Proceedings of the 1st Workshop on

Pervasive Computing @ Home

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Pervasive Computing @ Home

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1. Motivation and Theme

The Pervasive Computing @ Home workshop focuses on Pervasive Technology as applied specifically to a home environment. Two approaches have emerged in the research community for studying technologies as well as behavior in a home setting. The first is building a "living laboratory" (i.e. MIT, Georgia Tech, Intel, and Microsoft), where a very rich set of sensors, actuators and infrastructure are available for studying specific behavioral questions and technical challenges. The other is to create deployable versions of sensing technology, actuator systems and methodologies so that researchers can study behavior in a more natural and authentic setting (i.e. Georgia Tech's Digital Family Portrait, Intel's CareNet, Microsoft's Whereabouts clock). Both options provide valuable insight with regard to behavior and technology, but each approach has drawbacks. For example, the expense of building a functioning laboratory or the difficulty of ensuring the technology is robust enough for the home.

As many researchers and companies around the world study Pervasive Technology in the home, we wanted to bring together researchers to share insights on designing and deploying pervasive technologies for the home. The question we will discuss include why do we want to put technologies in people's home and what does it really take for that to be successful? What are the challenges? How do you run a field study about something that is supposed to work 24x7? What lessons can we learn from the state of technology adoption in the home today? Are there lessons to be learned from successful home and mobile technologies, such as Tivos, iPods and mobile phones? What cultural differences and similarities can we observe for pervasive technologies in the home? In the workshop program we have a set of papers reflecting on these questions and showing novel and interesting solutions. The papers report work of people who have placed technology in the home (or living laboratory) or who are planning on doing so in the future.

We expect the workshop to result in a community of researchers focused on pervasive computing in the home, a set of lessons learned about deploying technologies in homes and living laboratories, and a list of hot areas for research.

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Pervasive Computing @ ICS-FORTH

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Abstract. This paper introduces the Ambient Intelligence (AmI) Programme of the Institute of Computer Science of the Foundation for Research and Technology – Hellas (ICS-FORTH). In this context, a laboratory space of about 100m^2 comprising six rooms, called the "AmI Sandbox", has been created. In this space several AmI technologies have already been installed and related R&D activities are being conducted. In addition to that, a large-scale Ambient Intelligence Facility is currently being built. The facility will occupy a three-floor 3,000 m^2 building, comprising simulated AmI-augmented environments and their support spaces, laboratory spaces for developing and testing related technologies, staff offices and public spaces.

Keywords: Ambient Intelligence, living laboratory, interdisciplinary research.

1 Introduction

The Institute of Computer Science of the Foundation for Research and Technology – Hellas (ICS-FORTH), since its establishment in 1983, has had a long history and recognized tradition in conducting basic and applied research, and playing a leading role, in Greece and internationally, in the field of Information and Communication Technologies. ICS-FORTH comprises the following Research Laboratories and Centers:

- Biomedical Informatics Laboratory (BMI)
- Computer Architecture and VLSI Systems Laboratory (CARV)
- Computational Vision and Robotics Laboratory (CVRL)
- Distributed Computing Systems Laboratory (DCS)
- Human- Computer Interaction Laboratory (HCI)
  - Centre for Universal Access and Assistive Technologies (CUA- AT)
- Information Systems Laboratory (ISL)
  - Centre for Cultural Informatics (CCI)

- Telecommunications and Networks Laboratory (TNL)

Additionally, ICS-FORTH is running a horizontal interdisciplinary Research and Development Programme in the domain of Ambient Intelligence (AmI). The vision of this Programme is to establish itself as a connecting thread for the activities of the individual laboratories and to provide opportunities for defining interesting new problems. In this context, a laboratory space of about 100m^2 comprising six rooms, called the "AmI Sandbox", has been created in 2007. In this space, various AmI technologies and applications are being installed, integrated and demonstrated, and alternative ideas and solutions are being cooperatively developed, studied and tested. A cross-laboratory taskforce has been formed comprising researchers, technical staff and graduate students. Thus, the AmI Sandbox provides researchers the opportunity to bring along and share their know-how and resources in order to obtain hands-on experience and experiment in a highly flexible setting. Currently, the following activities are being conducted:

(a) Design, implementation and evaluation of an integrated, scalable approach towards the creation of AmI environments.

(b) Design of the simulation spaces and selection of the required hardware and software technologies.

(c) Installation, integration and testing of candidate AmI technologies in the AmI Sandbox.

(d) Definition of alternative representative scenarios of use for all the simulation spaces of an AmI Facility (see Figure 1), including the home environment.

The following technologies have already been installed in the AmI Sandbox:

- Computer vision system, comprising 8 cameras
- Surround speaker system with 8 speakers
- Various computer-operated lights (neon, spot lights, floor and desk lamps) using both the DMX and X10 protocols
- Computer-operated air-condition
- Various screens and high definition TVs, including touch screens
- One large front projection screen created by 2 ceiling-mounted short-throw projectors
- One back projection screen
- Several sensors (distance, temperature, etc.) and actuators
- Desktop and mobile RFID readers
- An interactive table
- Access control systems
- Positioning system through wireless access points
- Various robotic systems

- Based on these technologies, the various laboratories of ICS-FORTH, taking advantage of their related expertise and know-how, are currently working towards the development of several interoperating AmI components, such as:
- AmI software and hardware architectures
- Middleware
- Computer vision subsystem for multiple user localization and gesture recognition
- Speech recognition and speaker localization
- Environment sensing technologies and sensor fusion
- Dynamic surround sound playing system
- Environmental control
- Context management and reasoning
- Access control, information and communications security
- Seamless and intuitive user-environment interaction

The above components are to comprise a generic set of "building blocks" that will be employed to synthesize a wide range of AmI applications. Furthermore, the interaction of such different AmI components will be studied in depth. The first results of this effort are expected to be delivered by the end of summer 2008, in the form of an integrated AmI Sandbox demonstrator. These results, depending on their utility and impact, will be "propagated" to the ICS-FORTH Ambient Intelligence Facility (see Fig. 1), that is currently being built and that will occupy a three-floor 3,000 square meters building, comprising simulated AmI-augmented environments and their support spaces (e.g., computer and observation rooms), laboratory spaces for developing and testing related technologies, staff offices and public spaces.

Fig. 1. Digital maquette of ICS-FORTH' AmI Facility (currently under construction).

One of the key application domains that will be addressed in this new facility is housing. More specifically, the northern part of the building will enclose a simulated home environment that will expand on two floors which will be linked through both a staircase and an elevator and will include an open-space living room, a kitchen, a house office, two bedrooms (one for adults and one for children) and a bathroom. The home will integrate numerous application scenarios including local, remote and automated home control, safety and security, health monitoring, independent living,

(tele)working and entertainment. The AmI home will be fully accessible by the elderly and people with disabilities.

A first, small and focused, example of current work related to home control is an interactive application that supports accessible lighting control through multiple modalities, such as: (a) touch-screen-based, for sighted users with no motor impairments; (b) remote controlled operation in combination with speech for visually impaired users or tele-operation by sighted users; (c) switch-based scanning for motor-impaired users; and (d) speech-based interaction for all users. The visual interface and the hardware set-up of the system are depicted in Fig.2. The usability and accessibility of the system have been tested with several end-users with diverse abilities, including young children, blind people, people with hand-motor impairments and elderly. The findings of these evaluations: (i) confirmed the validity of the initial design decisions; (ii) supplied interesting ideas for future improvements; and (iii) provided strong evidence that the design approach followed can be effectively used for creating general-purpose environmental control interfaces that are accessible and highly usable by diverse user groups, including people with disabilities.

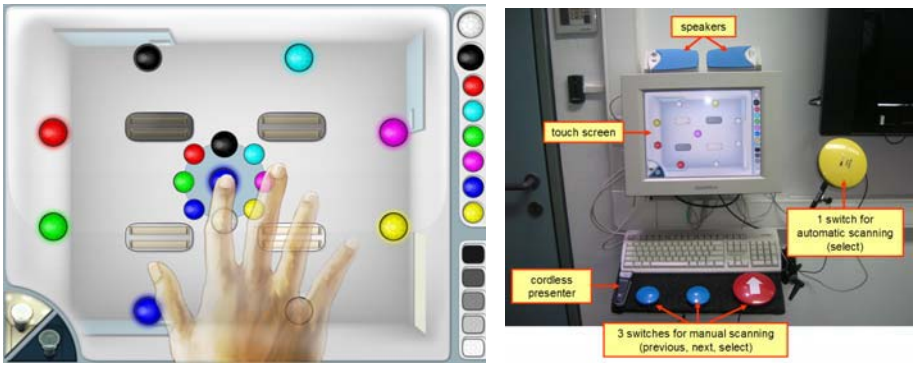

Fig. 2. The visual interface, also depicting a user's hand using the touch screen (left); and the prototype hardware set-up (right) of the lights control system.

2 Relevance to the goals and topic of the workshop

The activities described above have only recently started, and therefore the results are rather preliminary. However, as the home environment is the target of a substantial part of current and future research work at ICS-FORTH, participation in this workshop is considered as very interesting and important, since it will provide an invaluable opportunity, on the one hand, to learn the problems faced and solutions devised by others, and, on the other had, to liaise with key actors and establish mutually beneficial cooperations in this challenging domain.

3 Authors' Short CVs

Constantine Stephanidis

Constantine Stephanidis, Professor at the Department of Computer Science of the University of Crete, is the Director of the Institute of Computer Science (ICS), Foundation for Research and Technology – Hellas (FORTH), Head of the Human - Computer Interaction Laboratory and of the Centre for Universal Access and Assistive Technologies and Head of the Ambient Intelligence Programme of ICS-FORTH. Currently, he is also the President of the Board of Directors of the Science and Technology Park of Crete. Prof. Stephanidis is the Scientific Coordinator of the European Commission Coordination Action INTERLINK (2006-2009) that aims to identify and address world-scale, basic research problems in 'software intensive systems and new computing paradigms', 'ambient computing and communication environments' and 'intelligent and Cognitive Systems', under a human-centred perspective, and to define joint basic research agendas for world-wide cooperation in these domains. Prof. Stephanidis is the Editor-in-Chief of the Springer international journal "Universal Access in the Information Society" and General Chair of the HCI International 2009 Conference. He has published more than 300 technical papers in scientific archival journals, proceedings of international conferences and workshops related to his fields of expertise.

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Antonis Argyros

Antonis Argyros is an Associate Professor at the Computer Science Department, University of Crete and a researcher at ICS-FORTH where he has been involved in many RTD projects in image analysis, computer vision and robotics. Prof. Argyros is the deputy coordinator of the Ambient Intelligence Programme of ICS-FORTH and assistant scientific coordinator of the European Commission Coordination Action INTERLINK. Antonis Argyros is also a member of the Executive Committee of the European Consortium for Informatics and Mathematics (ERCIM). The research interests of Antonis Argyros fall in the areas of computer vision and robotics, visual perception of motion and scene structure, development of robot behaviors based on visual input, cognitive vision systems, vision-based tracking of multiple targets, and omni-directional vision. In these areas he has published more than 60 papers in scientific journals and conference proceedings.

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Dimitris Grammenos

Dimitris Grammenos is the lead interaction designer of the Human-Computer Interaction Laboratory of ICS-FORTH, and he is in charge of the Lab's Universally Accessible Games Activity. He is also a member of ICS-FORTH' Ambient Intelligence (AmI) Programme Coordination Team. He holds a B.Sc in Computer Science, and an M.Sc and Ph.D in Electronic Engineering. He has been involved in

several European R&D projects related to Design for All and Universal Access and has given related lectures, seminars and tutorials. He is a member of the Editorial Board of the "Universal Access in the Information Society" International Journal and a member of the Program Board of the International Conference on Universal Access in Human-Computer Interaction.

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Xenophon Zabulis is currently a Researcher at the Institute of Computer Science – Foundation of Research and Technology, Hellas. He received the B.A., M.S. and Ph.D. degrees in computer science from the University of Crete, Greece, in 1996, 1998 and 2001, respectively. He has worked as a Postdoctoral Fellow at the Computer and Information Science Department, at the interdisciplinary General Robotics, Automation, Sensing and Perception laboratory and at the Institute for Research in Cognitive Science, both at the University of Pennsylvania, USA. In addition he has worked as a Research Fellow at the Institute of Informatics and Telematics, Centre of Research and Technology Hellas, Greece.