Lecturer's e-Table (Server Terminal) Which Allows Monitoring the Location at Where Each Student is Looking During Lessons with e-Learning Contents Through Client Terminals

Kohei Arai
Graduate School of Science and Engineering
Saga University
Saga City, Japan

***Abstract*—Lecturer's e-Table (Server Terminal) which allows monitoring the location at where each student is looking during lessons with e-learning contents through Client Terminals is proposed. Through the lessons with e-learning contents through client terminal, it is obvious that student can take the lessons much efficiently when the student are looking at the appropriate location at where the lecturers would like the students look at. It, however, is not always that the student is looking at the appropriate location even if the system indicates the appropriate location. The proposed system of lecturer's e-table of server terminal allows monitoring the location at where each student is looking. Therefore, lecturer can make a caution to the student for the appropriate location at where the student has to be looking at. Through experiments with students, it is found that the achievement test score with the indication of appropriate location is much better than that without the indication. Also, learning efficiency with the caution is much greater than that without the caution.**

Keywords-e-learning; line of sight estimation; e-table for lecturers; eye based Human-Computer Interaction;

I. INTRODUCTION

e-learning is widely used for supplemental lessons with face-to-face lectures in a worldwide basis. The current problems of e-learning system is improvement of learning efficiency, effective e-learning contents (comprehensive), band width limitation, limitation of display size, question answering system, and authentication of students, etc. Other than these, students' manner for taking lessons is another problem. It is not always that the students' attitude for the lessons is properly right. Some of the students are looking at a different location at where e-learning content creators would like the students are looking at. Therefore, the achievement test score of the students is not good enough.

Lecturer's e-Table (Server Terminal) which allows monitoring the location at where each student is looking during lessons with e-learning contents through Client Terminals is proposed.

Through the lessons with e-learning contents through client terminal, it is obvious that student can take the lessons much efficiently when the student are looking at the appropriate location at where the lecturers would like the students look at. It, however, is not always that the student is looking at the appropriate location even if the system indicates the appropriate location.

The proposed system of lecturer's e-table of server terminal allows monitoring the location at where each student is looking. Therefore, lecturer can make a caution to the student for the appropriate location at where the student has to be looking at. Through experiments with students, it is found that the achievement test score with the indication of appropriate location is much better than that without the indication. Also, learning efficiency with the caution is much greater than that without the caution.

Computer key-in system by human eyes only (just by sight) is proposed [1], [2]. The system allows key-in when student looks at the desired key (for a while or with blink) in the screen keyboard displayed onto computer screen. Also blink detection accuracy had to be improved [3], [4].

Meanwhile, influence due to students' head pose, different cornea curvature for each student, illumination conditions, background conditions, reflected image (environmental image) on students' eyes, eyelashes affecting to pupil center detection, un-intentional blink, etc. are eliminated for gaze detection accuracy improvement [5]-[11]. Also e-learning system with student confidence level evaluation is proposed [12]. Furthermore, gaze estimation method and accuracy evaluation are well reported [13]-[23].

The following section describes the proposed system followed by implementation of the system. Then some experiments with students is describes together with achievement test score. Finally, conclusion is described with some discussions.

II. PROPOSED SYSTEM

A. System Configuration of the Proposed e-learning System with e-table for Lecturer

Figure 1 shows the system configuration of the proposed e-learning system with e-table for lecturer.

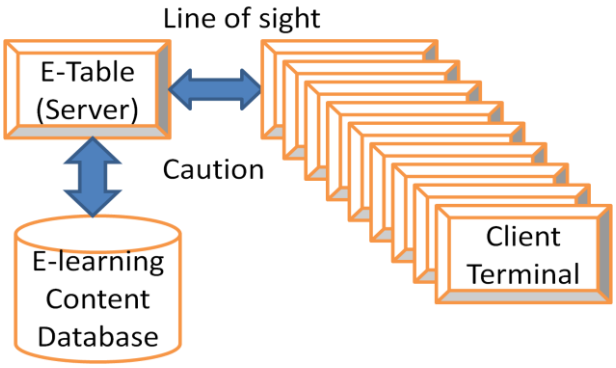


Fig. 1. system configuration of the proposed e-learning system with e-table for lecture

There is e-learning content database under the e-learning server. The server provides e-learning contents to the client terminals through e-Table of the e-learning server. In the client terminal, line of sight estimation system is equipped. Therefore, the lecturers can identify the location at where the students are looking. The location can be identified on the e-learning contents. The lecturers may choose the client display image by student by student. Therefore, the lecturers may awake the difference between the location at where lecturers would like the student in concern is looking and the location at where the student in concern is looking. If the location difference is too large, then the lecturers may give a caution to the student. It also can be done automatically. The system program measures the difference then the system provides a caution when it is beyond a threshold.

B. *Server and Client DisaplayLayout*

Fundamentally, the proposed e-learning system assumes synchronized mode of e-learning because the synchronized mode is much effective than on-demand mode. Therefore, lecturers may change e-learning operations freely. The proposed e-learning system may be used in on-demand mode as well.

There is e-Table for the lecturer as server machine with e-learning content database under the e-table. On the other hand, there are some clients terminals for students with line of sight estimation system which allows monitoring the display monitor location at where the student is looking. Lecture can monitor the students are looking on the display monitor during lessons by using the system.

Figure 2 shows the proposed e-Table server display image layout. The e-Table server display layout is divided into three portions, (a) portion of client display image with switch radio button for selection of student number of client display image, (b) server display image, and (c) control panel for manipulation of e-learning operations including stage selection. Using this e-Table server, lecturers can take a look at the client display image in concern by selecting the student with radio button. Lecturers also can control e-learning operation.

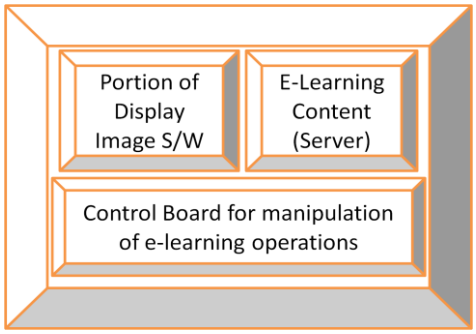


Fig. 2. Proposed e-Table server display image layout (Functions)

C. *Line of Sight Estimation*

One of the key issues here is line of sight estimation. Students wear a two Near Infrared: NIR cameras (NetCowBoy, DC-NCR130[1]) mounted glass. One camera acquires student eye while the other camera acquires computer screen which displays e-learning content. Outlook of the glass is shown in Figure 3 while the specification of NIR camera is shown in Table 1, respectively.

Fig. 3. Proposed glass with two NIR cameras

TABLE I. SPECIFICATION OF NIR CAMERA

Resolution	1,300,000pixels
Minimum distance	20cm
Frame rate	30fps
Minimum illumination	30lx
Size	52mm(W)x70mm(H)x65mm(D)
Weight	105g

An example of the acquired eye image with the NIR camera is shown in Figure 4 together with the binarized detected cornea and the extracted pupil image. In the NIR eye image shows a clearly different cornea from the sclera. In this case, although influence due to eyelash and eyelid is situated at the end of eye, not so significant influence is situated in the eye center. Also pupil is clearly extracted from the cornea center. NIR camera which shown in Table 1 has the six NIR Light Emission Diode: LEDs[2] which are situated along with the circle shape. The lights from the six LEDs are also detected in the extracted cornea.

[1] http://www.digitalcowboy.jp/support/drivers/dc-ncr130/index.html
[2] http://www.digitalcowboy.jp/

Fig. 4. An example of the acquired eye image with the NIR camera together with the binarized detected cornea and the extracted pupil image

Firstly, student has to conduct calibration for adjust the distance between the student and the computer display. In the calibration, student has to look at the four corners of the checkerboard which is displayed on the computer screen as shown in Figure 5.

Red rectangles in Figure 6 indicate the programming commands, the detected binarized cornea, and three corners of the checkerboard images.

Two images which are acquired with the camera 1 for student's eye and the camera 2 for the image of which student is now looking at.

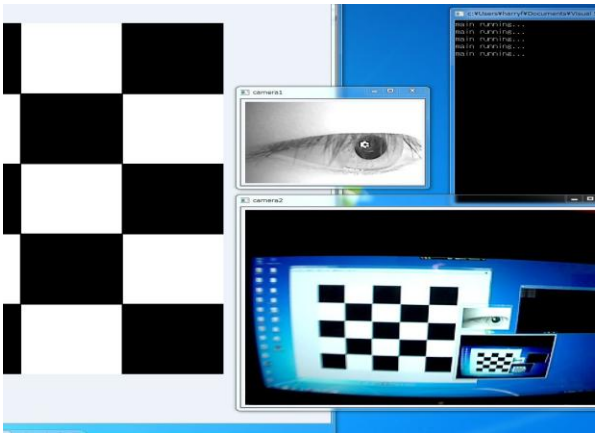


Fig. 5. An example of computer screen image which is showing commands for the computer program, student's eyes image together with checkerboard for calibration which allows estimation of distance between student and the computer screen.

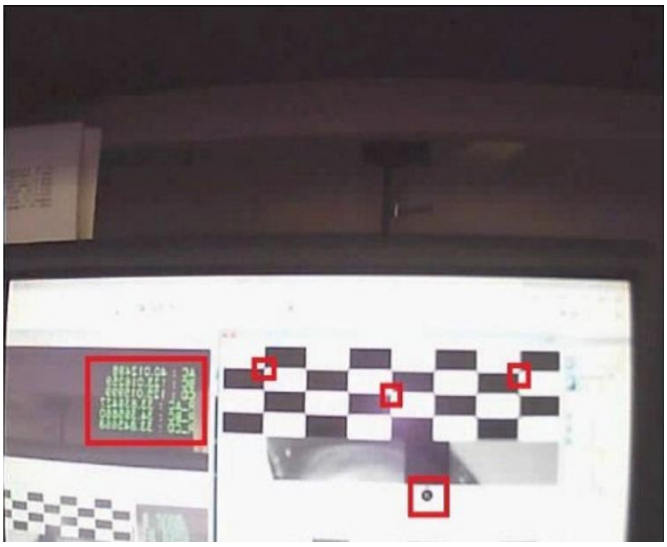


Fig. 6. The programming commands, the detected binarized cornea, and three corners of the checkerboard images.

At the bottom right in Figure 7 shows the image which is acquired with the camera 2. With the camera 1 acquired image, the system can estimate the gaze location. At the same time, the system can acquire the image of which the student is looking at.

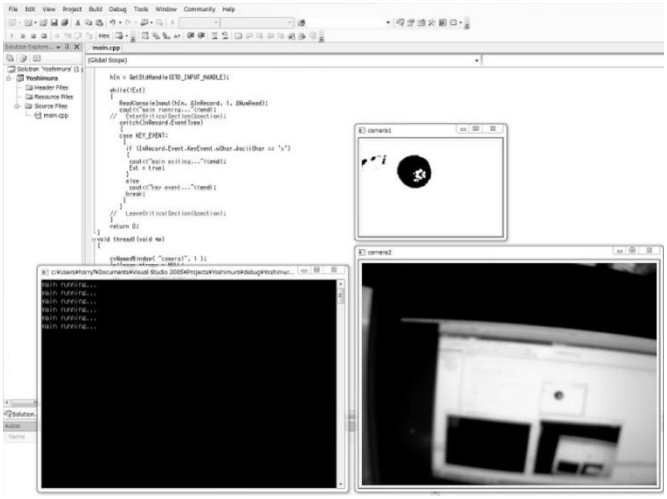


Fig. 7. Example of the image which is acquired with the camera 2 at the bottom right.

III. IMPLEMENTATION AND EXPERIEMENTS

A. *Implementation*

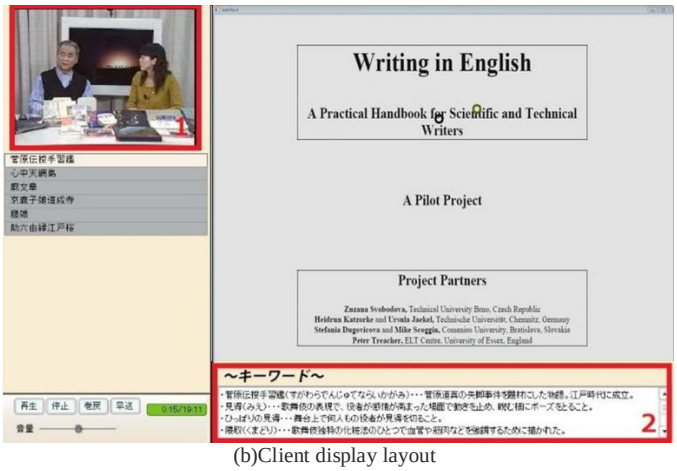
Figure 8 (a) shows an example of screen shot image of the proposed e-Table server display monitor of the e-table while Figure 8 (b) shows example of the display terminal of the client machine. On the top right portion of Figure 7 (a), there is e-learning content provided by the server while the client image can be seen on the top left portion with the black circle which indicates the location at where the lecturer would like the student is looking and with the green circle which indicates the location at where the student is looking. Also the student number is included in the client display image with radio button. Therefore, the lecture can change the client display image by student by student.

On the bottom right portion of Figure 8 (a), there is control panel for e-learning content reproducing while there is the other functionalities of the e-leaning system is situated on the bottom left portion. There are functions, Question and Answer: Q/A system, Bulletin Board System: BBS, Chatting, Making a Caution: MaC and so on.

Figure 8 (b) shows client display image. The location at where the lecturer would like the student is looking is indicated with red circle by frame by frame.

The experiment is conducted with the Document entitled "Writing in English –A Practical Handbook for Scientific and Technical Writers-" created by the European Commission of Leonard da Vinci Programme[3].

(a)E-Table server display layout



(b)Client display layout

Fig. 8. Example of server and client display layout

B. *Gaze Estimation Accuracy Evaluation*

The gaze instability is essential parameter in our system. It could influence typing accuracy. The ideal eye-based HCI should have gaze instability close to zero. Unfortunately, the zero gaze instability is difficult to be reached due to several causes such as flicker of the camera, noise, etc. Our proposed method will benefit on system with high gaze instability (unstable gaze output). We conducted gaze instability measurement by user follows the target point while we recorded the trajectory point of the gaze. The result is shown in **Error! Reference source not found.**9.

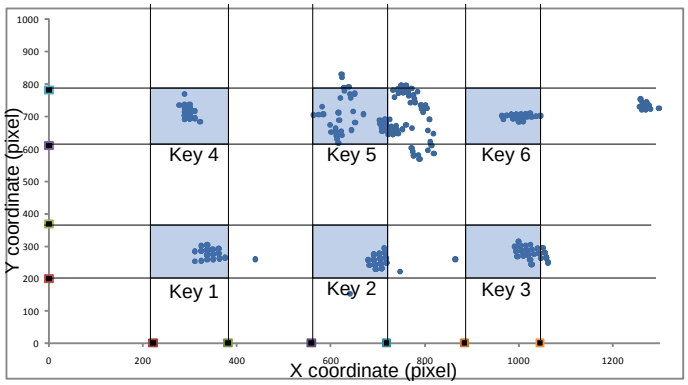


Fig. 9. Gaze instability. A single person looks at fixed five points on the screen while we recorded the trajectory points.

[3] http://afendirojan.files.wordpress.com/2010/04/writing-in-english-a-practical-handbook-for-scientific-and-technical-writers-2000.pdf

TABLE II. STANDARD DEVIATION OF GAZE INSTABILITY

Key	Standard Deviation (pixels)	
	x	y
1	13.19866	11.73971
2	11.38451	13.10489
3	20.65958	15.30955
4	7.167983	13.73321
5	108.7133	60.40783
6	100.1875	13.07776

In **Error! Reference source not found.**9, the trajectory points were taken while user was looking at 6 keys serially. This figure shows that at key 5, the gaze result has more scattered than others. It was caused by the position of eye at this key little bit occluded and it made the gaze result become unstable (the instability become increase). In other key, there is significant disturbance. The only noise from camera made the instability.

The standard deviation of gaze instability of each key is shown in Figure 9. It shows that our gaze estimation method has worst instability on key number five about 124 pixels. Therefore, gaze estimation accuracy is not good enough to identify one specific key.

Figure 10 shows a relation between blinking and the distance between the locations at where the student is looking and at where the lecturer would like the student is looking. As shown in Figure 10, it is fund that the timings are coincident between blinking and the distance is large as shown with red lines in Figure 10.

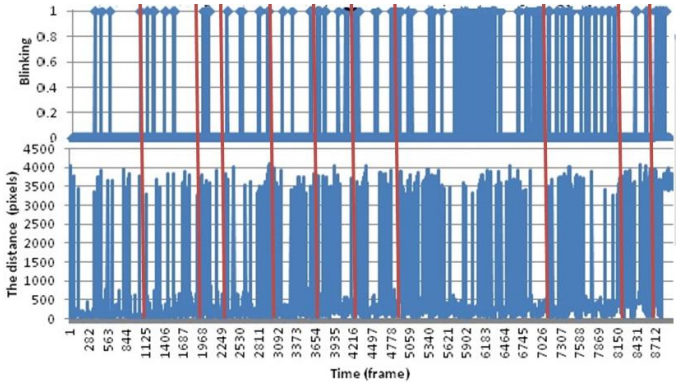


Fig. 10. Relation between blink timing and the timing at when the distance between the locations at where the student is looking and at where the lecturer would like the student is looking is large

IV. CONCLUSION

Lecturer's e-Table (Server Terminal) which allows monitoring the location at where each student is looking during lessons with e-learning contents through Client Terminals is proposed. Through the lessons with e-learning contents through client terminal, it is obvious that student can take the lessons much efficiently when the student are looking at the appropriate location at where the lecturers would like the students look at. It, however, is not always that the student is looking at the appropriate location even if the system indicates the appropriate location.

The proposed system of lecturer's e-table of server terminal allows monitoring the location at where each student is looking. Therefore, lecturer can make a caution to the student for the appropriate location at where the student has to be looking at. As the results from the experiment through e-learning lessons with Writing in English document, it is found that students made blinking when the distance between the location at where the lecturer would like the student to look and the location at where the student is looking is large. This implies that the student looses his/her concentration to the content. Therefore, achievement test result is good when the distance is small and vice versa.

Through experiments with students, it is found that the achievement test score with the indication of appropriate location is much better than that without the indication. Also, learning efficiency with the caution is much greater than that without the caution.

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AUTHORS PROFILE

Kohei Arai, He received BS, MS and PhD degrees in 1972, 1974 and 1982, respectively. He was with The Institute for Industrial Science and Technology of the University of Tokyo from April 1974 to December 1978 also was with National Space Development Agency of Japan from January, 1979 to March, 1990. During from 1985 to 1987, he was with Canada Centre for Remote Sensing as a Post Doctoral Fellow of National Science and Engineering Research Council of Canada. He moved to Saga University as a Professor in Department of Information Science on April 1990. He was a councilor for the Aeronautics and Space related to the Technology Committee of the Ministry of Science and Technology during from 1998 to 2000. He was a councilor of Saga University for 2002 and 2003. He also was an executive councilor for the Remote Sensing Society of Japan for 2003 to 2005. He is an Adjunct Professor of University of Arizona, USA since 1998. He also is Vice Chairman of the Commission "A" of ICSU/COSPAR since 2008. He wrote 30 books and published 322 journal papers