Interacting with the Ambience: Multimodal Interaction and Ambient Intelligence

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Abstract. Multimodality allows adaption of human-computer interaction on two different levels: on the one hand different users with different abilities can interact with information technology through a customized configuration of interaction devices supporting their individual needs. On the other hand output can be adapted to user context within different environments, e.g. in the car, in the living room, in the office. This position paper introduces two aspects of our approach to multimodal interaction developed in the EMBASSI and the DynAMITE project with the special focus on the Ambient Intelligence initiative of the INI-GraphicsNet.

1 Introduction

Multimodality allows adaption of human-computer interaction on two different levels: on the one hand different users with different abilities can interact with information technology through a customized configuration of interaction devices supporting their individual needs. On the other hand output can be adapted to user context within different environments, e.g. in the car, in the living room, in the office. In order to achieve this two main research challenges have been identified: the design and development of an architecture for multimodal systems and the coordination of different multimodal in- and output components according to a special context; the other challenge addresses the self-organization of ad-hoc device ensembles within dynamic device environments.
This position paper introduces two aspects of our approach to multimodal interaction developed in the EMBASSI and the DynAMITE project with the special focus on the Ambient Intelligence initiative of the INI-GraphicsNet[3].

[3] The INI-GraphicsNet is the International Network of Institutions for Advanced Education, Training and R&D in Computer Graphics Technology, Systems and Applications. Website at http://www.inigraphics.net

2 Approaches to Multimodal Interaction

2.1 Universal Access to Information Systems

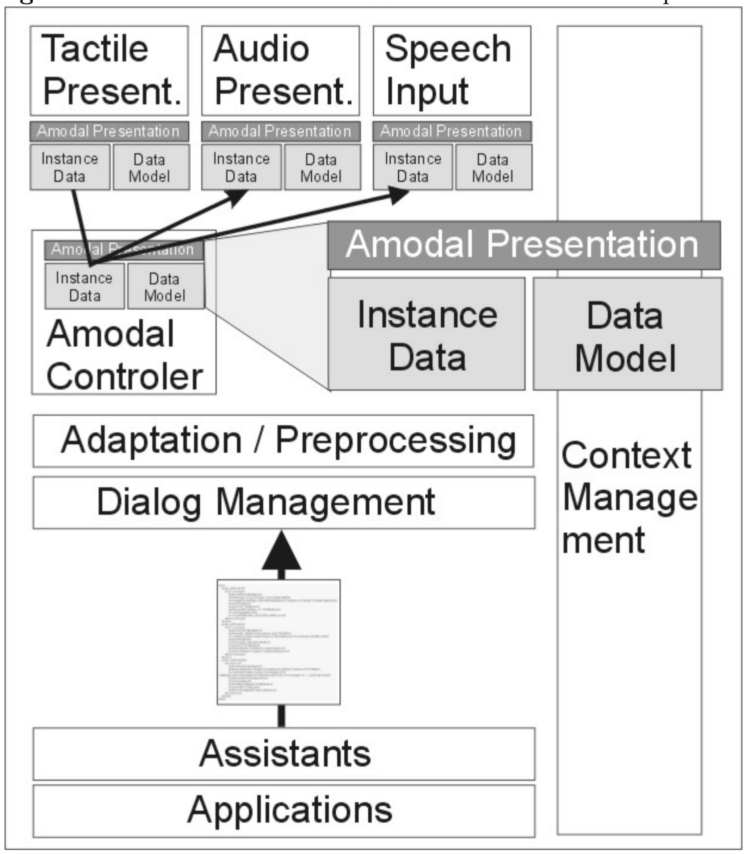
In his notion of universal accessibility Stephanidis [1] demands the adaptation of information technology to the user. Above all disabled persons in a public environment depend on the accessibility to information technology (e.g. cash dispensers, ticket selling machines, etc.). Due to the technological development and the successive intrusion of information technologies into everyday life, "the range of the population which may gradually be confronted with accessibility problems extends beyond the population of disabled and elderly users" [1]. Being accessible requires that a system is able to adapt to the users' needs, to the task scope and context, and to the technical platform used. An accessible system therefore is a system that is able to optimize its usability depending on the current user, task and system configuration. Universal Accessibility implies that support for users with special needs are not regarded as orthogonal to the application but rather part of the system itself. Users with disabilities are not considered as a distinct class of users, but rather as part of the continuum of human diversity [2]. As has been stated by Oviatt [3] "multimodal interfaces have the potential to accommodate a broader range of users than the traditional interfaces". Providing users with the means of multimodal interaction in their everyday life therefore will enhance accessibility and usability of such systems. Thus, multimodality plays an important role for the integration and rehabilitation of disabled persons also as for the improvement of accessibility of information systems for tomorrow's aging, multilingual and multicultural societies.

As In the EMBASSI[4] project an approach to provide handicapped users with multimodal and personalized access to public information systems has been explored. An agent-based interaction platform has been developed in order establish a second invisible communication channel between a user's personal mobile assistant and the terminal. This interaction channel was designed to allow terminals to transmit an amodal XML-based description of their user interface to a mobile device [4, 5]. On the mobile device a customized configuration of input and output devices (mainly existing assistive technology like Braille, a novel tactile display and special input devices for physically disabled users were used) could be used to display the interface. A user interface description language as new host language for the W3C XForms [6] has been developed. Figure 1 shows the general architecture of the EMBASSI interaction platform where different input and output modalities are synchronized over the W3C XForms data model structures. Assistants and components on the application layer were able to publish user interfaces to the dialog manager. Implementation of the user interfaces was realized on base on a Java API.

User tests have been conducted in order to evaluate the usability of the system. Multimodal interaction through mobile devices with customized interaction devices have turned out to be well accepted by disabled persons as for

[4] Website at http://www.embassi.de

Fig. 1. Architecture of the EMBASSI multimodal interaction platform.



instance by physically handicapped [7] and by visually impaired users [8, 9]. The EMBASSI prototype allowed physically handicapped users to interact with a demonstrator terminal even better and more accurate than users without the assistive device[10].

2.2 Ambient Intelligence

In the future we will be surrounded by smart intuitively operated devices that help us to organize, structure, and master our everyday life. The term *Ambient Intelligence*, coined by the European Commission's Information Technologies Advisory Group (ISTAG) and Philips, describes this vision [11]. Especially it characterizes a new paradigm for the interaction between a person and his everyday environment: *Ambient Intelligence (AmI)* enables this environment to become aware of the human that interacts with it, his goals and needs. So it is possible to assist the human proactively in performing his activities and reaching his goals. Up to now, it is the user's responsibility to manage his personal environment, to operate and control the various appliances and devices available for his support. But, the more technology is available and the more options there are, the greater is challenge to master your everyday environment, the challenge not to get lost in an abundance of possibilities.

In order to make this vision become true, the INI-GraphicsNet started the *Ambient Intelligence@INI-GraphicsNet* Initiative. The *AMI@INI* website[5] illustrates our current work on this research topic focussing on the following research areas:

- *Interaction and Devices*: This research topic concentrates on the development of device-independent interfaces (and interface descriptions), of intelligent ad-hoc interaction possibilities and self-organizing multimodality output
- *Intelligence and Awareness*: Here the INI-GraphicsNet initiative focus on the design and development of architectures and topologies for self-organizing ensembles [12] to support goal-based interactions [13].
- *Integration and Architectures*: Here the basic functionalities of *Ambient Intelligence* are examined and supported as well as an integrated reference model is designed
- *Integrity and Trust* is an important precondition for coherence in AmI. Without mechanisms that will guarantee security the acceptance of *Ambient Intelligence* environments will be very low.

Self-organization (and the design of device-topologies supporting self-organization) is one of the main preconditions to enable ad-hoc cooperation of device ensembles (e.g. to make it possible that a user can move from the office to the living room using the same personal devices to interact with her environment). Especially intelligent multimodal interaction with distributed networked devices within dynamical changeable ensembles requires concepts of software technology that makes coherent acting of single devices possible. Within the project DynAMITE[6] such a software framework is being developed and implemented.
Imagine a mobile device as your personal assistant to organize your preferences and your working files, which are distributed among your home or business network. Coming into a meeting the mobile device detects all available DynAMITE devices and sets up a spontaneous device ensemble. The interaction and presentation possibilities are enhanced by the additional abilities of the other devices. Because of the personal preferences of the user, the possible presentation of documents will be realized with the help of a video projector and synchronously the light will be dimmed. This service should be comparably available in every possible meeting or lecture room. This can only be achieved, if all devices form a spontaneous ensemble and are able to co-operate dynamically. Additionally they must be able to work out a shared strategy and to act homogeneous according to a conjoint goal.

[5] Draft website at http://www.igd.fhg.de/igd-a1/amiatini/index.html
[6] Website at http://www.dynamite-project.org

Thus the research activities in DynAMITE span the architectural integration of device ensembles as well as the operational integration of the provided functionalities. The concepts and the software framework of DynAMITE will ensure the independence of each device resp. software component; allow the dynamic extension of device ensembles with new components; avoid central components; and will identify the basic topologies of heterogeneous ensembles, the functional roles, and the necessary ontologies.
In the meantime the first version of the DynAMITE framework is implemented and downloadable from the project web site. It supports an API (Java JDK 1.3.1 or higher for developing own device topologies), that is fully extensible by new components during framework life time, that has powerful conflict resolution strategies and that easy to be used.
Special attention is drawn on the application of conflict resolution strategies to coordinate multimodal output devices. In contrast to other approaches to this topic (multimodal output strategies) the number of output devices is unlimited. Each system output to the user is rendered in respect of the current output devices and their location. Input and output modalities can be combined dynamically based on the architecture outlined in figure 1. Possible kinds of output devices are speech output devices, virtual characters and graphical user interfaces.

3 Future Work and Interest in the Workshop

In order to promote the development of multimodal technologies and in order to push forward the vision of Ambient Intelligence the application of international standards and the agreement on architectural and developmental principles seems crucial. As outlined above the integration of existing standards has been of major interest for the solutions developed so far. Future work still addresses standards like the V2 initiative [14] and other international approaches. Another central motivation is the dissemination and promotion of the Ambient Intelligence vision and the exchange of research approaches and results as well as increasing the awareness of the potential of this approach within the research community.

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