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TOWARDS SUSTAINABLE HOMECARE SOLUTIONS FOR AN AGING SOCIETY

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ABSTRACT

This paper discusses necessary steps and requirements for developing sustainable homecare technologies and illustrates the importance of a user-centered design approach for the long-term success of future care concepts.

Keywords: demographic change, sustainable healthcare solutions, technology acceptance, user requirements, living lab research.

INTRODUCTION

Social, economical and environmental consequences caused by a continuously aging population are commonly reported as major challenges most industrialized countries will have to face in the coming years. Especially in Japan, where the overall population growth is nearly zero, the population's average age is climbing rapidly. Already today, nearly 25 million Japanese are over 65 and approximately 20.000 citizens are over 100 years old [1]. What once was considered a population pyramid, has long started to change towards a cone shaped population structure in Japan. The World Health Organization [2] estimates that the original shape will have inverted to an up-side-down pyramid by 2035, with persons aged 80 and above accounting for the largest population group. If this development continuous, it is expected that by 2050 the number of kids who can care for their aging relatives is not sufficient anymore [3]. Other Asian countries show similar trends. For example in Singapore it is expected that within the next 30 years 20% of the population will be over 65 years or older [4]. And also in emerging economies, such as India or China, the dependency ratios are expected to increase considerably until 2050 [5]. Especially China is currently experiencing an immense increase in the number of elderly citizens, with nearly 140 million people already being 60 years or older [6]. Compared to approximately 400 million people aged 60 and above today, the World Health Organization [2] expects this number to increase for developing countries to approximately 840 million in 2025, which would represent 70% of all older people worldwide.

As a consequence of these ongoing developments, more and more elderly people are expected to require care in the coming years. At the same time, the demographic change will also result in a reduction of the number of people who can provide care to older and disabled people [7]. Hence, Adam et al. [8] argue that the demographic and financial constraints that most industrialized nations will be facing, will unavoidably lead to a situation, which makes it increasingly difficult to find enough caregivers for the growing number of elderly people. This apprehension is shared by various institutions and authors, including for example ATA [9] or Wilkes [10], who expect that the healthcare industry will be facing a critical shortage of public resources, nurses and other healthcare personnel within the next decades.

Technology-supported homecare environments are often cited as a promising solution to take care of the growing number of elderly and disabled people [11][12][13][14]. By providing a wide variety of medical services and support features (see, e.g., [15] or [16] for a detailed overview of state-of-the-art systems) intelligent homecare applications bear the potential of bringing medical, social and economical benefits to patients and caregivers alike.

SUSTAINABLE HEALTHACRE SOLUTIONS

Retrofitting homes with the necessary information and communication technologies requires not only significant financial investments, but also consumes substantial resources to build and considerable energy to be operated and maintained. Hence, it is essential to develop 'green' systems, which have minimal ecological impact on the environment. With development cycles of new technologies becoming constantly shorter, eco-friendly manufacturing and recycling processes are gaining more and more importance. While minimal resource consumption is unquestionable important with respect to sustainability, it is as important to ensure that existing systems are efficiently used. This requires that the relation between the perceived user benefits and invested resources are optimized. Today, the majority of research concentrates on the technical features of future healthcare systems. However, it is equally important to take user interests into account to guarantee full and efficient usage and thereby optimize the functional return of the technical investments.

PRIVACY AS A MAJOR DESIGN CHALLENGE

Ensuring a widespread diffusion of technology-enhanced homecare solutions requires fundamental acceptance criteria to be met in the design of new systems. In this context, especially privacy-related problems have to be addressed in an early phase of the development process in order to guarantee broad acceptance of smart healthcare services. Empirical evidence suggests that the acceptance of new technologies is largely influenced by the individually perceived concerns, rather than the actual technological risks. Hence, it is crucial to gain a detailed understanding about the concerns of potential end users and identify the factors influencing their perception prior to the actual design process. This is especially important as technology-enhanced homecare systems will be considerably different from existing information and communication technologies. With respect to user privacy, the two most important differences are the always-on nature of the devices and the invisibility of the technology. With traditional computer systems the duration of data collection - and potential surveillance - is clearly limited to the time a person uses the system. This clear distinction between 'online' and 'offline' might not longer be possible in technology-enhanced environments. At the same time, the integration of computers into everyday objects is likely to lead to the disappearance of sensory borders, and thereby could make common principles of privacy protection useless. Those problems are of particular importance as smart homecare environments will be mostly inhabited by users, who lack detailed technical knowledge about the computational processes, which take place in the background.

Previous work on technology-enhanced work environments (see, e.g., [17] or [18]) indicates that there might be different types of concerns associated with the usage of context-aware technologies. Some concerns refer to immediate consequence, while others represent long-term problems without direct effects on the individual user. In addition, many long-term consequences can not be influenced by the personal usage behavior. When a critical mass of people uses a specific technology, individual users might experience the consequences of this usage even if they chose not to employ the technology themselves. For example, if other people use wireless communication devices within a shared environment, all inhabitants are exposed to the radiation in a nearly equal manner. Currently, only direct consequences are addressed in the design of systems, while the influences of indirect consequences are largely unexplored and their effects on the adoption process are therefore still unclear. The same studies also showed that there are considerable differences regarding the perception of threats among different groups of users. In order to adequately address these concerns in the design of new systems, it is not only necessary to identify the concerns and perceived threats of potential end users, but also to analyze how the temporal scope of the consequence influences the perception process. Another important factor that needs to be explored is the value of personal information in technology-enhanced spaces. For their operation, intelligent homecare applications rely on appropriate and sufficient information from users. Previous work (see, e.g., [19], [20] or [20]) showed that the willingness to provide personal information is significantly influenced by a variety of factors, including individual characteristics of the users, their cultural background, or the level of control they have over the data capturing process.

Only if these research questions are appropriately addressed in an early stage of the design process of future technologies, it will be possible to design trustworthy and accepted systems for the home domain. Understanding the different factors and their interrelation is crucial for developing privacy-enhancing homecare solutions and guaranteeing the long-term success of sustainable care concepts.

LIVING LAB RESEARCH

Today, most studies investigating privacy issues in digital environments are based on fictive usage scenarios. While this is a widely used technique, recent evidence suggests that results gained in scenario-based evaluations are only of limited validity. For example, Acquisti and Grossklags [22] conducted an online survey on privacy in e-commerce applications and observed a tendency in test participants to overrate the value of personal privacy compared to their actual behavior. A similar tendency was observed in our own studies exploring the acceptance of computerized healthcare solutions in smart home environments. Hence, it is important to study users in realistic usage situations in order to gain valid information about their actual behavior in specific contexts. In order to do this, we conceptualized and developed the *Future Care Lab*, a simulated smart home environment at RWTH Aachen University [23]. Figure 1 shows the initial technical concept and the final realization of the living lab space.

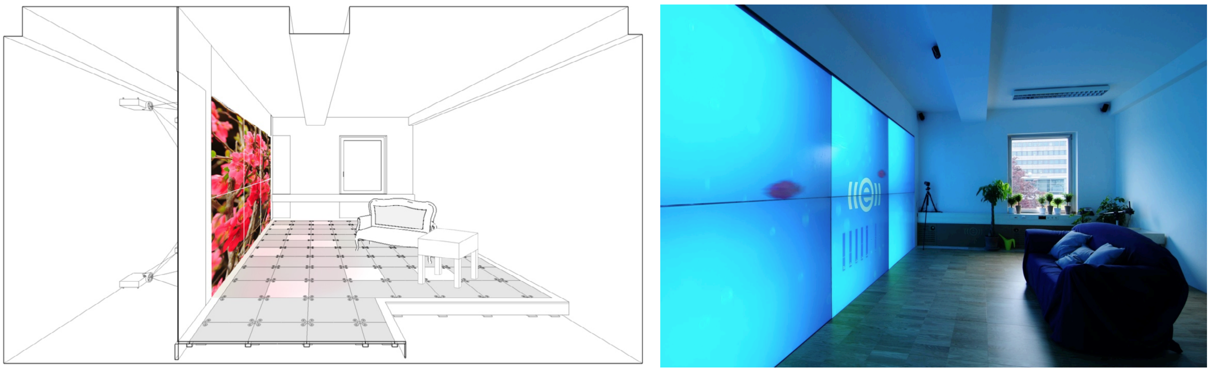

Figure 1. Technical concept (left) and realization (right) of the Future Care Lab.

The lab provides a full-scale technical infrastructure, consisting of different mobile and integrated devices, and allows using various immersive systems in different test settings. The setup of the lab enables in-situ evaluations of new homecare concepts and smart medical technologies by observing different target user populations in realistic usage situations. As the lab relies on a modular technical concept, it can be expanded with other technical products, systems and functionalities, in order to address different user groups. By this the lab has the potential to be sensibly adapted to new technical developments as well as societal changes and needs.

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