

Collaborating Note Taking

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Abstract

Collaborative note taking enables students in a class to take notes on their PDAs and share them with their “study group” in real-time. Students receive instructor’s slides on their PDAs as they are displayed by the instructor. As the individual members of the group take notes pertaining to the slide being presented, their notes are automatically sent to all members of the group. In addition, to reduce their typing, students can use text they receive from other students and from the instructors slides to construct their notes. This system has been used in actual practice for a graduate level course on wireless mobile computing. In developing this system, special attention has been paid to the task of inputting text on PDAs, efficient use of the screen real estate, dynamics among students, privacy and ease of use issues.

Keywords : Handheld devices, wireless networking, note taking, collaboration

Collaborating Note Taking

Introduction

In recent years, PDAs and wireless networking technologies have enjoyed tremendous market success. There has been an explosion in the different PDA and 802.11a/b/g products in the market. The two technologies are also being tightly integrated as evidenced by the availability of wireless equipped PDAs.

Despite their market success, these technologies are severely under-utilized (Singh, Denoue, Netke and Sacher 2003). PDAs are still primarily used for PIM (Personal Information Management) functions such as calendaring, to-do lists and contacts. More than 90% of the time, these devices remain switched off! This is despite several thousand applications being available on them. For example, Palm claims to support more than 19,000 applications (<http://palmsource.com/> dated 09/17/03) but the users typically use the same handful of applications.

There is a tremendous opportunity in using PDAs and wireless networking technology in education and learning (Soloway et al 2002). However, to realize the full potential of these technologies, several issues need to be addressed. In our work, we are addressing the following two issues:

- a) *Difficulty in the use of PDAs* – It is generally much harder to use the PDAs compared with desktop or laptop computers. Apart from several other difficulties in the use of PDAs, text input continues to remain a serious challenge for users.

Soft keyboards displayed on a screen for use by a stylus, or alternative text entry methods such as Graffiti are slow and/ or hard to learn.

- b) *Disconnect between the functionality the users need in their context of use and what is being delivered to them* - Porting PC applications to the PDA has not been a successful driver for their usage. Applications need to be developed that fit the use context of mobile users. In order to develop successful applications, one must develop a deep understanding of the application domain, understand the full potential and limitations of the devices and networks, understand the dynamics of mobile use, and then build the entire solution scenario keeping the human factors in mind.



Figure 1. Notes taken by students and text extracted from related material is shared among students

Text input is an integral part of any note taking activity. Given the difficulty that users face in inputting text on handhelds, we have implemented a collaborative note taking technique. It facilitates rapid input of text on small, networked devices by allowing users to reuse text entered by fellow note takers (Laurent, Chiu and Fuse 2002). In addition,

slides used by the teacher are presented as a thumbnail image on students handhelds from which they can reuse words.

We believe that there are significant advantages to making note taking in the class a collaborative activity. Similar to an instant messaging application, text notes originating from a user can be sent to the note-taking server, which can redistribute them to all study group members of the user.

We have implemented our collaborative note taking system keeping the above in mind and used it in a senior graduate level course on “Mobile Devices” in the Department of Computer Science, Naval Postgraduate School. Thirteen graduate students used a combination of HP-iPAQ PocketPC PDAs and laptop computers to receive slides, write notes and share them with their classmates. At the end of the course, we asked the students to fill-up a questionnaire and held meetings with them to receive their feedback. In addition, we analyzed data from the notes the system had collected.

The goal of this paper is describe our system, our experience in using the system, and the revisions made in the design for improved usefulness and usability.

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 et al (2001) make 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). Their article provides a coverage of a variety of efforts currently underway that make use of the handheld devices and wireless networking.

The problem of inputting text on PDAs has been explored by many people in the context of note taking in meetings or classroom. Our system enables rapid input of text on small networked devices by allowing users to reuse text entered by fellow note takers during a meeting or a presentation. In addition, circulating what others are writing makes note taking more lively and increases awareness, adding to the benefits of sharing notes after a meeting (see (Davis et al 1999)). To provide more choices and help users get started, the shared text is supplemented with text extracted from related material like past notes, meeting agendas or talk abstracts (see (Masui, 1998) for related work).

When developing handheld device-based systems, attention must be paid to the fact that even if the project starts with only one type of handheld device, the reality of markets will dictate that multiple device types must be handled. Because of the rapidly evolving nature of the handheld technology, new technology is being introduced in the market at a rather rapid pace. Typically, handheld devices go obsolete in their capability in about 10-12 months. This requires that the system must be able to deliver content to devices such that it makes the best use of the available device resources. This problem falls under the general theme of “content repurposing” (Singh 2004).

Description

Our collaborative note taking system works in a client-server mode (Figure 1) and has three main components:

- The user interface for creating notes
- A real-time slide extractor module
- The note server

Users access the system through a normal Web browser that is Java-enabled. In our current implementation, the teacher can only use Microsoft PowerPoint to present his/her slides. As slides are presented in the class, the system automatically captures the slide image and its textual content, and sends it to the note server. The server is mainly responsible for receiving slides and students notes, redistributing the notes to the appropriate students (as specified in the study group list in b Figure 2a), and storing all information into a relational database. We now describe the typical steps for using the system.

Logging and taking notes with Collaborative note taking

As shown in **Figure 2a**, users enter their username and select the members of their study group with whom they want to share their notes. The selected members are prompted to accept/reject the invitation to join the study group. They can then join the session.

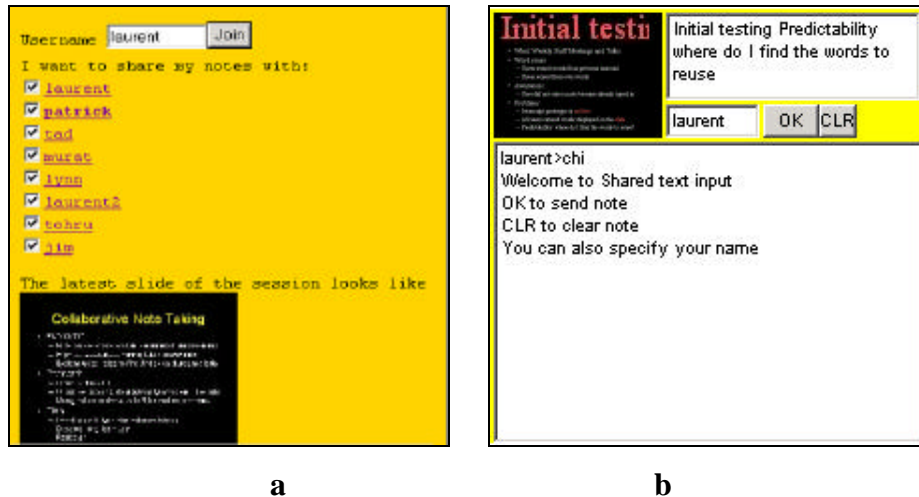


Figure 2. Users log in with their username and select their study group members. a) choosing the classroom and the device, either PDA or Laptop/Desktop, b) The user can now enter his/her notes. The PDA interface shown.

As shown in Figure 2b, the main interface is separated into 3 areas: the top left is the latest slide that was presented by the teacher; the top right contains the user's current note, and the bottom is the shared text area showing all notes taken by this student's buddies. To enter a note, the user simply types in text and click "OK". "CLR" is used to clear the content of the current note.

Reusing words from the slide and the shared text area

At any time, users can reuse words from either the slide image or the shared text area with a single tap on the corresponding words. The system automatically inserts this word into the current note. This is similar to doing a copy and paste, but it's much faster and well suited to stylus input. We explain in the implementation section how we were able to extract the words from the slide image.

Because of limited screen real estate on the PDA (240*320 pixels), we used a small thumbnail image to display the slide. To help users identify the text, the image is automatically zoomed in locally as users move the stylus over the thumbnail.

Note retrieval after the class

At their leisure, students can later access their notes from a standard Web browser (Figure 3). The system presents the list of the notes, grouped by date. Notes are displayed along with the slide that was shown at that time. By clicking on a thumbnail image, users can see a bigger version.

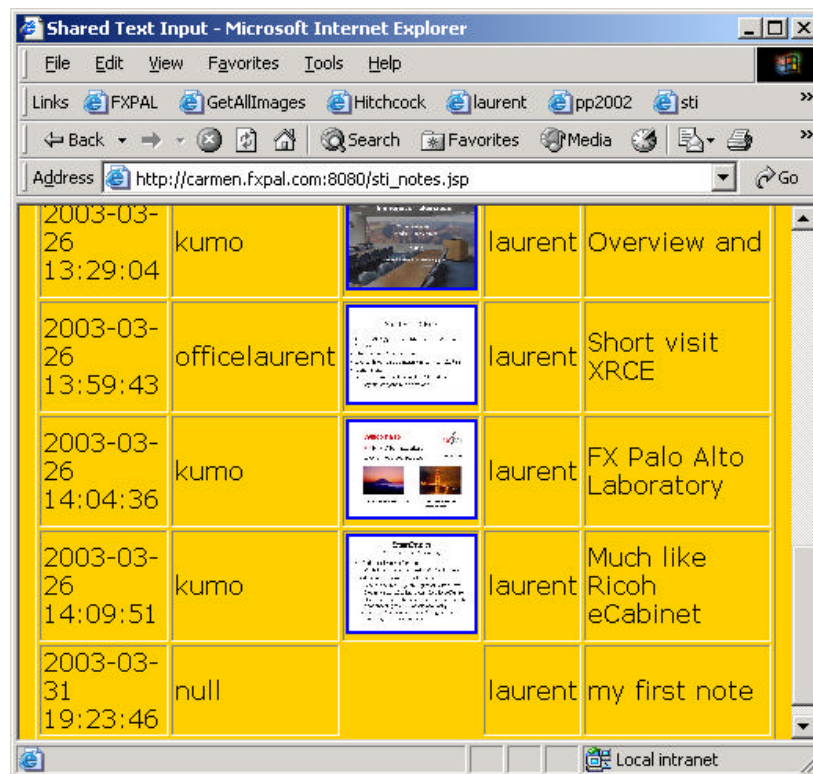


Figure 3. Note retrieval interface to access the notes after the class.

Implementation details

The Collaborative note taking server is implemented as a set of Servlets and Java Server Pages (JSPs). It currently runs under Windows and uses the MySQL to store all data, including slide images, textual content, notes and user preferences.

While connected to the system, the client applet uses a socket connection to receive and send notes from/to the server. The chat-like server component (spawned by the main Servlet at startup) relays the text and notifies clients of slide changes. We used an applet with a live connection to make the client applications more responsive to new slides and new notes.

A special add-on was written for PowerPoint in the form of a DLL. It is easy to deploy on a teacher's laptop and comes as a single DLL file. During the slide show mode, PowerPoint notifies our DLL for every slide change. The DLL accesses the PowerPoint Object Model to:

- Save the current slide as a JPEG image
- Extract the bounding boxes of the textual elements on the slide

It then sends both to the note server in a POST request using the Microsoft WinHTTP object. The server stores it in the MySQL database and notifies all connected users that a new slide is available. Each client downloads the image and the text bounding boxes from the server. In each client, a custom Java Panel component displays the image and lets users click on it to select the text underneath. This selected text is then inserted into the current note.

User testing

We used this 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. 13 students chose to participate in our experiment and we lent them HP iPAQ PocketPCs.

Interviews and observations prior to deployment

Prior to deploying the system, we observed that most students with laptops (10/20) opened PowerPoint and used the note field to take their notes during the class. One student used Word to take his notes. 2 students already had a PDA during the class, but they took their notes on paper; the PDAs were used to quickly check for references in Google using the wireless connection provided on the campus.

We also distributed a questionnaire to all students to understand their current note taking practices. 13 students responded. Students liked paper for its affordability and ease of use. Many students used laptops, but acknowledged their keyboard was not adapted to draw. In these cases, they still had a sheet of paper nearby. Students said that they manually copied a lot of information already shown on the projected slides. One student explained that manually writing the notes helped him remember the material better; others found it annoying but were forced to do it as the slides were not been handed out or made available electronically before the class.

Most students' notes are a linear recording of what the teacher says (10/13), but 9 students also declared including personal questions during the class. Most (12/13) students declared that being able to create connectors was critical for their note taking. Yet, we could not find any instance of that behavior during our observations on their laptops. One student with a laptop used a PostIt program to affix notes at specific locations on the slides within PowerPoint. All students said they did not have time to write everything they wanted. 4 students mentioned that the lectures were too fast; 2

thought that they wrote too slowly; 4 students declared asking for help during the class, and 7 after the class.

After an introduction of the system, we deployed it, giving students instructions to login from their PDAs and retrieving notes from the server

Feedback after 3 weeks

After an initial period where most students used the PDAs, an interview showed that 5 users had switched back to using their own laptops instead of the PDAs: they knew that they could not keep the PDAs after the experiment. However, these students still accessed the Collaborative note taking system from their laptop. 3 students who did not have a laptop switched back to paper: they directly annotated slides that were sometimes given out before each class. For the remaining of the experiment, we thus had 5 students using a PDA and 5 using a laptop. Students complained about 5 problems:

- Despite our zooming mechanism, the slide image was too small to accurately select text
- Students who had switched to their laptop asked for a bigger interface: we developed a special version of the applet where all three areas (slide image, shared area, personal notes) were larger. We also added a check box on the login screen where users could specify whether they were logging from a PDA or a laptop
- Students wanted to see the notes of their friends after the class even if they were not present. We modified the back-end JSP accordingly

- Students wanted to be able to navigate into their notes during the class, and possibly modify previous notes.
- Students did not like to check their buddies every time they logged in. We added a user preferences table in the database to store the buddies and added a few JSP pages to let students manage this list.

Lessons Learnt

Data analysis from the database

Ten students used the system from the end of March to June. 1085 slides were captured during 28 classes. 810 notes were taken. 229 notes (30%) contained words that had been reused either from the shared text area (59/229, or 25%) or from the slide images (170/229, or 75%). This result shows that students did find it useful to reuse words suggested either by fellow note takers or from the slide images.

Post experiment focus group

At the end of the experiment, we conducted a focus group with 5 students. Two of the students were PDA users and 3 used laptops for connecting to the system. Besides the size of the image slide, all students said that they could not reuse individual words from the slide image. Indeed, our initial slide-capturing tool only permitted the selection of a full line; since then, we have changed this component to allow the selection of individual words.

Two students also expressed privacy concerns: they were not comfortable with sharing all of their notes, even with their buddies selected at the beginning of the session. To solve this problem, we added a “personal note” button on the interface to let them create personal notes, accessible only to themselves.

Because the data showed that 75% of reused words came from the slides (compared to 25% from the shared text area), we asked students for feedback on this subject. Despite the usability issues with selecting text from the slide image, students found it easier to locate a word from the slide image than writing it from scratch. On the shared text area, it was harder to locate the words they needed. Furthermore, students did not find it necessary to reuse words from the shared area because they knew they could access the notes of their friends later using the web page.

Two students specifically complained about information overload when the shared text area became too crowded. They had no problem with 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 wanted to see the whole sentences written by their friends. An analysis of the data suggests a possible solution to this dilemma: many notes are similar in content, and the server could filter out similar notes instead of filtering out individual words. We have not tested this hypothesis.

Besides the quantitative analysis, we asked permission for looking at the notes themselves: some of them contained URLs. When asked, the student said that he would often look for additional references during the class and share his results with his friends. However, he complained about the lack of feedback: he did not know whether or not his friends liked this recommendation.

The instructor was very pleased with the experiment. The slide extracting tool was useful because the teacher could make last minutes 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, the teacher could quickly jump through slides or not show the entire document during a class; this feature turned out to be useful when the teacher could not cover all what had been prepared. This safeguard of 4 seconds is also useful because teachers sometimes add a few slides at the end of their presentations to prepare for possible questions, or to display additional references when needed.

Conclusions and Future Work

The data we collected and the feedback from the students validate our hypothesis that reusing text from a slide or from other users in real-time is useful to students. In addition, this experiment shows that the system not only improves text input speed, it also improves awareness among students during and after the class. We discovered problems with information overload in the shared text area and suggested a possible solution by filtering out similar notes before recommendation. However, presenting the slide image of the current slide was very useful and did not contribute to information overload.

Besides some usability problems due to the size of the thumbnail image and the capturing tool itself, users could quickly reuse words without spending too much time fishing for words.

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