Poster: MARTO: Dynamic Control of Learning Materials Based on Learners State

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Abstract

E-learning using digital learning materials is widespread due to freedom in choosing time and space for learning. Often, these learning materials are provided uniformly regardless of the learners' knowledge and the attention. However, to maximize the power of digitized materials, the presented materials can be dynamically adapted to the learner's state of learning, in particular, the degree of concentration. Based on the background, we propose MARTO, a system to change the content of learning based on the concentration level of the learner using an EEG. We have also examined how properly the concentration level is obtained with EEG by comparing it with the result obtained with eye gaze movement.

Author Keywords

education, concentration, EEG

ACM Classification Keywords

J.3 LIFE AND MEDICAL SCIENCES

Introduction

The way of learning to acquire some knowledge has become manifold due to the spread of computers and information networks. People tend to use computers and mobile phones and this style of e-learning contributes to eliminate the constraints of time and place in the learning environment. Video learnings are especially popular in cram schools, where students prepare for entrance examination of universities. However, the materials used in such lectures are uniformly designed and the learner's state of attention to the materials is not taken into consideration. When a learner is not paying attention to the materials, the content may not be suitable for the learner. Furthermore, unlike paper textbooks, the digitized content of learning can be content. However, a unit to be dynamically controlled has branches and confluences.

Second, MARTO has Content Control (CC) to change the transition of SUs based on the information from the learner. In our basic design, CC obtains two kinds of

controlled to modify itself.
Based on the above background, we propose Multiple Access measuRement TOwords learning (MARTO), a system to change the content of learning based on the concentration level of the learner using an Electroencephalogram (EEG). In particular, we focus on the level of learner's concentration. EEG is widely used to speculate human's inner state macroscopically and it application to emotion recognition is also intensively explored [1]. In our previous work[2], we used EEG to provide a feedback to the lecturer with the information about concentration of the learners using EEG. In this work, we have also examined how properly the concentration level is obtained with EEG by comparing it with the result obtained with eye gaze movement.

System Architecture of MARTO

There are two key components in MARTO. First, the learning materials are designed to be dynamically controlled. To enable this, a unit to be learned is divided into sub-units (SUs). SUs are sequentially connected from the start to the end for a uniform

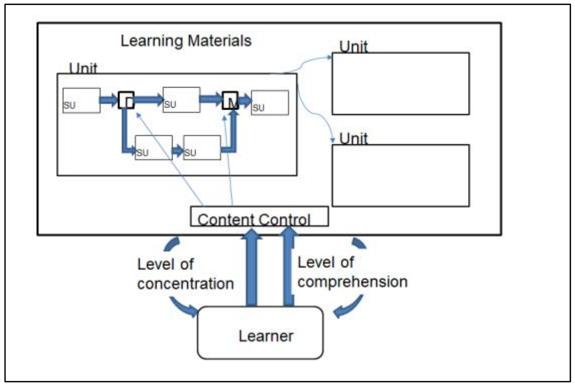

Figure 1: System Architecture of MARTO

Information: the level of concentration and comprehension. We use tests to identify the level of comprehension, but we have not implemented it. Currently, we are implementing the path for the level of concentration.

The level of concentration is calculated based on the strength of alpha wave as we did in the previous work [2]. It is continuously monitored and the calculated value is used at the branches of SUs.

Implementation

(1) Eye Tracker

An eye tracker is used in addition to EEG to show the validity of using an EEG. We use Eye tracker X60 developed by tobii. The device can obtain the gaze of a human at 60 Hz and the measurement is based on corneal reflex. The accuracy of focusing point is in the order of 1 cm at the distance of 60 cm.

EEG

We think EEGs become one of the COTS in the future to facilitate the acquisition of brain waves for many applications. However, as a basic experiment, we use a high-end EEG to collect more accurate signals. We used g.Nautilus manufactured by g.tec for MARTO for the first stage of research. The sampling frequency of g.Nautilus can be selected between 250 Hz and 500 Hz. Since the frequency of the brain waves is approximately 1 to 50 Hz, we think 250 Hz is sufficient for our measurement.

Experiment for Evaluation

We investigate the relationship between the eye gaze and the calculated level of concentration obtained with the EEG. Nine male students participated the experiment as subjects. We installed 16 EEG electrodes to a subject and asked him/her to watch a 970-movie lecture. The lecture is created by our group and its content is about neurotransmitters in the brain. Each subject is not acquainted with the knowledge in the lecture beforehand.

While the subject is watching the lecture video, his/her brain waves and eye gaze are simultaneously monitored with 0.5-s consecutive periods. For the eye gaze, we define the state of concentration when the eyesight of subject is directed at the monitor of lecture. At the same time, the level of concentration was calculated using the brain waves.

Results of Experiments

As a result of the experiment, we found differences in alpha and beta waves from three electrodes of O1, O2, Oz corresponding to the occipital lobes and six electrodes C3, C4, Cz, P3, P4, Pz corresponding the parietal lobe. A graph comparing the average of brain waves concentration and no concentration of ten subjects for each electrodes is shown in Figures 1 and 2.

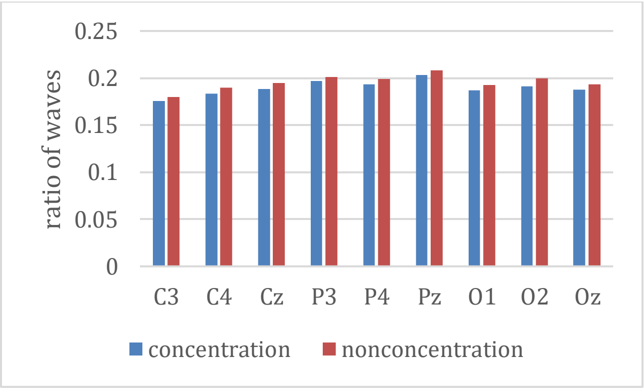

Figure 2: comparison of alpha waves

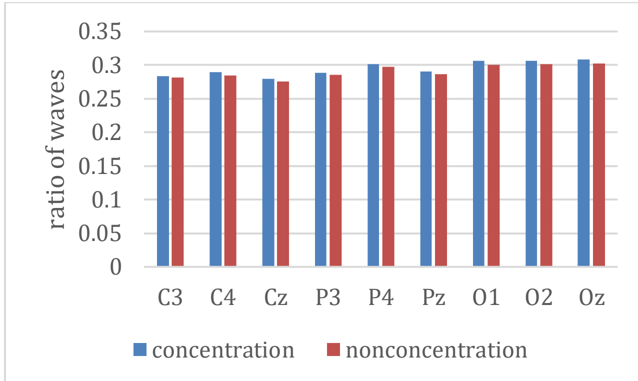

Figure 3: comparison of beta waves

Alpha waves were more frequent when they were not concentrating than when concentrating. This is consistent with the result of the related study [1]. It indicates that alpha waves are related to the concentrated state. On the contrary, beta waves are seen more frequently when concentrating.

	difference
alpha	0.0058
beta	-0.0045

Table 1: difference in states in parietal lobe and occipital lobe

We define μ as average and σ as standard deviation.

	μ	σ	$\mu+\sigma$	$\mu-\sigma$
alpha	0.0048	0.0019	0.0067	0.0027
beta	-0.0013	0.0054	0.0041	-0.0067

Table 2: difference in states of all

We look at the average of the differences due to the state at each electrode, alpha waves were 0.0058 and the beta waves were -0.0045. Alpha waves in the parietal and occipital lobes take values close to the mean plus standard deviation, therefore it has large tendency. Beta waves in the parietal and occipital lobes were not close to the mean - standard deviation, therefore it has small tendency.

Future Work

We considered only the state looking away from the picture as a not concentration state. It may be better to consider if you classify it as a decentralized state, that only a few seconds before and after diverting the line of sight, not just the moment when you diverted your line of sight.

Summary

In this paper, we have described MARTO, a system to dynamically control the learning materials with monitoring the learner's state. For our future work, we design the control path based on the level of comprehension.

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