Social Inclusion in Ambient Assisted Living Environments: Home Automation and Convenience Services for Elderly User

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Abstract - *Traditionally, Ambient Assisted Living applications focus on health-related services, like the detection of emergency situations, long-term treatment of chronic diseases, or the prevention and early-detection of illnesses. Over the last years, more and more projects started to extend these classical healthcare scenarios by designing applications that explicitly aim at increasing well-being and social inclusion for elderly users. With the transition away from purely medical services towards integrated homecare environments, holistic design concepts and evaluation approaches will become necessary. This paper takes a detailed look at state-of-the-art applications in this field and illustrates emerging challenges for the design and development of future homecare systems.*

Keywords: Ambient Assisted Living, Ambient Intelligence, Ubiquitous and Pervasive Computing, Social Inclusion, Older Users.

1 Introduction

Extended life spans, declining birth rates, and the increase in single households contribute to a growing number of elderly people at risk for institutionalization [58]. But long-term institutionalization is not only a big financial burden to the healthcare system and therefore hard to maintain in the coming years, it is also not the preferred choice of many aging people. With the recent developments in the fields of information, communication and sensor technologies, solid technical infrastructures for providing new patient-centered home care solutions become available. While the majority of computer-supported health care tools designed in the last decades focused mainly on supporting care-givers and medical personnel, this trend recently changed with the introduction of assistive technology for providing supportive and adaptive services to ill or disabled individuals at home [15]. This is usually done by enhancing physical spaces with computers and sensing technology to make them sensitive and responsive to the presence of people [17][35]. The idea of such Ambient Assisted Living (AAL) environments is to provide assistive technologies for supporting people with specific demands in their daily activities and thereby allowing them to grow old in their own homes [22][25][43]. While Ambient Assisted Living environments can provide a multitude of personalized and context-adapted services in various areas of life, the majority of existing systems focuses on one of the three application domains: the detection of emergency situations, long-term treatment of chronic diseases, or the prevention and early-detection of illnesses. A detailed discussion of existing Ambient Assisted Living systems can be found in [50].

2 Safety and Well-Being in Ambient Assisted Living Environments

While older people are obviously in need of extended long-term care, they wish to maintain their independence as long as possible (see, e.g., [18],[28],[36],[42],[55] or [62] for more details). Studies show that many older people regard their home as a sanctuary and therefore prefer to stay at home, even at an increased risk to their health and safety [14]. This wish is often related to a perceived increase in the quality of life in a familiar environment. Generally, quality of life is a quite complex concept referring to the individual perception of one's "physical health, psychological state, level of independence, social relationships, personal beliefs and relationship to salient features in the environment" [60]. But as people age, their perceived quality of life is mostly determined by their ability to maintain an autonomous and independent life [61]. Hence, a variety of authors, including Bayer and Harper [4], Shafer [51], Starner et al. [56] and Mynatt et al. [44],

identified the loss of personal independence as a major concern of most elderly people. More and more Ambient Assisted Living projects address these needs by designing applications that explicitly aim at increasing safety and well-being for elderly users. The following section takes a closer look at state-of-the-art applications in this field.

3 Current Approaches Towards Social Inclusion

3.1 Intelligent User Interfaces

Several user studies (see, e.g., [54]) showed that elderly people and their families regard social inclusion, safety and home automation as important features of future homecare environments. With respect to the interaction in such environments, one of the main research challenges is the design of adequate user interfaces. This is due to the fact that elderly people vary considerably in their physical and cognitive abilities, which makes it difficult to use traditional interaction models [31]. Focusing on single interaction strategies may not always provide appropriate solutions [16] as many older computer users are affected by multiple disabilities, and such multiple minor (and sometimes major) impairments can interact. To address this problem various authors developed intelligent user interfaces, which support users according to their individual needs. For example, Gajos et al. [24] developed a system that allows an automatic generation of personalized user interfaces. The system assesses the user's motor abilities and automatically generates an interface adapted to the individual abilities of the user. Jung et al. [33] even developed a smart bed, which is able to 'sense' the intention of the user and act accordingly. Based on integrated pressure sensors, the bed is able to detect an intended movement of the user and automatically changes posture according to the user's intention [6].

There is also a considerable body of research on intelligent interfaces compensating for physical disabilities of users. For example, the *EyeMouse* interface [34][63] is a non-contact interaction device that enables physically impaired patients to control computers or robots by eye movement [6]. The *Input Adapter Tool* developed by Carter et al. [12] automatically modifies the interfaces of JAVA-based applications in order to improve the accessibility for users with restricted motor abilities. A similar system for web pages was developed by Mankoff et al. [40]. More artistic systems include *EyeDraw* [30], which creates paintings based on the eye movement of the user or *VoiceDraw* [26], which converts voice signals into paint strokes.

Another widely explored approach for supporting patient-device interaction are gesture interfaces. With the *Gesture Pendant*, Mynatt et al. [44] developed a wireless device, equipped with a camera and motion sensors, that enables users to control different services within smart home environments, like, e.g., closing the blinds, locking the door, or diming the lights, by using different hand gestures. In addition, the device is able to monitor the physical activity of its user and request help in case of an emergency. In contrast to the *Gesture Pendent*, the *Soft Remote Control* system [7][19][49] is integrated into the users' environment, which enables device-independent interaction between users and different services within the environment. The system allows users to control devices by pointing at an object within the room and using pre-defined hand gestures to execute different functions [5][8]. An alternative gesture recognition approach using vision systems is proposed by Jojic et al. [32]. Based on previous work by Kuno et al. [37], Brumitt and Cadiz [11] propose a multimodal home control system that combines gesture and speech input in order to provide natural interaction commands.

3.2 Connectedness-Oriented Communication

As people age and become less mobile, meeting other people outside the own home becomes more and more complicated if not impossible [41][42]. The resulting erosion of social networks is a natural consequence experienced by many older people [46], which is especially severe as social relationships are widely acknowledged as an important factor to well-being in old age [1][10][21][39]. This is also underlined by a survey conducted by Gabriel and Bowling [23] in the UK, which found that social relationships are the principal contributing factor to quality of life for people aged 65 and over. Hence, it is very important to provide older people with adequate information and communication technologies, that enable them to remain integrated in social life, despite of their age and existing disabilities [25][45].

Exchanging task-related information is only one aspect of communication. Especially within spatially distributed families, it is equally important to have informal interactions, spontaneous conversations and awareness of people and events at other sites [9]. Traditional communication technologies, like telephone and e-mail, focus mainly on content and are not adequate to support a feeling of connectedness. In contrast, connectedness-oriented communication is intended to support and augment social relationships among people by fostering a sense of connectedness among them [38]. The degree of connectedness is closely related to the 'social presence' a communication media is able to mediate [53]. The more a communication media is capable of mediating the personality and non-verbal symbols of a remote person, the higher is its social presence.

A broad variety of projects addressed this problem by designing ambient awareness systems, which make use of ambient display technologies to facilitate lightweight, informal and emotional forms of communication in smart environments. While ambient displays, by their nature, are not limited to certain kinds of data, most systems map presence information associated with other people to artefacts, situated or integrated in the environment. The systems are designed to support users in effortless maintaining awareness of the whereabouts and activities of others, and do so, by representing this information through changes in light, sound, movement, or temperature in the user's environment [59]. Looking at the design of the output interfaces for ambient awareness systems, two fundamentally different approaches are visible. One group of applications uses physical artefacts to visualize information, the other relies on large graphical displays showing abstract pictures compositions.

The usage of physical artefacts to represent awareness information is especially common in applications that focus on providing intimate affective communication between pairs of people. Strong and Gaver [57] developed several artefacts that enable pairs of people to stay in contact with each other. They envisioned mobile users to carry small picture frames whenever they are outside their home. When a user picks up the frame, information is transmitted to a stationary device at the partner's home. Depending on the device, a feather inside an acryl cone is whirled around (*Feather* artefact), or a heating element warms a container with essential oil (*Scent* artefact). Another tool for supporting intimate communication is the *Kiss Communicator* [3]. Blowing on the device creates ripples of light that can be sent to a remote partner's device, once a desirable pattern has been achieved. *Lumitouch* [13], *The Bench* [20], and *Shaker* [57] are other examples of tangible interactive display for supporting connectedness-oriented communication.

Another group of ambient awareness systems focuses on providing awareness in small, closely-related groups in home environments. The *FamilyPlanter* [38], for example, was developed to be used by family members living apart. The system uses infrared and ultrasonic sensors, to monitor the presence of a user, and transmits the status to a selected family member via a server. At the receiver's side the *FamilyPlanter* presents the received information by rotating and illuminating optical fibers. Besides automatically generated presence information, the system also offers a possibility to explicitly send 'messages' by touching a sensor at the *FamilyPlanter*, which causes the artefact at the receiver side to emit a sound. A similar approach is taken by Hindus et al. [29] with the *Lampshade Intentional Presence Lamp* (IPL), a decorative artefact that serves both as a lamp and a communication device. In contrast to the *FamilyPlanter*, the presence of people is not automatically captured. Instead, presence information is only communicated, if the user explicitly activates the *Lampshade* device. Other system supporting awareness in small intimate groups are *Digital Family Portraits* [45], *Gleams of People* [48], *Faint-Pop* [47], or *Curtain IPL* [29].

4 New Challenges for the Design and Evaluation of Future Systems

With the transition away from purely medical services towards integrated homecare environments, holistic design concepts and evaluation approaches will become more and more important. For the conceptualization, design and evaluation of future homecare systems it is not sufficient anymore to rely on one prototypical user, one prototypical usage situation, and a one-to-one-relation of technology and task context [51]. Individuals live in environments and expect technology to be adaptive and useful, however, what is judged as useful may change depending on the application domain and usage context. For example, it has been shown [2] that one and the same mobile device can evoke different perceived benefits and drawbacks when used in a communication scenario compared to a medical monitoring scenario. Hence, the acceptance or rejection of a technical product is neither static nor independent from the specific context, in which the technology is used.

For a long time, design aspects have been discussed from a predominantly functional perspective. With the increasing penetration of technology into private spheres, technology must comply with the needs and wants of a diverse user group in order to be successful and fully accepted by those for which technology is designed. Evidently, a system or service can be usable in terms of performance measures, but, at the same time, it can be completely rejected. Therefore, the design focus should not only be on efficiency, task-appropriateness, and ease-of-use. A number of studies show that users desire more than pure functionality, but prefer interfaces with a high social and hedonic value, as they provide stimulation, identity, and valuable memories (see, e.g. [27] or [64]). Hence, other dimensions of usage should be included, like the pleasure of using a device or its appropriateness for a specific usage setting. Consequently, the design of future homecare environments should follow a strictly user driven approach starting by analyzing the relationship of users and technological product.

5 References

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