Handiness of device-free response analyzer systems in the classroom

Manabu Ito*, Motoki Miura

*Department of Applied Science for Integrated System Engineering, 
1-1 Sensui, Tobata, Kitakyushu Fukuoka, 804-8550, Japan

Faculty of Basic Sciences, Kyushu Institute of Technology, 
1-1 Sensui, Tobata, Kitakyushu Fukuoka, 804-8550, Japan

Abstract

Response analyzer systems with AR markers help teachers to gather data about students’ understanding levels quickly and at a low cost. In such systems, marker sheets held by students are recognized by front cameras that identify answers given by students. However, holding AR markers during classes is burdensome. Therefore, we propose a stationary marker for response analyzer systems. To evaluate the stationary marker system, we compared the conventional way of holding markers sheets with the proposed stationary method. The results show that the proposed stationary marker method is easier to use than the conventional method of holding markers.

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1. Introduction

To implement two-way, active classes, response analyzer systems with electronic devices such clicker tools and smartphones have been investigated. Response analyzer systems help teachers gather data about students’ answers to gauge the understanding levels of students in real time. Students do not fear making mistakes because they answer through devices. Therefore, students are engaged in the class more actively. Moreover, by using the gathered data regarding students’ understanding levels, teachers can assign students to a suitable difficulty class. However, response analyzer systems with electronic devices have the following two limitations.

- Teachers’ burden of managing the devices involved
- Cost of purchasing multiple devices

* Corresponding author. Tel.: +81-93-884-3429 ; fax: +81-93-884-3429. 
E-mail address: ito@ist.mns.kyutech.ac.jp
Teachers are burdened because they must carry as many devices as the number of students and charge the devices before each class. Moreover, the prohibitive cost of a large number of devices limits the introduction of response analyzer systems in regular classes.

To overcome the above limitations, device-free response analyzer systems have been developed\textsuperscript{3,4}. In such systems, students can send their answers to teachers by holding up a paper on which AR markers are printed. Cameras set up in the classroom recognize the markers held up by students. The AR markers contain students’ IDs, and the directions of the markers denote responses to multiple choices questions. Therefore, students carry AR markers themselves, the markers need not be charged, and the overall system cost decreases considerably. Moreover, teachers have to prepare only the markers and operate a PC to recognize them. However, the act of holding up papers during classes is troublesome for students, and it prevents students from making notes and thinking.

Therefore, we propose a stationary response analyzer system using AR markers. The proposed system comprises a quadrangular pyramid with AR markers on its sides. In the proposed system, students can convey their levels of understanding of a class to the teacher with the easy action of rotation by the self-standing marker. We adopted “random dot markers” that are robust to occlusion as AR markers in the proposed system. Random dot markers are suitable for device-free response analyzer systems because they can avoid obstacles such as other students and AR markers in the classroom.

We evaluate the stationary response analyzer system by comparing the stationary method with the conventional method of holding up response sheets. The responses of the test subjects were collected by administering a brief questionnaire after they used both systems to answer quizzes. The questionnaire responses show that the proposed stationary method is easier to use than the method of holding up response sheets.

2. Stationary Response Analyzer System

Figure 1 shows the proposed stationary response analyzer comprising a quadrangular pyramid having four markers with a red background. This response analyzer system is self-standing because of the use of three-dimensional markers. Students can provide their answers by simply rotating the markers. The number of choices is written in a small font on each side of the marker. This ensures that students know only their own answers and not those given by subsequent students.

These polka-dot markers are called “random dot markers.” A random dot marker having many dots is recognized by the arrangement of the dots. If some of the dots are not recognized by cameras, random dot markers play a part in AR markers. Marker IDs are recognized by comparing the recognized arrangement and the registered arrangement. Moreover, the red background stabilizes the marker recognition speed. In a classroom, other objects may limit recognition of the random dot markers. Therefore, we limit marker retrieval to the red regions. As a result, the marker retrieval speed of the proposed system does not depend on the surrounding environment.

3. Evaluation Experiment

To evaluate the stationary marker system, we compared the stationary method and the conventional method of holding up marker sheets. Test subjects were made to answer quizzes using both methods. Thereafter, they were made to answer easy questionnaires about the two methods. We analyzed these responses to check whether there was a significant difference between both methods.

3.1. Experiment Environment

The test subjects were 16 students from Kyushu Institute of Technology. Considering the marker recognition distance, we split the students into four groups, each containing 4 students, for performing the experiment. The experiments were conducted in three classrooms, and we shielded these rooms from external light.

In the stationary method, we used the proposed three-dimensional marker with a red background, as mentioned in the previous section. The stationary marker used in this experiment was a quadrangular-pyramid on which four different AR markers were printed. In the conventional method of holding up marker sheets, we used markers of about the same size as that of the stationary marker (Figure 2).
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