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Low-Frequency Haptic Interface Developed for Electrical Safety Experience Education

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Abstract Electric shock due to the increased use of power, equipment accidents, electrical accidents, such as electric fire and also continues to grow. To prevent electric shock accidents, an experience education is more effective than indoctrination education. But an electric shock experience education system required a proper physical stimulation on human body to experience electric shock. In this study, we conducted a study to take advantage of the realistic haptic interface using a low-frequency type experiential learning and prevention education. Results of this study could be applied to an electric shock experience education system.

Key Words : Realistic, Electric-Power, Low-Frequency, Cognitive Senses

1. Introduction

Away from the traditional manual inflatable Education Experience directly visual, tactile, auditory through utilizing Interactive Experience Whether a virtual environment with a real sense organs, mind and pay attention to the development of the simulator used by the experience of electrical wire electrical accident situations that may occur due to carelessness, such as in a real place, and ultimately the human use of electricity from electrical hazards, physical this was designed to prevent damage[1]. In spite of a wide variety of activities to prevent electrical safety accidents, electric shock accidents had not decreased in Korea as shown in table 1 [2]. It is very important that people are aware of electrical hazards and the proper preventative actions including education to reduce electrical shock. The most of electrical safety accidents happen because of human error. human error, a systematic and long-term education is required[3].

Table 1. Electric shock accident statistics for the recent three years in Korea.

Year	Death	Injury	Sum
2008	68	497	565
2009	46	533	579
2010	46	535	581

In order to prevent these accidents by The biggest problem of electrical disaster accident accidents can occur at various stages and a myriad number of ways because accidents happen. In particular, the risk of electrical shock because when a constant current flow to the body in extreme cases can lead to death is a horrible disaster. Homes, as well as common place in dealing with professional electrical safety accidents can happen at any time[4].

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Thus, electrical safety training to improve the ability cope using immersive virtual reality simulator was constructed. So far, education to prevent electrical safety accidents was indoctrination using text and image. Since the passive methods of education that are currently used by using are not the most effective[5]. It is unsuitable except adult who concern about electrical safety. Especially, introduction of various education method for child and infants who concentration and understanding are lack than adult is needed. In this paper, Interferential Current Type Low Frequency Stimulator was considered as the method to experience electric shock. Generally, Physiological therapy using Interferential Current Stimulator(IFS) has been in use for many years and its effectiveness is well documented[6]. The basic principle of IF) is to utilize the strong physiological effects of the low frequency electrical stimulation of muscle and nerve tissues at sufficient depth, without the associated painful and somewhat unpleasant side effects of such stimulation.

2. Method

The advancement of virtual reality (VR) technology and medical device enable to develop a system to experience electric fire and electric shock. An experience education system to prevent electrical safety accidents, which must use the proper stimulation values on a human body to experience electric shock accident. The interference of the two ACs at the intersectional area produces sinusoidal current modulation at a frequency equal to the difference between the two ACs. 3~20mA current stimulation provided in right palm and the forearm (adult 12 cm and child 10 cm) for 4 seconds in order to remove tiredness effect as shown in Fig. 1 and 2. And self-report 5-point scale about displeasure, and pain was reported by experiment participants.

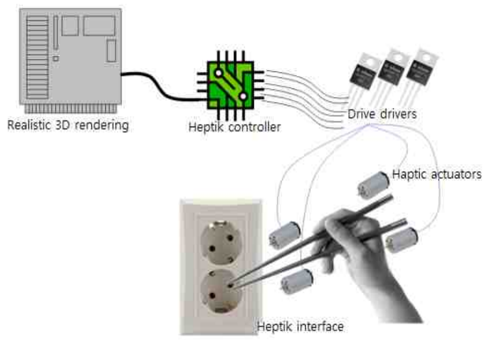

Fig. 1. Haptic Interface System Configuration

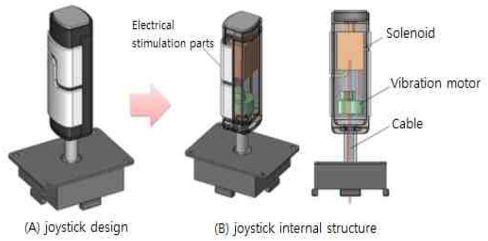

Fig. 2. Joystick design with a haptic device

Therefore, in order to maximize learning effect, it is need to determine threshold values of electric shock stimulation according to age, gender and experience education contents. This paper calculated threshold values of a human body according age and gender in using Interferential Current Type Low Frequency Stimulator in order to apply to an electric shock experience education system. Figure 1 illustrates a haptic interface system configuration and Figure 2 shows seolgyeeul joystick using a haptic device. Interferential Current Type Low Frequency Stimulator STI-300, which can adjust current stimulation from 1 mA to 50mA, was used to calculate electric stimulation values on the human body that can be applied to an electric shock experience system. 66 healthy volunteers participated in the experiment. They consist of 38 male (child 11, adult 27) and 28 female (child 13, adult 15). Before the experiment, data to have an influence on current stimulation values like as height, weight, age and gender was collected. Interferential currents two independent kilohertz frequency alternated currents (ACs) of constant intensity that are applied by two pairs of electrodes placed diagonally.

3. Test Result

The mean intensity was 14mA and mean of displeasure, pain and arousal was under 3-level (normal level). And there is no pain, inconvenience and displeasure in experiment. Table 2 shows experiment results according to gender (male and female) and age (child and adult). First, the participants are required to measure the effectiveness of the hands-on safety training simulator for electrical accident prevention. Participants of this study was to experiment with the 68 names of first grade to sixth grade in elementary school and are not pathological mental illness normal hearing and vision, with children from 7 years old to 12 years old with a sense of pain.

Table 2. Mean, Maximum (max), and Minimum (min) stimulation current of experiment participants

	Height [cm]	Weight [kg]	Current [mA]	Displeasure Mean	Pain Mean	Arousal Mean
Mean	164.00	56.92	14.30	2.68	2.67	2.63
max	189	85	20	3.83	4.00	4.19
min	104	18	8	1	1	1

In this paper, stimulation of IFC applied to human body was gradually increased. Also, in case that critical pain and displeasure of participants by large stimulation current was reported, the intensity of stimulation was adjusted to smaller level than the intensity which they can endure because of dangerousness of human body and psychological Trauma. And, in case of child, the reliability problem of the self-report 5-point scale by child's uncertain concept about displeasure, pain and arousal was minimized by securing statistically stable participants. Table 3 and 4 in the experimental group pre-post test, the mean response time of the control group and pre-post-test shows that the reaction time.

Table 3. Experimental and pre-post test reaction time difference between the value of the control group.

Division	Average response time (ms)	Standard Deviation(ms)
The experimental group pre-post test reaction time difference value (n = 25)	454	436
Control group pre-post test reaction time difference value (n = 34)	124	349

Table 4. Stimulation current and education effect

Male child	Max arousal, Min Current[mA]	Negative-Max arousal	*The most negative stimulus*
Mean	7.00	3.57	3.71
Max	8.00	4.53	5.20
Min	6.00	1.50	1.50
Male adult	Max arousal, Min Current[mA]	Negative-Max arousal	*The most negative stimulus*
Mean	12.78	4.42	4.86
Max	18.00	4.53	5.20
Min	7.00	2.50	3.50

Female child	Max arousal, Min Current[mA]	Negative-Max arousal	*The most negative stimulus*
Mean	7.63	3.44	4.19
Max	9.00	5.00	5.00
Min	6.00	2.00	3.00
Female adult	Max arousal, Min Current[mA]	Negative-Max arousal	*The most negative stimulus*
Mean	11.77	4.54	4.92
Max	18.00	5.00	5.00
Min	8.00	3.50	4.00

4. Conclusion

The biggest problem of electrical disaster accident accidents can occur at various stages and a myriad number of ways because accidents happen. results of this study could be applied to the determination of the proper stimulation values of an electric shock experience education system according to a variable such as electric shock education contents and age, gender, weight and height of user. And Through the sharing of information and objects and action, reaction is a physical experience, Temperature and vibration motor through electrical stimulation and vibration Step by step to be able to experience the real environment made. Thus, the existing electrical safety training was the development of learning more is expected.

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<Research Interests> Electric and Electronics Application, Automatic Control