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DEVELOPMENT OF THE SIGN LANGUAGE TRANSLATOR SYSTEM USING MYO AND RASPBERRYPI2

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Abstract. *In this paper, the differences between the non-disabled people and dyslexic person or hearing-impaired person were understood, and the sign language translator to enable communication between them was developed. One of the current sign language translators should always be equipped with a camera because it recognizes sign language by camera, and it has limitation in real life because it was interpreted directly by the listener. Other one of the sign language translators attached to the finger or inserted into the hand is not good in appearances. The sign language translator developed in this study is a wearable device using Myo and RaspberryPi2 to enable communication anytime and anywhere with other person. Using this device, it is expected that the dyslexic person or hearing-impaired person can communicate easily with non-disabled people and their independence and quality of life will be achieved.*
Keywords: Sign language translator, Myo, RaspberryPi2, EMG senor, Inertial sensor

1. **Introduction.** Recently, with the rapid development of IT technology, human centric computing technologies in order to maximize user convenience have been paid attention to. In addition, these technologies are providing support to the daily life of the disabled people which occupy about 10 percent of the world's population [1]. As well as, the latest domestic and foreign policy changes from the protecting and taking care of the disabled people to Independent Living Paradigm to emphasize the equal rights and human rights of the disabled [2]. However, the information gaps between the disabled and non-disabled people are decreasing currently, but still at the low level. Therefore, studies to provide IT services to the disabled people in various fields have been going in the industry, school and especially the government research institutions [1,3,4].

In this paper, a wearable sign language translator that can alleviate the communication difficulties experienced in daily life of the dyslexic person or hearing-impaired person has been developed.

In one of the current sign language translators, the sign language was interpreted by the recognition by the camera and Kinect. It always has limitations that the sign language should be interpreted by listener directly, and be equipped with a camera or Kinect. In the other one of the sign language translators that is attached to the finger or inserted into the hand, it is not good in appearances.

Therefore, in this paper a wearable sign language translator using the wearable gesture control and motion control device – Myo and RaspberryPi2 was developed for better communication anytime and anywhere as one of the most important factors in your daily life.

Firstly, the sign language translator is to enable smooth communication between the non-disabled people and dyslexic person or hearing-impaired person by using Myo and

RaspberryPi2. So the target is the daily life sign language of 1,073 Korean sign language [5,6]. The sign language translator developed in this study has the advantage that the disabled people communicate easily without repulsion so that there are no differences between the non-disabled people and dyslexic person or hearing-impaired person. It is expected that the dyslexic person or hearing-impaired person can communicate easily with non-disabled people and their independence and quality of life will be achieved.

This paper is composed of six chapters which are as follows. Introduction describes background purposes, and the structure of the study. Section 2 describes configuration and subject of the sign language. Section 3 describes the evaluation index for evaluating the performance of sign language translator. And Sections 4, 5 explain the sign language interpreter S/W (Software) and H/W (Hardware) parts. Finally, Section 6 suggests conclusions on this paper, the limitations and future research.

2. **Sign Language Structure Analysis.** Sign language is a restricted language to be applied only to those who know how to use some of all [7]. So, prior to the development it is necessary to understand the sign language and analyze the structure of a sign language.

Sign language used in the analysis was the 1,073 daily life sign language in Korean sign language, because the purpose of this study is the communication of daily life [5].

Firstly, sign language is a visual language for dyslexic person or hearing-impaired person. It has been recognized as another language because it has a different language system in comparison with a vocal language [8]. The sign language is composed of the shape of hand, the position of hand, the motion of hand, the direction of hand or palm, and facial expression.

3. **Sign Language Translator Evaluation.** It was constructed by three evaluation items for performance evaluation of developing a sign language. As items are recognition accuracy, voice conversion speed and average service life; development objectives for each evaluation item were planned as follows: Recognition accuracy is more than 70 percent, voice conversion speed is less than 0.5 second, and average service life is 2 days. The following Table 1 summarizes the evaluation items and contents.

Table 1. Evaluation items

Item	**Contents**	**Target**	**Unit**
Recognition accuracy	How exactly interpreted that sign language	70	%
Voice conversion speed	Time to translate sign language into speech	0.5	second
Average service life	Average use period of sign language translator for a single charge	2	day

4. **Sign Language Translator Program (S/W).** Sign language translator program is a python-based program. It is used to store individual's data such as the change of muscles and the position of hand, prior to using sign language translator developed in this study. Development environment for the program is shown in Table 2.

Table 2. Development environment for sign language translator program

Section	**Item**	**Contents**
OS	Raspbian	OS for executing a program in the RaspberryPi2
Development tool	gedit	Used for a basic text editor for Linux coding Python

Every time you talk in sign language, the position of hand is different because it does not always use sign language in the same height. Therefore, the process of null adjustment for the arm of each person must be processed. Through this process, it can reduce errors that occur when translating sign language by setting the standards. Figure 1 is a setting screen of individuals to set the standard for the accuracy of the sign language translator.

FIGURE 1. Sign language standard setting screen

In addition, the five motions for each person such as the fisted state, the interdigitated state, and the spread finger state, must be stored. It is possible to improve the accuracy in the sign language translation by this program.

5. **Sign Language Translator (H/W).** Sign language translator is composed of Myo, Raspberry Pi2 and speaker. Process of sign language translator is shown in Figure 2. Talking in sign language wearing Myo of the sign language, the values of electromyogram (EMG) sensor and inertial sensors embedded in Myo are sent to RaspberryPi2, and the transmitted values are determined as the sign language by the stored database. The translated voice of the determined sign language is spoken to the listener by the small speaker.

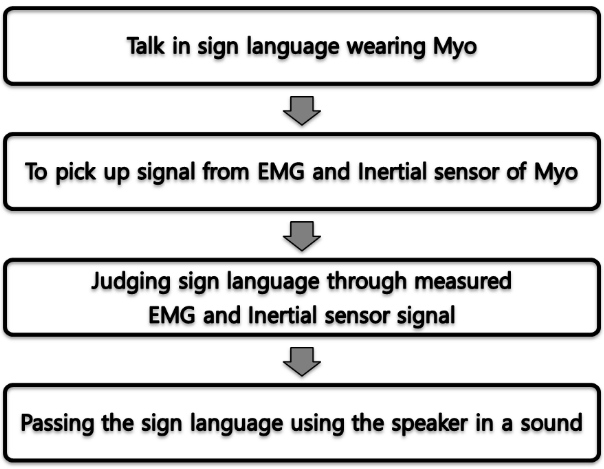

FIGURE 2. Process of sign language translator

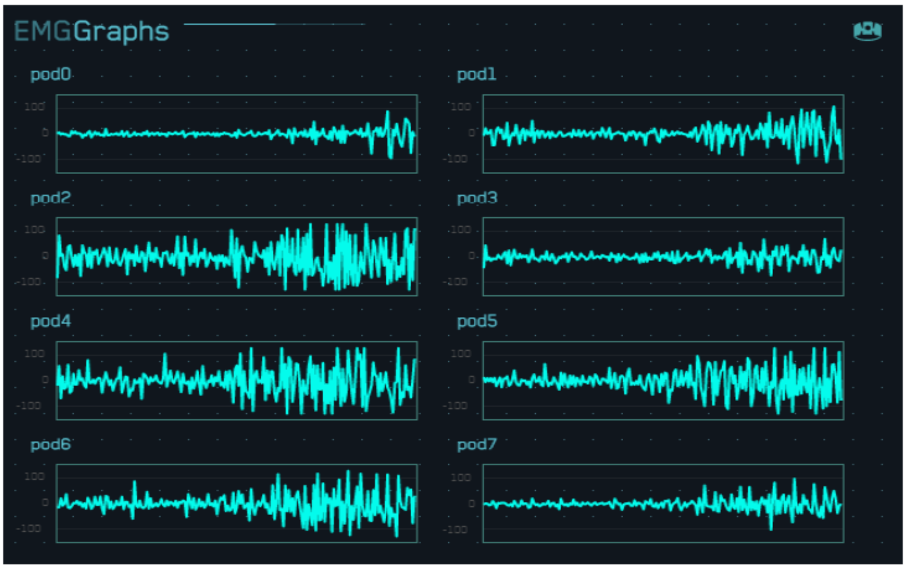

FIGURE 3. Value changes of the sensor values

Myo is the next-generation wearable device as muscle awareness controller. Figure 3 is a screen that can check the subtle changes of the sensor that is built in the Myo (EMG sensors).

In the sign language translator, the IMU (Inertia Measurement Unit) data coming from the built-in sensor is converted to the values as the roll, pitch, and yaw representing the motion of the arm by the following formulas. Equation (1) shows the rotation of hand, Equation (2) moving up and down, and Equation (3) represents the left-to-right motion. 'quat.# ()' appearing in the conversion formula shall mean the IMU data.

The following equations written in C language are converted to the Python language using in a real program.

$$\begin{aligned}\text{float roll} = \text{atan2 } (2.0\text{f} * (\text{quat.w } () * \text{quat.x } () + \text{quat.y } () * \text{quat.z } ()),\\ 1.0\text{f} - 2.0\text{f} * (\text{quat.x } () * \text{quat.x } () + \text{quat.y } () * \text{quat.y } ()));\end{aligned} \tag{1}$$

$$\begin{aligned}\text{float pitch} = \text{asin } (\text{max } (-1.0\text{f, min } (1.0\text{f}, 2.0\text{f} * (\text{quat.w } () * \text{quat.y } ()\\ - \text{quat.z } () * \text{quat.x } ()))));\end{aligned} \tag{2}$$

$$\begin{aligned}\text{float yaw} = \text{atan2 } (2.0\text{f} * (\text{quat.w } () * \text{quat.z } () + \text{quat.x } () * \text{quat.y } ()),\\ 1.0\text{f} - 2.0\text{f} * (\text{quat.y } () * \text{quat.y } () + \text{quat.z } () * \text{quat.z } ()));\end{aligned} \tag{3}$$

In sign language, it is necessary to distinguish shape of hand as well as motion of hand, namely it is whether fist hand or spread the finger and the EMG sensor data is used in this time. By the process that stores in advance the shape of hand using the sign language translator program described before, the EMG data is stored. When determining the shape of hand, whether either side is closer to the EMG sensor data in the stored shape of hand is discriminated and the number of the determined shape of hand is returned. So the movement of the hand and the shape of the hand are determined. The most important part is to determine whether this motion of hand refers to sign language. The number is matched to the motion of the hand and the voice corresponding to the number is spoken.

Figure 4 is data sample for sign language translator. The sign language translator is stored into an array to sensor data, enters the same order as the corresponding arrangement and outputs the sound of the word by speaker. If sign language of 'apple' was composed [1,3,5], the database enters the array test [1,3,5]. User has done motion [1,3,5], and the audio file "apple.MP3" is spoken by speaker. In the process, the open-source Myo-raw is used for connection to Myo and the open-source pygame was used to output the audio file. Components of the sign language translator are shown in Figure 5.

```
test[0] : apple
test[1] : banana
test[2] : orange
        ⋮
test = [[1,3,5],[2,3],[4,6,7]]
mp3 = ["apple.MP3","banana.MP3","orange.MP3"]
```

Figure 4. Data sample for sign language translator

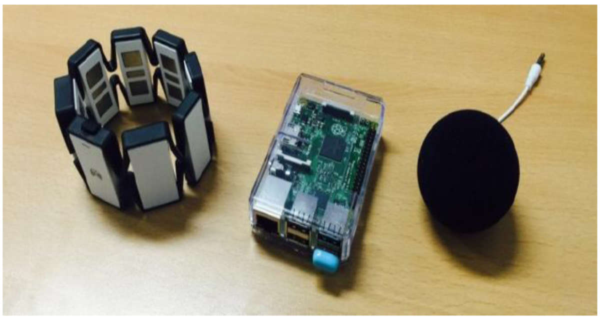

Figure 5. Components of sign language translator

Table 3. Evaluation result

Item	Unit	Target	Now
Recognition accuracy	%	70	72.4
Voice conversion speed	second	0.5	0.32
Average service life	day	2	3

It is possible only 1.6 percent of 1,073 needed sign language in daily life. However, it is necessary to evaluate the performance in order to assess the possibility of the future of the sign language interpreter developed. Therefore, we evaluated the performance of a sign language interpreter as currently developing a sign language interpreter. Recognition accuracy and voice conversion speed were measured 30 times for each sign language, and average service life was measured 3 times and the average value used. The results are summarized in Table 3. As the average recognition accuracy is 72.4 percent, the average voice conversion speed is 0.32 second, average service life is 3 days, and it was evaluated as both reached the target value planned initially.

Thus, we have seen the development potential of these wearable sign language interpreters through this study, and we will continue in the future by adding a sign language to allow smooth communication in everyday life.

6. **Conclusions.** In this study, a sign language translator using Myo and RaspberryPi2 was developed. Then the talk using sign language is spoken to voice by identifying the sign language through EMG sensors and inertial sensors in Myo. So, the communication between the non-disabled people and dyslexic person or hearing-impaired person is expected to be good. Also the creation effect of the employment will be expected by the activation of the industry and related services industry in terms of social welfare, and the quality of life, the promotion of the self-reliance and self-esteem enhancement of disabled persons living will be expected.

However, this study has some limitations. First, sign language is currently available to only 12 units (1%) among 1,073 unit sign language necessary for daily life. However, the possibility of wearable sign language translator developed was known. Continually, a possible sign language has been adding. In addition, currently one-way communication of the disabled people is only possible such as showing other's voice on the display panel. In future research it is necessary to supplement bi-directional communication.

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