Evaluation of a Device that Combines Exercise and Entertainment -In the view of Electroencephalogram analysis-

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Abstract— **The purpose of this study is to develop a device that combines exercise and entertainment. Therefore, we developed an application and a driving device to visualize the energy consumption during exercise. The first device utilizes a smart phone; the second devices utilize the action of jumping rope, handgrip, boxercise, or playing a Kendama. The result of the test is that the driving devices responded correctly to the shaking or sound input of the smart phone, as well as the jumping rope action, handgrip action, or a Kendama action. We investigated the physiological effects of this device using EEG as a measurement system. In the examination of the EEG, it was found that after use, a sense of relaxation was obtained.**

Keywords—Exercise and a driving device; Training; Rehabilitation; EEG

I. INTRODUCTION

Physical fitness tests conducted in Japan have been a decreasing trend since the 1980s. As a result, an increasing requirement of medical expenses and a large number of elderly people who need to be taken care of have become serious problems in Japan society [1]. As a cause of the decline in physical strength and exercise ability, 1) exercise time to play outside and sports due to popularization of television and mobile games is getting less, 2) The places for children to play are decreasing, 3) Attending a cram school aimed at higher education deprives much of the children's playing time, and exercise time is decreasing. Therefore, it is important to increase the children's playing time and continuity for physical exercises.

On the other hand, rehabilitation devices have been developed for motor function improvement of the elderly and the handicapped. However, the activities of these instruments which are aimed at certain exercising abilities or muscular recovery tend to be monotonous. In addition, innovation in sensor technology improvement and dissemination of smart phones and tablets of the digital device of the embedded technology by the development of IT technology is progressing rapidly. The smartphone has an acceleration sensor, a temperature sensor, a gravity sensor, and so on. We have maintain and improve physical fitness and health by managing the number of steps using acceleration sensor and managing mileage, time and Consumption calorie with the use of acceleration sensor, GPS, to manage the distance traveled, time, consumption calorie, and to maintain and improve physical strength and health With these devices, it is difficult to simultaneously solve the shortage of exercise, which is a problem among generations, and research and development are being carried out as individual measures at the present.

Therefore, in order to solve these problems, 1) Simple exercises can be performed in a narrow space. 2) Constant motion can be done regardless of age. 3) Continued exercise can be done. 4) Inexpensive application of existing embedded technology is possible.

It is necessary to develop an exercise device which has the above characteristics.

II. MANUFACTURE OF A DEVICE THAT COMBINES EXERCISE AND ENTERTAINMENT

With the device, no matter where children, the elderly, the disabled or ordinary people, anyone can do exercises at the same time. Moreover, it is a set (consisting of applications and driving devices) which can even make comparisons. This enhances entertainment by combining various conventional exercises and training with devices with gaming properties, and there is ease of us so that anyone can easily feel free to play.

Furthermore, this device is characterized in that it is not necessary to unify the exercise in order to compare momentum. Currently, we have developed six types of devices. A) Shuffling the smart phone; B) Sound input like applause; C) driven by rope skipping; D) driven by muscular strength training; E) driven by playing Kendama; F) driven by tapping the screen of the mobile phone; G) driven by playing a boxercise. In this device has possible competition with various exercises by using the same driving device.

A. Application and the driving device using acceleration sensor

Figure 1 is the driving device of the smart phone. The device composes two parts of devices. One is the device for reading the movements. The other one is the driving device in response to the movements. This set of device can read by application the figure of the acceleration sensor. As the communication method, 500msec every count's electricity will be supplied. The driving device is equipped with an Arduino and FET driver to control the motor.

B. Application and the driving device using sound input

Figure 2 shows the application and the driving device which uses sound input. Visual display is possible, in case of a low sound, a small circle in bottom right will be seen as showed in figure 2(a); but if the sound is loud, the circle will turn to a larger one, as what figure 2(b) shows. The subjects of this set of device are the elderly and the disabled, etc. The driving device can be operated when there're claps, sound of instruments or any other voices.

C. Driving device that reacts to a jumping rope action

A jumping rope action and the driving device are showed in Figure 3. This set of device is made up of the movements of a jumping rope action and the driving device which will react to the movements.

D. Driving device that reacts to rehabilitation exercises and grip strength training

Figure 4 is a set of device with a handgrip used for grip strength training or rehabilitation exercises and the driving device. For the method of detecting the "hold" action, at first the maximum or minimum resisting figure of the bending sensor will be detected, then it will be counted when it is within 10% of either of the two figures.

E. Driving device that reacts to Kendama

Figure 5 is the set that contains a color sensor and the driving device. The sensor will be fixed in the side cups (large and small) and the handle cup of the Kendama, times of the ball hitting the large side cup and the handle cup by turns will be counted, thus the motor in the device set can be driven.

F. Driving device that reacts to tap the screen of the mobile phone

Figure 6 is a device in which a drive device moves by tapping a marker placed on a smartphone.

Since this device can adjust the display speed, it can be used from elderly people to children.

G. Driving device that reacts to play a boxercise

Figure 7 is a set of punching gloves and mitts. This device incorporates a pressure sensitive sensor in the mitt and gives the driving device 500 msec per times as it is one pressed.

Figure 8 show the relationship between various exercise input devices and exercise, rehabilitation, and entertainment. As shown in the figure, this device does not only exercise, but also incorporates elements to enjoy.

III. CONFIRMATION AND VERIFICATION ON THIS DEVICE MOVEMENTS

In order to observe the use situation of this device, we asked children to use for trial use. Figure 9 is the photograph of the children using this device at the Arakawa Industry Exhibition event. As a result of using it in the event, about 30

Figure 1 Device driven by application using acceleration sensor and shuffling movement

Figure 2 Device driven by sound input

Figure 3 Device driven by a jumping rope action instrument

Figure 4 Device driven by handgrip instrument

Figure 5 Device driven by Kendama instrument

Figure 6 Device driven by tap the screen of the smartphone

Figure 7 Device driven by hit a mitt

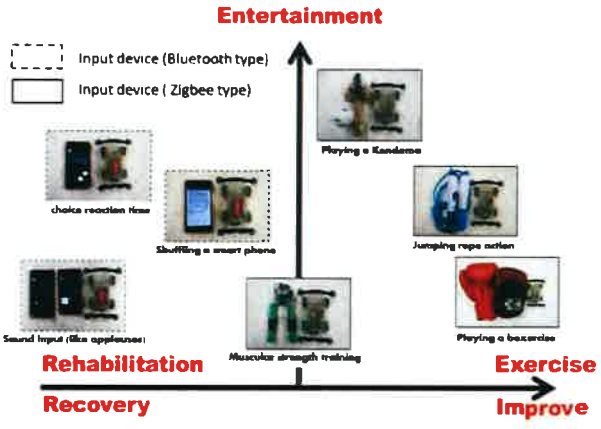

Figure 8 Relationship of devices and communication type

Figure 9 Image of arakawa industry exhibition event

Figure 10 Image of the home for the aged event

Figure 11 Experiment of EEG

people were able to exercise with enjoyment using this device. Furthermore, in order to ascertain whether this device can be used even by elderly people, I used it in a home for the aged. There were a total of 20 subjects, among them included 10 mild dementia patients and 10 severe dementia patients.

Figure 10 shows the situation when a patient with mild dementia uses this device. In the case of patients with mild dementia, they were able to understand and exercise on how to play this device. However, in the case of patients with severe dementia, they were unable to understand this device. This device was found to be capable of corresponding to the mild authentication patient.

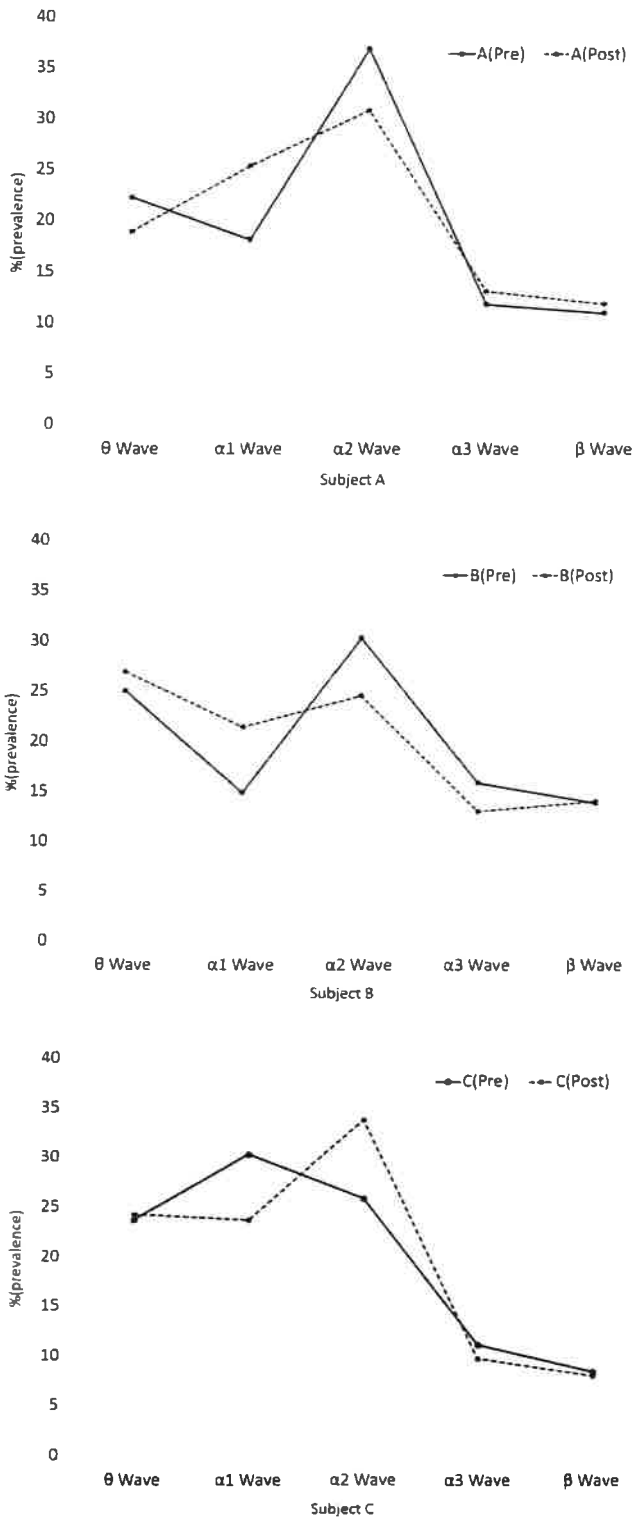

Figure 12 Results of The EEG measurement

IV. RESULT AND METHOD OF MEASURING EEG

To investigate physiological effects with this device, we used electroencephalography (EEG) as measurement system tools. The subjects were five male students (15-17 years old).

Figure 11 is the measurement landscape of the measurement experiment of brain waves. Measurement directed a subject to sit down on a chair so as not to move a head.

The EEG (FM-717; Futek Electronics Co. Ltd.) was recorded using a monopolar lead from Fp1 and Fp2 according, with an Ag/AgCl electrode and referenced to the left earlobe (A1). Artefacts such as ocular movement were removed from the EEG data. The power density of each of θ (5.0Hz; sleepiness state), α1 (7.5Hz; relax state), α2 (10.0Hz; relax and concentrate state), α3 (12.5Hz; concentrate and tense state), and β (22.0Hz; dispersion state of concentration because of the tense state) band taken in condition was averaged and used for analysis. The EEG (FM-717; Futek Electronics Co. Ltd.) was recorded using a monopolar lead between Fp1 and Fp2 according, with an Ag/AgCl electrode and referenced to the left earlobe (A1). EEG was recorded for one minute each before and after exercise. That exercise was a move to shuffle smartphones for the measurement of EEG. The course of experiment was one lap for 4 meters, drive device ran four laps.

Figure 12 shows the results of three subjects. Subject A used α 2 waves and α 1 waves decreased after using the device. Subject B had a high relax and concentrate state, but sleepiness state and relax state increased after the exercise. This may be because exercise intensity was too low. Therefore, it is thought that there was little exercise stimulation and drowsiness became high. Subject C shows a tendency to relax and to have a concentration state after the exercise though the relaxation state was high. As a result of the experiment, it was suggested that the relaxation effect and concentration effect could be obtained by using this device.

V. CONCLUSION

In this study, we developed a drive unit to convey the device and the motion to detect the body movement.

By developing motion input that combines mobile phones or exercise device, it became a highly entertaining device. For children and elderly people, it was possible to enjoy using the device.

Moreover, in the examination of the EEG, it was found that after use, a sense of relaxation was obtained. This device can to use from children for exercise to the elderly people for rehabilitation.

For future plans, we are to increase the number of subjects and examine to detail.

REFERENCES

[1] "Results of the FY2012 Physical Fitness Survey (Japan Fitness Test)" Ministry of Education, 2012

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