

Interaction with Context-Aware Mobile Hand-Held Devices

Jonna Häkkilä

Information Processing Laboratory, P. O. Box 4500, 90014 University of Oulu,
Oulu, Finland

jonna@avaruusmies.com

Abstract: Interaction with context-aware mobile hand-held devices creates new demands for user interfaces and interaction methods. These devices, which detect the use context in order to adapt the device behavior in appropriate means, provide challenging design tasks in the field of human-computer interaction, when the aspects of mobility, small size and reliability have to be taken into account. The device has to meet user's demands as well in efficiency and acceptability as with the ethical issues in privacy and control. This paper draws together several aspects requiring a specific concern, and introduces the author's research plan for the considered topic.

Keywords: human-computer interaction, context-awareness, mobile devices, mobile computing

1 Introduction

A context-aware (CA) device is aware of the use situation and is able to adapt to it by providing appropriate functions or response. Context-aware devices can retrieve the information from the environment, the inner state of the device, and user's willingness and habits of completing certain actions under given conditions. There is lot of research e.g. in the field of data mining, sensor data fusion and recommendation systems, which contributes to the development of smart applications, where the device is aware of the surrounding world. Mobile devices form an especially appropriate platform for context-aware applications, since they are used in numerous different situations where the preferred features or settings may alter (Schilit et al, 2002; Mäntyjärvi et al, 2002).

With conventional devices, the interaction between user and the device is based on the assumption that the user knows what (s)he wants, and proceeds actions in order to reach that goal.

However, the approach with CA devices may often be quite the opposite. The devices should be smart enough to understand the user's needs, make decisions and proceed with the adequate actions without interrupting the user. The device can gather the data e.g. from integrated sensors, other devices, localized tags, and user input. CA systems should be able to hide complex technology and overwhelming data flow surrounding us, and provide the user with information and actions, which (s)he needs and expects. By using the context information, the device should adapt to each use situation with improved usability (Schmidt et al, 1999; Schilit et al, 2002).

Earlier studies of context-aware applications have mainly concentrated on a selected application or feature, where the user's intention is assumed to be known (Abowd et al, 1997; Bohnenberger et al, 2002; Schmidt et al, 2001; Duri et al, 2001). My aim is to approach the topic from a more general point of view, where the application is not aiming for a certain determined function, but provides flexibility for application personalization and gives user

chances to employ different degrees of adaptation and select preferred features integrated with context-awareness.

This paper is organized as follows. First, general concepts and fundamental features in the use of context-aware mobile hand-held devices are discussed. Secondly, the research problem and current state of the study are described. Finally, future steps are introduced.

2 User and the Device

With CA devices, the user interaction methods and UI design will be critical. All of the available information may not be relevant or interesting to the user, and as the amount of available information grows, some selections must be made. However, at the same time the user has to maintain the control over the device and may not be restricted by its behavior. The device should also be smart enough to understand, what kinds of actions are more important and which may cause more crucial effect from the user point of view than some others.

User modeling for CA devices is demanding, as in many situations we cannot ask “what is it what you want?” since the user may not be aware of the possibilities. For instance, the user walking in the city may get information about what is on sale in the pet shop today, who are the people walking by, which CD a passing skateboarder is listening to, which movie is going to start next at the cinema, and that somebody has lost her earring here in the street - and this all just for one street block. In the future, we will be overwhelmed with information and opportunities to act.

The interaction must remain intuitive and simple despite the fact that CA devices deal with a large number of different data and are able to provide much more information than the user is willing to take in the use situation. The CA applications may introduce different types of interaction methods according to the context. CA devices may advance the use of multiple human modalities, as they should adapt to each situation and provide the best possible solution in each particular case.

With the new kind of devices, the privacy issues will also be relevant (Smailagic & Kogan, 2002). For instance, one might introduce an application where the device interacts with other devices nearby and informs the user if some friend is close by. However, this may seriously violate privacy of the users. In order to sustain privacy, the user has to be able to define when he wants to stay anonymous,

and when the device should appear as invisible to the surrounding digital world.

One must also consider how much the user is willing to let the device guide her/his actions. It cannot be allowed, that the device would limit the user’s behavior, for example, by neglecting certain messages from the environment by assuming that the user is not interested in them. The device should be able to adapt its behavior not only with the novel user phase but also in the long term. The user might become interested in new topics, which may change her/his previous profile.

3 Reliability in Use

The reliability of the CA applications will be critical from the user point of view. This challenges the technology and algorithms used for context recognition (Mäntyjärvi et al, 2002). Also, a CA device should be able to learn from the use situations, and chronological and concurrent events. The teaching of the device should mainly maintain autonomous, so that it remains hidden from the user and does not require special training sessions, which usually require extra effort and cause discomfort. However, also the appropriate level of adaptation must be considered.

The priority order of the occurring tasks with conflicting context information needs to be defined. In contradictory situations the device has to be able to decide which contextual model is most probable and which actions are most excusable if the reasoning has failed. If the device fails in context recognition and behaves in a way, which causes harm to the user, (s)he will shortly stop using the device or limit its use to non-contextual features and applications. For instance, a CA mobile phone may be designed to manage incoming relying on the information of the environment’s noise level. If the phone erroneously classifies a symphony orchestra concert as a city environment based on the facts that noise level is varying and moderately loud, it thus sets the ringing tone loud and allows incoming calls. In the unfortunate case of a call, one can expect the user to remember public embarrass and leave the phone home after that.

4 Research Proposal

4.1 Research Problem

The aim of my PhD research is to study human computer interaction in context-aware mobile hand-held devices, user expectations and acceptance of

related applications; and to design interaction methods and UI for a selected CA application implemented on a mobile phone, and test and verify it with users. At the same time, attention is paid to improving the interaction design process and the usability testing methods for mobile hand-held devices in order to meet the needs for context-aware applications.

4.2 Current State of the Study

Work done to date includes a literature review “Advanced Interaction Methods” and post-graduate studies concerning interaction methods, information processing and usability. The publications to date consist of an in-depth paper “On-line Personalization of a Touch Screen Based Keyboard” (Himberg et al, 2003), and accepted but yet unpublished paper “Dynamic Auditory Cues for Event Importance Level” (Häkkinä & Ronkainen, 2003). With both applications, the device was dynamically adapting in order to better match to the users constraints with improved usability. Both research projects included user testing.

Generally, current research is driven towards a fundamental picture of interaction issues of CA mobile devices. Recently, a study concerning user-defined context-recognition application for a mobile hand-held device has been completed and results will be published.

Current research involves a design of location-aware mobile system for a city environment. The ongoing first phase of the research includes the study of user expectations and intuitiveness of the interaction. At the moment, preliminary design is verified with interviews and paper prototyping. The next phase of the research includes a design and realization of a functional prototype with a location tracking system. The user interface employs the knowledge gained from an earlier study, and the application will be user tested in city environment.

Future work concentrates on the applications, which employ sensor data used for low-level context recognition. The interaction research considers how the sensor data is applied to the CA UI features and which actions are appropriate to take place. After that, a selected CA application is designed and implemented on a mobile hand-held device. The application is based on context aware information based on sensor data gathering and processing, user profilization and user entered information. The UI is adapted according the CA information. To verify the application, usability tests will be arranged.

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