Evaluation of a Location-Linked Notes System

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ABSTRACT

We present a location-aware messaging system that lets users read and post notes linked to a particular location. We developed multiple clients (designed to run on desktop computers, personal digital assistants (PDAs) and cell phones) so that users could choose the most contextually-appropriate device to interact with the system. We allowed remote access and authoring to avoid imposing artificial restrictions on users' needs. We report on the findings from our evaluation of the system. The goal of the evaluation was to explore novel potential uses of the system that result from promoting open use of it and to identify users' preferences regarding the different features of the system. In our evaluation, we found that users were receptive of this system for leaving and receiving location-targeted reminders. They also overwhelmingly approved of the remote access and authoring capability, and suggested scenarios where these features would be crucial. We discuss our experiences building the system and our findings from the initial evaluation.

Categories and Subject Descriptors

H.5.m [**Information interfaces and presentation (e.g., HCI)**]: Miscellaneous

Keywords

Location-aware computing, context-aware computing, annotation of location.

1. INTRODUCTION

Before the advent of the digital age, interpersonal communication consisted of writing down a message for another person and leaving it where he/she is expected to look for it.

Most digital communication systems have focused on enabling communication between two persons or among a group of persons without regard to the physical location of each of them. The general opinion is that such an approach breaks barriers of location in communication and opens the doors to direct interpersonal conversation among people widely separated geographically. But such communication underestimates the importance of location in certain types of messages and messaging applications.

There is often a need to bind a message to a particular location, because it is highly relevant only at the chosen location (and irrelevant otherwise). In the physical world, this factor is clearly evidenced by the ubiquitous presence of sticky notes, handwritten notes placed on doors to community areas, informative write-ups about museum exhibits, and personal notes to others.

The importance of location is also underestimated in current electronic reminder systems. A user can set reminders that go off at a particular time. Although a very handy tool to keep oneself updated with one's schedule, these systems (either hardware-only, e.g., digital watches, or software-based, e.g., calendaring tools) have the unfortunate side effect of popping up inopportune reminders in certain locations. Like other communication systems, they do not account for location, and would, for example, remind one to buy groceries while the user is in a meeting with her boss.

Several research projects have explored the use of location in the design of communication technologies. All of them had a particular focus in their research, and thus their results were tied to their particular design goals. We wanted to evaluate the use of location-based notes at a general level. What use is appropriate? How do users envision using such a system? How strictly should the location aspects of the system be enforced?

Some of the research questions in this area concern the preferences of users regarding public as compared to private messages, setting expiration times for messages, messages annotating a location as compared to messages for people at a location, remote authoring, and remote access. Even though location seems to be an important piece of context to be attached to a message, we wondered how strictly the location aspects of the message should be enforced. Imagine a user wanting to leave a messsage on her office door, would she need to be physically located in her office to do so? What if she is at home and wants to see if any of her students have left a message on her door? Are there scenarios where the actual physical location is not important to a location-based application (although location information is used as context information?)

In this paper, we report our experiences studying how the availability of remote authoring and access affects the use of a location-based notes system. We built a system that lets users leave notes for each other at a particular location. Our system provides a way to annotate a given location or send messages to a group of people such that other users passing by that location will be able to see messages left by other people.

This paper is organized as follows: Section 2 summarizes previous work done on location-based annotation systems. Section 3 introduces the research questions we aimed to answer with this study. Section 4 lists the design issues that arose during the design

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process, and section 5 describes the implementation. A user study was developed and is described in section 6. Section 7 explains our results and the implications for future work are discussed in section 8.

2. PREVIOUS WORK

There are many projects which explore annotation of location with digital information. This section discusses the applications built for use on college campuses, which is a common setting for the study of ubiquitous computing systems [2]. The E-Graffiti project [3] was begun at Cornell University to explore the usability of location-based applications. An implementation was made available to a class of students using wireless laptops. Several problems were encountered with the system. The main issue they encountered was that the users perceived the system as a messaging or chat service to communicate among users, not a system that takes advantage of knowing the user's location. The E-Graffiti project allowed remote authoring of messages but did not allow remote access. The use of laptops inhibited the mobility and usability of the E-Graffiti application because laptops cannot easily be used when walking or moving about on the campus. Our system allows access from personal digital assistants (PDAs), cellphones, laptop or desktop computers.

The lessons learned from the E-Graffiti project were implemented in Cornell's CampusAware project [4], a campus tour application. It allowed users to leave public notes about locations on the Cornell campus. It included a web client that allowed users to post and read notes about any location, so that staff and other users could add notes to the system without having to physically travel to the location. Like E-Graffiti, remote authoring was allowed but remote access to messages was not.

The GeoNotes system [8], which was location-aware and allowed the user to annotate a specific place, was much like the CampusAware system. The goal of this system was to enable end users to act as active producers of information, not just passive consumers of information posted by others. GeoNotes allowed neither remote authoring nor remote access as it was designed to be strictly location-based.

Another similar project is the ActiveCampus project at the University of California at San Diego [6]. E-Graffiti is a function of their ActiveCampus Explorer application, which displays a map of nearby locations which is marked with nearby sites of interest, buddies and events. The ActiveCampus project supports neither remote authoring of, nor remote access to messages [5].

Our project differed from previously-implemented systems in several fundamental ways:

- E-Graffiti allowed remote authoring but not remote access. GeoNotes allowed neither as it was designed to be strictly location-aware.
- GeoNotes allowed a much broader range of possibilities with identity and anonymity.
- GeoNotes allowed users to comment on content already present and distinguished original contents from comments. The system was used as a chat system and was compared to instant messaging systems like ICQ because of its interface, something which the researchers had not thought of when designing the system.

The choices that the system designers made about regarding authoring and access may have limited the possible uses of these systems. To enforce the location-aware aspect, users were required to be physically present at a particular location to read a message. In our project, we decided not to impose any restrictions on our users but instead explore what functionality was desired by them rather than the alternative of providing a subset of features and examine usage.

3. RESEARCH QUESTIONS

Our purpose was twofold: first, to investigate the possible uses of location-based systems and second, to focus on the usefulness (or lack thereof) of remote authoring and access. Our research involved studying user preferences for remote authoring and accessing to location linked messages. This conflicts with concerns raised by previous studies in this area, notably the GeoNotes system [8].

3.1 Remote vs. In Situ Access and Authoring of Notes

Previous efforts in this area, like GeoNotes and E-Graffiti did not allow remote access to messages; users could not check for messages at locations other than their current physical location. Also, GeoNotes did not allow for remote authoring of messages (leaving a message for one location from a different location), while the E-Graffiti project did. In order to explore what users preferred, we decided to have our system support remote as well as in-situ access to and authoring of messages. In addition to leaving and checking messages at their current location, users could also check for and leave notes at any other location. We included tasks in our experiment that explored both these options and surveyed our users about their preference.

3.2 Message Access: Push versus Pull

The choice between being alerted to messages automatically (the "push" mechanism) or manually retrieving messages (the "pull" mechanism) generated much discussion. Barkhuus and Dey [1] discuss several studies; their own study on the user's perception of control revealed that even though users felt less control using applications that automatically reacted to the user's context, they still preferred proactive applications that would alert them to changes.

Other systems, such as E-Graffiti, GeoNotes and ActiveCampus, did not support pushing of new messages, even though the GeoNotes system did include a configurable query feature that would alert users when notes were posted to a location that matched their query. The designers of the ActiveCampus system supported push functionality on just the ActiveClass portion of the project, but chose not to push E-Graffiti messages.

Through our evaluation, we were keen to investigate whether users preferred a push- or pull-approach with location-linked notes.

4. DESIGN ISSUES

4.1 Granularity of Location

One issue with location-based systems is the decision about how best to present location information to the user. The application may not need to know the user's precise location, but instead a zone [9]. We explored different representations for indicating and storing location information such that its usage in our application would be easy for the user. The two alternatives were a flat location model, where a user can be in exactly one location (identified by a number, and indexed by a string representation) and a hierarchical representation.

The hierarchical representation closely models the real world scenario, where a user can be inside a room, a building, a university campus and a city at the same time. The Aura Location Identifier

system from CMU provides such a hierarchical representation that can be layered on top of a purely geographical (co-ordinate-based) approach. [7]

However, for the limited scope of our experiment (user evaluation on a university campus), we found hierarchical names to be too difficult to remember, and an unnecessary hindrance to the actual task of obtaining user feedback about the system at large. Considering that some of our users had not used a personal digital assistant (PDA) in the past, we decided to use a very simple flat naming scheme.

4.2 Factors Affecting the Design

During our discussions of the design of this system, we found several factors affecting its use. In order to understand the interrelationship of these factors, we created a matrix illustrating the design space.

The factors considered here and listed in Table 1 are:

- Domain (public versus private.)
- Messages that expire versus messages that never expire.
- Location as a placeholder for information (information is not about that location, but for people at that location) rather than an object of interest (the information is all about the location, without regard to the people who may be present there.)
- Remote versus in-situ access.
- Remote versus in-situ annotation (authoring).
- Push versus pull access strategy.

In Table 1, we see the effect of each factor on every other factor. These are the influences that we hypothesize to exist between each pair of factors. We initially planned to test our hypotheses through actual implementation of the system with all factors present. However, due to the high correlation between several of these factors, we decided to limit the scope of our study to examine the effect of all other factors on two chosen factors, namely: remote authoring/access, and in-situ authoring/access. Tasks were designed accordingly, to study the correlation between the factors selected for study.

5. IMPLEMENTATION

5.1 Architecture

Applications that run on multiple platforms, like our prototype, will have certain common elements; we implemented these common functions using web services. The client applications on each platform invoke methods from a web service to receive and update information such as the current location and messages for the current location.

5.2 Devices

Our prototype system supports PDAs with wireless access and a web browser capable of rendering basic XHTML, cell phones with browsers supporting a light version of XHTML or desktop clients running a regular web browser. All interfaces were browser-based for easy extensibility. Each version of the interface communicated with the web services at the back-end to obtain and update the current status and location of a user.

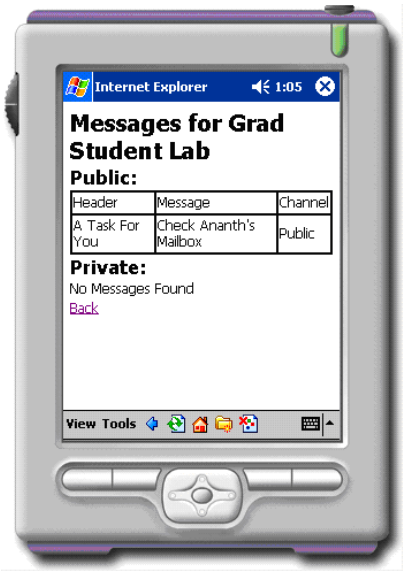

Figure 1: PDA (screenshot captured using an emulator)

5.3 Interface Considerations

Special care was taken to design the PDA interface [Figure 1] so it would not mimic an instant messaging (IM) application. Previous experiments on location-based messaging systems have reported that these systems were regarded by several users as enhanced IM applications; this ultimately led to a mismatch of expectations between the users and the researchers about the objectives of the system. Figure 2 shows the interface on a cellphone.

6. EVALUATION

6.1 User Tasks

We targeted our evaluation to explore whether or not remote access and authoring is an important feature to users of a system that is location-based. We wanted to see whether allowing the user to use the system from any location made the application seem like e-mail with an extra step required to specify a location, or whether the possibility of being able to read and post messages from a different location would open up novel uses for the system.

Four tasks were designed, two that would involve the user being physically present at the location of the note and two tasks which could be done remotely.

Figure 2: Cellphone (screenshot captured using an emulator)

Table 1: Inter-relationship of various design factors.

Design Issue	Domain (public / private)	Message Expiration (expires / do not)	Message about: Location or Users at that location	Authoring (remote / in-situ)	Access (remote / in-situ)	Retrieval (push / pull)
Domain (public / private)	•	Expiration necessary for private, not so much for public.	More likely about the location for public messages.	More likely in-site for public messages.	Independent.	Private messages more likely to be pushed, public messages more likely to be pulled.
Message Expiration		•	Messages about a location less likely to expire (than those for persons at that location).	Remote authoring more likely for messages that expire.	Independent.	Independent.
Message about: Location or Users at that location			•	Messages about a location are more likely to be left by a user at that location.	Independent.	More likely to prefer messages for users being pushed.
Authoring: Remote / In situ				•	NA	NA
Access: Remote / In situ					•	Depends on who the sender is.
Push versus Pull						•

6.2 Evaluation of the System with a Prototype

For the purpose of evaluation of the system, we used a Palm Pilot—Tungsten C PDA (with 802.11 connectivity). We implemented a Wizard of Oz scheme to determine the user's location remotely. An administrative interface allowed the tester to update the user's location. Initially, we disabled the remote access feature of the system, so that the user would have to be physically present at the location at which he/she wanted to read or leave messages. After the first two tasks were completed, the remote access and authoring feature was enabled, and the user was free to check or leave messages at any location, regardless of where he/she was physically located.

6.3 Questionnaire

After each task, the user was asked to fill out one section of a questionnaire. The task-specific question queried the user as to whether he/she felt that posting location-linked notes was a better method for accomplishing the given task than the traditional methods of leaving paper notes or sending e-mail.

Once all four tasks were complete, a set of general questions were posed to the users. The first two questions asked if the users felt that they should be physically present at a given location to read or write the messages posted there or whether remote access or authoring would be preferable. Users were also asked how often they saw themselves using the system and if they could think of other uses of the system. We also wanted to consider the social aspects of the system, so the final question asked them to rank who they saw themselves communicating with most often: themselves, friends, peers, professors or the public.

7. RESULTS

Our evaluation was conducted with eight users, consisting of five males and three females. Five users were Computer Science graduate students. The rest of the group consisted of a professor, one high school student, and one middle school student.

The users unanimously agreed that remote authoring and remote access were both necessary features.

One user stated that if such a system were in widespread use, he/she would use it weekly, while everyone else indicated they would use it daily.

7.1 Checking for Messages at the User's Physical Location

This task required the users to check for messages in the Computer Science Graduate Student Lab while they were inside it.

The majority of the users felt that the system was useful for such tasks, though some of them had concerns regarding the actual implementation of such a system. Another user felt that the system would be useful only if he were prompted automatically about received messages. One user felt that e-mail was preferable for such notifications in locations such as the Lab that is home to several public access computers.

7.2 Leaving a Message at the User's Physical Location

This task asked each user to pretend he was leaving a note at his office indicating that he was leaving for a thirty minute lunch.

All of the users felt that leaving a note like this was a very good use of the location-linked notes system. Even though this task in-

volved being physically present at the location, two of the users recognized that being able to check a person's availability from a remote location would be very useful and would save users the time and effort involved in walking to the office. Other users expressed concerns that such notes would only be available to students who have PDAs and notes would most likely only be read if the PDA alerted the reader to read the note.

7.3 Leaving Notes at a Remote Location

The second portion of the user evaluation allowed the user to author and access notes from any location. The first task in this section involved reading a reminder left at the Student Center and leaving a note to himself/herself to be retrieved the next time the user was in the same place.

A majority of the users felt that the location-linked notes system was better than e-mail or paper for leaving a reminder. However, three users felt that it is most useful if the user is automatically alerted that a message is available when the user is in that location. One user felt that using location-linked notes as reminders is only useful when leaving reminders for others, not self, and one user suggested changes in the user interface to reduce the effort necessary to leave and check notes. One user also suggested making the messages both location- and time-dependent, so that reminders to oneself would appear at opportune moments.

7.4 Checking a Message from a Remote Location

The final task involved checking a professor's status remotely by checking to see if he had left any location-linked notes on his office door. The message left there stated that the professor was in a conference call and did not want to be disturbed.

Six of the eight users felt that this task was a good use of location-linked notes, with three enthusiastically supporting this use. Two users felt that the same purpose could be accomplished using some other method.

Potential pitfalls about this use of location-linked notes included the concern that it was only useful if the user (the professor) was consistent in updating his status. Another user pointed out that such location-linked notes are only useful if students are carrying a mobile device.

7.5 Social Aspects

Users were asked whom they would mostly send messages to and to rank their responses. The results are shown in Table 2, where each dot represents one user.

Opinion was divided among our users about the usefulness of our system for leaving personal reminders (i.e. messages for themselves.) More than half ranked leaving notes for themselves as their primary use of the system, whereas two others considered this the least useful aspect of the system. Table 2 shows the ranking of the most-likely recipients of messages.

From Table 2, we infer that a majority of people see this location-linked application first as a reminder system, second as a system for social interaction, and third as a system for collaborating with professors and colleagues. It also shows a desire to use it for private messages more than for public posting.

Students do not have a home base, changing locations throughout the day. Dourish [2] found that even with nomadic patterns, students know the locations of other students in their social circle. While Dourish suggests that this nomadic lifestyle reduces the need for location-tracking services, our survey shows that a location-based system is suitable for social interaction among friends.

Table 2: Rankings of Likely Recipients of Location-Linked Notes (Each '•' represents one user.)

Ranking	1st	2nd	3rd	4th	5th
Yourself	••••		•		••
Peers	••	••	•	••	
Friends	•	••••		••	
Professors		••	••••		•
Public			•	••	•••

8. IMPLICATIONS FOR FUTURE WORK

8.1 Sending Messages to a Category of Locations

We realized while creating the scenarios for the user evaluation that certain notes are specific to a generalized class of locations rather than a specific member of this class. For example, a location-linked note to "buy milk and groceries" applies in the real world to all locations of type *grocery store*, not just one grocery store.

The system could be meaningfully extended to support this in the following manner: each location known to the system is part of one or more location types. These location types occupy the same address space as the locations themselves, so from the point of view of the user, it is completely transparent whether a message is sent to a single location or a group of locations. When a message is sent to a location group, it will be displayed whenever the user is known to be in any one of those locations. It will be shown successively in more than one location till it expires (or is deleted by the system).

8.2 Blending Applications

In the past, applications like Instant Messaging and e-mail each had their own independent use. Now, they are starting to blend so that multiple applications pool together the information they have to enable the user to make connections previously not possible. For example, Apple's Mail program on the Macintosh indicates the online presence of contacts from the iChat program.

Thus, although Location-Linked Notes as a stand-alone application may have a limited domain of possible uses, combining its capabilities with other applications would enhance both the applications. For example, when a user changes his/her status in an instant messaging application, the same status could show up as a location-linked note located on the user's office door.

9. CONCLUSION

Location can be an excellent source of context, and location-based applications are expected to become more prevalent in the future. The design aspects of location-based applications need to be considered carefully to examine how the available location information may be used in an application and how best to make use of the context-aware aspect of the application from the point of view of the user.

Previous systems specifically restricted users from remotely accessing notes and some restricted remote authoring. Our results show that users actually prefer the ability to access and author notes remotely and that this feature can enable new uses of location-based messaging systems that may not have been envisioned by its designers.

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