

# DETECTION OF LEARNER'S CONCENTRATION IN DISTANCE LEARNING SYSTEM

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## ABSTRACT

Learner's eyes in a distance learning class provides a meaningful information. The information of each learner's concentration to the content on the computer screen is very important for the instructor in order to improve his/her lecture skills. Currently, the learners can evaluate their instructor's lecture only through online questionnaire. However, there is a difficultness in using this way. In reality, the responses to the questionnaire do not reflect the true evaluation of the instructor's lecture skills. In other words, the learners provide positive response to the questionnaire and not negative response in order to satisfy their instructor. This is because they think that, their negative responses may bring negative impression towards their instructor. As a result, the instructor's lecture skills cannot be improved enough, hence, a novel automatic evaluation scheme to effectively reflect the learners' interests to the class is required. This study proposes a new algorithm to automatically detect each learner's concentration to the distance learning class through the biological information such as pupil variation, fixation duration, fixation frequency and eye blinks, and to send the feedback to the instructor if the learners tend not to be concentrated on the class. In this paper, the methodology to detect the learner's concentration to the class using an eye tracker device will be stated, and then the effectiveness of the proposed algorithm will be discussed through the evaluation experiments in terms of the detection accuracy, intuitive and subjective manners.

**Keywords:** Distance Learning, Learners, Concentration, Eye tracking, Fixation Duration.

## 1. INTRODUCTION

Recently, Distance learning (D-learning) systems have gained popularity in higher education facilities. D-learning provides an access to learning when the source of information and the learners are separated by

time and distance, hence, the interaction between learner's and instructor is missing [1],[2]. Due to the absence of physical direct interaction between the learners and instructor, it is difficult in some cases for the instructor to recognize the learners' conditions during the class. Therefore, in order to evaluate the quality of instructor's presentation skills, the learners answer the given online questionnaire to provide the feedback. However, the study conducted by [3] shows that the learners are afraid of honestly evaluating the instructor based on their performance because they doubt that their evaluation might bring the negative impression towards their instructor which might affect them academically, especially in the aspect of the final examination assessment. In other words, the learners provide the positive assessments in their evaluation in order to satisfy their instructor. Recently, a few studies have focused on ensuring the quality of teaching and learning [4], [5], however, they focused much on learners' emotions.

In this paper, a new algorithm, which detects each learner's concentration in d-learning class through the biological information such as pupil variation, fixation duration, fixation frequency and eye blinks, will be proposed. More specifically, this study will focus on a computer based distance learning. During the real time class, the student's eye movements will be recorded in the eye tracking system and analyzed. If more than the threshold number of the learners are not concentrated in the class, the instructor will receive the alert in order to adjust the teaching strategy accordingly. This study will focus on the improvement of the instructor's presentation skills by considering two conditions from the learners, which are "concentrated" and "not concentrated".

The rest of the paper is organized as follows: The basics of the eye tracking technology will be presented in Section 2, Subsequently, Section 3 will review the related work and Section 4 will describe the proposed

system Design. In section 5, the evaluation of the proposed system through experiment will be described and discussion of the results will be stated in Section 6. Finally, in section 7, this paper will be concluded and the future work possibilities will be provided as well.

## 2. EYE TRACKING SYSTEM

Eye tracking is the process of measuring the point of gaze on a computer display. The device which performs the process is called eye tracker. It operates in contact with the user's eyes and the eye activities are recorded through the sensors located on both ends of the device. In nature, human eye is not still and it has instantaneous movements called saccades followed by the fixation duration from 200 to 600 msec [1]. [6] Relates the fixation duration with the mental activity and they argued that the fixation duration varies depending on the individual and the task which the user is performing.

## 3. RELATED WORK

To assess the learner's engagement in class during an ongoing class lecture is the hot topic in Human Computer Interaction (HCI) research to date. However, there are still many challenges that face online delivery courses. One of the challenges is about the best approach that could be used to evaluate the quality of online delivery [7]. Some studies have focused on assessment of the learner's concentration in the distance learning. In the study of [6] proposed the concentration level assessment (CLAS), which is crowdsourcing based approach to enable effective concentration assessment. In an online video class, they argued that the effective way of assessing the learner's concentration will help their instructors to adjust their teaching strategies accordingly. [8] proposed a web search learning environment called meta analyzer for assisting teachers in analyzing learners behavior using search engine problem, however, most of the studies focused on Asynchronous distance learning.

## 4. PROPOSED SYSTEM DESIGN

Figure 1. Shows the distance learning system. A learner accesses the class using a web browser from his/ her computer. During the class, the learner's eye activities will be recorded in the eye tracking system through the two sensors which are installed in the eye tracking system. The recorded information will be analyzed and interpreted into two conditions, namely, concentrated and not concentrated. If the number of the learners in the class who are not concentrated exceeds the threshold level, the alerting system will immediately send a message to the instructor. Being aware of the message on the instructors computer screen, the instructor will adjust the teaching strategy accordingly.

The framework design of the proposed distance learning system consists of four main components and four sub

components as described below;

### (1) Instructor

Designs and creates the course content, assignment and quiz as guided by the LMS, and interacts with the learner using the system.

### (2) Learner

Is an individual who has registered for the distance learning class and has all access to LMS. He/she performs class activities online while the device placed in front of him/her tracks his/her eyes movements.

### (3) Eye Tracking System

Tracks and records the learner's eyes movement information in real time manner using cornea reflection technique, and analyses the recorded data and determines if the learner is concentrated or not on the class.

### (4) Server

Comprises of four components; Web, Database, Alerting system and LMS.

#### Web server

Provides the web services as requested from LMS.

#### Database server

Is a storage system of all information requested from LMS.

#### Alerting system

Is a system that displays the message on the instructor's screen when more than the threshold number of the learners tend not to be concentrated.

#### LMS

Is a software application which guides the instructor how to manage documents such as presentation material and homework, and delivers the distance learning course.

## 5. EVALUATION

An experiment was conducted in order to evaluate the proposed system in terms of the pupil size variation. Before the experiment was started, the eye tracker device was connected to the computer via USB 3.0 interface. The eye tracker was placed beneath the computer display where the distance from the tracked subject to the eye tracker was 60 cm. The resolution of the display was 1600 x 900 pixels and the light intensity of the experimental environment was set to 120 lux.

The eye metric which has been considered to detect the learner's concentration in this study is pupil size variation. It is related to learner's mental activity in distance learning class. In order to detect the learner's concentration, two video lecture contents were prepared namely, interesting and boring video lectures. The interesting video is the video lecture which is related to learner's major and the bored video lecture is the one which is delivered in foreign language so the learner could not understand the lecture. Before experiment, each learner was asked if he/she had any problem

mentally and physically, then the learners who had no problem were selected as the subjects in this experiment.

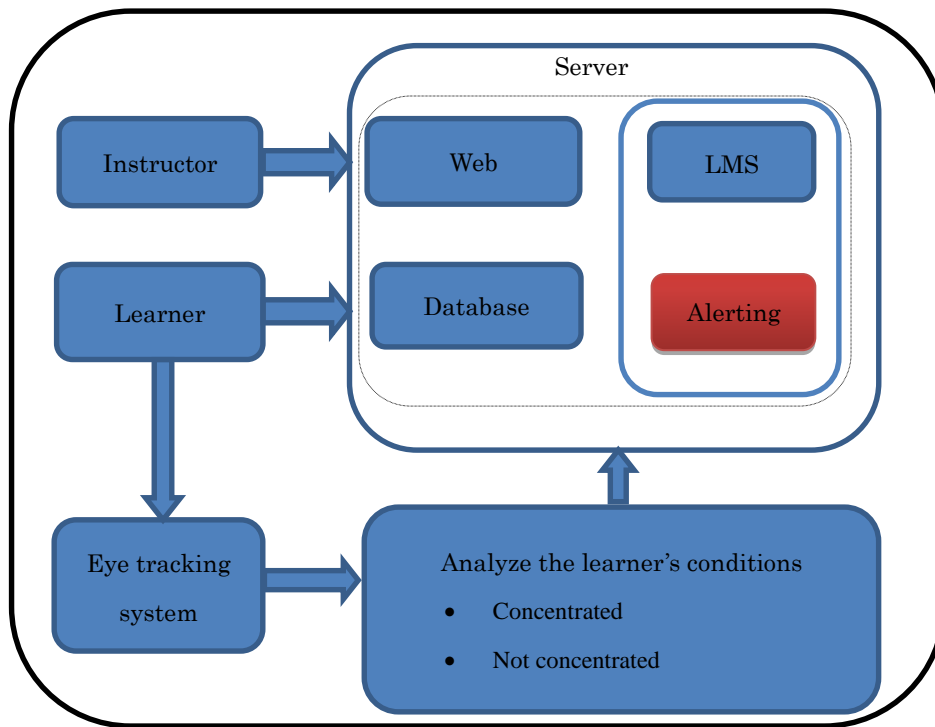


Figure 1. Proposed distance learning system

As the experiment procedure, the learner was instructed how to use the eye tracker. The system calibration was performed using nine dots to examine the area on the screen where the learner could view. After the calibration finished successfully, the information of the learner's eyes movements were recorded into the eye tracking system for five minutes on each video content. After recording, the learner was interviewed based on the video content in order to confirm whether the learner understood the content or not. The interview results is shown in Table 1. Finally, the pupil size for each video was analyzed compared to the normal pupil size. The normal pupil size is the size of the pupil before any task.

No. of Subjects	Video lecture 1 (Interested Video)	video lecture 2 (Video delivered in foreign language)
	Did you understand the content?	Did you understand the content?
1.	Yes	No
2.	Yes	No
3.	Yes	No
4.	Yes	No

Table 1. Summary of interview results after the experiment

The normal pupil size depends on the light intensity of the environment, but in general it varies between 2-6 mm. During the concentration the pupil size constricts until 1.5 mm from the normal condition and when the learner is not concentrated the pupil size dilates until 8 mm from the normal situation. Figure 2 illustrates the pupil size variation results for four subjects obtained by the experiment.

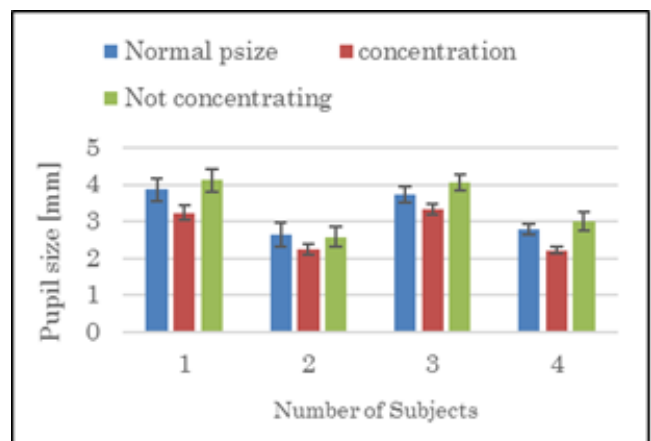


Figure 2. Pupil size variation obtained from the experiment

## 6. DISCUSSION

The result in figure 2 shows the difference in variation of the pupil size in three condition, namely, normal, concentrated and not concentrated. The results support the general hypothesis that the constriction of the pupil size implies concentration condition and the dilation of the pupil size implies no concentration condition. Based on the result, it is proven that the pupil variation is considered as a good parameter to detect the learner's concentration during the distance learning class.

## 7. CONCLUSION

In this paper, an automatic approach to detect learner's concentration in a distance learning class has been proposed. From the pupil variation result in Figure 2, it is proven that the learner's concentration can be detected automatically by using eye tracking system, however, the results for the other parameters have not, as yet, been discussed in this paper.

In future, more parameters to detect the learner's concentration such as saccades and Fixation Length will be studied. Moreover, an Electroencephalogram (EEG) will be studied and deployed in this study to detect the learner's concentration through brain activity.

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