

Taking Notes on PDAs with Shared Text Input

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Abstract: This paper presents a system designed to support note taking on a wirelessly connected PDA in a classroom. The system leverages the devices' wireless connectivity to allow students to share their notes in real time, allowing individuals to quickly reuse words from their fellow note takers. In addition, presentation material such as Powerpoint slides are also extracted when presented by the teacher, giving students further means to reusing words. We describe the system and report on the findings of an initial user study where the system has been used for four months during a graduate level course on wireless mobile computing with 20 students.

Introduction

There is a tremendous opportunity in using Personal Digital Assistants (PDAs) and wireless networking technology in education and learning (Soloway, 2001). For example, PDAs have been used to increase participation in large classrooms (Ratto, 2003), or let users annotate slides remotely (Anderson, 2004). In our ongoing work, we are interested in supporting note taking because it is a ubiquitous activity for students. Unfortunately, text input on a PDA remains a challenge for novice or casual users. Soft-keyboards displayed on a screen for use by a stylus, or alternative text entry methods such as Graffiti are slow or hard to learn. Many systems have been designed to improve the speed of text entry (Darrah, 1990, Masui, 1998, MacKenzie, 2002).

Instead of developing yet another text entry mechanism, our attempt to make note taking more efficient and enjoyable on a PDA is to leverage the connectivity of the devices: the system circulates notes in real-time and displays them (Figure 1). At any time, a user can quickly reuse notes or words already entered by fellow note takers with a single tap on the words. Automatically, this word is added to the current note, saving time and effort to enter it again using the tedious soft-keyboard.

In addition to improving efficiency, circulating what others are writing makes note taking more lively and increases awareness, adding to the benefits of sharing notes after a meeting (Davis, 1999). To provide more choices and help users get started, the system also sends the image and text of the slide currently projected by the teacher. Again, users can quickly tap on the slide image to reuse words from the slide into their notes. Because many users already take notes on laptops, the Shared Text Input system is also accessible from a laptop computer (Figure 2). This provides two benefits. First, many more users get a chance to participate in the note taking activity. Second, notes taken on laptops provide a valuable source of words for PDA users where laptop users type very fast on their full size keyboards.

We bring two main contributions. First, the study shows that sharing text in real time does improve the efficiency of taking notes on a PDA. Students equally reuse text from the slide image and from the shared text. Secondly, the study shows that many students also value the awareness and communication aspects of the system. For example, some students do not retype a note already written by a fellow note taker. All students also use the system as a chat tool to communicate quietly during the lecture, asking each others questions. However, some students also felt overloaded by information as they tried to pay attention to both the lecture and the notes showing up in the shared text area.



Figure 1. The Shared Text Input applet accessed from a PDA in Pocket Internet Explorer. Users can quickly type in notes by reusing words from the slide image (bottom) or from the notes taken by their friends (middle). Users simply tap the word they need to paste it into their notes.

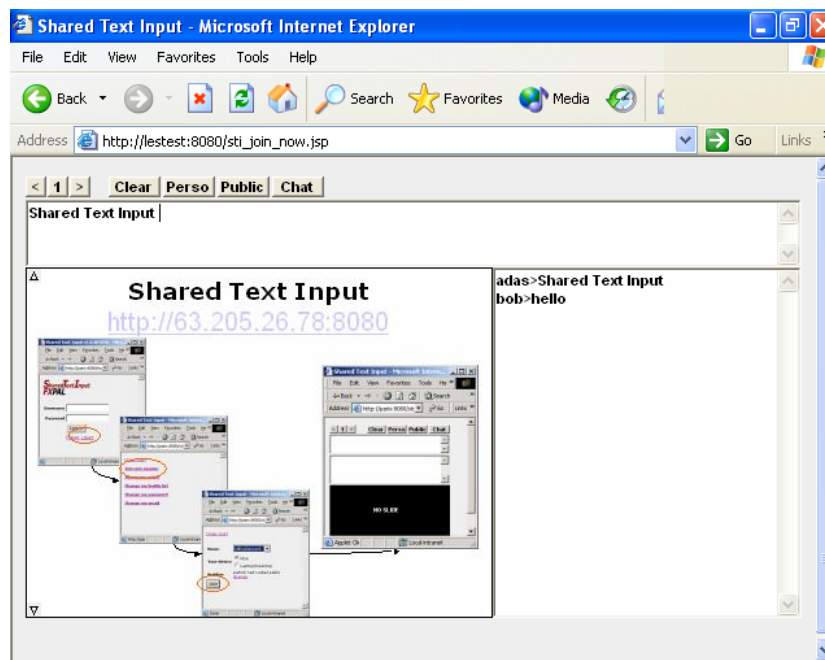


Figure 2. Shared Text Input accessed from a laptop.

Background

PDA and wireless networking technologies have become immensely successful in recent years. In addition to general use, there are significant opportunities for using them in education and learning. Soloway (2001) makes a case for the use of PDAs in K–12 education in schools, promoting the idea of one PDA per student. The opportunity

provided by wireless Internet learning devices for K–12 learning and education is further explored by Roschelle and Pea (2002). Several research prototypes have already been deployed, not only involving PDAs but also tablets PCs. Ultimately, all systems try to improve the classroom experience.

In ActiveClass (Ratto, 2003), the goal is to augment participation in classroom settings when class size and diversity tends to create passive modes of learning. Students can ask questions from a PDA and vote for other students' questions. At any time, the teacher can see the list of questions and choose to address the most popular ones. ActiveClass does not support note taking. We note that some students complained that their notes taken on paper could not be synchronized with the questions and answers brought up during the class. By integrating both, our system could solve that problem.

Pebbles (Myers, 2001) allows students to annotate presentation slides in real time by inking on their PDA, augmenting opportunities for students to ask questions by directly leaving comments or questions on the projected slide. Students cannot take personal notes and notes are not persistent but rather ephemeral traces of ink used for real-time annotation of slides.

Livenotes (Kam, 2002) is essentially a shared whiteboard application that uses wireless communication and pen-based computing to allow a real-time conversation within a small group of students. Students record handwritten notes on their respective tablets, such that the same notes appear in real time on the tablets of their group members who are also running the software.

Classroom Presenter (Anderson, 2004) focuses on providing the teacher with tools to annotate his or her slides in real-time from a TabletPC. The teacher can draw the attention of students on specific points and better explain concepts not originally shown on the prepared material by scribbling diagrams and adding text.

With NotePals (David 1999), students take their notes in digital ink on a PDA, and the notes are combined automatically into a shared document after the class. This system spreads note taking responsibility across the group, and group members need only PDAs during their meetings. However, NotePals only allows note sharing after the class and it is not possible to reuse material from others during the class.

Debbie (Berque, 2002) allows the students and teacher in a pen-based electronic classroom to share written information during class. The teacher can draw freehand sketches directly on the surface of the teacher-station's video-tablet or electronic whiteboard. Each student can write freehand on his or her display to make private annotations to the teacher's material. The teacher can import portions of a student's work space for viewing and discussion by the entire class. The teacher can also ask the students to sketch answers to problems that are related to the topic discussed. Because of this, class sessions tend to unfold as highly interactive activities.

StuPad (Truong, 1999) focuses on allowing students to add personal annotations on top of the slides being presented by the teacher. The underlying capture system is eClass (formerly Classroom 2000). One motivation of StuPad is to reduce the need for students to copy off notes already displayed by the teacher, so that students can better concentrate on the lecture. However, personal annotations are introduced so that students can still take notes for individual processing.

The System

Technology overview

The interface is implemented as Java applets, one designed to fit the size of a PDA, another to be used from a laptop. The server was developed in Java servlets served by Tomcat from Apache. Notes are stored in a MySQL database for later retrieval. The applets connect to the server with a socket, allowing the server to push new notes to each client. This synchronous communication makes sure that words can be reused as soon as other users make them available, making the system more useful than if the user had to manually refresh the list by pulling new notes from the server.

In addition to the server and java applets, a real-time slide extractor module was implemented in Visual Basic as a DLL add-on for Microsoft PowerPoint and installed on the teacher's laptop. When the teacher opens a PowerPoint file and presents it, the DLL receives an event from PowerPoint and is able to extract the JPEG of the slide. More

importantly, the DLL can query the PowerPoint Object Model to extract all textual elements and their location on the slide. When a user taps or clicks on a slide image, the system is thus able to retrieve the word located underneath. The DLL sends the image, the words and their bounding boxes to the server through a standard HTTP POST.

Experiment settings

In the experiment, the classroom had WIFI coverage available by all students from the PDAs and laptops. The teacher presented his slides using PowerPoint from a laptop also connected to the network with WIFI.

Users access the system through a normal Web browser that is Java-enabled. Compaq iPaq's were used for this experiment and configured with the Java Virtual Machine sold with the iPaq's (Jeode). The applet was then accessed from Pocket Internet Explorer as shown in Figure 1. All users were able to access the applet from their laptops, including one running Mac OS X.

Before taking notes, users are first presented with a list of all registered users. Individuals can choose with whom they want to share their notes. This feature was requested by several users prior to deployment. It allows users to work in study group and not share their notes with all connected students.

Taking notes

To enter a note, the user simply types in some text in the text box located at the top and clicks either the "perso", "chat" or "public" button. Clicking "perso" creates a personal note that no other user will be able to see, even after the class. "Chat" creates a note like in a standard chat application, with the text prefixed with the username. Only users selected on the logging screen will receive the chat note. "Public" works like "chat" except that the username is not added.

As already mentioned, a unique characteristic of our system is that users can reuse a word from the slide image or the shared text area with a single tap. The system automatically inserts this word into the note at the current insertion point. This is similar to doing a copy and paste, but is much faster and well suited to stylus input.

To help users select words from the scaled-down version of the slide, the system zooms in the word located under the stylus as the user moves the stylus. When the user finds the correct word, he/she lifts the stylus and this word is added to the note.

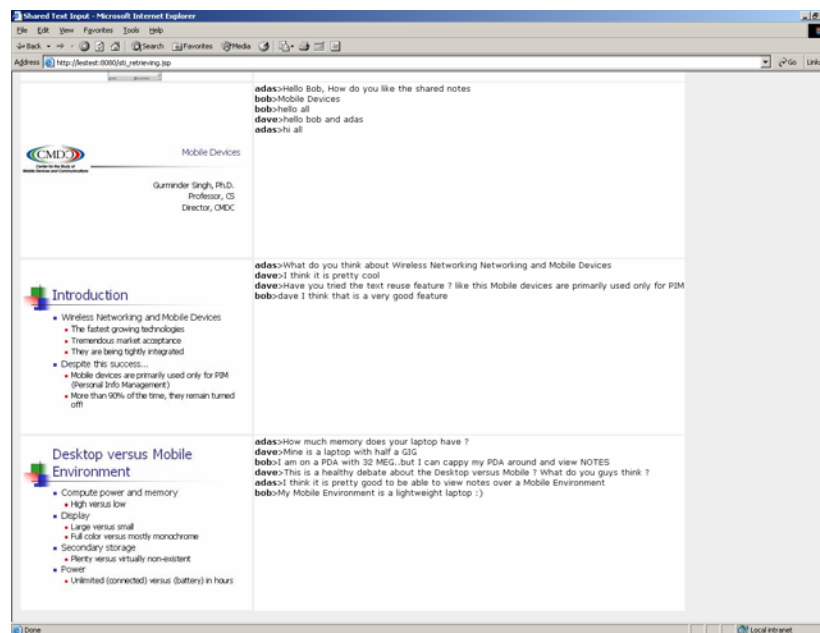


Figure 3. Students can retrieve their notes after the class from a standard Web browser. Notes are sorted by time and grouped by slide.

Note retrieval after the class

An important aspect of note taking is retrieving the notes after the class. This is supported by a set of Java Server Pages (JSPs) that allow students to visualize their notes and the notes taken by their friends from a standard Web browser (Figure 3). After users choose a date, the system generates a web page displaying the list of notes ordered by time and grouped around slides. For each group, this user's notes are displayed in bold, notes from others in normal font, chat messages are easily identified with the username in front, and personal notes are displayed in italic. By clicking on the slide image, users can get the higher resolution version.

Findings

We deployed the system at the Naval Postgraduate School in Monterey, CA in a class of 20 students during a four-month period from March to June 2003. 15 students chose to participate in our experiment and we lent them iPaq PDAs with wireless cards. Within three weeks, 5 users had switched back to using their own laptop instead of the PDAs. Some students said that they had switched because they could not keep the PDA after the experiment. However, these students still accessed the Collaborative Note Taking system from their laptop. Others used their laptops but discontinued using our system because notes were not stored locally. These students did not have access to the Internet from their home.

Log analysis

The database contained 1044 slides, captured during 33 classes. From the 15 registered students, 8 used the system to take notes and 7 never entered a note.

Three users only used the system for 2 days and we chose to remove them from the subsequent numbers presented here. The remaining 5 students used the system for more than 6 classes, with a maximum of 10. These active users took 400 notes in total. 10% of these notes contained words reused either from the shared area or from the slide image. Words were equally reused from the slide or the shared notes.

Focus group

The analysis coming from the database does not tell us about the user experience. Also, not reusing words does not mean they were useless: students could have read them without clicking on them. To better understand these points, we conducted a focus group with 5 students at the end of the experiment. 2 students were PDA users and 3 used laptops.

Two students expressed privacy concerns: they were not comfortable with sharing all their notes, even with their buddies selected at the beginning of the session. A student said that she was anxious while writing her notes because she knew they would be shared. Interestingly, she did not think about using the "Perso" button.

We also asked students for feedback about reusing words from the slide versus the shared text area. All students liked reusing text from the slide image by simply clicking on it. They liked it better than reusing words from the shared notes. As they were about to take a note, they knew what words to expect on the slide because it was the same being projected in the class. On the other hand, it was harder for them to locate words from the shared area. In this regard, laptop users suggested we implement a word completion technique that would suggest words from the shared text area as they type in their notes. A similar approach could also be implemented on the soft-keyboard on PDAs.

Interestingly, many students said that it was not necessary to reuse words from the shared area because these notes could be accessed later.

Two students complained about information overload when the shared text area became too crowded. They had no problem seeing the slide image because it was in sync with the slide being projected. In a previous version of the system, the server filtered the notes before distributing them to connected users, in essence keeping only keywords. Students quickly turned down this idea: they really saw value in seeing the whole sentences written by their friends. This feedback clearly indicates that students found the shared notes useful even when they don't reuse specific words.

We also asked permission to look at the notes themselves. Some contained a URL. When asked about it, the student said that he often looked for additional references during the class and shared his search results with his friends. However, he complained about the lack of feedback: he did not know whether or not his friends liked this recommendation. We have not yet fixed this problem but since our system knows who reuses what, it would be simple to indicate some feedback to the recommender.

Although reusing words from the slide or the shared text area was useful, students still had to enter most of their notes using the soft-keyboard on the PDAs. Most of these PDA users were frustrated. For a while, one student tested a foldable keyboard plugged into his PDA. But this solution turned out to be frustrating as well: he would have to lean forward all the time in order to see his note on the small display.

Many students also complained about networking problems. Besides variability in the wireless coverage within the classroom, students told us that the PDAs would automatically disconnect and switch off to save power. Unfortunately, the socket connection did not resume when students turned on the device. This engineering problem forced users to refresh the applet in Pocket Internet Explorer to start a new session. In doing so, they also lost the content of the shared area (but not the notes previously created).

Generally, although distributing the application using an applet was a simple solution, it also prevents the system from storing the notes locally. This is especially important in case of network failures but also if students want to read their notes from the PDA while disconnected. Students who had switched back to using their laptops cited this lack of local storage as the main problem.

Teacher's feedback

The teacher was very pleased with the experiment. The slide-extracting tool never failed and allowed him to make last-minute modifications before the class without having to copy the modified PowerPoint file onto the external Web server.

Also, because slides are only captured if displayed for more than 4 seconds, he could quickly jump through slides or not show the entire presentation during a class. This feature turned out to be useful when he could not cover all of what had been prepared.

Conclusions and future work

This initial experiment shows that reusing text from a slide or from other users in real-time is useful to students taking notes on a PDA. Although we had designed the system for PDA users, laptop users also liked seeing what others had typed.

We identified problems with information overload in the shared text area. A solution would be to filter out similar notes but not filtering out small words from each note: students want to see the complete notes. Presenting the slide image of the current slide was very useful and did not cause information overload. Reusing text from the slide was found to be easy and very useful to all users, including laptop users.

PDA users liked reusing words with a single-tap operation, but they were frustrated with the soft-keyboard for new words they had to enter, which according to our data still occurred for about 90% of their notes. A natural solution seems to use ink recognition on the PDA. Another approach is to leave ink as ink (Denoue, 2003), yet provide ways for users to seamlessly share text or ink across devices.

In addition to gathering and analyzing further classroom data, there are several additional opportunities for subsequent investigations. First of all, following up on the use of GSS technology at HICSS conferences (Valacich, 2001) and other workshops (Shirky, 2002), there is the question of how sharing notes can add value to workshop and conference settings. These kinds of technologies offer new ways in which to conduct background communication using a broader variety of devices and drawing upon both slides and previous communication to facilitate creating input. The technology thus offers increased opportunities for participation from the audience point of view, which, in turn is likely to enhance the amount of knowledge resulting from the meeting experience.

A second interesting opportunity relates to archival of notes and slides. Selected workshops often try to transcribe discussions that take place after a paper has been delivered. Our system and others provide an alternative means for capturing such discussion in digital form. This experience can then be reflected back to the classroom setting. How valuable are notes to students in the days after they have attended the lecture (Abowd, 1999)? What role do the notes play in preparing for a final examination or project? Do the notes still have value after the course is completed? What would be the impact of making such notes available to new students taking the course?

Finally, if it becomes easier to create notes, it is likely that more notes will be taken. If that is the case, how well will students be able to extract the information they need from those notes? Can summarization techniques be applied to make it easier for students to find what they are looking for in this new abundant resource of notes they, or others, have taken?

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