

# An Investigation on Acceptance of Ubiquitous Devices for the Elderly in a Geriatric Hospital Environment: Using the Example of Person Tracking

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**Abstract.** In this study, we investigate the acceptance of radio frequency identification (RFID) technology for localizing elderly people, suffering from dementia. We discuss how, and to what extent, we can balance economic and humanistic interests versus patient privacy and other libertarian concerns. We used specifically developed questionnaires and guided interviews and investigated the opinions, attitudes and beliefs of both medical professionals and patients. For this purpose, one of the most modern equipped geriatric clinics has been examined: the Albert Schweitzer clinic of the Geriatric Center Graz. The findings showed that RFID technology provides enormous economic benefits for both medical professionals and patients, whilst at the same time; these invasive surveillance technologies threaten our patients' privacy. Most astonishing was that almost all of the people involved, were unaware of both opportunities and problems of such ubiquitous devices. Similar to many new and emerging technologies, it has the potential to both benefit and harm society.

**Keywords:** Human-Computer Interaction, Usability, Acceptance, Ubiquitous Computing, Hospital, Older Adults, Person localization.

## 1 Introduction and Motivation for Research

One of the utmost concerns in health care is the growing proportion of people of advanced age [1]. Demographical, structural and social trends tend towards more and more elderly people, which may have dramatic effects on health care [2].

The increasing amount of information technology being designed and developed for both the care givers and these potential patients must support their needs, demands and requirements. A clear benefit must be offered, whether in a physical, medical or emotional respect. The benefit of using new devices must be appreciable, in order to

provide a motivation for its use, and the balance between intuitive use and awareness of its potential problems [3]. In previous studies within hospital settings [4], [5] the lack of combination of technological and socio-psychological issues have been described. However, it is exactly this combination of psychological and technological research, which will assist ubiquitous computing (UC) to reduce problems and to generate new improvement potential in Health Care. Empirical evidence on tracking people with RFID-based tags is particularly rare [6]; consequently research in this area is urgently required.

## 2 Theoretical Background and Related Work

Many new technologies have been developed to promote safe mobility of geriatric patients and to eliminate or alleviate adverse events, for example patient falls, bedrail entrapment, and most of all patient wandering [7]. Many institutions pursue projects that focus on smart living spaces, for example the MIT AgeLab and PlaceLab [8]. Large companies, including Microsoft, Intel, Philips Honeywell, have made commitments to research and develop technologies for independent living and proactive health care [9]. Previous work describes existing infrastructure and improvements with UC in hospitals [10].

Many elderly people are suffering more or less from dementia, which can be described as a progressive decline in cognitive functions. Affected areas in cognition include, amongst others: memory, attention, orientation and location, the latter resulting in uncontrolled wandering; and there is no evidence so far to recommend the use of any non-pharmacological intervention to reduce or prevent wandering in people with dementia [11]. People suffering from dementia have no ability to perform even simple daily activities (Activities of daily living - ADL) due to the lack of remembering the proper sequence of events and on how to use the required tools, and most of all, they can bring themselves into dangerous situations [12]. Consequently, technology to assist people with dementia is highly necessary and much is available today. Lawson (2001) was one of the few, who took not only technology for people with dementia into consideration, but developed dimensions of quality of life, taking into account aspects of autonomy, privacy, dignity, spiritual well-being, functional competence, comfort, security, individuality and enjoyment [13].

However, most of the developed technology has been tested in the infrastructure of laboratories rather than been researched in real-life within hospitals. Contributing towards stimulating further research in the field, was our main motivator for this work.

## 3 Materials and Methods

### 3.1 Experimental Environment: The Albert Schweitzer Clinic II

The Albert Schweitzer hospital II was established on the premises of the Geriatric Health Center Graz (Geriatrischen Gesundheitszentren, GGZ). This establishment encompasses a "Memory Clinic" with 22 beds and an attendant "garden of the senses", as well as 120 beds for Geriatric Medicine. Within the hospital, there is a day

clinic, an acute-geriatric and remobilization clinic, a coma vigil station - Appalic Care Unit, and the Albert Schweitzer Hospice. Geriatric medicine involves treating patients whose clinical picture shows the necessity of constant medical, custodial, psychological treatment and nursing. A significant goal is the promotion of physical and mental efficiency. The Memory Clinic is particularly important: The goal of the multi-professional team is to ensure the highest possible quality of life and personal liberty, while continuing to ensure security and the promotion of existing abilities.

The patients being treated are mobile, with light to moderate dementia; who exhibit conspicuous behavioural traits and have special care requirements. One manifestation of dementia is constantly increasing cognitive restriction. The progress of the illness, and the associated memory loss, causes incorrect assessment of danger in daily activities. The need to arrange their life independently and autonomously remains, making it necessary to provide technical precautions to minimize their risk. The GGZ installed technical facilities and equipment in order to create appropriate freedom for their patients.

### **3.2 Technical Solution: Person Tracking**

The company Kapsch provided the GGZ with a communication solution based on IP technology. A principal component of the system is the localization of disoriented patients with the assistance of a WLAN infrastructure. The complete area of the Albert Schweitzer Clinic premises, including the external areas, was equipped with a Cisco WLAN solution. There are currently 170 Cisco Access points (AP's) of the type 1131 on 5 central WLAN Controllers. The wireless LAN control system (WCS) of the CISCO Company is implemented as the management solution, in case of failure of an AP the surrounding APs can supply this sector. All Access Points are supplied with electricity centrally by the floor distributors (Power over Ethernet).

A cluster of two Cisco call managers for approx. 500 IP Phones was already accessible in the network of the city of Graz. An intensive test of both Cisco and Siemens WLAN IP Telephony was made in the GGZ. The Cisco solution was chosen due to the substantially better quality of the terminals and the redundancy concept. In addition to the two existing servers in Graz, a third was installed in the GGZ computing centre, and an upgrade was made to Cisco Unified Communication manager 5.1. If one of the three servers fails, either of the other two takes over this service without interrupting communication. Today, approx. 120 WLAN IP phones of the type Cisco 7921 are employed, WLAN IP Phones from Ascom and GSM and WLAN dual mode phones from Nokia are currently being used experimentally.

The system offers the possibility of telephony (wired and wireless) connection via SIP. Thus, diverse terminals (different manufacturers) and systems can be simply integrated. The existing telephone system will continue to be used for cabled (wired) telephones. A particular advantage of this solution is the simple administration of the system via graphic interfaces. Individual domains are defined with different administrators (GGZ, Businesses, City of Graz), so that each administrator can only configure "its" own IP Phones.

In December 2007, in the course of a large redundancy test in the City of Graz Net, all possible failure scenarios in a controlled, real-time operation, were run through, however, the system proved to be successful.

### 3.3 Localization of Disoriented Persons

After the implementation of the WLAN infrastructure described above and the WLAN telephone solution, the "Deso" solution from Kapsch was also implemented.

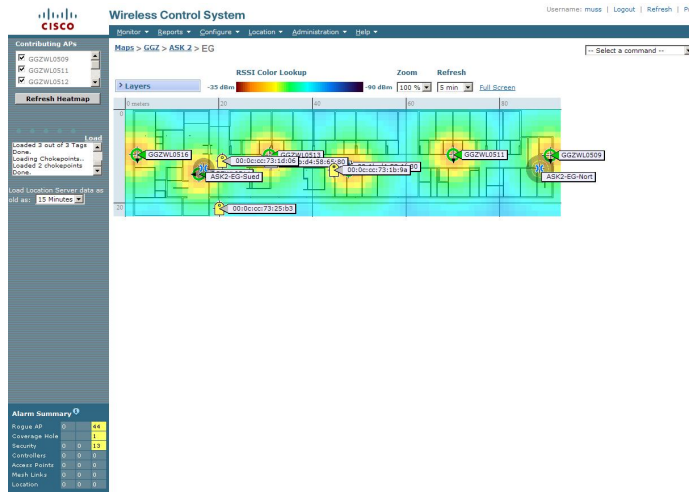
The components employed were: Cisco Location Appliance, Kapsch Alarmserver, Kapsch AeroScout Dienst & User Interface, AeroScout Exiter, AeroScout TAGs.

The Cisco location Appliance is a component, which, as an addition to the Wireless Control System (WCS) makes omni-directional and full-coverage localization possible; i.e., with appropriate positioning of the Access Points, a "rough" localization of a WLAN terminal with an estimated accuracy of 5 – 10 meters is possible. However, for the application area of the GGZ this is not sufficient. In principle, the disoriented patients are "assigned" areas in which they can move about freely. AeroScout Exiters are affixed to the exits. Consequently, one can rely on an alarm when a patient leaves the area. Additionally, the clear areas are supervised, in order to carry out a rough positioning (see above).

The patients concerned receive an AeroScout Tag (see figure 1). This is a WLAN component, which was specially developed for the localization of people or special medical devices (e.g. infusion pumps etc.). The tag is attached to the patient either as bracelet, collar or sewn into their clothes.



**Fig. 1.** (right): AeroScout attached to a patient



**Fig. 2.** (left): A 15 minutes interval localization screen

The tags communicate with the WLAN infrastructure in programmable, intermittent, intervals. The maintenance personnel assign a tag to the patient and enter the sector, within which the patient may move. Should the patient leave this sector, the tag sends a signal to the alarm server, which in turn calls the maintenance personnel and notifies them. The approximate position of the patient in the area of the GGZ can



**Fig. 3.** (right): The position of the Exiter within the building



**Fig. 4.** (left): The Exiter Access Point

then be determined over the WCS. All the services provided by the company Kapsch run on a Linux Server and are managed using graphic interfaces (PHP), with the exception of the Kapsch Alarm Server (K-AS), which is the heart of the system, was installed in January 2008 and runs under Windows.

The main advantages of our K-AS are the large flexibility of the alarm input and output possibilities, its modular architecture and the speech alarm.

K-AS is used in the general health sector, also in the university clinic Graz (among other things for red alerts) and in the Rehab Tobelbad. The City of Graz already had a K-AS for an alert in the case of network and IT problems. Therefore, this could be configured to provide a mutual monitoring of the alarm servers in the GGZ and the City of Graz. A system running on Windows has a very high expenditure for patching and therefore the threat from viruses and similar problems is substantially larger than with a Linux system, for this reason the distributed alarm servers will only run on Linux systems. Oracle is used for the central data base (and for the alarm server) in the GGZ. The standard data base is MySQL.

### 3.4 Evaluation

The Structured Interview Model was selected for the empirical investigation since the range of topics was clearly outlined [14], [15]. Since different approaches to this theme were available to the interviewers (technical training versus commercial training), specifically the *Tandem Interview Model* was applied [16]. The question catalogue was arranged as follows: introduction and background of the questionnaire; objective of the survey; duration of the interview; questionnaire; The actual questionnaire covered three prime data areas; institution; patients; relations;

On the basis of this questionnaire, N=25 people from the fields of management, hospital services, physicians, nursing staff and social work were interviewed in their familiar environment [17].

## 4 Results and Discussion

"Ethics is the boundless extension of responsibility towards everything that lives" This quotation from Dr. Albert Schweitzer is placed in the forefront of the GGZ's mission statement. All actions, and everything done by the people interviewed, are in the mission statement of the GGZ: "Meet Life with a Smile". The patients are cared for according to the "Psychobiography Health Care Model" of Erwin Boehm. In the foreground, there is always: what is necessary for the patient. Therefore, quality of life, security and protection rank in the highest places.

The results of the interviews showed clearly: The people being cared for must come first, and only as much technology as can be absolutely medically, moral and ethically justified, may be used. These results agree with the mission statement. It is interesting that, while the employees concerned considered the tracking of persons suffering from dementia a necessity, they reacted negatively to the idea of surveillance. According to § 3(1) of the Heimaufenthaltsgesetztes (Home Residence Act) of 2004, monitoring is considered as an infringement of liberty. This is demonstrated "when a patient or person being cared for is physically prevented, against their will or without their permission, from changing their location, in particular by mechanical, electronic or medicinal measures, or by the threat thereof". In § 5 of the Heimaufenthaltsgesetztes (Home Residence Act), who may arrange surveillance, which formal criteria are to be fulfilled and when the infringement of liberty is to be removed, is regulated. It is also regulated, how the measures are to be documented (§ 6) and how the information and communication is to take place (§ 7). Surveillance by means of AeroScout is therefore, in the legal sense, an infringement of liberty and must therefore be regarded as extremely sensitive. The evaluation of the individual questionnaires showed that there is a consensus regarding the employment of the technology. It is interesting that almost all interview partners possessed no knowledge of the possibilities of RFID technology. At the same time, they are satisfied with the Deso-System currently in use. The people concerned with the care and nursing of the patients, were equally unambitious when it came to suggesting ideas as to the use of further supporting technology. When it concerned the decision, as to whether the AeroScout is to be used, in other words to monitor the patient's movements, it was clear to everyone involved that an appropriate diagnosis and the observation of the nursing staff care are crucial for a team resolution.

## 5 Conclusion and Future Outlook

The rapid advances being made daily mean that we are unable to anticipate exactly what aids will be available and how these will affect lives. In order to prepare the elder population to live longer and more independent lives with the help of this technology, we must first introduce them, not to any particular device but to the concept of modern engineering. They must be willing to judge innovations on their merits rather than rejecting them out of hand. This awareness and acceptance can be fostered and increased by education and example. The industry must be cognizant of the fact that awareness training must go hand-in-hand with good design and that knowledge of

the user is as important as functionality, since without the user's cooperation, functionality must be ineffective. Much further work is needed to enhance quality of the development for the Elderly, especially for those suffering from dementia.

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