iCare – Supporting People with Increased Need for Care with Smart and Mobile IT

Michael BÄCHLE[a], Stephan DAURER[b], Andreas JUDT[c] and Tobias METTLER[d,1]
[a,b] *Baden-Wuerttemberg Cooperative State University Ravensburg*
Department for Management Information Systems
Marienplatz 2, D-88212 Ravensburg
{baechle, daurer}@dhbw-ravensburg.de
[c] *Baden-Wuerttemberg Cooperative State University Ravensburg*
Department for Informatics
Fallenbrunnen 2, D-88045 Friedrichshafen
judt@dhbw-ravensburg.de
[d] *University of St. Gallen*
Institute of Information Management
Unterer Graben 21, CH-9000 St. Gallen
tobias.mettler@unisg.ch

Abstract. The recent developments in the area of mobile computing have fueled the debate on potential applications for independent living, well-being and medical interventions both in the academic field and in practice. A considerable amount of research and development of IT-based assistance systems is focused on clinical applications. However, assistance systems that can be used in everyday life by a broad user group of people with increased need for care are rare. In this paper we present the vision of *iCare*—a research program to support a safe and independent living of people with special needs. In addition, we exemplarily introduce *DeSearch*—a privacy-aware sensor-based network to locate missing people—as a first result of *iCare*.

Keywords. Independent living, assistance system, ubiquitous computing, information technology, smart IT

1. Introduction

With the advent of ubiquitous computing and broad availability of mobile technology, also a new strand in medical informatics research emerged that shifted its focus away from the clinical context to the day-to-day reality of patients [1]. With the systems becoming more and more patient-centered, the functional and aesthetic requirements (e.g. lean and seamless design) as well as environments (e.g. indoor and outdoor) in which novel applications have to function considerably increase complexity. Additionally, in many cases there is need for a more longitudinal and continuous (or at least event-based) patient monitoring capacity, rather than in-situ, cross-sectional data collection as often being used at the clinical bench or hospital bedside.

[1] Corresponding Author.

Sensor-based systems for health monitoring and prognosis have therefore gained great attention lately [2]. With the help of sensors and actuators integrated in clothing, shoes, bracelets, phones, watches, or integrated in smart home appliances, it is possible to constantly track and accumulate a huge amount of biological, physical, behavioral, or environmental information [3], which—if deliberately combined and designed with foresight—can be purposefully used to ensure continuity of care or even improve the quality of life of people (e.g. increasing mobility, staying longer at home) [4]. Also from an economic perspective, such integrated sensor networks may be largely beneficial as they have the potential to relieve the pressure of health and care institutions by reducing the number of onsite visits or even stationary treatments [5].

Furthermore, there is an increasing development of assistive technology for seniors which can be used at home and in everyday life. In this realm most assistive technology can be assigned to one of the following clusters: general information and communication technology, robotics, telemedicine sensor technology, medication management applications, and video games [6].

In this paper, we therefore set forth a visionary perspective—named *iCare*—that tries to make use of sensor-based systems to holistically support people with special needs to master their living as independently and safely as possible. The remainder of the paper is therefore structured as follows. In the next section we describe in more detail the vision of *iCare*. This is followed by the description of the prototypical instantiation of an exemplary component of our overall vision. We conclude with a critical discussion about the implications for continued research and provide an outlook regarding the next steps of our work.

2. Research Program of iCare

2.1. Description and Goals

It is the main goal of *iCare* to reduce the conceptual and technological IT solution gap for people with increased need for care. We define "people with increased need for care" (PINC) in general as a person in need of care who could benefit from *iCare* and in particular as people with dementia or disabilities. We thereby focus on already available smart and mobile IT components to assist PINCs and their respective caregivers. It is not the goal of *iCare* to develop new technologies but to show the potential of already existing smart and mobile technologies for the following goals:

- We want to maintain the independence of PINCs with smart and mobile IT solutions.
- We want to encourage PINCs (and their caregivers) with smart and mobile IT solutions to train and preserve skills.
- We want to enable PINCs to remain in their own homes as long as possible by using smart and mobile IT solutions.

2.2. Research Framework

Following the Design Science approach [7] several steps and methods will be part of the program. To focus *iCare* on the needs of PINCS and their caregivers we refine the Design Science approach by Action Design Research [8]. Therefore, the process steps

of building the IT artefacts, intervening by the stakeholders, and evaluating are concurrent and interwoven activities. Fig. 1 shows the design of the *iCare* research program. The figure shows not only several steps but also the integration of several stakeholder groups into *iCare*. To meet ethical, legal, medical and technical requirements *iCare* will integrate caregivers, physicians, legal experts and providers of IT solutions into the research program. An agile process model (e.g. Scrum) can be used as iterative approach to build the artefacts [9]. A substantial part of *iCare* will be a laboratory where interesting settings of daily life and care can be simulated to test and demonstrate the benefits of standard smart and mobile IT components for the needs of PINCs and their caregivers. The last step in the framework will be on-site evaluation, e.g. in senior residences, together with participants of the different stakeholder groups. These activities are concurrent and, as already mentioned, interwoven. Several iterations may be necessary to design the final IT artefacts. Finally, the IT artefacts can be handed over to a third party in a transformation process for new professional services for PINCs and their caregivers.

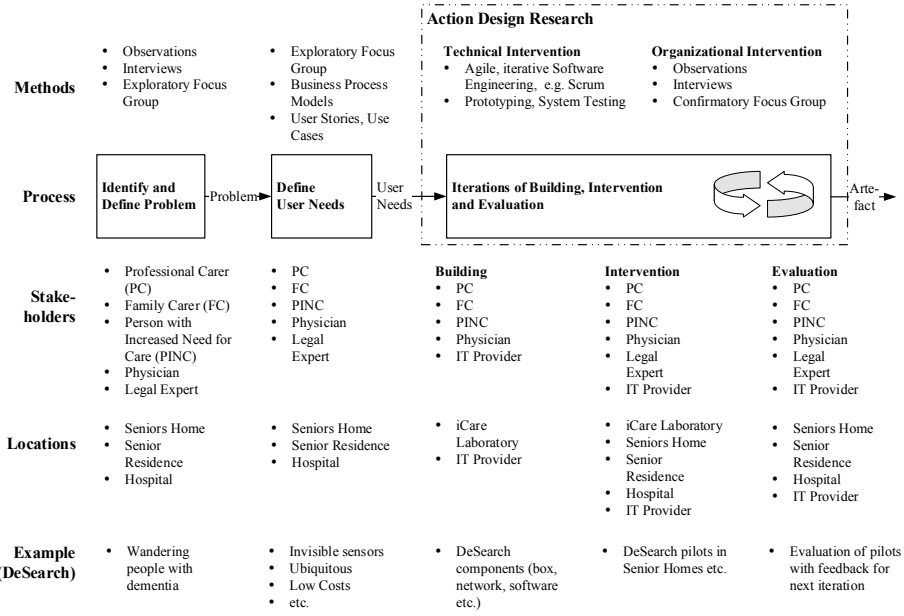

Figure 1. *iCare* Research Framework (PC=professional carer; FC=family carer; PINC= people with increased need for care).

3. The DeSearch Network

In this section we introduce *DeSearch* a privacy-aware sensor-based network to locate missing PINCs. This network was initially designed for wandering people with dementia. Our research showed that this approach is also applicable for PINCs. Past research projects considered the use of embedded devices, wristbands or smart phones as disturbing for the PINC and barely useable for caregivers or nursing staff due to

devices' size and/or battery life. Thus, the detection of a PINC's geographical location must be realized with largely invisible sensors. Due to the state of technology, these sensors cannot be realized with single board computers (SBC). We decided to identify the PINC by several Bluetooth 4.0 sensors, which are attached to essential parts of the clothing, e.g. shoes, trousers or jackets. These Bluetooth badges are expected to fit into unobtrusive clothing artifacts like buttons or lining while providing a long life without any further maintenance effort.

Nodes, which are *DeSearch* apps on private mobile phones, and permanently installed *DeSearch* boxes in public places or vehicle fleets, span the detection network. The *DeSearch* control center manages the assignment of badges to PINCs and receives emergency calls from caregivers and nursing staff. Neither the app users nor the boxes get personal information about any PINC. The detection can only be activated in cases of emergency, so a permanent tracking of people can be completely avoided while the *DeSearch* network consequently guarantees the PINCs' privacy.

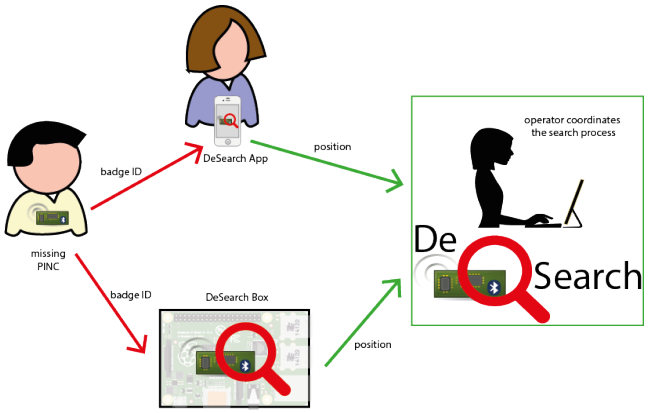

Figure 2. Detecting geographical location of missing PINC.

In contrast to past research approaches, we build a network of active devices to detect missing PINCs. Today, we can reduce the size of our Bluetooth badges to 16 mm width and 6 mm height with an estimated production costs of 10 € for a sensor embedded in a button. As a consequence of the privacy-awareness, non-permanent tracking of the PINC allows to reduce the search area significantly. A motion profile can only be recorded after an emergency call was received by the *DeSearch* central. As a result the time to detect a missing PINC depends on his or her distance to a *DeSearch* node. In a further research project *DeSearch* badges could be located by direction finding.

4. Conclusion and Outlook

There is an increasing diffusion of ubiquitous computing in various areas of life. In the context of medical care there is a growing amount of research and development of IT-based assistance systems which are mostly focused on clinical applications. In addition, there is more and more development of assistive technology which is targeted on the needs of seniors. While conceptual work is largely available, comprehensive technologies and market-ready products are rare.

The research program *iCare* aims to build upon existing base technologies and to provide solutions that are not matched to a narrow target group but to a wider spectrum of PINCs. The *DeSearch* Network is the first artefact and solution of that kind. An important goal of *iCare* is to focus on the needs of PINCs while simultaneously addressing the needs of other important stakeholders. For instance, involving people with dementia in all phases of the development of supportive IT applications is reported to improve the results and may even have empowering effects on the patients [10]. However, family carers might have a special need for information about the PINC during the utilization phase.

iCare follows a mixed-method approach as exhibited in the research framework. Here various stakeholders are part of each phase. Examples of research questions that will be addressed during the research and development process are: What is the intersecting set of needs of different types of PINCs—where are differences? Which factors need to be considered to improve technology acceptance of PINCs? Which viewpoints on the suitability for daily use exist by various stakeholders? Which key technologies are applicable to build various solutions and that are open for connectivity in the smart home? What are feasible business models for these solutions?

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