Supporting Mobile Workgroups on a Wireless Campus

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Abstract: The daily life of a student involves a lot of collaborative activities with fellow students or faculty taking place in a variety of locations on the campus. We have implemented a number of location-aware applications to support the activities of mobile students workgroups. We describe the features of three of the most used applications, and we discuss some issues that we have encountered.

Keywords: group work, location aware applications, handheld computing, wireless campus

1 Introduction

Students on a campus are involved in collaborative work across different locations on a daily basis. Throughout a typical day, they might attend classes in different buildings, work on their own or in groups in dedicated locations (e.g., library, computer lab), meet with fellow students to work on common projects, meet with faculty, etc. Still, in contrast with other professions, there are no handheld tools to support students' activities. Taking advantage of the wireless network deployed on the Carnegie-Mellon University (CMU) campus, we have developed a set of applications to support students' workgroups.

2 Applications

The three applications we describe in this section complement each other by addressing different aspects of the students' collaboration needs. Portable Help Desk allows students to locate resources and people; MatchMaker addresses the need to locate a nearby expert; IdeaLink is a meeting support tool. We give an overview of each application's novel features. More details, including software architecture issues are presented in [1].

2.1 Portable Help Desk

The Portable Help Desk, or PHD, provides quick information retrieval. This tool allows a mobile student to build maps of their immediate area, including static and dynamic resources and the location of their colleagues, contact information and resources availability. While tracking a colleague, their contact information is displayed. Printer queues, restaurant hours and stock of carbonated beverages and food in connected vending machines can be displayed. The PHD application is a location aware system.

We have built both visual and audio interfaces for the PHD application. Each interface supports students in different contexts. A student who is walking around is less distracted by the hands-free speech interface, while a stationary student may use the richer visual interface.

Figure 1. Visual interface of the PHD application.

Figure 1 shows the visual interface for the PHD application. People and resources are selected in the left pane, the results of the queries are presented in the middle pane while locations of people and resources are displayed on the map in the right pane. The speech interface is free of the distraction of a visual interface enabling the person to walk about and retrieve information that should not be displayed in a public location. Speech-PHD utilities the same database of information, so all responses are formatted in similar manners. Figure 2 is a transcript of the same queries that were made in Figure 1. This system is aware of the person's current location, allowing it to answer questions such as "Where is the nearest ATM?"

Student: "Locate Fred."
Speech-PHD: "Fred is located in Hamburg Hall"

Student: " What is Bryan's phone number?"
Speech-PHD: "Bryan's phone number is 412-802-6819"

Figure 2. Transcript of the audio interface of the PHD application.

The usage scenario of the visual and audio-based PHD systems is to deliver relevant information to the student in both proactive and user driven manners. Proactive information is delivered to a person when they are engaging infrastructure resources such as printers. When a person begins a print job, PHD will alert them to a large print queue and suggest a nearby printer with a shorter print queue.

A design group waiting for a team member can use PHD to locate their missing colleague and estimate their time of arrival. This helps avoid repeating the beginning of a meeting for a late member. When the team is getting hungry, they can lookup the hours of nearby restaurants, find an ATM or just check if the coke machine is stocked.

2.2 Matchmaker

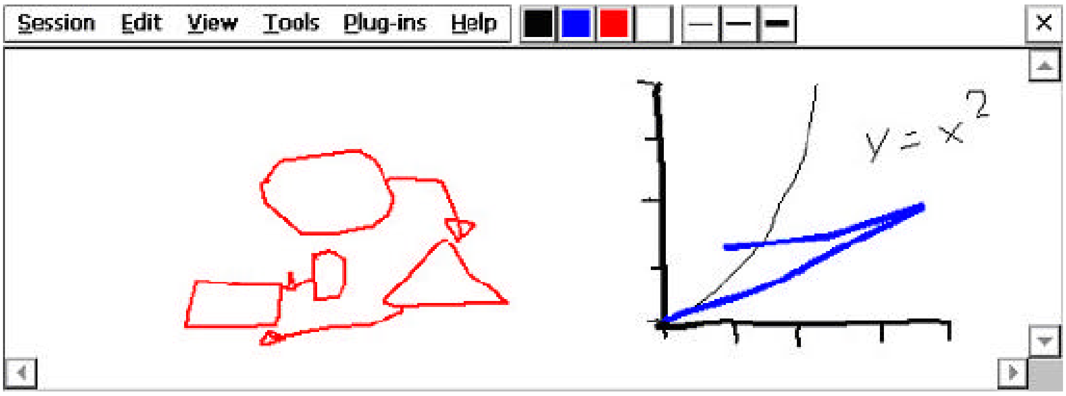
Matchmaker is an application that helps a student with a question rapidly identify an expert with the knowledge to answer. The suitability of an expert colleague may depend on many factors such as technical expertise, friendliness, proximity, and availability. Matchmaker infers expertise and skills by observing an expert's track record rather than by asking him explicitly. This application utilizes temporal context in determining the availability of an expert and spatial context in determining the distance between the student and expert.

The Matchmaker system connects a student's query with an expert who is located nearby, who is available, and who has a profile listing the skills needed and has a history of answering similar questions. By choosing an expert who is near the student initiating the question, the expert's time is not used for moving towards the student, unless face-to-face interaction is absolutely necessary. After contacting the expert with the question, the Matchmaker system then requests feedback from the chosen expert to determine if they are best suited to the question. The profile of the queried expert is updated in order to increase the accuracy of choosing experts. The Matchmaker system reduces the time and increases the efficiency of locating help.

Matchmaker system has been deployed and enables students to efficiently contact CMU's School of Computer Science Computing Support Group (CSG). The CSG maintains an extensive database of previously answered requests; this information enabled the system to generate profiles of the CSGs experts.

2.3 Idealink

Idealink is a virtual meeting tool optimized for small screens of portable devices. Students commonly use it on HP Jornada WinCE devices. The user interface is a shared whiteboard, which can be archived for later review. The interface is designed to utilize a minimum of screen area while preserving a whiteboard metaphor. The shared whiteboard is of infinite size and can be scrolled indefinitely in any direction. There is no explicit floor control: any person can draw at any time. Social protocols help solve conflicts and identify who drew what when needed.



Idealink is intended both for co-located and remote (e.g., over the telephone) collaboration. There is no enforced limit to the number of participants in an Idealink session, although it is designed with small groups in mind (2 to 5 people). The small size and the unobtrusiveness of the handheld devices on which Idealink runs are interesting properties: Contrary to a PC or even a laptop, the system's screen doesn't foster attention and is more easily put away when not in use. People can pay more attention to inter-personal interactions and shared artifacts.

3 Usage issues

The deployment of the applications we just described among showed a number of issues. We emphasize here two issues related to location awareness in mobile systems.

3.1 Location sensing

In our implementation, location is sensed through the 802.11b wireless network that covers the whole campus. More precisely, each network access point tracks mobile devices in its coverage zone. Typically, a base station will cover an area of a few hundred square feet. Thus, the granularity is insufficient to determine for instance, in which room, or even on which floor a device is. Additional work is under way to triangulate signals received by a mobile device from nearby base stations and thus provide fine-grain location information. A more serious problem that we encountered is that our mobile device can only be tracked when they are on. When a student moves from one activity to another, he or she usually turns off the device, thus hindering tracking. As a result, the tracking system will only be able to provide obsolete information. One lesson we draw from our experiences with location tracking is the need to accurately describe the quality of the sensed location information. For example, according to our framework for context information quality, granularity and freshness of the location information are quality attributes [2]. Providing this information to the application, and possibly to the student allows people to understand the limits of this technology, and use it with care.

3.2 Privacy of location

Privacy is of course a serious issue when applications, and thus colleagues, start tracking people's whereabouts. While PHD for instance, offers a valuable service to collaborating workgroups, the location sensing ability of the system is also a liability. We have developed a specific tool, called Privacy Guard, to allow people to protect their information. Privacy Guard enables basic privacy policies in addition to advanced expressions describing people, groups and time periods where a person's location can and cannot be reported. Location information and permissions are securely sent to a central server. When the server receives a query for a person's location, the server compares the requesting client with the permissions of the tracked person. The client then receives the location of the person or a refusal to answer the request. Privacy Guard works as a first line of defense to guard against gross privacy invasions. However, further research is needed to understand what privacy safeguards are really needed, and how to make them usable.

4. Conclusion

The applications described in this paper have been deployed on campus and have been used throughout the last year by approximately 50 students. Informal feedback showed both usefulness and shortcomings. One issue we have started to address is the evaluation of the user interface of these systems, in terms of the usability of both the user interface and the location awareness capabilities. We have collected data over the last year that we are in the process of analyzing. We expect to be able to report evaluation results at the workshop and in a longer version of this paper.

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