Current Approaches to Ambient Assisted Living

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Abstract. Research in the field of technology-supported personal care gained considerable momentum over the last 10 to 15 years. This paper provides a comprehensive overview over state-of-the-art research activities in this field by illustrating major projects and research initiatives as well as highlighting successful approaches to Ambient Assisted Living.

1 Introduction

More and more elderly people are expected to require care in the coming years [8]. It is estimated that approximately 5% of persons aged between 65 and 69 years need medical support, this number rises to 10% for the group of people aged 70 to 79, and even 80% for people being 80 and over [52]. Similar statistics from Germany underline the magnitude of this problem. Currently, around 8 million people are suffering from disabilities, which in 85% of the cases are caused by previous diseases [53]. While only 10% of the population aged 65 requires care, this number rises to 50% for people aged 85 [55]. Especially the group of people requiring stationary care is constantly getting bigger. The number of people living in care institutions increased in only 6 years from 573.200 people in 1999 to 676.600 in 2005 [54]. And this group is expected to increase further in the coming 10 years. While today around 2.15 million people require either institutional or homecare in Germany, this number is estimated to increase to 3 million until 2020 [20]. The need for assistance does not only arise due to the prevalence of chronic medical conditions, but also due to the declining physical abilities of older people. Decreased mobility makes carrying out daily tasks both at home and outsides more and more difficult, if not impossible, which makes third-party's assistance unavoidable in many cases [21][30][43].

Hence, it is not surprising that research in the field of technology-supported personal care gained considerable momentum over the last 10 to 15 years. A comprehensive overview over early activities in this area can be found in [12]. More recently, a variety of large-scale, multi-national projects were launched within the European Union, mostly funded within the 6th and 7th framework programmes. For example in 2007, 16 projects started within the 6th framework programme focusing on different aspects, including service-oriented infrastructures for visually impaired (HAH project), healthcare and communication (NETCARITY project), sensor technology for personal assistance (SHARE-IT project), or activity monitoring and bio-feedback (SENSACTION-AAL project). In 2008, additional projects on similar topics started within the 7th framework programme. Besides these EU-wide initiatives, there are also a variety of national programs with a special focus on Ambient Assisted Living applications.

This paper provides an overview over past and ongoing Ambient Assisted Living projects. Consequently, this paper is not a research paper in the classical sense, but meant to be a scholarly overview article illustrating current developments and trends in the field of Ambient Assisted

Living. While there are a variety of projects developing smart healthcare systems for institutional care, e.g., [3], [4], [26] or [34], the focus of this paper will be on home care applications. To enhance readability, the presented projects are clustered into four groups, depending on their main research focus: (1) General Support of Elderly, (2) Medical Systems, (3) Intelligent Environments, and (4) Technical Infrastructures.

2 General Support of Elderly

The first group comprises projects that offer assistive services especially tailored to the needs of elderly or disabled people. These services include information and communication applications, assistive domotic appliances, assistive technologies and home automation systems (see Table 1).

Tab. 1: Overview over projects focusing on assistive services for elderly and disabled people.

Project	Project Description
COST 219	*COST 219* (Co-Operation in the Field of Scientific and Technical Research) is a European cooperation focusing on the design of easy-to-use information and communication systems for elder users [42]. It consists of 25 member countries, including 15 EU member states as well as Iceland, Norway, Switzerland, the Czech Republic, Slovakia, Hungary, Poland, Turkey, Slovenia, and Croatia [12].
VAALID	The *VAALID* project (Accessibility and Usability Validation Framework for AAL Interaction Design Processes) is an EU-funded research project aiming at the development of an immersive simulation platform for designing and validating assistive services, like warning indicators, assistive domotic appliances, and means for establishing communication with the outside world [25].
INHOME	*INHOME* (An Intelligent Interactive Services Environment for Assisted Living at Home) is a European research project focusing on the design of services for providing improved quality of life for elderly people at home [50]. Funded under the 6th framework programme, the project develops generic technologies for managing pervasive technologies, embedded household devices, entertainment equipment, and home automation systems [25].
SENTHA	The *SENTHA* project is funded by the German Research Foundation (DFG) and aims at designing everyday household technologies for elderly users. The projects has a special focus on improving the home environment and living conditions of older persons [6].
ALADIN	The *ALADIN* project (Ambient Lighting Assistance for an Ageing Population) is a European research project focusing on context-sensitive lightning solutions for elderly people. The project aims at developing an adaptive light system, which can adapt various light parameters in response to psychophysiological user data in order to contribute to healthy sleep (appropriate durations, frequencies and times of the day) and thereby preserve and enhance elderly peoples' lifestyle [10].
SOPRANO	*SOPRANO* is a European research project funded within the 6th framework programme, which aims at developing a technical infrastructure for enabling independent life at home. The project has a special focus age-sensitive and accessible design and employs participatory design methods for involving potential end users in different steps of the development process [32].

3 Smart Medical Applications

The projects of the second group have a particular focus on the design of smart medical applications that increase the comfort and independence of patients at home. Examples for such applications include unobtrusive capturing methods for vital parameters, smart textiles and clothes for health monitoring, and intelligent systems for health and lifestyle support (see Table 2).

Tab. 2: Overview over projects focusing on smart medical applications for increasing comfort and independence of elderly and disabled people.

Project	Project Description
PROSAFE	*PROSAFE* is a French research project developing lightweight sensors for continuously collecting activity data from Alzheimer's patients with the goal of identifying abnormal user behaviors (see, e.g., [9] or [14]).
PHMon	The objective of the *PHMon* (Personal Health Monitoring System with Microsystem Sensor Technology) project [16][45][46][51] is the development of a personal health monitoring system, which enables an interference-free measurement of different physiological parameters [37]. The project is developing an integrated sensor system for monitoring blood pressure, blood glucose, respiration, and intraocular pressure [31].
CONTAIN	The *CONTAIN* project aims at integrating communication, sensor and actuator technologies into smart clothing in order to continuously monitor vital data and environmental parameters. Based on this technical infrastructure, different tele-medical applications are provided, including emergency detection and response as well as integrated communication services [21].
NUTRIWEAR	The *NUTRIWEAR* project aims at the development of a mobile monitoring system for capturing vital parameters. It has a special focus on the development of smart textiles with integrated electrodes and circuits for unobtrusive and autonomous data capturing [5].
MyHeart	The *MyHeart* project is funded within the 6th framework programme and aims at developing personalized and easy-to-use solutions for supporting healthier lifestyles [36][40]. Focusing mainly on cardiovascular diseases, the project develops wearable systems and associated smart services that empower users to take control over their health states [31].
WEALTHY	*WEALTHY* is another EU-funded project focusing on the development of smart textiles for personal healthcare. The main objective of the project is the design and development of a comfortable health monitoring system [31].
PerCoMed	*PerCoMed* is a German research project identifying the chances and risks of using pervasive computing technologies in the healthcare domain as well as the drivers and barriers for innovation and diffusion of these systems [18][38].

4 Intelligent Environments

Projects in the third group focus mainly on the design and development of intelligent environments for supporting everyday activities of elderly and disabled people. Services provided by these environments include prototypes of networked multi-sensor networks, novel approaches for inter-generational communication, smart digital appliances, or smart monitoring systems (see Table 3). Not all described services are exclusively designed for elderly people. Nevertheless, most ill or disabled people would largely benefit form the described systems and the implemented applications could be easily transferred to Ambient Assisted Living scenarios.

Tab. 3: Overview over projects focusing on intelligent environments for elderly and disabled people.

Project	Project Description
NETCARITY	*NETCARITY* is a EU-funded project developing a networked multi-sensor system for elderly people in order to support healthcare, safety and security in home environments. The project aims at different interface types, which address user needs more adequately. The implemented prototypes include Tablet PCs using touch-screen technology, devices linked to a camera and projecting virtual representations of real objects onto a surface allowing users to easily interact with familiar items, and virtual representations of real people offering guidance and support through displays around the home [25].
interLiving	The *interLiving* project [23] is part of the Disappearing Computer initiative of the European Union and explores the needs of diverse families with respect to the design of future home environments. The project specifically addresses matters of inter-generational family

	communication and aims to study and develop innovative artefacts that support the needs of co-located and distributed families [39].
BelAmI	*BelAmI* is a bilateral German-Hungarian collaboration project developing innovative technologies and system in the area of Ambient Intelligence [1][27][28]. The project focuses in particular on questions of mobile communication, human-machine interaction, microelectronics, and software engineering.
Smart Home	The *Smart Home* project at Samsung aims at developing a set of smart digital appliances for enhancing life experience in smart home environments. The main goal of the project is to improve everyday home life with new computer and interaction technologies, while keeping the natural character of domestic life as much as possible [41].
Hospital Without Walls	*Hospital Without Walls* in an Australian tele-health project exploring new ways of long-term home care and monitoring [13]. The project in particular aims at the development of a wearable fall monitoring system for smart homes, which continuously checks the heart rate and body movement of patients at home [15].

5 Technical Infrastructures

The last group sub-sums projects focusing on technical infrastructures for supporting elderly and disabled people. The services provided by these systems, include scalable and adaptable systems for modular sensor integration, middleware frameworks for Ambient Assisted Living solutions, sensor technologies for unobtrusive and cost-effective real-time monitoring of patients, as well as technical infrastructure for providing home healthcare services (see Table 4).

Tab. 4: Overview over projects focusing on technical infrastructures for supporting elderly and disabled people.

Project	Project Description
TOPCARE	The *TOPCARE* project (Telematic Homecare Platform in Cooperative Health Care Provider Networks) develops different types of devices and telecommunication systems as a technical infrastructure for providing cooperative healthcare services in the home domain [31].
PERSONA	The *PERSONA* project (Perceptive Spaces Promoting Independent Aging) deals with the development of a middleware framework for Ambient Assisted Living solutions and focuses on care and support services for elderly users as the main application area [25].
AMIGO	The *AMIGO* project develops open, standardized and interoperable middleware and user services [48]. The project has a special focus on the development of prototype applications, which demonstrate the potential of AAL technologies for everyday life. This is done by addressing different usage scenarios and application domains, like, home care and safety, home information and entertainment, and the extension of the home environment by means of ambience sharing for new forms of personal communication [44].
SENSATION	The *SENSATION* project explores different types of sensor technologies, for enabling unobtrusive and cost-effective real-time monitoring, and detecting and predicting physiological states of patients with respect to wakefulness, fatigue and stress [31].
SHARE-it	The *SHARE-it* project focuses on the development of a scalable, adaptive system for add-ons to sensors and assistive technologies, which enable to modularly integrate them into intelligent home environments [11].

6 Conclusion and Outlook

This paper provided an overview over state-of-the-art approaches in the field of Ambient Assisted Living. Today, the majority of existing projects is focusing on improving homecare by providing personalized and automated medical services in the users' home. Nevertheless, it is also important to notice, that Ambient Assisted Living applications do not only improve quality of service, but also bear the potential to significantly reduce the costs of long-term care [2][7][10][29][35][49]. For example, Heinze [20] expects potential savings of up to 30% through remote medical services for

patients with cardiovascular diseases. Similar studies by Johnston et al. [24], Gothe et al. [17] or Tang and Venables [47] come to equally positive results. So it is not surprising, that Demiris and Tan [15] expect technology-supported home care to become one of the fastest-growing domains in the health care industry over the next decades. The presented projects successfully demonstrated the potential of Ambient Assisted Living for increasing quality of life in an aging society. With most technical challenges being solved by now, it is time to turn existing research prototypes into commercially available products and make them available to a large user population at an affordable price.

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