

Research Statement

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As computing becomes more pervasive, seamless and mobile, new paradigms of services and user interactions are emerging. Over the last several years I have carried out research in the area of context-aware computing, mobile computing, human computer interaction, and privacy. As an HCI research scientist, I am interested in pursuing the following areas:

- Ubiquitous, Context-aware and Social computing
- Social and privacy implications, specifically related to context-aware services
- Computer-mediated communication, specifically mobile communications

Current Research

My dissertation work has been twofold. The first part focuses on enhancing cellphone awareness with the purpose of minimizing inappropriate cellphone interruptions and to create more socially intelligent and thus accepted cell phones. I have introduced, designed, and investigated three different approaches toward that goal. The approaches capitalize on the emerging fields of ubiquitous computing, context-awareness and smart environments and are intended to function in a minimally intrusive manner. The second part focuses in exploring privacy implications and sharing preference and patterns for context-aware telephony as well as developing techniques that best evaluate privacy concerns in natural settings.

The many benefits that cell phones provide are at times overshadowed by the problems they create, as when one person's cell phone disrupts a group activity, such as a class, meeting, or movie. Cell phone interruption is only highlighted by the ever increasing number of mobile devices we carry. Cell phones, with all the services they provide such as phone calls, reminders, text and instant messages, are the prime example of mobile devices that demand constant cognitive attention from the user and also serve as a frequent source of interruption and distraction. Interruption caused by inappropriate notification can cause inconvenience, disruption and embarrassment for the owner. Interruption is not limited to the owner of the cell phone only but extends to the surrounding environment as well. While much work has been done to enhance interruption of desktops, inappropriate interruptions from mobile devices and cellphones has not yet been addressed satisfactorily.

In the first part of my work, I proposed using automatic context-aware configuration as a potential solution to the problem of inappropriate cellphone interruption [1]. Given the personal attachment between people and their mobile devices such as cell phones, context-aware automatic configuration may not be the preferred solution for users. We have conducted an in situ experiment to examine the feasibility, effectiveness and people's reactions to such a solution. Our results demonstrated the visibility and usefulness of automatic configuration. The results were discussed in light of user-system interactivity level (hybrid, passive, and active context-awareness), and control versus convenience. As an example of automatic context-aware configuration, I have developed a prototype system that used information provided by the calendar book to infer users' activity and context and to automatically configure cell phones accordingly [2]. The prototype was also examined using an in-situ user study in which we used PDAs that run a cell phone simulator. The study examined the feasibility and design factors of the calendar solution. Our results confirmed the applicability of this solution given the high level of predictability of structured activities and appropriate cell phone configuration can be predicted with high accuracy using the calendar information. The study also examined the consistency of mapping activities to configuration for each individual and across different participants. The results of the study were examined in relation to inaccuracy, spontaneous activities, and user reactions.

Next, I presented the caller-based approach which leverages the caller's judgment to make an educated decision on whether it is appropriate time to interrupt assuming he has access to the receiver's context information [3]. This approach, however, raises many privacy issues that may render it infeasible. I employed ethnography field research techniques with the aim of evaluating the feasibility of that approach. The study

answered the following questions: are people willing to disclose context information in exchange for less inappropriate interruptions? In other words, are the incentives and services offered by the context-aware telephony application good enough to overcome the privacy concerns? What kind of context information are they willing to share? What is the effect of the caller-receiver relationship on context disclosure? How do people differ, and on what do they agree? The study also aimed at identifying the type of contextual information that provides the caller with the most information and allows her to make the best judgment without jeopardizing the receiver's privacy. Lessons of privacy preferences and sharing patterns of context information were identified and extensively discussed to provide valuable guidelines for designers of context-aware services.

I also proposed a third novel approach toward automatic configuration aimed at minimizing cell phone interruption: a collaborative technique that automatically adapts its configuration according to that of the majority of the surrounding cell phones [4]. I have conducted a user study to investigate the validity of this approach, its limitations and design guidelines. An important part of my thesis was to generalize the important lessons we have learned from designing and exploring the three different approaches to minimize cellphone interruptability depending on user context and availability. Important design criteria were extracted to guide designers of context-aware telephony services in particular and context-aware services in general.

The second part of my work, examined the use of surveys in measuring privacy concerns for context-aware services. Context-aware services are becoming increasingly popular. Yet because such services utilize personal information about people (i.e. what they are doing, where and with whom they are doing it), the privacy implications are substantial. Several research efforts have been aimed at better understanding the privacy concerns, preferences, and management systems in existing and future context-aware services. Much of the previous research on privacy in the area of pervasive computing relies on surveys and polls as the main evaluation tools. Two different evaluation techniques were used to study the privacy concerns for a specific context-aware service: a paper based survey and in-situ questionnaires (Experience Sampling Method). We compare a survey to an in-situ study. Because an in-situ study collects data from the users in their natural setting, we regard it as a more accurate approach to measuring privacy preferences as compared with the survey. The results of the two techniques were compared given the same experimental conditions. Our results from the two techniques differed significantly, suggesting that surveys are not reliable in predicting privacy concerns of context-aware services. To our knowledge this was the first work to quantitatively support the inherent inaccuracy in using surveys especially to measure privacy concerns and sharing preferences for context-aware services.

Other Interests

In the past I have led a team of four graduate students that developed in-door wireless location system for the Computer Science building [5]. We extended the work done by the RADAR system [6] to a 3D-space. We used the measurement of the signal strength to build a radio map which was used for location prediction of mobile stations. We implemented different algorithms of efficient searching of the radio map that accommodated for missing and inaccurate data. We also implemented a mobile client application that tracks the location of mobile users and presents it on a dynamically generated map of the building. My responsibilities as a team leader involved analyzing the requirements of the project, divide responsibilities, follow the students' progress, and advising.

Future Directions

The techniques employed by my thesis to address inappropriate cellphone interruptions are first steps. The ultimate goal is to create a more socially intelligent cellphones that provides much richer set of services and interactions with users in different social environments and situations. There are multitude of ideas and paradigms that are worth exploring.

In the future, I would like to continue working on improving the accuracy of cellphone interruptions through combining the different approaches I discussed above together with additional new approaches. Specifically, I would like to integrate the approach of empowering cell phones to be more context-aware (by using calendar information and collaborative applications) with the approach of empowering the caller to be

aware of the receiver's context. We believe this method offers the most promising solution provided that the right balance between the two approaches can be established. After all, interruption appropriateness can only be determined in the context of both the initiator and the receiver. For example, a receiver who is busy at a meeting might nonetheless be awaiting a call from somebody regarding updates related to the meeting. Interruption in such a situation is appropriate even if it may seem otherwise from an outsider's perspective. A challenging research issue is to examine how combining the different approaches presented here can contribute to better awareness and less inappropriate interruptions and would not place extra burden on the users.

In addition, I would like to contribute to the emerging field of social computing by expanding the scope of my research to explore new paradigms of human interaction with smart spaces in general and smart phones in particular. I believe the widespread of smartphones and smart spaces will provide a unique environment with great potential for new services with new paradigm that will shift the focus from human-computer interaction to a human-human interaction. In that regard, I am planning to discover and investigate applications and interaction paradigms between users and the surrounding environments using cell phones which are the most pervasive devices. The collaborative model described in this research is not limited to minimizing disruption and has the potential to be generalized to provide a variety of services. For example, cell phones may carry their users' preferences for room temperature, and smart places could customize the room temperature according to the majority's preference. Certainly, future work should also include attempts to identify interesting services and their feasibility based on the collaborative model.

I am also interested in developing user evaluation tools that can efficiently and accurately capture privacy risks. Accounting for privacy risks would help designers create and deploy useful context-aware and ubicomp systems by incorporating privacy management tools within the systems

Finally, a critical area of context-aware computing that has not been addressed adequately is the effect of inaccuracy on the users. Inaccuracy and uncertainty is an inherent part of context information and achieving perfect and reliable context information is hard if not impossible. Inaccuracy is an inevitable part of context-awareness due to the inherent inaccuracy and ambiguity from the sensors, context providers, human errors, inference mechanism, and unpredictable behavior. Accounting for uncertainty and inaccuracy is key in achieving public acceptance for context-aware applications. It still remains unclear whether inaccuracy will change their attitudes on the usefulness of context-aware applications, whether they will still be willing to use the applications after producing inaccurate behaviors, and the extent to which this inaccuracy will frustrate them. I would like to undertake the efforts to such questions which I believe would influence the design of context-aware applications and services and inspire better design.

In summary, as mobile devices become cheaper, smaller, faster and more pervasive, there will be a potential for many new interaction paradigms to emerge. I am interested in designing novel computing services and interfaces to augment everyday environments and diverse social setting as well as investigating social ramifications such as privacy, security and technology acceptance.

References

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