastly, the sixth statement, "I would use this as a learning reference material.", received a very high rating of 5.2 out of 6. Although the previous categories received a low rating as compared to the sixth statement, many are fond of the concept of the final output which makes the score high.

Criteria	Average Rating
The animation is accurate.	3.4
The animation is natural looking.	3.4
I understand the performed signs.	**3.0**
The avatar is eye-catching and child friendly.	3.2
Layout of video is organized.	3.6
I would use this video as learning reference.	**5.2**

Table 1: Results of Evaluation

After gathering the data, the evaluators suggested to modify and revise some parts of the animation as the sign language from the video used has a slight difference compared to the sign language they are currently using.

5. Conclusions and Recommendations

Based on the evaluation done, the animation/avatar (1) lacks accuracy, the sign language performed by the person on the video seems to be slightly different than that of the sign language used by the evaluators. This suggest that sign language is very diverse, it does not have a fixed structure; (2) lacks naturalness, it is highly recommended to put facial expressions and body movements when animating. This allows the children to understand more since they are still in the learning age; (3) needs a change of appearance, it is recommended to use or create avatars that looks similar to

the people of the chosen language. This makes the children more entertained, attached and focused on the avatar; (4) needs to slow down by 50-60%, children can't process sign language quick unlike adult signers since they just started learning. Alongside with the animation, it is also recommended to input English words to help boost the vocabulary skills of the children either at the beginning or ending of the video. Overall, the concept of this project is well-received by the evaluators.

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