Getting Real with Ubiquitous Computing: the Impact of Discrepancies on Collaboration

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Abstract. Ubiquitous computing is still a maturing field of investigation. The vision of the seamless integration of computers to people's life has yet to happen, if it ever has to become a reality. Nowadays, most mobile, distributed systems and sensor technologies have their faults and limitations. Users of ubiquitous technologies often learn to avoid or rectify the systems failures. However, there is still a lack of quantitative information concerning how they impact the collaboration. Therefore, we propose to use a 'field of experiment' approach based on a pervasive game platform. Our aim is to rely on a mix of qualitative and quantitative evaluations to find out how uncertainties modified the collaborative processes.

1 Introduction

Nowadays, a considerable amount of development is taking place in ubiquitous computing and a growing number of research labs are investigating this field. They work in the various research topics that form ubiquitous computing, including distributed computing, mobile computing, sensor networks, human-computer interaction, and artificial intelligence. The father of ubiquitous computing, Mark Weiser [1], defined it as forcing the computer to live out here in the world with people. Currently, the field is still not as mature as Weiser envisioned.

Ubiquitous environments must deal with unreliable network, latency, bandwidth, security, unstable topology, and network homogeneity. The most ubiquitous device, the mobile phone, has its faults. Lack of coverage, broken conversations, bad roaming, empty batteries, the limitations are plentiful and must be dealt with on a daily basis. Many times we learn strategies to adapt to avoid of rectify the systems failures. We are still a far reach of the strict definition of ubiquitous "existing or being everywhere at the same time: omnipresent".

In our case, we are interested in studying the impacts of technological limitations and users manipulations by terms of collaborative interactions. The platform we use to meet this end is the emerging field of ubiquitous computing games, which offers an interesting platform to study the aforementioned phenomenon. This approach is also the one described by [2] and [3].

In this paper, we first introduce the current studies in that field. Then we explain the pervasive game we developed and the outcomes of the first experiment we conducted. We conclude by describing our method of mixing collaborative and quantitative data to study the role uncertainty plays in collaborative ubiquitous systems.

2 Dealing With Myths of Ubiquitous Computing

Previous user-centered studies have been done to understand how to design applications based on the lack of maturity, the underlying imperfections and inherent uncertainties of ubiquitous technologies. The most common methodology to do so is the use of ethnography and hence the collection of qualitative data about people's behavior towards technology and collaboration.

Benford et al [4] reveal some of the complexities involved in designing collaborative location-based experiences. Based on qualitative data from the location-based educational game called Savannah, they describe the frustration when users are unable to establish a shared context and act together due to system limitations. Moreover mismatches between the designer's conceptual model and user's mental, inherent to ubiquitous technologies application design, lead to serious confusions among the players. They leave open design questions on how users avoid and rectify the difficulty of the system (e.g. when connectivity is temporarily lost, when the GPS unit loses line of sight or in case of poor latency between the mobile devices and the server).

Likewise, Antifakos et al. [5] argue that perfect and reliable context information is hard if not impossible to obtain. They evaluated a feedback mechanism that displays the uncertainty inherent in the context information. Their study shows that human performance in a memory task is increased by explicitly displaying uncertainty information. However they claim that further studies must be performed on "the tradeoff between the cognitive load, which displaying uncertainty information causes, and the added value that it provides.

Finally, Chalmers et al [6] go a step further through the argumentation of seamful rather than seamless design to reveal the physical nature of the ubiquitous systems in, for example, the uncertainty in sensing and ambiguity in representations. Conversely, they emphasize that seamful design as just one potential way to “design for appropriation” and to support the more widespread acceptance of ubiquitous computing technologies.

3 CatchBob!

Our approach targets the use of a game to study how people deal with uncertainty. In line with this goal, we developed a pervasive game called CatchBob! as an experimental platform for running psychological experiments. Catchbob! has been designed to elicit collaborative behavior of people working together on a mobile activity. In the game, groups of 3 teammates have to find a virtual object on our campus at EPFL in Lausanne. Completing the game requires the players to surround the object with a triangle formed by each participant's position in the real space. To reach this goal, they employ an application running on Tablet PCs as depicted on figure 1.

Fig. 1. CatchBob! interface as used by a player

In addition, the tool also enables communication: players can synchronously annotate the map with the stylus. The annotations constantly fade out until they become completely invisible (after 4 minutes). Another meaningful piece of information given by the software is an individual proximity sensor that indicates whether the user is close or far from the object through the number of red bars displayed at the top of the interface.

All the players' interactions with the applications (positions, annotations, getting others' positions, connection loss) are logged. We also developed a replay tool that allows showing the paths of each player. This application allows us to confront the players to a replay of the path they took during the game, as well as the actions they performed. A lot of information can be gathered from this to make sense of what happen during the game.

4 Previous experiment

The results of our previous study on location awareness [7] show that it is better to let users control and express their location the way they want as opposed to have it automated. Giving them the possibility to embed location cues with other kind of information like map annotations appeared to be a good solution to support collaborative processes like communication or strategy discussions. By extension, it is now fair to question the importance of positioning accuracy as well as the quality of the coverage and connectivity of ubiquitous system.

During post-game interviews, we also discovered mental model mismatches on how the players perceived the system would work and their actual experience. In talking about their experience of the game in general, some players said "I did not move physically, but I moved on the map" other "The proximity to Bob changed even though I did not move". Some players came with a pre-conception on the quality of indoor positioning systems. One stopped playing, because of the latency in the synchronization of the annotations. We now want to find out if the players overcome and adapt to the technological limitations or whether it impacted their overall performance in the game.

5 Conclusion

The approach deployed here is called 'field experiment' approach [8] which means that we want to take the advantage of both ethnographical studies (ecological validity, use of qualitative data) and controlled experiments (controlled factors, use of quantitative data). As we did to study the use of location-awareness tool [7], we plan to rely on a mix of qualitative and quantitative evaluations to find out how uncertainties modified the collaborative processes. First and foremost, qualitative data are interesting with regards to describe the kind of situations where people face discrepancies as well as the solutions they use to overcome the systems' limits. Then quantitative indexes would allow us to get some concrete measure of how uncertainties impact the task performance or collaborative processes. Among the quantitative index we have, there is the uncertainty of location which is represented by the amount of time when no position was given to the player, the positioning accuracy described by the number of scanned access points. The uncertainty of connection, the number of seconds and frequency the user has been disconnected, is also of interest since it might be detrimental to both the task performance and communication among the group. This will allow us, for instance, to check the correlation between these variables and the frequency/quality of communication, the players' spatial behavior or the time they spent to complete the game. Eventually, we believe that the articulation of both kinds of data is relevant to make sense of users' behavior.

6 About the authors

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