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Extending Traditional Design Approaches for Pervasive Computing

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Key words to describe the work: Human-computer interaction, design, pervasive and mobile computing, ubiquitous computing, social issues.

Key Results: The development of a framework for the design of pervasive systems.

How does the work advance the state-of-the-art?: Offers a social understanding in the design of pervasive systems, thus addressing many important issues that such systems raise.

Motivation (problems addressed): The social issues and problems presented by the introduction of pervasive systems.

Introduction

How can we reason about new and future pervasive technologies? With a potentially infinite number of combinations of such technology, is there a way to avoid pitfalls such as intrusion of privacy? At best, we currently have depictions in Sci-fi movies of instances of such technologies. But thinking through such examples one soon realizes that they just don't work. Is that the best we can do?

We are currently lacking a framework for understanding and describing pervasive technologies. Much like the GUI and Windows framework helps us in thinking about the various software applications that exist, I have developed a model that can foster the growth of pervasive technologies and their acceptance by the general population.

What this work builds on

Pervasive computing was supposed to be part of our everyday life and promised to assist us in all our activities regardless of our location. This vision of pervasive computing is that, ultimately, our whole society will benefit from such systems, and not just a few people doing very constrained tasks within physical "islands" of computing support. A pervasive system cannot reach its full potential – and cannot really be described as pervasive – when it is limited to, say, a "smart house" or a "smart car". If the whole of society is to benefit from such systems, then the whole of society must be part of such a system. Thus, the social issues that arise are not just side effects or problems that can be dealt with ad hoc, but are at the heart of the challenge – and the solution.

The point of departure for my research has been the traditional HCI wisdom of designing a system for a user performing a task in a domain. In light of the potential of pervasive systems for both success and disaster, I have extended this traditional framework to address the social issues which are unavoidable when dealing with pervasive systems. Social issues and considerations lie at the heart of my framework which translates user-task-domain to citizen-sphere-space.

I have also used ideas from the domain of urban architecture. I perceive architecture as a pervasive system, and architects as the designers of this system. Most of the ideas I have borrowed from this domain deal with the impact of the design of public spaces on societies and communities, the psychological impact of space on humans, and finally some more general ideas on the design and manipulation of space.

Furthermore, I have based some of my work on public policy and economics, mainly with respect to public services. I have used ideas like universal access and obligatory provision, which are embedded in the notion of public services. I have also examined the impact of providing services as a public service, and identified potential benefits in doing so [Kostakos & O'Neill, 2004]. Finally, work from the area of computational grids is closely related, which I believe can provide the back-end for nation-wide pervasive systems.

Contribution

This new framework provides the necessary tools to reason about pervasive technology, and also to ensure that designs do not end up as disasters. This framework can predict situations where the technology may cause problems, as well as propose desirable technological characteristics to support specific situations.

Furthermore, the spheres aspect of my framework offers a model of privacy (based on social interactions) which helps us in understanding how information flows in pervasive systems. In combination with the citizenship characteristics identified in my framework, I propose a model for providing pervasive services, based on what is currently known as public services (both in terms of design and deployment). Additionally, I have investigated into the possibility of coupling the public services model with computational grids as a means of offering the requited technological support for the back-end of pervasive systems.

Moreover, I have used the notion of spaces (physical locations with social constraints) along with interaction spaces (conceptual volumes supporting interaction) to provide a guide on how new technologies may be designed and placed in environments such as public spaces. This guide takes the form of predictions attributed to specific combinations of technology and type of service. But also, these predictions can work as guidelines in describing the desirable characteristics that technology should embody for a specific situation.

Both my models of privacy (spheres) and spaces are intertwined with the classification of public-social-private, meaning that private is only for one, public is for everyone, and social is semi-public because of social constraints and rules.

Evidence

The widespread evidence of people resisting intrusion of privacy hints us that this issue is going to be a great obstacle to overcome for designers of pervasive systems. Further evidence exists that physical location alone is insufficient for consideration in the design of systems, but should be coupled with social factors. There is also evidence to suggest that incompatible contexts can cause problems as in the case of mobile phones ringing in theaters.

Research has also shown physical artifacts, enhanced with digital technology and placed in public spaces to have an effect on social interactions within the community. Based on this, additional work has been done on how to design public spaces in order to foster desired social interactions.

In order for pervasive computing to succeed in its vision, we must try to identify the strengths of the designs we propose, and how they should be integrated into our physical and social environments. Humans and computers can work together, feeding each other's strengths: computers are good at storing and retrieving information, constant monitoring and other monotonous tasks, and performing complex calculations, while humans are good at identifying patterns, spotting changes, responding to new situations, and extrapolating from knowledge and experience. We have identified an analogous situation in the case of the built physical environment and pervasive computing technology. One of the goals of architecture and urban design is to manipulate physical spaces in such a way as to provide greater functionality to people, and to allow them to do things quickly, effectively and with minimal obstacles. We could therefore say that space constraints are minimized in order to overcome time constraints. The situation with computer systems is complementary: performing complex calculations and data manipulation and exchange in order to overcome spatial constraints, i.e. minimizing time constraints in order to overcome space constraints. It would seem, therefore, that these two complex systems, the build environment and computer systems, could potentially benefit from each other by tackling each other's weaknesses and feeding off each other's strengths.

Finally, evidence suggests that providing services as public services can enhance the acceptability and usage patterns of the service. Furthermore, it ensures that the resources are available to maintain the system of production and delivery, and to also uphold the rights of citizens.

References

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