AirTransNote: Augmented Classrooms with Digital Pen Devices and RFID Tags

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Abstract

This paper introduces our design of “AirTransNote,” a computer-mediated learning system that employs digital pen devices to minimize student’s exertion in classrooms. But although the design frees students from PC operation the teachers still have to handle their PC during their lectures. We have enhanced the system by introducing an RFID technique in which a portable controller enables the teacher to show a student’s note with an intuitive operation and enhance our concept of “Augmented Classroom.” Augmented Classroom enriches conventional classroom with augmented reality technologies. The design is presented along with a feasibility study that assesses the effect of the interface.

1 Introduction

Wireless networking technology greatly increases the degree of freedom in computer-mediated communications used in educational setting. The potential of widespread use of such technology is recognized and investigated[6], and the technologies have been applied in various ways. Many researches have focused on the “note taking” activity and many systems have been implemented [1, 5, 10, 11]. Since “note taking” is one of the fundamental practices across our classrooms, the paradigm is familiar to the students. However, almost all systems require the students to shift from the conventional learning style to a new one. And that requires special skills of handling digital devices. We believe that the effort for the behavior change in note taking should be minimal for the learners to maximize benefits.

We have developed a system “AirTransNote” for reducing the effort for the shift. AirTransNote [7] is designed to augment the learning/teaching activities in the traditional classroom by sharing notes. AirTransNote can capture student’s note written on a regular paper with a digital pen device and transmit the note to the teacher’s computer, which recognizes the note and allows the teacher to give feedback to the students immediately. We have introduced the real time transmission of both the student’s notes and the feedback using a PDA with wireless network connection. Our “paper-centric” design contributes to bring the computer-mediated learning into conventional classrooms, and it is felt that note taking on regular paper is more natural than on a tablet PC. For the student’s ease the system automatically connects to the teacher’s PC after a hot key is pressed on the PDA. The end result is that the paper-centric design of AirTransNote frees students from PC operation and helps focus the entire attention and effort on intelligent note taking.

However, former AirTransNote still requires the teachers to handle PC during a lecture, which may hinder their traditional teaching activity. To remedy such hindrance we introduce RFID technique into our system. This paper describes the design and also presents the result of the feasibility study of the new system.

2 AirTransNote with RFID Technique

Before explaining the new system design let us describe the purpose and typical usage of AirTransNote. In a traditional classroom a teacher may often raise a question to a student in order to check his/her comprehension. The student replies to the question, expresses his/her own ideas and transcribes his/her answer on the blackboard to share with other students. There is communication between the student and the teacher and between the teacher and the class. AirTransNote facilitates such communication by making these interactions smooth and effective by projecting the student’s note immediately on a shared large display for the benefit of the class.

AirTransNote comes with its own ATN Browser as a browsing tool. Initially, thumbnail image of each student’s note is arranged as the students’ seat arrangement (see Figure 1). When the teacher clicks on a thumbnail, the ATN Browser zooms in to the note to show the detail. The teacher can select the note by panning and zooming operations or clicking a student’s ID of the seat map on the control panel (top-left window of Figure 1). It was observed that some
students asked the teacher to “Please close up my answer numbered XX!” in previous experimental lecture and thus the interaction was activated.

It was found that the PC-based operation is not enough for teachers to utilize the system in lecture. One reason is that not all teachers are accustomed to operate a PC. Even though the operation of the ATN Browser is simple, some training is necessary. The other reason is more substantial. In our initial design, we predicted that the teacher would stay in front of the PC during the class and would check the students’ activities through ATN Browser. However, according to the observation of lecture with our former system, we found that the teacher preferred to walk around the classroom to instruct the student directly. In that situation the teacher is unable to project the student’s note immediately because the teacher has to walk back to the PC and that was not as timely and hindered smooth interaction.

The on-site direct selection of the student’s note can be realized by operating the student’s PDA, but a function of authentication will be necessary to keep out of mischief, and it is still inconvenient. Therefore we employ RFID technique by introducing a portable controller (Figure 2 left) for teachers to provide an easier way to select a student’s note. The portable controller consists of a PDA and a RFID reader1. Also we put a passive RFID tag sheet on each trans-mitter for student (see Figure 2 center). Figure 3 illustrates the design of an AirTransNote.

A typical scenario is as follows. The teacher walks to watch the student activities with the portable controller on hand. When the teacher wants to introduce a student’s note, he/she just hovers the controller on the student’s transmitter. The controller detects the RFID tag on the transmitter and sends a zooming command to the ATN Browser via wireless communication. Finally, the ATN Browser zooms in to the selected student’s note so as to show the entire region on the ATN Browser. Sometimes the entire view is insufficient to perceive the note content due to the resolution. Therefore, the ATN Browser comes with a tracking function. When the student takes note or draws figure after the “selection,” the ATN Browser automatically controls the view by zooming and panning, so as to show the note or drawing in proper (pre-defined) size (see Figure 4). Therefore the teacher can easily zoom into a student’s note even when standing right next to the student and the student can explain his/her note. The “selection by hovering” process is more intuitive than selecting student/transmitter ID by using PC, and surely reduces errors. Moreover the process relieves student’s anxiety about surprised projection, since the students can notice the teacher’s intention from his/her physical actions. Thus the portable controller contributes to the natural, intuitive, smooth and moderate interaction of note sharing.

In addition to the intuitive interface for teachers, introducing RFID technique provides two important benefits to both the teachers and the students. They are:

a. Reducing effort for deployment The portable controller and RFID tags can significantly reduce the effort in preparing the system in class. In the previous system without RFID tags, the teacher was obliged to distribute transmitters to students so that the transmitter’s ID matched to those of the student’s ID which took a long time. With the RFID tag, the teacher does not have to worry about matching the transmitter’s IDs with student’s because the teacher can access directly into the student’s note. When it needs to match the virtual note arrangement with real seat one,
the teacher can rearrange by picking up the transmitters by walking the classroom with the portable controller while the students are working. The “post-binding” method is effective in practical use. Moreover the post-binding method reduces administrative task. In the former system, we had to give a unique transmitter’s ID for each PDA. But we can substitute a device identifiable key such as MAC address for the transmitter’s ID.

Incidentally, matching the virtual note arrangement with student is necessary for further note reference after the class. And usually it can be completed by seat map with student ID. In case of indefinite seat, the teacher has to acquire extra student-specific IDs to tie up with the notes.

b. Using real estate of shared large display effectively
The previous ATN Browser had a control panel window, which enabled the teacher to shortcut to the student note by ID or the seat map. With the remote portable controller, the control panel window will seldom be used. Thus we can maximize the note window and show the note in more detailed view like Figure 4. Since the resolution of large display such as projector or plasma display is not high, the maximized view is preferable. The previous control panel is now implemented on the newer portable controller.

![Figure 3. Composition of AirTransNote](image)

3 Comparison with Other Systems

PDA based systems  Singh et al. [8] developed a collaborative note taking system in which the students could reuse the text in teacher’s slide or another member’s note by tapping to reduce the typing. Our system employs PDA as a device for transmitting note. Though the real estate problem even exists with our system in displaying comments, the digital pen can alleviate the efforts of inputting. Tallyn et al. [9] also pointed out the advantages of (augmented) paper media in educational settings.

Tablet-PC based systems  A Tablet PC is similar to a digital pen device in collecting time-stamped notes. The Tablet PC is more flexible than the digital pen in that it can change/modify the notes and its properties such as colors and thickness. Also the display can reflect the feedback with overlays. Thus many systems have been developed[4, 5, 6]. However, Tablet PC is large, heavy and quite expensive. Also it does not provide the natural feeling of taking notes, which is significantly different from taking notes on real paper. We consider that the familiarity is more important than flexibility especially in early stage of the computer-supported lecture.

Appliance for interaction  EduClick[3] employs wireless remote controllers for collecting student’s answers in class. The device is cheaper than a PDA and it consumes less electricity. The simplicity of EduClick will contribute casual and wider use but its shortcoming is that it only accepts selection-based responses.

4 Feasibility Study

We conducted a feasibility study in April 2005. The purpose of the study was to assess the effectiveness of the AirTransNote system including the proposed portable controller. We collected 20 volunteer participants who were all graduate students of the institute of the first author. The period of the experiment was one hour. We asked the participants to work out two types of question: geometry test and IQ quiz. We prepared them as “augmented worksheets,” which automatically give replies according to the participant’s selection. When the participant selects correct answer, the transmitter plays a “ding” sound; otherwise, it plays a low buzz sound. Also we prepared a questionnaire, which informs the acceptance of selection by sound. We
took first 5 minutes to distribute the three worksheets and explain the system, next 20 minutes for geometry test, next 20 minutes for the IQ quiz, and last 15 minutes for the questionnaire. The teacher utilized the portable controller to close up to the student’s answer, and let the students explain these questions. We made the session anonymous, that is, the virtual note arrangement differs from real seat one. The participants could not identify notes in thumbnail view with other participants. Figure 5 (a) and (b) show scenes of the study.

Results and Discussions

From the teacher’s view, the portable controller was very useful for closing up to a student’s note immediately. The teacher could easily select a student and let the student to explain his/her answer for the class. The student could explain the idea of solution by utilizing his/her notes and by adding extra annotations. We are convinced that the activity was one of the best utilization of our system. A slight drawback that surfaced during the experiment was the fact that the teacher tended to select students who sat on aisle seats. We hope this tendency is covered by relaxed seat arrangement and teacher’s attention. Regarding the improvement of the portable controller, it should be extended not only zooming but also other advanced operations such as showing an explanatory sheet or graphical chart which represents summarized result of the students’ answer.

Figure 6 shows the result of questionnaire items listed in Table 1. According to the result of Q1 and Q2, the participants thought this system is more suitable for exercise use rather than conventional one-to-many lecture style. Regarding the immediate transferring function of notes, 75% of participants were satisfied (Q3). However, other claimed that the system should provide an option not to send the note immediately. We implemented the real-time transferring because of the simplicity. Nevertheless, we have to consider alternative transferring options to satisfy all student choices.

The result of Q4 shows many participants were agreed with the effectiveness of sharing notes. Related to the sharing, as compared with our previous experiment on mathematical class at high school[7], few participants mentioned stress in this feasibility study. We thought the following five reasons would have affected the stress: (1) Difficulty and formality of the problem may aggravate, (2) Small answer area which prevents rewriting may aggravate, (3) Confidence that the answer is correct, which is given by feedback, may alleviate, (4) Anonymity in the thumbnail note view may alleviate, and (5) Recognition by physical hovering operation to publicize the note may alleviate. All factors were controlled to alleviate the student’s stress in this study. We have to investigate the effect of each factor in further experiments.

We had assigned “sound” for main feedback since we wanted to make the system transparent and invisible from the user. Consequently the transmitter often plays a sound as a reply. Most participants said that the feedback is important because it helps confirm the result. But some participants said that the system is too noisy to concentrate on the problem. One reason was that we missed the questionnaire sheet design; it replied to every stroke even in comment areas. We should design the augmented worksheet with care. Also the system allows the students to turn down the volume and the system should provide calmer feedback not to disturb the student’s learning.

Though several issues were disclosed no participants mentioned dissatisfaction with RFID. Thus, AirTransNote will be acceptable for students as well as teachers.

To facilitate the proposed activity, we have to reduce the additional tasks for managing. Though distributing task can be alleviated by RFID technique, the system still has an issue for recharging the battery. We will solve the issue by introducing special equipment similar to EduCart[2].
5 Conclusion

The paper-centric design of AirTransNote is effective since it frees the students from PC operation. However, the teachers were still required to handle their PC during the lecture. We introduced RFID technique to improve the efficiency of the teacher’s task. Also we described some additional advantages both in lecture and in preparing phases. As a result, we could show a realistic vision of the future classroom that is naturally augmented by technologies. Though the scenario we propose in this paper is limited to the simple note publicizing, the paper-centric note-taking system with wireless communication possesses a generality for enhancing conventional lectures. We continue to improve effectiveness, value, and usability of AirTransNote to infiltrate into lectures on conventional classroom.

References


