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A SELF-ADAPTIVE SOFTWARE SYSTEM TO SUPPORT ELDERLY CARE

Kostiantyn Kucher
Danny Weyns, Associate Professor, Computer Science Department
Linnaeus University, SWEDEN

ABSTRACT. Providing social care to elderly people poses increasing challenges to the society. In this research, we focus on the challenges of night care services provided by welfare helpers to elderly people living in their own houses. We study a self-adaptive software system that exploits smart home technology and provides innovative services to the stakeholders by collecting data at the homes of the elderly people and providing welfare helpers with the information they need to act. Self-adaptation enables the system to configure itself when new technology or services are provided, and adapt to the context of use. To guarantee sustainable solutions, we follow a multi-disciplinary approach with close involvement of stakeholders.

Setting and Motivation. Providing support for well-being and care of the growing ageing population poses one of the major societal challenges. Studies have shown that worldwide the number of elderly people above 60 has increased significantly over the last 50 years and will keep increasing the following decades. Innovations in the field of Information and Communication Technologies (ICT) are both a driver and a support to tackle some of the demographic challenges [1].

Challenges and Goal. A decade of vast research on well-being and elderly care has taught us the need for a multidisciplinary and integrated approach to realize sustainable solutions for promoting and supporting socio-technical innovation. We identified the following key research challenges:

1. How can we translate social needs of elderly people and care providers into requirements for innovative socio-technical solutions?
2. What is the appropriate architecture of the socio-technical solution? What are appropriate mechanisms to ensure an appropriate level of openness of the solution with respect to the privacy of stakeholders, introduction of new technology, and context-awareness of usage?
3. How do we measure the effectiveness and acceptance of socio-technical solutions on the well-being and care of elderly people?

Tackling these challenges calls for an iterative and creative process with direct involvement of representative groups of different stakeholders (elderly, care providers, etc.) as well as researchers from social and technical disciplines.

In this research, we consider these challenges from the point of view of one important aspect of social care in our society: the night care services provided by welfare helpers to elderly people living in their own houses. We focus on small to medium size communities in Sweden.

The overall research goal is to investigate, design, implement, and validate a socio-technical solution that addresses the primary problems of night care services provided by welfare departments.

Research Approach. Initial field studies have identified three types of recurring problems with night care services: (1) unnecessary visits of welfare helpers that could be avoided (e.g., an elderly sleeps quietly), (2) anticipatory visits that could anticipate a lot of overhead, if detected in time (e.g., a saturating diaper), and (3) critical visits that could avoid severe problems (e.g., an elderly fell).

To tackle these problems, we envision a self-adaptive software system that exploits smart home technology and provides innovative services to the stakeholders. With smart homes, we refer to homes equipped with unintrusive sensor infrastructure. Self-adaptation [2] refers to a system that is able to monitor itself, and adapt when needed according to some goals. Examples of services are a voice-enabled alarm that can be used by an elderly to contact a welfare helper, an application on a mobile phone that gives a welfare helper an overview of the current locations of colleague welfare helpers, a monitor interface that provides specific information about an elderly to relatives, etc.

The left part of Figure 1 shows the high-level architecture of the distributed self-adaptive software system. A *Smart Home System* collects and synthesizes the sensor data of a home, and sends useful information to the *Mobile Care Assistant*. The welfare helper uses this system to make decisions about visits and interact with the elderly or other persons when needed. *Relative Systems* provide

communication facilities to interact with elderly and welfare helpers. The *Department Server* has a dual role: collecting relevant data produced by the different systems to support analysis (e.g., to detect patterns in the behaviour of users), and providing a repository where new software can be downloaded.

The right part of Figure 1 shows the top-level decomposition of the smart home system. The *Auto-Configurator* supports dynamic discovery of (new) sensors and services, and configures the system based on personal needs and living conditions of the elderly. Self-configuration may require download of software at the department server. The *Context-Adaptor* detects changes in the context and dynamically adapts services based on the preferences of the elderly. As an example, the adaptor may activate a service that enables an elderly to alarm a relative via voice when he/she enters the bathroom without having the alarm with him/her. The mobile care assistant has a similar architecture, where the auto-configurator and context-adaptor supports adaptation functions related to the services of the care providers. As an example, the adaptor may activate a service that provides particular information regarding an elderly once the welfare helper approaches the home of the elderly.

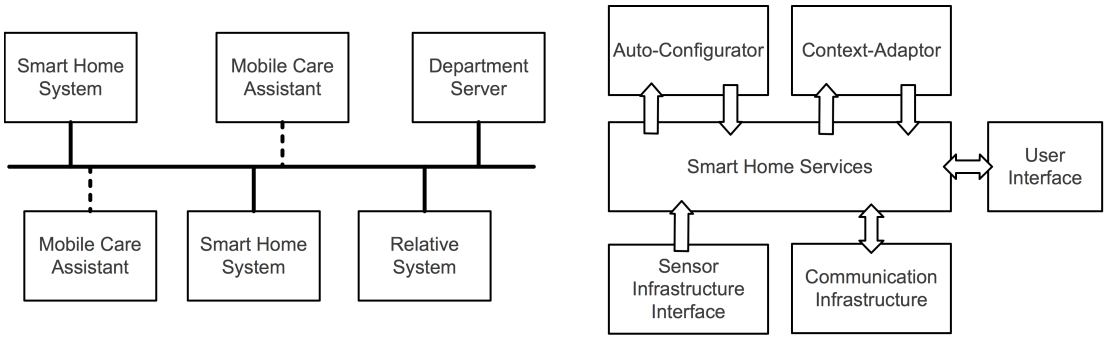

Figure 1. High-level architecture of ICT solution and Smart Home sysytem

Related Work. The usefulness of ICT solutions in the domain of assisted living has been shown in previous studies [3]. Lessons learned from previous and on-going projects will be taken into account in this research, such as the TigerPlace project [4], which provides a carefully designed monitoring system, but lacks focus on user interaction and injury prevention aspects, or the PERSONA [5] and universAAL [6] projects that propose comprehensive designs for assisted living infrastructures, but focus on the business perspective instead of concrete solutions. In general, existing studies indicate that the success of solutions depends on stakeholder involvement and multi-disciplinarity of research.

Ongoing and Future work. Currently, we are finalizing the design of the self-adaptive software system together with the implementation of an initial prototype. To perform initial tests, we are developing an emulator of the sensor infrastructure. The next task will be the design and implementation of user interfaces that allow stakeholders to effectively use the services. Once the initial prototype is operational, we will perform a small-scale evaluation in the field. This study will involve researchers from the Linguistics and Social departments that will perform discourse analysis of the results of observations and interviews to identify the effectiveness and limitations of the provided services. The feedback will be used to iteratively and incrementally develop improved solutions. In the final stage of the research, a systematic empirical study is planned to validate the research results.

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