Bernt Schiele Anind K. Dey
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Preface

Ambient Intelligence (AmI) was introduced in the late 1990s as a novel paradigm for electronic environments for the years 2010–2020. The concept builds on the early ideas of Weiser, who was aiming at a novel mobile computing infrastructure integrated into the networked environment of people. AmI takes the embedding of computing devices one step ahead by integrating computational intelligence into the entire surrounding of people, thus moving technology fully to the background and the user into the foreground by supporting him or her with intuitive and natural interaction concepts. According to the definition, AmI refers to smart electronic environments that are sensitive and responsive to the presence of people. Since its introduction the vision has grown mature, so as to become quite influential in the development of new concepts for information processing, combining multi-disciplinary fields including electrical engineering, computer science, industrial design, user interfaces, and cognitive sciences.

The AmI paradigm provides a basis for new models of technological innovation within a multi-dimensional society. The added value of the AmI vision lies in the fact that the large-scale integration of electronics into the environment enables the actors, i.e., people and objects, to interact with their surrounding in a seamless, trustworthy, and natural manner. This is directly connected to the growing societal need for communication and the exchange of information. AmI environments will therefore not only support peoples lives with the purpose of increasing their productivity, but they will also serve the largely unmet need of people for self-expression, personalized health-care, and social connectedness. A major issue in this respect is given by the growing awareness that novel concepts should meet elementary user requirements such as usefulness and simplicity. Hence, it is generally believed that novel AmI technologies should not aim at increasing functional complexity in the first place, but they particularly should contribute to the development of easy-to-use and simple-to-experience products and services. Obviously, this statement has a broad endorsement by a wide community of both designers and engineers, but reality reveals that it is hard to achieve in practise, and that novel approaches, as may be provided by the AmI vision, are needed to make it work.

Since the introduction of AmI in the beginning of this decade much research effort has been invested in the development of the concept. As a direct result of the large European investment made in the area through the Framework Program 6 (FP6) of the European Commission, there are many interesting developments that provide first proof points of the realization of the AmI vision. AmI 2007 is a conference that serves the scientific community with a platform to present research results and discuss progress in the field made so far. AmI 2007 can be seen as the continuation of a sequence of AmI symposiums and conferences in Europe. It builds on EUSAI the European Symposium on Ambient

Intelligence. EUSAI 2003 and EUSAI 2004 can be seen as the first two scientific symposiums ever held on AmI. In 2005 EUSAI was organized as a joint activity with sOc (Smart Objects Conference) and presented as the sOc-EUSAI conference. Last year we decided to drop the European flavor a to fully join the activities of the two research communities to continue as the AmI conference of which AmI 2007 was the first edition.

AmI 2007 put much emphasis on the desire to combine both scientific research and practical evaluation of novel concepts. Therefore, the conference was organized along the lines of two tracks named as Research Track and Experience Track. The current LNCS volume, which is the formal proceedings of AmI 2007, is structured along the lines of these two tracks. AmI 2007 furthermore provided the research community in AmI with a venue to discuss in an informal setting preliminary results and upcoming ideas through a number of workshops. We felt that we should not hold back the results obtained in these workshops as they are in many cases quite intriguing and therefore may be stimulating in the development of novel ideas. Therefore, we decided to publish these results in a separate Springer volume under the title *Constructing Ambient Intelligence AmI 2007 Workshop Proceedings.*

The material contained in the present volume reveals that the realization and implementation of the AmI vision in its relative short period of time of existence is rapidly gaining traction, and that some of the early ideas following from the vision are growing mature. Examples are the use of context-aware services in smart environments and the high level of personalization that is attained in ambient-assisted living environments. Also the experience design results indicate that there is a growing awareness of the fact that the success of the AmI paradigm heavily depends on the social acceptance of the newly proposed AmI technology and that we need to look carefully at the human factors side of the vision to study the relation between AmI technology and the behavior of people, thus revealing the true added value of AmI in the everyday-life of people.

In view of this, the AmI 2007 proceedings can be considered as a timely document that provides many new results and insights in the development of AmI. We are fairly confident that it provides a meaningful contribution to the dissemination of the AmI vision and we would like to thank all those who have contributed. We hope that you as a reader will have many pleasant and fruitful reading hours.

September 2007

Emile Aarts
Alex Buchmann

Message from the Program Chairs Research Papers

On behalf of the Program Committee for the Research Papers, we would like to welcome you to AmI 2007 - European Conference on Ambient Intelligence. We received 48 research paper submissions, with authors from 22 countries, and we accepted 17 papers.

Each paper was assigned to three Program Committee members for review (resulting in a total of 46.000 words). The reviewing phase was followed by a discussion phase among the respective Program Committee members in order to suggest papers for acceptance. The three PC Chairs then met in Darmstadt to make final decisions about acceptance based on all reviews, the discussion results and, if necessary, additional reviewing. We would like to thank all members of the Program Committee for their most valuable and highly appreciated contribution to the community by reading submissions, writing reviews, and participating in the discussion phase.

The range of topics evident in the selected papers covers many important topics in ambient intelligence: from sensors and mobile devices, over localization, context awareness and middleware to interfaces and applications of ambient intelligence.

We hope that you find the papers to be interesting, informative, and thought-provoking.

September 2007

Anind K. Dey
Hans Gellersen
Bernt Schiele

Message from the Program Chairs Case Studies and Lessons Learned Papers

The introduction of Ambient Intelligence (AmI) has shifted the focus from system-centric interactions towards user-centric experiences with intelligent environments. Such a shift did not only bring forward new requirements for technologies but has also created the need for innovative research methods and tools. The main goals of user-centric experiences with environments are to investigate how technology can deliver positive experiences into every day life environments, to consider people's social, creative and cognitive skills and to face the users' acceptance of the system, their privacy and trust concern.

A lot of research groups in universities, research institutes and in the industry have applied this way of technology development in the past few years. Many research labs have been funded and were built that offer a daily life ambience to support the testing and evaluation of technology prototypes under real life conditions. This kind of living and early involvement laboratories will dramatically increase the social acceptance of technology. First products are already on the market that support this kind of ambient experience as well as accomplish assistive function for health and security. Thus, this paradigm chance of developing technology proofs its advantages and has started a success story that will dominate the way research will be conducted and developments will be implemented in at least the next decade.

The conference track case studies and lessons learned introduces high-level reports of researchers relating to this AmI core. The following papers introduce first hand reports from AmI laboratories and thus highlight innovative and novel results that deal with experience prototyping and user-centered design. End user insights into current AmI development are given. The Program Committee is proud to present a high level selection of current research reports and papers that reflect the most important activities of current AmI research.

In this special track of AmI 2007, the European Conference on Ambient Intelligence, we present five selected papers discussing the experiences and lessons learned in the area of research and application development for AmI environments. These papers touch upon methodological, infrastructural and technical issues involved in AmI research.

Although any paper focusing on AmI application and experience research will bring forward methodological, infrastructural and technical challenges, the papers in this special track present a more elaborate discussion of these issues rather than on only the research findings. By making explicit the lessons learned and experiences of AmI research we bring forward the way of working in AmI-related research.

AmI environments do not only offer supporting and comforting experiences to its end users, but these environments can also become socially connected spaces that provide a sense of presence with, for example, remote family and friends. In the paper "Expected Information Needs of Parents for Pervasive Awareness Systems," Kahn et al present their experiences with using an on-online survey technique to gather end user requirements for an intelligent awareness system that connects parents with their children. This paper taps into the problem of suitable user requirements gathering techniques for designing AmI services.

AmI research has introduced the concept of Experience and Application Research Centers (EARC). These EARCs offer realistic testing environments for end users to experience innovative concepts while researchers have advanced instruments in place to learn more about, for example, the usability and acceptability of the proposed solutions. In their paper "User-Centered Research in ExperienceLab," de Ruyter et al. present their lessons learned in deploying three EARCs in the context of AmI application development. Highlighting both the infrastructural and the methodological aspects of using EARCs this paper aims at providing the AmI researcher with some valuable insights into the role of EARCs.

In the paper "Assemblies of Heterogeneous Technologies at the Neonatal Intensive Care Unit," Grönvall et al. share their experience in designing an AmI environment for a demanding and dynamic context as found in a neonatal intensive care unit. Specifically, the authors discuss their lessons learned with solutions that enable end user composition and control of AmI assemblies of technologies.

Besides experiences with methodologies and testing environments, this track presents a paper focusing on the lessons learned for using a specific technology in AmI application development. In their paper "Improving Mobile Solution Workflows and Usability Using Near Field Communication Technology," Jaring et al. share their lessons learned for deploying near field communication (NFC) technology in solutions to improve workflows in mobile situations. The experience presented in this paper is of high value for researchers and application developers in the area of AmI for mobile contexts.

To conclude, this track presents a paper discussing the lessons learned in developing and testing AmI scenarios for a public environment such as the retail environment. In their paper "Enhancing the Shopping Experience with Ambient Displays: A Field Study in a Retail Store," Reitberger et al. discuss their experiences in designing and evaluating a system for creating a sense of shared awareness between shop visitors. Such applications illustrate the potential role of AmI technology as a social mediator.

September 2007

Boris de Ruyter
Manfred Tscheligi
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Mobile Interaction with the Real World: An Evaluation and Comparison of Physical Mobile Interaction Techniques

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Abstract. Mobile devices are more and more used for mobile interactions with things, places and people in the real world. However, so far no studies have discussed which interaction techniques are preferred by users in different contexts. This paper presents an experimental comparison of four different physical mobile interaction techniques: touching, pointing, scanning and user-mediated object interaction. To evaluate these techniques across different scenarios and to collect real usage data, four prototypes were implemented: a system for mobile interaction in smart environments, a mobile tourist guide, a mobile museum guide and a prototype for mobile interaction with advertisement posters. In each setting an experimental comparison was performed. Based on the results of these studies, which involved over 60 participants in total, advantages and disadvantages of these interaction techniques are described. Context-specific user preferences are presented for the interaction techniques, to help application designers and developers decide which interaction technique(s) to integrate into their application and which consequences this decision has.

Keywords: Physical mobile interaction, touching, pointing, scanning, user-mediated object interaction, evaluation, comparison.

1 Introduction

An important step towards implementing the vision of ubiquitous computing is the use of mobile devices, which are the first truly pervasive computers and interaction devices. So far, most mobile devices, applications and services mainly focus on the interaction between the user, the mobile device and available services. The context of use is often not considered at all or only marginally. This does not conform to our everyday life and behaviour in which context plays a central role. However, in the last few years, a huge interest in industry and academia in using mobile devices for interactions with people, places and things can be observed [1, 2, 3].

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This paper coins the term *physical mobile interactions* to describe such interaction styles in which the user interacts with a mobile device and the mobile device interacts with objects in the real world. They enable the nearly ubiquitous use of mobile services that are connected with smart objects. In the used terminology, a smart object can be a real world object, a person or even a location.

The usage of physical mobile interactions simplifies the discovery and use of mobile services, enables new kinds of object-, person- or location-based applications and removes several limitations of mobile devices. The most important and widespread physical mobile interaction techniques are identified to be touching, pointing, scanning and user-mediated object interaction [4].

But so far very little research is reported that has analyzed which interaction technique should be provided by an application and which interaction technique is preferred by which users in which situation. Because of this, it is very complicated for application designers to decide which physical mobile interaction technique to support within a new application or service. The application context, the location of the object, the distance between object and user, the service related to the object and the capabilities of the mobile device for instance are important factors that influence the preference of a user for a specific type of interaction technique. Therefore a study-based comparison of several types of physical mobile interaction techniques was conducted, with the main focus on an evaluation of which type of interaction technique fits best in which situations, applications and scenarios. Touching, pointing, scanning and user-mediated object interaction were used in four different prototypes and analysed in four different user studies. The results reflect the advantages and disadvantages of these interaction techniques as seen by potential users.

The paper is organized as follows. The next section gives an overview about physical mobile interactions whereby the focus lies on the interaction techniques touching, pointing, scanning and user-mediated object interaction. Next, the prototypes used for the user studies and their implementations are described. We then present the four user studies and the corresponding results. Based on this we summarize the results and discuss the advantages and disadvantages of the different physical mobile interaction techniques in the different contexts. The paper is completed by a discussion and outline of our further work.

2 Physical Mobile Interactions

A detailed overview and discussion of physical mobile interaction techniques can be found in [4, 5]. The aim of this section is primarily to give an introduction into the interaction techniques touching, pointing, scanning and user-mediated object interaction that is needed for the understanding for the following text.

By means of the interaction technique touching the user can select a real world object by touching it with a mobile device or by bringing them close together (e.g. 0 - 5 cm). Want et al. were one of the first who presented a prototype for this interaction technique which incorporates RFID tags and an RFID reader connected to a mobile device, in this case a tablet computer [6]. For instance, they used this prototype to interact with augmented books, documents and business cards to establish links to corresponding services like ordering a book or picking up an email address. In [7] this