

Physiological Response Towards e-Learning Courses by Using Skin Temperature

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At present, the possibility of the adaptive e-learning comes to attention. To do this, we need to construct the method to control e-learning contents. One possibility is the introduction of the bio-sensing because of the relation between the bio-data and learner's physiology. In this paper, we show the relation between bio-sensing using skin temperature and learner's physiology. We conducted an experiment including two different types of e-learning materials. One is characterized as an interactive material and another one is characterized as a non-interactive material. Moreover, the physiological sensor which is skin temperature sensor was attached to the learner. Hence, the skin temperature data analysis was achieved by using the statistical approach.

1. Introduction

With the development of the internet, the importance of e-learning is rapidly growing due to the high demand of learning at anytime and anyplace. Moreover, the e-learning system is essential not only for the educational intuitions but also many organizations that provide useful materials to train their employees by using e-learning system. However, learners could not take any information efficiently if they do not concentrate because of tired, sleepy, and etc. Therefore, the approach to verify that learners can totally concentrate is considered to be a significant issue in e-learning development. In other words, the instructors can keep an eye on the reaction of learners while providing lecture in a normal classroom. Thus, the instructors can adjust their lecture concurrently if learners could not

pay more attention to the lecture. Meanwhile, the lectures on e-learning are generally characterized as a video-recorded teaching that the reaction of learners could not be realized directly by the instructors. In order to achieve the most efficient of e-learning system, providing interested e-learning contents and also the approach to realize the learners interest or response are necessary. One possible approach is applying various physiological sensors for detecting human mental and somatic state¹⁾. In this study, we investigated the physiological response by using skin temperature (ST) sensor along with learning on two different types of e-learning material; one is characterized as an interactive material and the other is a non-interactive material. Skin temperature (ST) sensor is assumed to evaluate human sensations effectively because autonomic nervous system activity associating with sensations causes skin temperature to vary⁶⁾.

2. Experiment Conditions

The volunteers participating in e-learning experiment were ten male students from the Faculty of Information Science and Technology, Sendai National College of Technology. They have an age between 19 to 20 years old. During the experiment, all participants had to take two different types of e-learning materials. Each material was taken about 25 minutes to complete. Moreover, the skin temperature (ST) sensor also was attached to a nose of participants in order to measure physiological signal while they were taking both e-learning materials (figure 1).

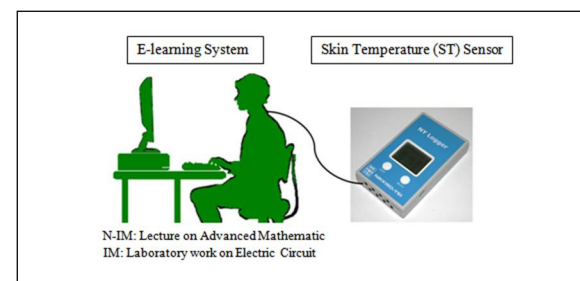


Figure 1 Physiological data acquisition by ST sensor

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3. Different Types of Two e-Learning Materials

These two e-learning materials were provided by e-learning system in e-learning Higher Education Linkage Project (eHELP)⁵⁾⁸⁾⁹⁾ at Nagaoka University of Technology. A non-interactive material (N-IM) is a lecture on advanced mathematics which is a video-recorded material by university's instructor (figure 2). The virtual laboratory work on electric circuit was used as interactive material (IM) (figure 3). Participants had to perform given tasks by instructor consecutively during learning on IM material.



Figure 2 Screenshot of non-interactive material



Figure 3 Screenshot of interactive material

4. Physiological Signal

According to physiological signal in this experiment, skin temperature data was recorded by handheld temperature data collection (NY Logger Series N540, Nikkiso-Therm Co., Ltd.) (figure 4). These skin temperature data were collected continuously in every second until the completion of each material that is roughly about 25 minutes.



Figure 4 NY Logger Series N540

5. Data Analysis

Due to the assumption of skin temperature could be affected by sensations⁶⁾, especially stress or concentration. It could be evaluated by facial skin temperature⁴⁾. Thus, it could be used to refer in data analysis. The skin temperature sensor was achieved in every second during the experiment which is about 25 minutes to complete each material. In order for better comparison and analysis, the skin temperature data were manipulated into an average value of every 60 seconds. Therefore, the skin temperature data in a minute time series were performed by statistical approaches including the arithmetic mean and standard error. Moreover, paired t-test analysis was performed in order to find the difference of skin temperature data against two types of e-learning materials.

6. Experimental Results and Discussion

The nose skin temperature for ten participants was acquired for study. All participants were required to learn two types of e-learning material, IM and N-IM material. The experiment period of each material was 25 minutes long. The experimental results were shown as below.

Figure 6 shows the average value during the whole experiment period in the form of baseline corrected. In order for better comparison, the average values of both conditions have the same initial value which is 0.0. As illustrate in figure 5, the nose skin temperature of interactive and non-interactive material condition are projected and vary by time. The trend of nose skin temperature in IM condition is quite stable at the onset of experiment while another condition, N-IM, trends to rise slightly. After conducting the experiment for some period of time, the significant difference was observed between both conditions ($p < 0.01$). In other word, N-IM condition trends to slightly change until the experiment ended. Meanwhile, nose skin temperature remarkably dropped temporarily in the IM condition (Denoted by a black arrow in the figure 5). Since the drop of nose skin temperature can indeed be used to infer stress because nose skin temperature will vary with autonomic nervous activity induced by the sensations like stress.³⁾Therefore, it could refer that the learners have more stress or concentration while learning on IM material than N-IM material. Due to the

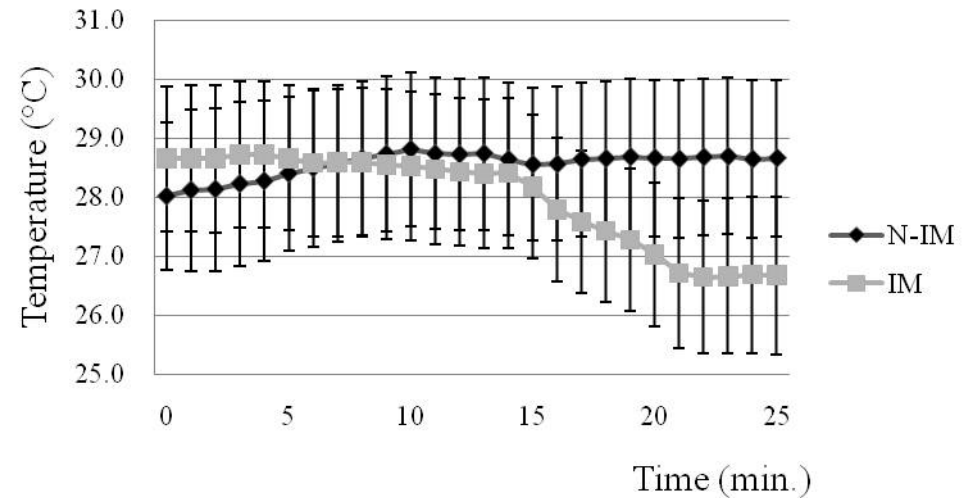


Figure 5 Nose Skin Temperature of ten participants in the time series (avg. ± SE)

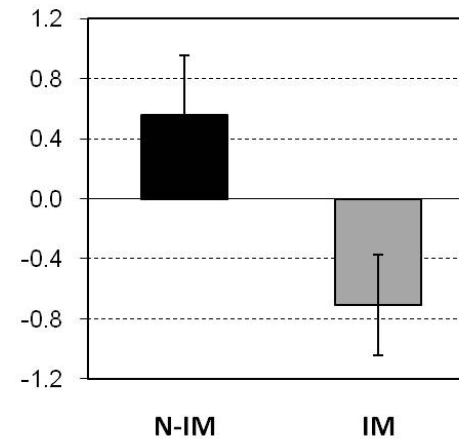


Figure 6 the average value during the experiment period

condition of interactive material (IM) was practice-based material that learners were required to complete many tasks on time, they had to stress or concentrate on doing the given tasks. Thus, it is plausible result that the decline of nose skin temperature was observed in IM condition. However, we properly realize the fact that the emotions in human is very complicated and difficult to exactly define. Some stress in both e-learning materials could be occurred from the physiological equipment with physical contact, in other words, learners were required to attach the skin temperature sensor to the nose area. Moreover, the surrounded environment could effect to the emotion of learners. Nevertheless, the result of this study could suggest that skin temperature is considered to be another practical index for classifying the difference between interactive and non-interactive material.

7. Conclusion

At present, the e-learning development further focuses on e-learning contents which can be adaptive to learners interests. For this purpose, physiological signals including skin temperature sensor were widely applied to measure their physiological response. Skin temperature analysis to investigate the significant difference against two types of e-learning material, interactive and non-interactive material, was studied. The nose skin temperature was obtained from skin temperature sensor during the learners was taking each material. The statistical approaches were used to analyze the collected skin temperature data. Then the significant difference in nose skin temperature between both materials was observed.

8. Future Work

According to the adaptive e-learning is considered to be an important issue in e-learning society because the usage of e-learning is increasing continuously. The efficient indicators to grasp the learners physiological response or interest are required to apply in the adaptive e-learning system. We are well aware that this kind of system will be practical and applicable to real use once the researches relating to learners physiological response are totally mature and the results are sufficiently reliable. Therefore, our future work will focus on conducting more experiments and measuring physiological signals by using different equipment. The

various types of e-learning material also will be applied in order to investigate the significant difference of physiological signal against them. Moreover, integrating the emotional model of recognition with the physiological signals also provides an interesting field for the future research in the adaptive e-learning system.

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