Portable Vision-based Response Analyzer with Sheet Bending Recognition

Manabu Ito
Department of Integrated System Engineering
Kyushu Institute of Technology
1-1 Sensui, Tobata, Kitakyushu, Fukuoka, 804-8550
Email: ito@ist.mns.kyutech.ac.jp

Motoki Miura
Faculty of Engineering
Kyushu Institute of Technology
1-1 Sensui, Tobata, Kitakyushu, Fukuoka, 804-8550
Email: miuramo@mns.kyutech.ac.jp

***Abstract*—Device-free response analyzer system, which employs fiducial marker sheets and its recognition technologies, has been proposed to reduce the management tasks of student devices such as clickers and smartphones. Conventional device-free response analyzer systems utilize a PC and cameras to realize the recognition of the fiducial markers. However, the installation of the PC and cameras requires additional burdens for teachers. We have implemented the function of device-free response analyzer on a tablet OS. Thanks to the portability of the tablets, the teachers can easily conduct the response analyzer lecture. We have also implemented a sheet bending recognition, which enhances the modality of the marker-based response analyzer, to our system.**

I. INTRODUCTION

In a lecture, communication between teachers and students is important. To facilitate the communication, a clicker tool that is one of response analyzer device for students to express their intentions has been developed. Using the clicker tool, a teacher can check students' understanding level quickly. In recent research, most students thought a clicker tool help them to get motivated for learning when the clicker was used in the class [1]. Then, active learning for students and efficient progress of a class are expected. But it is not easy to use many clicker tools in a large class because of the burden of managing devices and its cost of the special hardware.

Device-free response systems [2], [3] have been investigated to solve such problems by introducing a vision-based approach. The device-free response systems utilize response marker sheets instead of student devices. The response marker sheet is a paper or a cardboard that is printed an AR marker. Students answer by holding a response marker toward a teacher, and the teacher collects the answers through cameras connected to a PC. The system recognizes the direction and the ID of each student marker, and stores as a personal response.

Although the device-free approach is effective to reduce the burdens and costs, we consider that the following problems should be solved.

- The teachers should deploy a PC and cameras to conduct the lecture.
- The response marker sheet limits the number of communicable responses from students.

To solve these problems, we propose a portable system implementation for the device-free response analyzer. Also, we introduce a method of detecting bending amount of response marker sheets for the portable system.

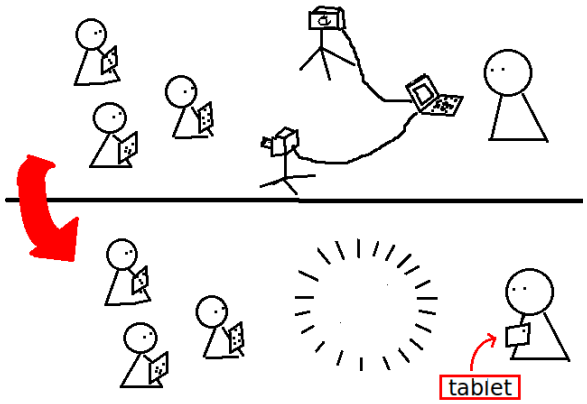

Fig. 1. Response analyzer with tablet

II. RESPONSE ANALYZER WITH TABLET

Figure 1 top shows a conventional usage scenario, which utilizes a PC and cameras to capture student marker sheets. In this scenario, teachers should deploy the PC and the cameras, and connect to each other. It takes time and efforts for daily lectures.

By using a tablet, the time and efforts can be diminished because the tablet usually contains a camera (Figure 1). The teachers can conduct a lecture with response analyzer by bringing their own tablet. Therefore, it does not take time to prepare equipment such as a PC and cameras.

Not only reducing the deployment efforts, but also the introducing tablet has the following advantages.

- Since the tablet is lightweight and compact, it is easy to carry to the classroom.
- Thanks to the portability, the tablet can cover wider area than a conventional static camera if the teacher moves/pans the tablet camera around the classroom.
- The result of recognition can be overlaid on the capturing image like augmenting the real scene. The teachers can instinctively understand the correspondence of the

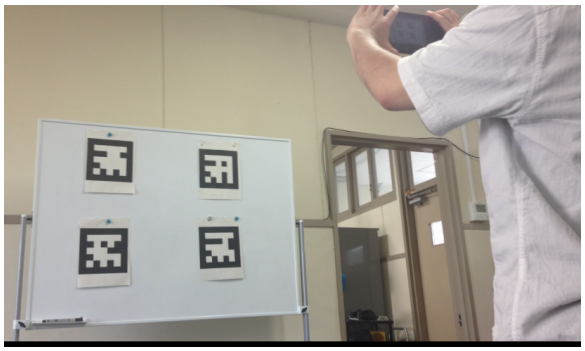

Fig. 2. Scene of shooting

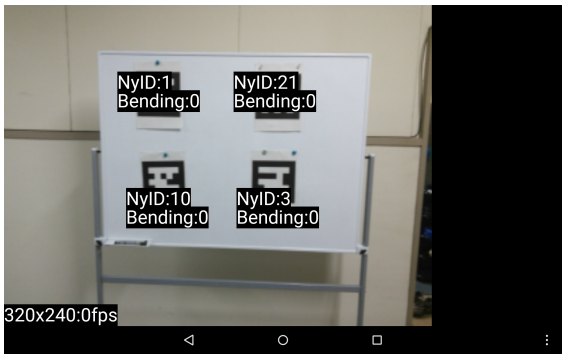

Fig. 3. Recognizing markers by tablet

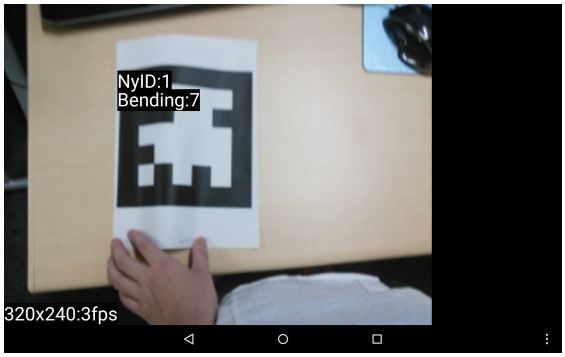

Fig. 4. Detecting the bending amount

response results and students by watching the tablet screen.

III. Bending amount

To increase the number of communicable responses from students, we introduce a method of detecting bending amount of response marker sheets for the portable system. The bending amount of response marker sheets can be modified easily and intuitively by students while holding the sheet. We consider that the bending amount can be used to express the students' emotion. For example, when the student has positive feeling, the student keeps the sheet flat. When the case of negative feeling, the student bends the sheet while holding.

We chose a bending detection method written in [4]. The method calculates the straightness of the marker edges, and estimates the bending amount. The straightness is determined by the distances from the point on the external border contours to the line segments between the corner points. This method can be applied to the conventional AR markers such as ARToolkit and NyID. Suzuki et. al. proposed a method that can detect markers on a cylindrical surface [5]. They introduced a special marker pattern that the border contains white dots. The special marker patterns can improve the accuracy of the bending amount. In our research, we employed the simple method with the regular markers, since the computational resource of the tablet is limited rather than PCs.

IV. proposed system

We implemented a prototype system on Android OS (Nexus 7). To recognize AR marker, we adopted NyARToolkit for Android. We employed NyID patterns for the response marker. NyID can be used without registration of marker patterns in advance. Figure 2 shows the shooting scene, and Figure 3 is the screenshot image of the shooting. Each ID of the marker sheets can be detected properly. We also confirmed the detection of bending amount by the tablet (see Figure 4). We had succeeded to recognize five NyID markers at the same time. The distance from the AR markers to the tablet was approximately two meters.

V. Conclusion and future works

In this paper, we proposed a portable system implementation for the device-free response analyzer. Also, we introduced a method of detecting bending amount of response marker sheets for the portable system. Since the tablet is highly portable, the teachers can employ the lectures with response analyzer easily. Also, the tablet is helpful for looking over all the markers in the classroom. As a future work, we improve the user interface for the teacher to rapidly grasp the tendency of answers. Also, a rotation of response marker sheet can increase the number of responses from students. To combine the rotation with the bending amount, it is expected to develop this system. We believe that the proposed system with a tablet enhances the usability of response analyzer system and makes the active learning popular.

References

[1] C. W. Huang, J. K. Liang, and H. Y. Wang, "EduClick: A Computer-Supported Formative Evaluation System with Wireless Devices in Ordinary Classroom," in *Proc. of Int. Conference on Computers in Education*, 2001, pp. 1462–1469.

[2] M. Miura and T. Nakada, "Device-Free Personal Response System based on Fiducial Markers," in *Proceedings of the 7th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education (WMUTE2012)*.

[3] A. Cross, E. Cutrell, and W. Thies, "Low-cost Audience Polling Using Computer Vision," in *Proceedings of the 25th Annual ACM Symposium on User Interface Software and Technology*, ser. UIST '12. New York, NY, USA: ACM, 2012, pp. 45–54. [Online]. Available: http://doi.acm.org/10.1145/2380116.2380124

[4] M. Miura and T. Sui, "A Simple Sheet Bending Recognition for Augmenting a Two-dimensional Marker-based Response Analyzer," in *Proceedings of 4th Int. Conference on Informatics, Electronics & Vision (ICIEV15)*.

[5] A. SUZUKI, Y. MANABE, and N. YATA, "7-1 design of ar marker for cylindrical surface," *ITE Winter Annual Convention*, no. 2012, pp. 7–1–1, dec 2012, in Japanese. [Online]. Available: http://ci.nii.ac.jp/naid/110009669654/en/