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SMART LIGHTING CONTROL SYSTEM USING MYO AND ARDUINO

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Abstract. *Recently, the important issue of the IT market is the wearable devices and its application. The application of the wearable devices to the various fields will lead to significant changes in our daily life as well as the IT market. In this study, the smart lighting control system was developed by utilizing the Myo wearable device attached to the arm. The way to create more value with the smart control system for the lighting was also provided. In addition, it is expected to create more values by applying to various fields such as the smart home coupled with the IoT.*
Keywords: Lighting control, Myo, Arduino, EMG sensor, Gyro sensor, Performance, Smart home

1. **Introduction.** Recently, in IT industry the smartphone market has entered into the stage of the maturity and there is a post smartphone era that has a slow growth [1]. In addition, the society that people and things/things and things are connected with the networks has come and the life style has been changed by using actively ICT (Information & Communication Technology) in everyday life. Accordingly, it is expected that the next generation devices that provide various functions will appear and the related demand and market will be increased rapidly [2]. The wearable device emerged to the new profit source and next development power [3]. The wearable devices is 'Wearable Computers' also known as body-borne computers or wearables that are miniature electronic devices that are worn under, with or on top of clothing. It is a device where the information is shared among people and things through the networks and that people and the quality of life will be increased to the high level. The value can be generated in the various areas such as health, sports, education, and gaming applications. In addition, it can create new value in various areas by the connection and integration with ICB (IoT-Cloud-Big Data) [1]. For example, by the connection with the Internet of Things (IoT), the smart home, O2O commerce, and smart car services will be enabled and the customized services will be provided by the cloud-based big data analysis. The trend of wearable device is in the form of portable devices such as smart glass, and smart watch. In the near future, it will be changed to the attachable type devices such as the band attached to the skin and eventually it will be changed to the transplant type device to the skin or taken directly into the body. Also, it will be the device that can protect people with the clothes fused with IT equipment [4,5].

In this paper, the smart lighting control system was developed by utilizing the wearable device – Myo attached to the arm. The lights can be easily controlled by the simple hand movement in the systems that has the function such as the on/off of the lighting, the change of the color, and the variation of the illuminance by using the wearable device – Myo. In addition, it is expected to create more values by applying to various fields such as the smart home coupled with the IoT.

2. Background.

2.1. Myo.

Wearable devices have diverse types, such as portable, attachable, and eatable. Attachable type is the device to get biometrics by reaching skin directly [6]. Figure 1 is an Myo used in this paper. Myo is an attachable wearable device like the muscle controller recognizing the movement of the muscles by using the built-in EMG (Electromyogram) sensor in the device. The movement of the muscles is recognized by using the EMG sensor, and the gesture is recognized with a tiny amount of current from the muscle. Therefore, it is possible to control through natural body movement. Since the various sensors such as inertial sensors and Gyro sensors are embedded into Myo, the recognition of the various actions is possible by recognizing the movement of the arm.

FIGURE 1. Myo

2.2. Arduino.

Arduino is a control board for controlling the device, and it has a structure for connecting a device such as a sensor or component. Therefore, Arduino is used to develop an interactive device to control the lights, motors and other physical output receiving input from switches or various sensors [7]. These Arduino boards are of many different types and are used as appropriation to the development environment. Figure 2 is an Arduino Uno board used in this paper.

FIGURE 2. Arduino Uno board

3. Smart Lighting Control System.

3.1. System architecture.

Figure 3 is the context diagram of smart lighting control system using Myo and Arduino. When the user's motion is inputted through the Myo, the commands for the LED lighting matched to the motion are performed by the smart lighting control system based on Myo and Arduino.

FIGURE 3. Context diagram of smart lighting control system

The smart lighting control system consists of the Myo, Arduino and RGB LED bulb. Myo is wearable device, and it can recognize diverse hand movements by recognizing education and change. Therefore, this paper would have enabled lighting control through the change of hand movements. Specify the function according to the shape of hands. Arduino is device that enables product interaction by controlling such as LED or motor, which accepts the input value from diverse switches or sensors. In this paper, the Arduino Uno board and the LED lighting were used. Because of LED lighting energy saving and environment-friendly characteristics, it can be applied variously to the design of lighting, illumination control, color control, and dimming of lighting [8]. In this paper, the RGB LED bulb can emit a multiple color in the single bulb to provide the variations.

3.2. Motion detection & lighting control algorithm.

Motion recognition is one of the most important elements in the smart lighting control system. The lighting is controlled by the control command conveyed to the lighting through the motion recognition. The algorithm of motion recognition and lighting control system is shown in Figure 4. The subject wears Myo and performs the specified action. And the sensor value for the specified action is stored through EMG sensor and Gyro sensor embedded in Myo. The stored value is compared to the data in the DB, the action is recognized, and a function matched to the specified action is performed. If the stored value does not match the data in the DB, the subject will perform the specified action again by vibration.

4. Results.

The function of the smart lighting control system developed in this paper is shown in Table 1. Firstly, the thumb, the middle finger, and the pinky finger of the hand are encountered twice for the connection to the smart lighting control system and Myo. The Myo vibrates if the system and Myo are connected. The most basic function of lighting control – On/Off of the lighting is implemented by the changes in hand shape. To clench the fist is set to 'On' and to open the hand is set to 'Off'. Illumination change can be recognized as the change of the rotational angle of the arms. As the rotation angle is larger, the light is brightened more. The color of the light is changed to the sequence specified by the movement of the wrist.

Figure 5 is a photo of a smart lighting control system developed in this study. The prototype was composed of three bulbs to show that it is possible to control multiple lighting, and each of the bulbs can perform functions defined above.

In this study, the lighting control system using a wearable device was developed. It can be used as part of welfare to provide convenience for the seniors with limited mobility or disabled person because it takes advantage of the fact that the lighting can be easily

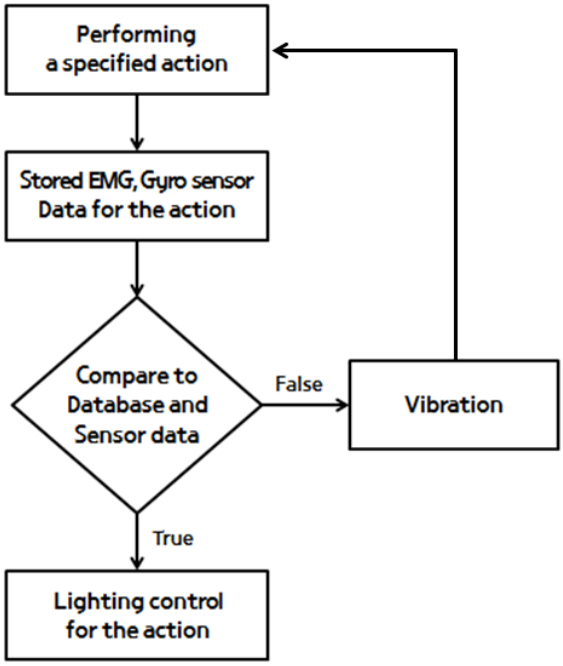

FIGURE 4. Motion detection & lighting control algorithm

TABLE 1. Defining features of the smart lighting control system

Function	How to implement	Motion
Pairing	Change hand shape	 Pairing
On/Off	Change hand shape	 ON OFF
Dimming Up/Down	Change angle of rotation	Dimming Up  Dimming Down
Color Change	Change angle of waving	 Color Change

controlled with just a simple operation. In addition, the way by integrating the various fields that can create more values is proposed. First, a new culture business through a fusion of performance is suggested. Figure 6 is an example of the fusion of the performance and arts – the lighting control of the bridge, the Diamond Bridge in Busan. Currently, those who want to plan the arts and cultural performances seek the diversity and new ways of performing. Therefore, the performance planners create the show to

FIGURE 5. Smart lighting control system using Myo and Arduino

FIGURE 6. Examples fusion of smart lighting control system and performance

use the various methods (visual stage effects, a variety props). So adding a sensual effect using Myo to the existing cultural content will become more interesting. It will be possible to extend the method of emotional and psychological expression, and it could be a creative performance by as more detailed and natural directing as possible. For example, performers by attaching the additional various sensors directly control the performance equipment with hand gestures, or through fusion with the lighting control performance in the attractions such as Diamond Bridge, and a direction of a new performing arts will be suggested. In addition, it is expected to create more values by applying to various fields such as the smart home coupled with the IoT. Thus, there can be the possibility of future expansion/development.

5. **Conclusions.** In this study, the smart lighting control system using Myo and Arduino was developed. When the subject wears the wearable device – Myo and performs the specified operation, it is possible to easily control the light with the hand movement, for on/off of the lighting, colors change, illumination changes, and selections of the lighting. The system can provide convenience for the seniors with limited mobility or disabled person because it can control the lighting in a simple action. Also the smart lighting control system can create various applications by the integration with the various fields. Through the fusion of performances, the way of the new performing arts, and the new culture businesses are suggested. In addition, it is expected to create more values by applying to various fields such as the smart home coupled with the IoT.

Lighting gives an impact on the emotional changes of people and ergonomics [9,10]. Therefore, we will analyze the pattern of the user, and we will develop the lighting control system based on user's emotion in the future. Also, the control of the other devices using one of the systems by adding various actions will be studied and developed.

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