Abstract

This paper focuses on the social computing and usability issues connected to the use of a wearable computer as support of the clinical ward round. An evaluation of a prototype system was performed with a group of doctors and nurses, who physically tried out the system in a simulated ward round scenario and were interviewed about their experiences. Generally, the doctors and nurses felt such system would be helpful in diminishing paper work and enhance collaboration. The most critical component of the prototype system was the navigation in electronic patient documents using gesture interaction. The doctors found the gestures difficult to learn and were worried the patient contact would suffer as a result of too much attention being needed by the gestures.

Introduction

In healthcare scenarios, wearable technology promises advantages such as hands and touch-free operation and context-aware user interfaces. The obtrusiveness present in today’s desktop applications, which demands the full user attention, can be minimized by using novel interaction techniques that better coexist with the clinical work at bedside. Moreover, such systems have the potential to change and streamline existing workflows. Combining wearable technology with pervasive computing devices, such as sensors or actuators, is an approach with high potential for being an important part of IT solutions for applications in hospital environments [1][2][3].

The wearIT@work project is based on a user centred design UCD approach and thus emphasises the importance of studying users’ acceptance of the wearable computer, its potential impact on social, organizational and human factors as well as usability issues [4][5][6]. These topics were examined in an evaluation of a wearable prototype system aimed to provide support for doctors and nurses during the ward round. The study described and discussed in this paper was performed in a hospital of the Gespag group in Austria.

Today, the ward round itself and the related activities often require tedious and redundant documentation work and long communication chains. In order to prepare the ward round nurses have to make sure that the relevant patient documents are printed out and correctly sorted into the files in the document cart. The ward round itself is comprised of the following basic tasks, which have to be performed by the doctor/nurse team:

- Elicit information about the patient’s current condition,
- Interact with the patient (talking, examinations),
- Make decisions about and order further treatment.

As of now, almost all patient information is elicited from the paper documents. Any orders for further treatment are typically noted by a nurse and later entered into the computer or written on special paper
forms for communication with the appropriate department (for a detailed account of the scenario see [7]). The prototype system allows for automatic identification of a patient and a doctor, touch free accessing of patient documents at the bedside and immediate entering of examination orders.

In the first section, the setup of the experiment is described, including a brief description of the system, of the test environment and the test procedure and the evaluation method. Next the results concerning social computing are presented and discussed, followed by the results on the more practical interaction issues. Finally, a conclusion is given.

**Experiment setup**

Nine doctors and eight nurses with different amounts and types of experience and roles participated in the tests, which took place in a real patient room but with a dummy patient. Below, the prototype system itself and the test procedure are described.

**Technical Setup**

The system’s setup is depicted in figure 1. A patient room was prepared to test the prototype. The fixed installation included the swivel-mounted bedside display attached to the patient’s bed (1) and a patient dummy from the training department (2) which was equipped with a RFID wristband for identification (3). A video camera (9) was positioned in such a way that it could capture the doctor during his interactions with the bedside display and the patient. The technical infrastructure necessary to keep everything running was positioned on a table in the corner of the room.

End users tested the system in pairs of a doctor and a nurse. The doctor (4) wore the interaction wristband with an RFID-tag and an acceleration sensor (to facilitate gesture interaction) (5) and a Bluetooth headset (6) for speech input of examination requests). The nurse (7) was given a PDA for entering examination request data.

![Figure 1: swivel-mounted bedside display 2.patient dummy 3.patient RFID wristband 4.doctor 5.interaction wristband 6.bluetooth headset 7.nurse 8.PDA 9.video camera 10.table with technical infrastructure 11.entrance into the room during the tests](image-url)
Test Sequence
Each evaluation session started with an introduction to the project and an explanation of the prototype. Following, participants practiced the interaction (especially the gestures). The training session was split into two halves. During the first part, the doctor and nurse received an explanation as to the system’s usage and were asked to familiarize themselves with the interaction methods. Next, a sequence of activities similar to that of the actual tests was explained and performed. After the training, three test sequences were performed.

A test sequence began with the doctors and nurses entering the room via the door (11) and proceeding to the patient’s bed. The doctor then used the interaction wristband to scan the patient’s identification wristband in order to advice the system to bring up the patient’s file on the bedside display. Next the doctor opened a document and scrolled to its end. There she found instructions to perform the next steps, e.g. opening another document which number was given. The last document contained instructions on performing an examination of a certain body part of the patient and on issuing an examination request afterwards. The details of the request were completed by the nurse, finishing the sequence.

During the training run, instructions were given to the participants, but in the test sequences the participants worked mostly independently.

Evaluation method
The purpose of the tests was to evaluate how well the doctors and nurses could interact with the system in the context of a typical, slightly simplified ward round work flow. In order to analyze the performance of the participants, identify problems and capture spontaneous comments, each test sequence was filmed in its entirety for later analysis. At a later point in time, practical interaction problems, conflicts between system interaction and work flow and comments were documented.

Due to the novel nature of the system interaction and the limited time for practicing in the experiment, the results of a quantitative analysis of performance was not considered to be representative for the use of the system after a longer training period. Thus, the results presented here describe the beginner problems and already observable learning tendencies/performance improvements, and should not be understood as a final evaluation of a ready-to-be-used system.

Following the users testing of the system, participants were interviewed – doctors and nurses separately - in German or English according to preference. In addition they were asked to fill out a questionnaire concerning their physical experience using the system and another concerning the social computing aspects. The questionnaires were constructed using Likert scales.

Results and Discussion
Social computing
Recognizing the projects goals
Most of the doctors and nurses explained the project goals as aimed at creating a paperless ward round, making the work process faster, easier, more efficient, and more convenient. In other words, optimizing the workflow of all the tasks performed for the patient while minimizing errors. We find that the overall understanding of the purpose of the project is the result of a real need for improving the work process and conditions which currently exist in the ward round. Most, expressed an interest in a technology that could assist them.

Doctors and nurses reported that currently much time and information is lost between the start of the ward round and its end, at which point the information is documented into the patients’ files, processed and translated into actions. At the moment laptops and paper charts are used simultaneously, with different kinds of information being found on each format. The process of searching for information on one or both systems is time and energy consuming and uncomfortable. Moreover, while the amount of time to conduct the ward round is limited the number of patients to check is large, plus using a laptop or notebook on the