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UCD in Wearable Computing – A Case Study

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1 Introduction

Wearable computing has been an active research topic for quite a while. Although many of the technological challenges have been solved, there is an increasing demand for research in the area of usability. Wearable computing considers scenarios where today's desktop and mobile solutions are inappropriate. Unlike well researched desktop or mobile scenarios, users in wearable computing are away from their desk and have to carry out complex tasks in the real world. The primary task requires most of the user's attention that often cannot be redirected to the computer. For this reason end user involvement becomes very important. Therefore, applying UCD principles to the development process is a natural choice. However, current research in mobile usability (Kjeldskov & Stage 2004) shows the insufficiency of the available usability engineer's tool set. With wearable computing scenarios the problems are magnified, because the user's primary task needs to be integrated into the interaction.

How to successfully apply existing UCD methods in such settings is still an open issue. Practical research on this topic is rare. This paper focuses on the challenges and pitfalls when applying UCD to wearable applications. The reported experiences were gained during the development of a wearable prototype for the ward round in a hospital. In a first step, potential use cases for wearable technology were identified in cooperation with the hospital staff. User observations, interviews and focus group discussions revealed a scenario focusing on the ward round. Several UCD activities were carried out resulting in a usability test of the final prototype.

From the methodological issues encountered with field observations, mockup-studies and usability testing; and the general problems of lab vs. field evaluation, involvement of the non-user and communication of HCI findings, only field observations, lab vs. field testing and issues of the non-user are covered briefly in this abstract.

2 Case Study – Ward round

During the ward round, doctors need bedside access to patient records. In a paperless hospital of the future, patient records may be displayed and searchable via a bedside display. Beyond accessing patients' records, doctors need to record findings and setup appointments for further patient treatment. Both, the findings and the appointments have to be stored in and synchronized with the hospital's information system immediately. The scenario as such has several challenges: the collaboration between doctor(s) and nurse(s), the physical contact with the patient which requires subsequent disinfection and frequent task switching between several primary tasks and the computer task.

2.1 Field Observations

Early in the project a series of observations was conducted, where doctors were shadowed during their daily ward round. The goal was to discover the activities performed during a ward round, together with information about the environment and its influences on the doctor's work. To integrate the system seamlessly with the current ward round process, quantitative data about exemplary instances of the current process was necessary to analyze typical work situations. During the observations, a number of challenges were encountered.

First of all, the environment was completely unknown to the observer. When observing office users the basic setting is already known in advance and the observer has first hand experiences with this kind of settings. A ward round, however, is most likely new to an observer. As a consequence, it was difficult to assess the importance of events and environmental factors and note the right things. The speed at which unknown activities take place is another challenge the observer has to cope with. The ward round is a highly optimized and parallelized process. For example, a doctor might read the patient's file, order an examination, talk to the patient and document his visit, all in less than a minute. In a typical approach, one would interrupt the doctor and ask for clarification when things went too fast and were not understood. However this approach is prohibited by the environment that is studied. The doctor is not performing the ward round in his office, but in the hospital based on a strict schedule. In the present example, the hospital administration did not approve any technique that would have interrupted the ward round or would have made the patient aware of the fact that a study was in progress. For this reason and also for privacy reasons, audio and video recordings were not allowed. Therefore computer support as in (Klug 2007) was necessary to capture scenarios in sufficient detail.

2.2 Lab vs. field evaluation

When evaluating computer systems developed for the field context, there are two basic approaches: evaluating in the lab and evaluating in the field. Evaluating in the field means putting the system in its target environment whereas lab testing means reproducing parts of the context of use in a controlled environment. The selection of the appropriate method depends on the goals of the study and on the context of use itself.

Field evaluations ensure a realistic primary task as well as physical and social contexts, but are often hard to conduct. For example, the functionality of the prototype often needs to be almost complete for a field evaluation. Also the amount of uncontrollable variable hinders the discovery of reasons for specific usability problems. Lab evaluation, on the other hand, can be done with mock-ups and in a lab it is also possible to control all the variables. But the context of use simulated is only an approximation and the quality of usability and performance predictions largely depend on its quality. The main factor in these approximations is the simulation of a primary task, like the examination of a patient. A reasonable amount of research has been performed where the physical context of use was simulated in the laboratory (Kjeldskov & Stage 2004; Baillie & Schatz 2005; Been-Lirn Duh et al. 2006). However, there are not many results available regarding the simulation of the primary task (Witt & Drugge 2006).

In our case study for both, the mockup evaluation and the usability tests, a laboratory context was chosen for several reasons. Firstly, the prototype was not fully functional in the sense of being integrated with the hospital systems. Thus, no real patient data could have been accessed and no real examination orders could have been entered, which would be unpractical when dealing with real patients in the field. Secondly, most of the doctors had no prior experience with a similar application and especially not with gesture interaction. Thus, it was expected that a great deal of attention and time – which cannot be spared in a real ward round – would be required for interacting with the system. Thirdly, the involvement of real patients in the experiment was not possible due to privacy reasons. Fourthly, it would not have been possible to control which and how often primary tasks were performed. Thus, it would have been difficult to make sure that the important interdependencies between human computer interaction and the primary task were actually present and that these could be individually accounted for. Of course, some of the factors present in the reality like time-pressure or natural communication with patients or colleagues could not easily be simulated.

2.3 Involving the Non-User

Herstad (Herstad et al. 2000) introduces the non-user as „a person, or group, that is not directly using the technology in question, but that at the same time is affected in some way by the use of technology“. The authors motivate non-user involvement in the design process. In the healthcare scenario, doctors and nurses are the end users of the introduced system, and wearable computers will influence the doctor's surroundings. Patients are a major part of these surroundings. Unfortunately, privacy issues restrain contact to patients and make the inclusion of patients in the design phase impossible. Instead, the patient's view is mainly based upon doctors' and nurses' comments or the designer's appraisal which makes it hard to evaluate.

The doctors' and nurses' comments regarding the patients' view resulted in two assumptions affecting the proposed interaction methods for the ward round prototype system. First, patients will be annoyed by speech interaction. They will feel addressed if doctors use speech commands to navigate through the system. Second, they will be bothered by obtrusive navigation gestures. In other healthcare scenarios, e.g. when patients will be anaesthetized, speech interaction might be an adequate interaction solution. Nurses clearly know the proc-

esses of a ward round, therefore they will not be distracted by the system as non-users. Interviews and focus group discussions revealed another interesting effect. Doctors were worried about how using gestures might affect their relationship with the patient. They were concerned to make themselves look strange performing gestures. Involving the non-user is therefore quite important to eliminate any wrong conclusions about any impact of users on non-users and vice versa.

2.4 Conclusions and Future Work

This paper identifies challenges and pitfalls one has to cope with when applying UCD to scenarios in the field context based on a case study. The field context adds new challenges to stationary and mobile scenarios. It requires the application of UCD as a must while leading to problems with established UCD tools and methods. Field observations, usually delivering mostly qualitative data about the scenario have to be extended in order to collect quantitative data and information, to allow an analysis of how a computer task can be performed in parallel. The decision whether to apply lab or field tests becomes more difficult when designing for the field context, because of the increased importance of the user's context and primary task. Further research is clearly necessary to adapt UCD methods and tools to the field context.

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