Findings from Observational Studies of Mutual Assessment System "Sounding Board"

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Abstract

The authors have designed a system for mutual assessment using a handheld device, which can be used easily without disturbing the ongoing activity and can provide feedback on others' assessments instantly in various forms on an as-needed basis. To assess others with this system, a user has to point the terminal toward a target person and push a button. The bodily action of pointing the terminal toward the target produces a natural awareness in the participants concerning the assessor and the assesses. This paper describes an overview of the system and findings from observational studies of the experiment.

1. Introduction

Collaborative activities usually require participants to mutually assess each activity. For example, in discussions among elementary school students, each student expresses an assessment such as agreement or disagreement in diverse ways. Assessments are performed either explicitly, e.g., by utterances, or more implicitly, e.g., by thought. If we can record these actions, and present them visually and instantly, it will benefit both teachers and students. The teachers would be able to review the history and content of assessments and consequently provide more accurate evaluations, compared to the existing post-test or questionnaire evaluations. On the other hand, the students would be able to visualize the assessment activities instantly, and thus understand the ongoing lesson more thoroughly by observing other students' assessment activities.

Based on this concept, we designed a system, named "Sounding Board,"[1] for mutual assessment using a handheld device. The device can be used without interfering with the ongoing activities, and it instantly provides feedback on others' assessments in various forms, as needed.

The device used for assessment is handheld to facilitate the ease of choosing an assessment instantly while performing an action. The user points the device to the other participants to convey the intent of assessment. In this way, the Sounding Board system does not interfere with ongoing activities.

Finally, we conducted an experiment to test whether the Sounding Board system is easy enough to be used by elementary school students. We confirmed that the basic operation of the Sounding Board is feasible. We also obtained important findings regarding the use of handheld devices in education.

2. System implementation

2.1. System Overview

The Sounding Board system consists of an ID badge, which transmits the user ID, a handheld device for assessment, and a tally-and-display system.

Fig. 1 indicates the flow of assessment. Each student has a unique ID badge, placed on their chest, which transmits the ID code by infrared (IR) signaling, and a handheld input terminal. The input terminal receives and displays the ID from the badge of the target student. Then a learner pushes a button displayed on the screen that represents the content of the assessment. This selection is transmitted to the database server via a wireless network. The results are compared and displayed using a graphical representation.

2.2. ID badge

The dimensions of the ID badge are 59 × 79 mm. It consists of eight IR LEDs, two indicator LEDs, a PIC microprocessor (Microchip PIC16F628A), a DIP switch to set the ID, a lithium-ion battery, and a battery charger. The microprocessor generates

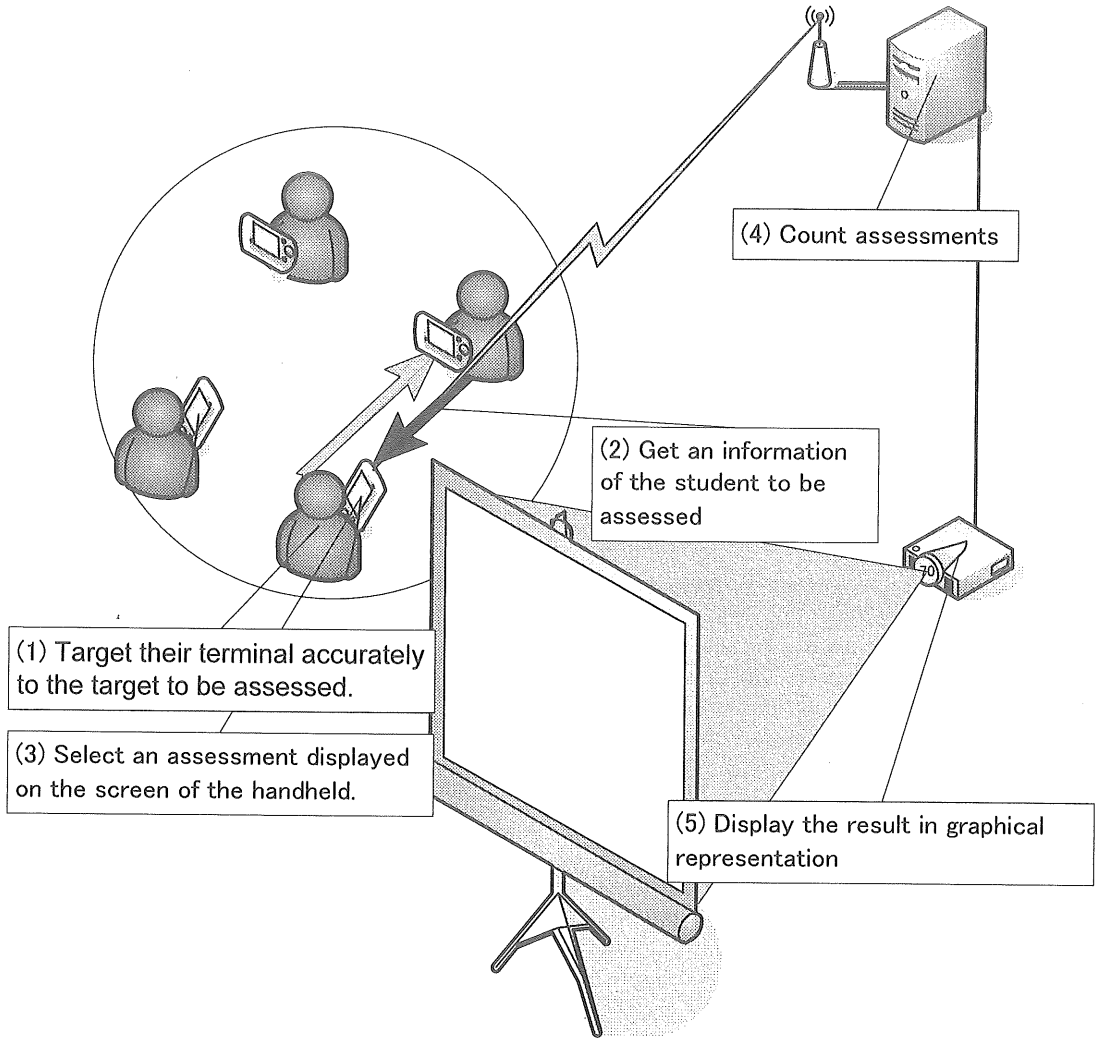

Figure 1. Overview of the Sounding Board system

bit strings for transmitting the ID and PWM pulses to modulate these bit strings.

If a number of badges simultaneously transmit IDs, transmission collisions prevent the receiver from recording these IDs correctly. The ID codes are therefore transmitted with random intervals of 30 to 80 ms between two transmissions. The IR LEDs were mounted on a PCB board at different tilt angles to capture the IR waves from not only the front but also the lateral side of the badge.

2.3. Assessment Terminal

2.3.1. Hardware Configuration. The handheld input terminal is composed of an IR receiver and a Windows CE handheld device (Hewlett Packard Hx2790b), which has a QVGA touch panel (240 × 320 dots), Compact Flash card slot, and IEEE 802.11b wireless device. The OS of the device is Microsoft Windows Mobile 2003 Second Edition for Pocket PC.

A revamped Compact Flash Type-II compatible RS-232C receiver (Ratoc REX-CF60) receives and decodes IDs transmitted from the badges. A PIC microprocessor (PIC16F648A) and an IR device (KODENSHI KSM-2003LM2EL) are added to the receiver. To limit the capture range, a privacy filter for PCs with a 30-degree capture range is attached to the handheld device. A user therefore has to point their terminal accurately to the target to be assessed.

2.3.2 Software Configuration. We developed an application for mutual assessment that can list the target students identified and then assess the

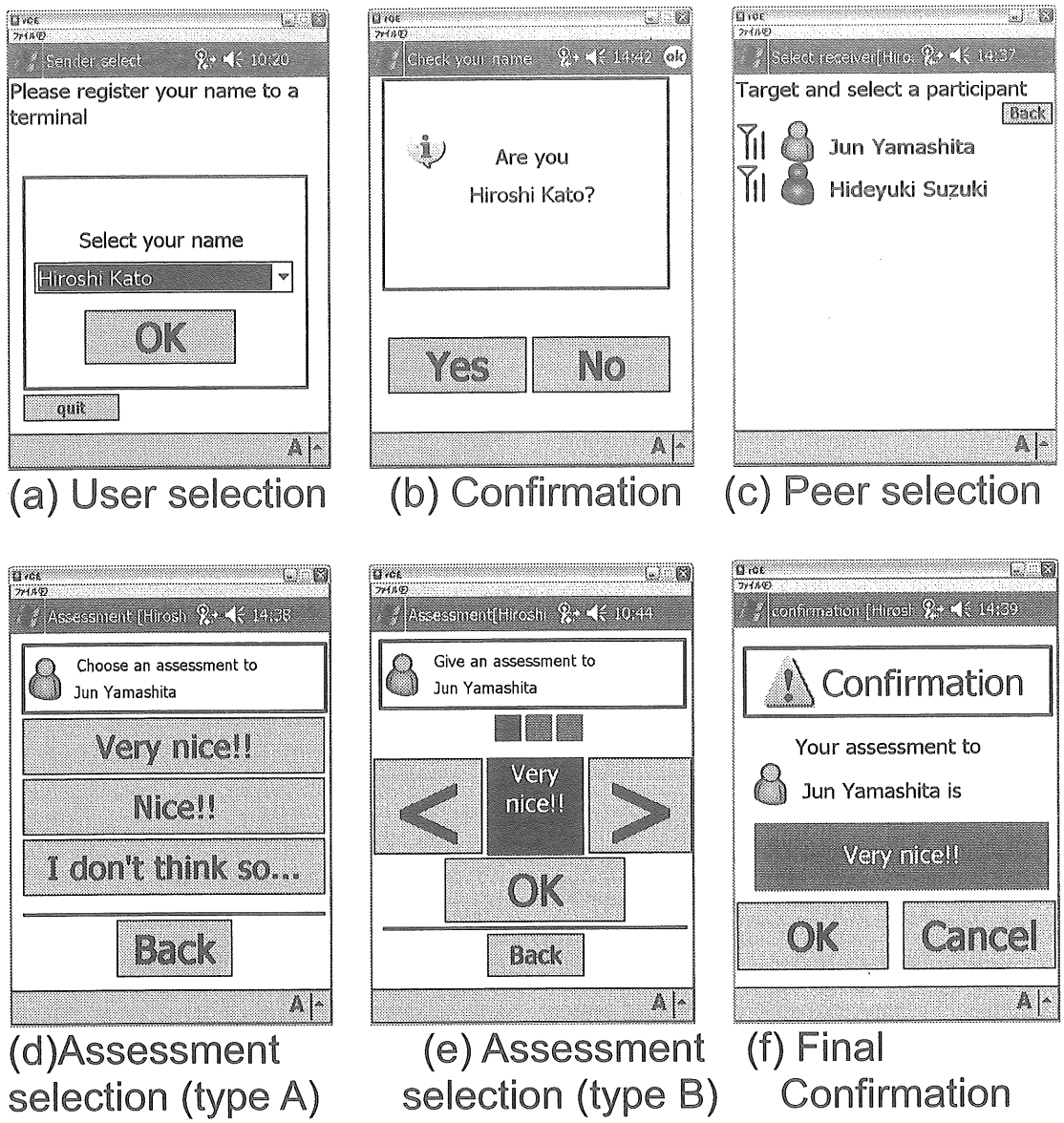

Figure 2. GUI design on the handheld assessment terminal

selected student. Although the rating scale depends on the lesson objectives and contents, the fundamental GUI design for assessment is common, being similar to that shown in Fig. 2. Through this application, users can use a dialog box to input their name (a), select the target to assess (c), choose the assessment (d) or (e), and confirm the assessment (f).

2.4. Tally-and-Display System

2.4.1. Assessment Database. An assessment database collects and stores the data transmitted asynchronously from the handheld input terminals via wireless networks. In addition, it stores the student's personal information (name, nickname, class, etc.), rating button attributes (design, sound, value, etc.), and allocation tables that represent individual students with individual terminals. A PC with Windows XP SP2 is used as the server. The software for collecting the data is written in PHP-5.2.2, and MySQL-5.0.41 is used as the database. The web server used is Apache-2.2.4.

The applications running on the handheld cannot access MySQL directly because there are no suitable libraries available to connect to the MySQL databases. To address this problem, we prepared a webpage to access the database, and applications on the handheld can access the database via this webpage.

2.4.2. Graphical Display System. A graphical display system written in PHP script retrieves data using specified conditions from the assessment database and summarizes the data by various representations. The assessment data input by students is instantly (with delay of a few seconds,

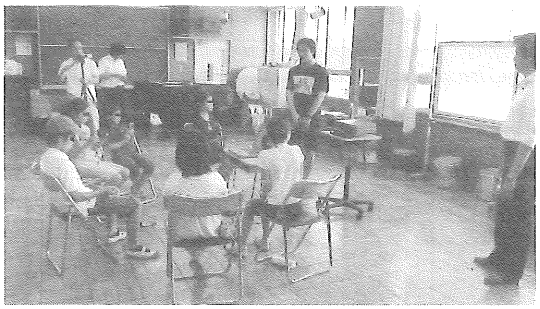

Figure 3. Experiment in the elementary school

depending on the server's processing capability) evaluated and displayed as charts, which can be used to generate real-time feedback for the students. This system offers six kinds of charts; however, in the experiment described below, we used only bar charts to display the information.

3. Experiment

We conducted an experiment to evaluate the system performance. The participants were elementary school students who used the Sounding Board in discussions. Fig. 3 is a shot from this experiment.

3.1 Experimental Condition

3.1.1 Participants. We recruited 6 fifth-grade students between 11 and 12 years of age.

3.1.2 Task. The task was to decide "Our favorite school lunch." The teacher moderated the discussion to change the flow of conversation. Each student nominated lunches and stated their properties. The other students then assessed the statement with the handheld devices. Finally, the teacher summarized their discussion, and the students assessed the nominated lunches and decided their favorite lunch. This discussion was videotaped using two cameras.

3.1.3 Recording of Handheld Device Operation. To record the students' operation of handheld devices, the assessment application data was recorded. Recorded data included the status of received IDs and the rating history.

3.1.4 Inquiry Survey. We conducted a questionnaire survey consisting of 13 items to test the usability of the Sounding Board system.

3.2. Usability of the Handheld Device

According to the results of the questionnaire survey, most of questionnaire items received

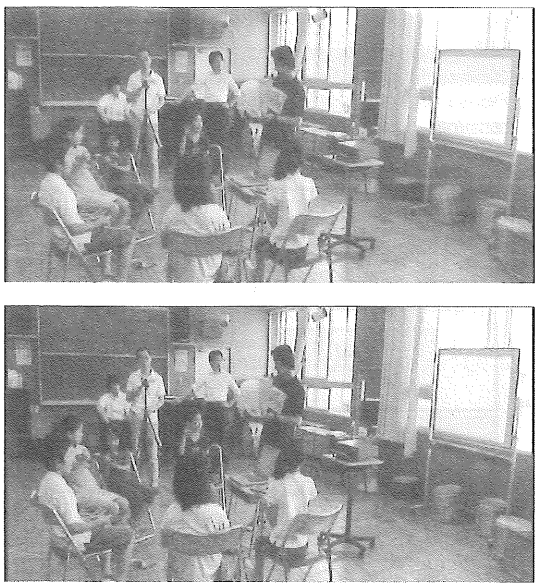

Figure 4. A student hide observed hand movement of her left side (above), and then she assessed the speaker (below) .

positive assessment. The opinions summarized from the survey are as follows:

- The assessment method proposed in this research has been widely accepted, even for elementary school students.
- The weight of the handheld device is approximately 200 g. Some students thought that this was heavy for handheld use.
- Some students were unable to instantly decide on the assessment rating.

In this experiment, we employed a three–point rating scale ("Dai-sansei," very nice; "Sansei," nice; "Soukana," I don't think so) for assessment, after consulting the teacher. The choice of the terms used and the score assigned to each term is highly controversial.

Comparison of the operation log and conversation transcript revealed that students who were not the speaker heard the speaker's statements and assessed them properly. In other words, the assessments were not selected randomly. The assessments by different students required a few seconds and were done almost simultaneously with each other. This suggests that each student could assess intuitively.

3.3. Observational Study

3.3.1. Influence of Body Movements on Assessment. Video analysis suggested that body movements influenced the flow of discussion effectively. When a student wants to assess someone, they first point their handheld device toward the target. This movement is easy to notice, and therefore, other participants know which student is being assessed. In this experiment, the

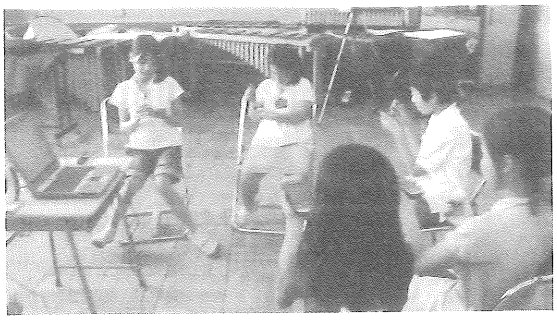

Figure 5. A student hide her badge by her hand.

following scene was observed (Fig. 4). A statement was given by a student. One of participants could not directly observe the speaker of this statement. However, she observed hand movements of other students to assess the speaker and determined the identity of the speaker. However, it is still unclear whether she fully understood the speakers' statement. Therefore, awareness of body movements is not enough to understand situations.

3.3.2. Location of the Badge. Similar to other badge-style devices such as Active Badge[2] by ORL and Meme tags[3] by MIT, the ID badge was also attached at the chest level. However, the experiment showed that this location is not optimal because a user's hand movements to operate the handheld device can hide the badge itself (Fig. 5). Another candidate location for the badge is the head. Usually, a user does not operate the handheld device in front of their head, and the badge will not be blocked by hand movements. A cap can be used to attach the badge. On the other hand, if the badge is attached at the head level, the motion to point to the targets will not be a natural one. Usually, when we identify people by pointing or some other action, we point at the targets chest, which involves a natural motion. If the badge is worn on the head, a user may need to point upwards, which is not always be considered natural.

3.3.3. Tilt Angle. The videotapes also showed that a student could not use the handheld terminal properly. This student could neither receive IR signals nor select peers displayed on the screen. This problem occurred because the tilt angles to capture IR signals and to look at the screen of the handheld device were different. The same problem happens when we use a remote control.

To select a peer user to assess, a user needs to hold their handheld device horizontally and receive IR signals. The user then taps the screen because many targets are displayed on the screen. Keeping the handheld device horizontal causes poor visibility of the screen. Therefore, a user needs to tilt the handheld device up; however, this angle is not suitable to receive IR signals.

To address this problem, we can attach an IR receiver to the handheld device at an angle. This angle satisfies both the IR signal reception and visibility of the display. In this instance, a user always tilts the handheld device toward the front. It is not clear whether this tilt hinders the aiming behavior. More detailed experiments are required to clarify this issue.

3.3.4. Changes in Formation. The Sounding Board enabled the teacher to examine the ideas of each student in detail. Assessments of students usually depend on the teacher's memory. The Sounding Board records each student's assessment on a time scale, enabling the teacher to form more accurate assessments.

The teacher also noticed changes in students' actions. We found a student who did not assess instantly, but always observed the teacher and waited for the right moment to speak. On the other hand, another student spoke less than usual, but the terminal's operation log showed more frequent operation of the terminal. He assessed all the speech activity in the discussion.

4. Summary

We developed a device named Sounding Board that enables mutual and instant assessment during an activity. We performed an experiment in an elementary school, whose students were able to operate the handheld device without difficulty. However, some technical problems are yet to be resolved, e.g., the trade-off between the viewing and IR receiving angles and the occlusion caused by hand.

5. Acknowledgments

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References

[1] Yamashita, J., Kato, H., Ichimaru, T., Suzuki, H. Sounding Board: A Handheld Device for Mutual Assessment in Education, In Proc. CHI2007 Extended Abstract, ACM Press (2007), 2783-2788.

[2] Want R. et al., The Active Badge Location System. ACM Trans. Information Systems, vol. 10, no. 1, pp. 91-102, January 1992.

[3] Borovoy, R., et al., Meme Tags and Community Mirrors: Moving from Conferences to Collaboration, in Proc. of Conference on Computer Supported Cooperative Work (CSCW-98), pp. 158-169, 1998.