

Goal-oriented Assistance in Ambient Intelligence

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Abstract. Ambient Intelligence will change the way people interact with devices. In order to support users best user studies must be performed to collect pools of possible goals and to choose the kind of assistance that is accepted at most. In parallel technologies for Ambient Intelligence must be enhanced to guarantee the application of assistance technologies¹.

1 Ambient Intelligence effects a Metaphor Change

Up to now, it has been the user's responsibility to manage her personal environment and to control the various appliances and devices that are available for her support (see Figure 1 left). The more options a bundle of devices offers to their users, the greater is the challenge not to get lost in an abundance of possibilities. Because technology as it exists today forces its metaphors upon the user. He must find an appropriate strategy that combines functions of the offered devices in order to reach his goal (in general a change of the current environment state). At best the functions could be executed successively without any side effects that have to be considered (see Figure 1 bottom left). Unwanted side effects (e.g. room lights that decrease the contrast of the display screen of a TV set) will reinduce a new goal and thus force the user to change his strategy. Consequently, it is possible for the user to be more occupied with finding strategies and functions than he is with his actual goals. Ambient Intelligence changes this pure function oriented usage metaphor of today's technology to user's goal orientation. If this metaphor change is accomplished the environment's full assistive potential will be mobilized to take over mechanical and monotonous tasks - as well as stressful feature selections and combinations - from the user and manage appliance activities on her behalf (see Figure 1 right). Then technology meets the wants of the user and not vice versa.

2 Workflow Cycle of Ambient Intelligence

In order to realize the creation of reactive and intelligent environments for the user's goals and needs, Ambient Intelligence implementations have to consider the following basic requirements that define the principle workflow cycle of Ambient Intelligence (for more details see [11]):

¹ The content of this paper was presented at the Workshop on Experience Research in Ambient Intelligence (<http://www.experience-research.net/>), that was held on 27th and 28th June 2005, in Eindhoven, the Netherlands

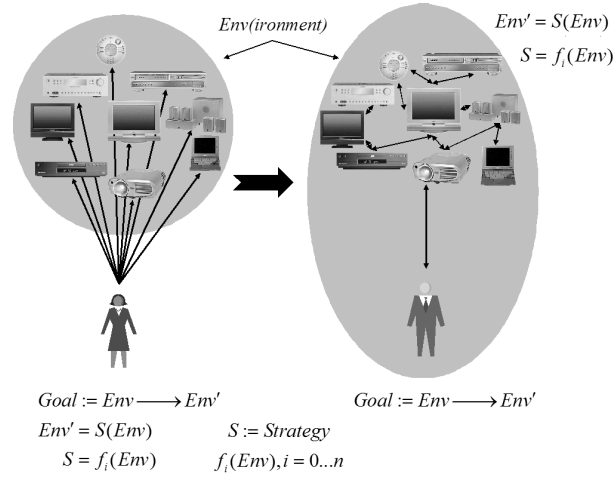


Fig. 1. The metaphor change that is effected by Ambient Intelligence: Instead of developing a strategy that determines a sequence of available (device) functions (left side) the user can concentrate on his goals (right side).

1. *Awareness*: the environment itself (and its devices) must be aware of the user's current situation, his interaction within his environment and its own current state (and possible changes in this state)
2. *Intention Analysis*: then the environment must be able to interpret those occurrences into user goals and, accordingly, into possible reactions that enable a cooperative, proactive support for the user.
3. *Strategy Planning and Execution*: in a final step, the environment must be able to translate the interpreted goals into strategies that can be fulfilled by the environment's devices and functionalities in order to adapt itself to the user's needs.

Obviously there is a strong link between the detection of the user's goals and their realization. In order to plan an execution strategy (and for the following execution of functions) Ambient Intelligent environments have to consider the appropriate kind of assistance against the current user situation and the user's preferences. Furthermore the kind of assistance (as reaction of the Ambient Intelligent environment) has to be in accordance with the personal mental model of the user. Consequently, if Ambient Intelligence realizations fail to address these challenges, they will not be accepted by users (see [15] for a detailed view on this topic).

3 Different Kinds of Assistance

The project EMBASSI[5, 8]² analysed different kinds of assistance by experimental Wizard of Oz studies in living room environments. A total number of 143 subjects had

² The focus project EMBASSI was funded by the German Ministry of Education and Research (BMB+F) under the grant signature FKZ 01 IL 904 and addressed methods of man-machine

to interact with a networked and partly autonomously acting home entertaining system which presented integrated functions like TV, radio, audio and video playing, telephone, and light controls[14, 16]. A short summary of the results:

- 7 kinds of assistance can be defined (range from situations where the user is fully informed about all details of the environment changes till situations where the environment changes without any direct access of the user)
- 6 kinds of action phases (of the user) could be differed (goal realisation, information, situation awareness, decision making, execution, (impact) control)
- furthermore different kinds of adaptivity and modality are important.

It is obvious that the decision for an appropriate kind of assistance against the user's action phase (that have to be interpreted from the current user situation) is not trivial. In EMBASSI some scenarios were implemented and some user studies were performed (see [13] for an example). Some results were very encouraging.

4 Research Challenges

There are already implementations of intelligent environments that are suited to illustrate the visions[3] of Ambient Intelligence[1]. Well-established examples are the *Easy Living* project from Microsoft [2], the *Interactive Workspaces Project* [12] from Stanford University or the *Intelligent Classroom* [7] from Northwestern University. But the assistance (resp. intelligence) that is offered by those prototypes and demonstrators is carefully handcrafted by the programmers. It is not able to adapt to the current user situation or to choose between different shapes of assistance.

The research efforts to guarantee appropriate assistance in order to fulfil the visions of Ambient Intelligence have to concentrate on two major directions:

Improvement of technologies : In order that device ensembles (see Figure 1 right) are able to "discuss" about the user's goals and about possible execution strategies middleware technologies have to guarantee methods for self-organization[6, 10] and conflict resolution mechanisms to moderate discussions within device ensembles[11]. The project DynAMITE develops a decentralized self-organizing middleware and offers some demonstrators on its website[4]³. Furthermore intelligent components must be provided to derive strategies for reaching user goals (see [9] for a planning system that was developed in EMBASSI).

User evaluation for reasonable assistance : Assistance for the users has to occur in the most appropriate way. Therefore typical Ambient Intelligence scenarios like the intelligent living room must be examined to get a complete pool of possible user goals. Then possible user situations (depending on current environment states) must be defined that indicates such goals - to provide awareness and goal recognition afterwards. Furthermore different kinds of assistance must be evaluated by user studies to examine

interaction. The consortium management was performed by the Fraunhofer Institute for Computer Graphics (Fh-IGD) and Grundig.

³ DynAMITE-Dynamic Adaptive Multimodal IT-Ensembles is funded by the German Ministry of Education and Research (BMB+F) under the grant signature FKZ 01 IS C27 A. The consortium management is performed by the Fraunhofer Institute for Computer Graphics (Fh-IGD).

the acceptance of different assistance approaches taking into account the user's action phase. Other research topics are the parallel execution of assistance strategies, reliability, controllability, verifiability and the correspondence of system reactions with the mental model of the user.

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