SitMod: A Tool for Modeling and Communicating Situations

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Abstract
Home environments will change in the near future due to use of awareness technology. Future homes will be able to sense situations and react appropriately. User profiles can be used to personalize the aware home environment. This study researches the use of situated user profiles, in which the elements of the profile are linked to situations. First, a formal model for home situations is constructed based on the results of qualitative user studies. In a later stage of the study, the role of the profiler as a mediator will be investigated.

Keywords: User profiles, situated awareness, ambient intelligence, mediation.

1.   Introduction

Context-aware systems interpret the environment by clustering low-level stimuli from sensors into abstract situations. These situations trigger appropriate system actions based on stored settings. System actions and user actions change the environment and the cycle is started again (Figure 1). Aware environments can adapt to for example their inhabitants, activities, and events.
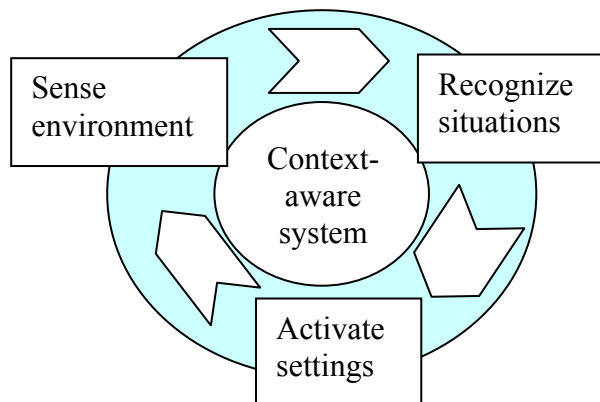

Figure 1: Context-aware system overview

The behavior of an aware system can be personalized. These personal settings are stored in a user profile. A *user profile* is a container with attribute-value couples for a specific user. A *profiler* is a component that creates, maintains and manages user profiles.

The home is an interesting and challenging application area for aware systems. Although people are curious in nature and want to try out the new possibilities of aware systems, they are also afraid to lose control in their own house. New devices like residential gateways are being developed that connect devices and sensors in a house; these devices can easily host a profiler module. Hardware solutions are already available; we now face the challenge of creating the right user experience.

1.1. Situated Profiles

A *situation* refers to the current state of the environment. Crowley [1], who published interesting work in the field of robotics and computer vision, states the user's situation is a particular assignment of entities to roles completed by a set of relations between entities. Entities generally correspond to physical objects. A role is a 'way of using' an entity, so for example the object 'table' can serve the role of a 'seat'. Relations describe connections between (properties of) entities, for example you are 'sitting on' the table.

In her book [6], Lucy Suchman describes the situated action theory. She states a dynamic environment is unpredictable in nature; actions cannot be planned in advance. Also, people are not solely working on logical tasks and goals, they are unpredictable emotional beings. Hypothetically, a system that reacts to situations can better handle the dynamic world compared to a system based on logical steps.

Situations can also be used as a framework for a user profile. A *situated profile* is a user profile where the values are relative to situations, thus the values are only valid in specific situations. Consider for example a situated profile describing the music preferences of a user. The user might like to listen to Bach, but only at night. The preference (Bach) is situated. In preliminary user studies, test subjects were well capable of specifying system behavior using situated preferences.

Non-situated Profile	
attribute	**value**
music-taste	Bach
	News radio
…	…

Situated Profile		
attribute	**situation**	**value**
music-taste	at night, when alone	Bach
	at breakfast	News radio
…	…	…

Figure 2: Example of situated and non-situated profiles

Next to personal settings, a profiler can also store intelligence on how to update the profile. It would be interesting to store application-specific intelligence as objects inside the profiler. An application can then create "intelligence"-objects, and feed them to the profiler. These intelligence-objects tell the profiler what information to sense and store, and how to reason about the information in the model. The intelligence-objects can also be situated, i.e., the intelligence would only be active in specific situations. A situated profile could help a developer structure the intelligence.

1.2. Formal Model for Home Situations

Situations can be used as a framework for a user profile. A formal model for situations is needed, in order to make it possible for an automated system to handle situations. Average users most likely do not want to define entities and relations themselves; they will be using predefined entities and relations most of the time. We use user studies to get a better insight in how people process situations. The studies will also tell whether the 'feeling in control' increases when users are able to inspect the model and change settings. We will define a model based on the results of the studies, and the model will then be used in the situated profiles.

Humans and computers do not necessarily communicate at the same abstraction level. A person could say "when I'm working at home". This informal description of the situation leaves many aspects ambiguous, so it will be hard for an automated system to recognize the situation. Different approaches help make the abstraction-problem manageable: 1) help the user to accurately specify the situation, and 2) make a system that knows how to cope dynamically with ambiguous situations as they occur. An aware system needs to be able to translate abstract descriptions of situations into concrete situations that can easily be detected. The formal model must allow for changing the abstraction level of situations. For many users, an ideal system would allow them to specify situations in a natural, abstract way.

1.3. Mediation

Situations may lead to ambiguity, because of subjective/ambiguous interpretation of situations [4], imperfect sensors [1], and conflicting settings in profiles. These conflicts can not always be solved in advance. For example, a profile might say "Bill likes Bach in the evening", and also "Bill does not like music when he is reading a book". There is no problem when Bill does not read books in the evening. On the other hand, when Bill does read a book in the evening, the system does not know what to do. The conflict in the example has no serious implications, but one could think of more serious conflicts.

A profiler might contain intelligence on how to deal with conflicts. It could detect part of the conflicts before they occur. A profiler could be able to compare alternative approaches to solve the specific conflict, and decide which one is best. And it could decide if it is necessary to bother the user with the conflict, or if the conflict can just as well be ignored. Dey [3] proposes to leverage off any useful AI techniques for reducing the ambiguity and involve end users in removing any remaining ambiguity, through a process called mediation.

2.   Example of a Future Scenario

The following example illustrates the use of a situated profile in an aware home.

Part I: Situated Settings

It is 2030, Bill lives in an aware house in Seattle, and he arrives home after a day of hard work. A camera next to the front door recognizes his face and his mood, and activates the appropriate personalized home atmosphere settings: dimmed lights and relaxing background music. Bill likes to watch the Jay Leno late night show when he comes home. He instructs the system: "When I enter the living room after work, I want to see the latest Jay Leno show on the TV." The next day, when Bill enters the room after work, the show is started automatically.

Part II: Mediation

After watching the show, Bill carries the rubbish bag to the street corner, and he locks the house for the night. When he returns to the living room, the situated preference is triggered again; the system recognizes Bill entering the living room after work. The profiler notifies Bill already saw the show, and decides to ask Bill what to do. The television screen shows the message "press PLAY to see Jay Leno again". Bill does not press PLAY, and the profiler decides to update the situation in the profile.

3.   Problem Statement

3.1. Goal

The goal of the Ph.D. project is to develop a tool for modeling and supporting user-system communication of common user activities and situations in the home to support the design of aware systems. The tool will be designed in a modular and open way to enable addition of new activity related objects and events.

3.2. Focus

Research focus will be on:
-        development of a model and tool to formalize, abstract and concretize situations
-        visualization & interaction of situations to support user-product communication
-        design of a mediation interaction concept to enable users to edit system interpretation
-        user testing of SitMod via lab simulations of situations and in-home tests

The tool will be used to create a situated profiler for the atmosphere controller in StudioHome, a living room lab where atmospheres can be dynamically created, part of ID-StudioLab.

Figure 3: Pictures of atmospheres in StudioHome; the tool will be used to create a situated profiler

4.   Methodological Approach

We use a research-through-design process which is iterative with users in the loop (Figure 4). The first study researches how people build mental models of situations in home, and how these situations can be characterized and communicated. In an iterative process, formal representations of situated settings via an ontology based on theory of situated actions [6] are defined, and a communication mechanism for situations and settings as well as a mediation agent that resolves situation ambiguity, are built, tested and evaluated.
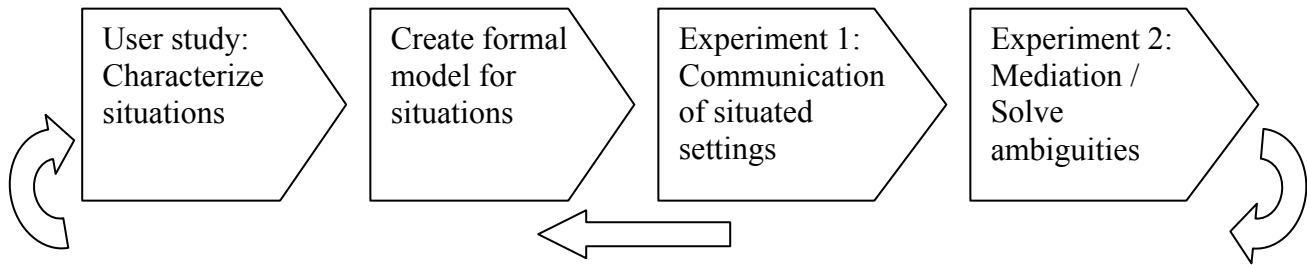

Figure 4: Process diagram

4.1. User Studies

The current focus is on how people build mental models of situations in the home. A qualitative approach is followed, based on the grounded theory [5]. Using the grounded theory approach, data can be systematically gathered and analyzed through the research process, resulting in a theory grounded in data. Data is collected using interviews and puzzle-like assignments (Figure 5), in quick iterations. The research begins with an area of study with no preconceived theory, and allows the theory to emerge from the data.

Figure 5: In the user study, users are asked to write down situated actions (1), and link these actions to a map of their living room (2)

The preliminary results of the study indicate people tend to think in activities ("I am reading a book"), events ("I enter the room") and needs ("The flowers need water"). If people consider certain views of situations more natural than others, it seems logical to use this insight when designing a formal model for situations. Consequently the interaction concept is also influenced.

4.2. Planned Experiment

The user studies result in a formal model for home situations. An experiment will be designed to validate the model. The experiment will be held in StudioHome. Test subjects will be asked to enter situated settings for atmospheres in the living room lab, using an experimental user interface. The test subject will work together with an expert user in order to check and improve the situated settings.

5.   Potential for Innovation

Existing projects (e.g. Aware Home, MIT House-n) tend to focus on technical aspects. In this project, user studies form the basis for the design of the formal model, a mediation mechanism, and the development of the tool. We hypothesize the user-centered approach will lead to a more natural interaction between users and aware environments. The results will be incorporated in a tool that supports developers in creating aware environments.

6.   Expected Contribution to the Pervasive Computing Literature

The project results in a tool that supports industry in the development of user-system dialog systems in aware environments. Publications will appear on the research on formal model for home situations, the mediation mechanism, and the tool.

7.   Acknowledgements

8.   References

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