Relieving the Medical Workers' Daily Work Through Wearable and Pervasive Computing

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Abstract

We intend to relieve the daily work at care-centers, allowing medical workers to focus on the patients and their needs. This goal can be achieved by employing technology that automate and simplify tasks previously requiring tedious interventions, giving more time for the important human to human interaction. For any technology to become accepted by the medical workers, we must ensure that it is highly natural and unobtrusive, without interfering with their caregiving. By studying the medical workers' daily work, we can draw conclusions on what problems they encounter, allowing us to develop prototypes which can be deployed and used at the care-centers. In doing this, we can proceed to study the acceptance and usability of our proposed solution, and see whether and how it solves the problem. In this position paper, we present our current and future research in wearable and pervasive health-care.

Keywords

Health-care, care-centers, medical workers, wearable, pervasive

Communities' Topics addressed

Well-Being Services@Work: Support for mobile health professionals, Support for collaboration among mobile health professionals, Intelligent assistive work environments to optimise health and wellbeing in the future workplace

1 Introduction

Within the area of health-care, pervasive and wearable computing offer solutions for improving the life of patients. For example, by employing sensors, patients can live their daily life in the comfort of their home, while still having their vital signs monitored by a hospital. Sometimes, however, this is not enough, and the patient needs to stay in care-centers. In these facilities, medical personnel provide care and meet with patients daily, while at the same time handling a number of other practical or administrative tasks less related to their profession. We have found that many of these tasks take away valuable time from the medical workers, instead of spending it with the patients who should be their main focus. This can cause stress and negative feelings, detrimental for the important meeting between patients and medical workers. Therefore, in order to further enrich patients' lives, the means by which medical workers perform these tasks need to be improved, and we see pervasive and wearable computing to be a natural way to achieve this.

Our goal is thus to simplify the daily work for medical workers at care-centers, thereby allowing them to focus more on the patients and their needs. We can achieve this goal by employing technology that automate and simplify tasks previously requiring tedious or manual interventions. For this technology to become accepted by the medical workers who are the intended users, we must ensure it is highly natural and unobtrusive, and that it does not interfere with their regular work as caregivers. By studying the medical workers in their daily work, we can better draw conclusions of what problems they encounter during the day. This allows us to develop solutions in form of prototypes which can then be deployed and used by the workers at the care-centers. In doing this, we can proceed to study the acceptance and usability of our proposed solution, and see whether and how it solves the problem. The most viable solutions can then be further refined, and possibly used as a starting point for spin-off companies.

At Luleå University of Technology in Sweden, the Centre for Distance-spanning Health-care (CDH) has been involved in, and is currently active in, a number of projects related to health-care. Through good connections to the local municipality and care-centers in the region, we are therefore well fit to perform health-care related research activities in real life settings. In this position paper, we present our current research in wearable and pervasive health-care, the results and conclusions we have drawn so far, and discuss how we intend to progress in our work.

2 Relation to Existing Theories and Work

In previous work, we have explored different areas within wearable and pervasive computing related to collaborative work in general. By building on these results, we can apply them in the more specific field of health-care and the different situations medical workers may encounter.

For example, in [Drugge, Nilsson, et al. 2004], we describe ways to share experiences and knowledge over a distance using wearable technology. This is certainly applicable in situations where medical workers need to access each others expertice when physically apart.

3 Research Approach

We do applied research, meaning that what we do should be of immediate use to real people, in real situations, in the real world. Our research within the area of health-care shall lead to prototypes demonstrating the concept at care-centers in our city, allowing us to perform research, development and studies in close collaboration with the medical workers who use the technology. At the same time, we enable industry and funding partners to immediately see the possibilities, opening up for spin-off companies and business enterprising.

The approach we have for our upcoming research is to deploy prototypes built from existing technology that we integrate into functional products. We will conduct user studies of how they are used and what benefits they bring, and validate our results through interviews and inquiries with medical workers, patients, and other personnel who use the prototypes.

4 Findings

Despite much of the technology enabling pervasive computing being a reality today, the actual deployment of the technology at the intended locations for use is by no means ubiquitous. For example, at a local care-center for elderly people, one of the factors that cause the most stress is the alarm system currently in use. When an alarm is triggered, it goes out to all medical workers in the building, regardless of whether they are currently occupied with other tasks. Although partial solutions exist, e.g. using the Active Badge location system [Harter, et al. 1994] which is over a decade old as of writing, it seems deployment of this or similar solutions is very slow. We see an advantage in creating prototypes and deploying them in real life scenarios, that will directly demonstrate how care-centers can benefit from new research results.

4.1 Scenarios

We will now describe three scenarios that convey our intentions. Each illustrates a specific problem existing in health-care, and goes on by describing the means by which it can be solved.

Scenario 1: Alice, our medical worker on duty, is currently attending Bob, a patient with a history of heart disease needing special care from time to time. Suddenly, Alice receives an alarm on her beeper. She quickly excuses herself to Bob as she rushes away to find and determine the source of the alarm; perhaps she is the only nurse that can handle this situation – she ponders, as she runs through endless corridors. Upon arriving at the source of the alarm, she sees that a patient, Carol, has fallen and injured her leg. Luckily, a team of other nurses are

already there, taking care of the situation. Alice, relieved to find everything under control, walks back to Bob who she attended earlier. Only seconds after arriving, the alarm goes off again…

Key problem: When an alarm is triggered, *all* nurses are alerted, regardless of their current workload, their location in the building, their expertice and their history with a patient. This is a source of frustration and stress, since only a single or a few nurses usually need to be informed.

Solution: Alice's uniform, equipped with wearable computing technology, receives the alarm signal. It recognizes that Alice is attending Bob, and notes that this task is highly important due to Bob's medical history. It also determines the position of itself to be in room A3304, too far away from the source of the alarm in the other end of the care-center. It reports this information to the alarm system, which in the mean time has queried other nurses' computers, and found a group of more suitable candidates to alert – an expert on fractures, a nurse who happened to be in the room next door, and a nurse who regularily takes care of Carol. As a result, Alice can continue to attend Bob without interruptions, while Carol is taken care of by the expert group.

Scenario 2: Alice, our nurse on duty, works in the rural parts of northern Sweden. Today, she is going by car to Dave – a patient currently staying at his home in a remote village far from the care-center where he occasionally stays. The route takes an hour of driving in bad weather. When Alice arrives and can examine Dave, she realizes she briefly needs to access his medical journal. Due to security policies, she cannot use her laptop to access the journal, as there is a slight risk that a patient glances at classified information. Fortunately, a medical station is just an hour away, so Alice spends two more hours of driving, to access his journal for a few minutes…

Key problem: Displays on traditional laptops risk leaking private information about patients if non-authorized persons glance at it, meaning security policies cannot allow access to the journal system from a patient's home. A more secure way of accessing this information is required.

Solution: Alice visits Dave, and realizing that she needs access to his journal, picks up her head-mounted display (HMD) and clips it to her glasses. The HMD gives her full view of his medical journal, without risking anyone but herself to view it. The closeness between Alice and her wearable computer makes it less easy to steal, and the policies therefore permits its use.

Scenario 3: Alice receives a phone call from the elderly patient Fiona who complains about chest pains. Alice tries to pinpoint the exact source of the pains, but is unable to figure this out. Worried, without possibility to examine her further via phone, Alice decides to visit Fiona in her home apartment. Upon arriving, Alice asks Fiona to point out the source of her pains, and it turns out they are actually located in her throat. Relieved, Alice recalls that sometimes elderly people use slightly different wording when describing their body parts. Alice leaves, as she needs to rush back for a meeting, yet wonders whether there is a better way of handling cases like these…

Key problem: In many situations, voice communication is not enough for a nurse to accurately determine a patient's health situation over a distance. Although physical consultations are important, time does not always permit it. Thus, richer communication over a distance is needed.

Solution: Alice receives a phone call from Fiona, and upon hearing about her chest pains, asks her to sit by the TV so that they can talk face to face. Fiona moves to a comfortable chair in front of the TV which turns on and automatically starts an e-meeting with the nurse, live video allowing them to meet. Fiona points out the source of her pain, and Alice is relieved. Since she saved a lot of time not having to walk over to Fiona in person, she spends it on keeping her company via the e-meeting, providing some relief to the loneliness that elderly sometimes feel.

4.2 Solutions and Challenges

The solutions we propose to the scenarios above are all realistic to implement and deploy as prototypes at selected care-centers in our region. The challenges lie not so much in technology itself, as in the integration of existing solutions into a larger, more coherent, pervasive computing environment for health-care. We see the goal of making technology natural to use as being an important factor for acceptance, both from the medical workers' and the patients' point of view.

In the 1st scenario, we can easily design a system that keeps track of nurses throughout the day. This has privacy implications that should not be neglected, as it may lead to a "big brother is watching" mentality if care is not taken. Therefore, we must ensure the users feel in control, e.g. by only providing positioning when required by an alarm that is triggered. Similarly, once a suitable group of nurses is determined, the way by which they are interrupted may have an effect on how they will perceive the system. Earlier research [Nilsson, et al. 2004] regarding this, show that user preference and performance will be affected differently based on the interruption used.

In the 2nd scenario, besides the obvious security problems and regulations that need to be taken in consideration, the primary research question is how to allow the medical worker to interact with the electronic journaling system in a streamlined fashion. Normally, when the nurse is located at a care-center, a regular computer and keyboard is used. The difference of using a HMD and a more secure way to input data, (a keyboards can be glanced upon by non-authorized persons), needs to be investigated. No matter how good the backbone of the system is designed, the user's interaction with it is what will ultimately determine if and how it will be used in practice.

In the 3rd scenario, e-meetings allow a richer communication that can convey more information between participants. The use of a computer disguised as a TV makes the elderly patient more comfortable, since many patients want to live life as they always have without new devices that they do not understand. Informal e-meetings of this kind, where patients and medical workers meet over a distance, can be realized easily with existing technology. The key is to incorporate it in the environment, and make it so easy to use that users should not need to think about the interface that lies between them and the underlying technology.

As a continuation to this scenario, we can add the following: "Later that day, Fiona's friend Edwina comes by and asks whether she wants to join her for a walk. Fiona feels a bit tired and regretfully declines. Rather than leaving Fiona behind in solitude, Edwina dons a coat with built-in e-meeting support, allowing her to share video and audio with Fiona so she can follow along virtually – viewing nature and hearing the birds singing as if being there in person." This is an example of mobile e-meetings [Drugge, et al. 2004], deployable with existing technology. Such e-meetings warrant further studies, to determine what benefits, if any, they can bring to patients.

5 Conclusions

Much of the technology for relieving the daily work of medical workers already exist, and the key for success lies in integrating and deploying this in a real world environment. As we currently have access to a care-center facility, and since a new modern care-center of the future for the elderly is planned to be built in our city, we see these as opportunities for deploying our current technology, refine it further and conduct research on its effects.

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