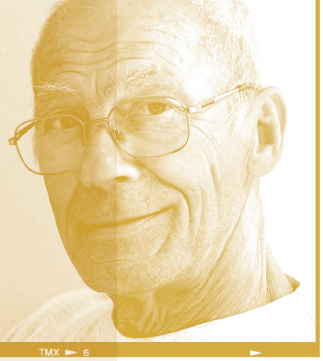

Ambient Assisted-Living Research in CareLab

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DEMOGRAPHIC TRENDS ARE signaling the overwhelming need for information and communication technology (ICT) based consumer health and wellness applications. One of the high potential growth areas is in elder care: According to the World Health Organization, the proportion of people age 60 and over worldwide is growing faster than any other age group [4]. Hence, there will also be a reduction in the number of people who can provide care to these seniors. This clearly points to an opportunity for technological solutions to support independent living for seniors. Ambient Assisted Living refers to electronic environments that are sensitive and responsive to the presence of people and provide assistive propositions for maintaining an independent lifestyle.

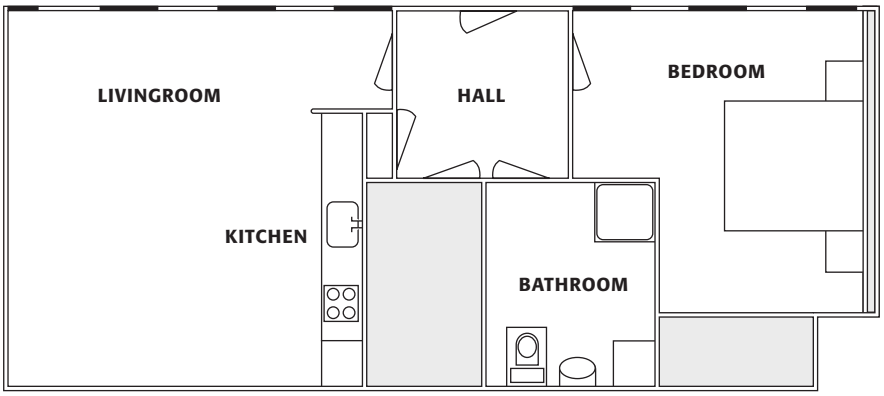
Health and wellness applications span the continuum from fitness applications up to remote patient-monitoring systems for chronic-care patients. The development of these solutions requires continuous user involvement to ensure a seamless fit with user needs and preferences and to promote care-provider endorsement.

CARELAB

As an instrument for ensuring early user involvement in the development of innovative applications of technology, a CareLab has been established at the Philips High Tech Campus in Eindhoven, the Netherlands.

This CareLab resembles a one-bedroom apartment for seniors and is equipped with a rich sensor network to study the contextual settings in which people will use the health and wellness applications (Pictures 1, 2, 3, 4). The sensor information is processed and combined to extract higher-order behavioral patterns that can be related to activities and states, such as the presence of people or the state of the home infrastructure.

With the CareLab it is possible to explore at an



Picture 1: CareLab Floorplan

early stage the user's acceptance of these solutions and to assess the interactive and functional qualities of these solutions before deploying them into field settings.

AMBIENT ASSISTED LIVING

Both demographic and socio-economic trends have pointed to the need for Ambient Intelligence (AmI) concepts and technologies to go beyond the realization of entertainment scenarios and to support people in maintaining their well-being. These AmI concepts and technologies should address user needs by focusing on the *safety and protection* of the personal environment and the *stimulation and enabling* of elderly people to maintain an active lifestyle.

Safety and protection. According to the World Health Organization, 30 percent of people over 65 and 50 percent of those over 80 fall each year [3]. Twenty to 30 percent of those who fall suffer injuries that reduce mobility and independence and increase the risk of premature death. In addition, depression, fear of falling, and other psychological problems are common consequences of repeated falls. Within this context it is clear that there is an important role for intelligent environments to provide a feeling of safety and protection by means of contextual monitoring (Picture 5).

Stimulation and enabling. The process of normal aging comes with several forms of physical and cognitive decline. Such decline can lead to situations of reduced mobility and in turn to reduced social interaction. AmI environments can provide the feeling of self-efficacy by offering solutions for stimulating physical and cognitive fitness and enabling active participation in society (Picture 6).

CURRENT RESEARCH TOPICS

Lifestyle assistant. Within the CareLab we have implemented and tested a Life Style Assistant system that offers an intelligent and adaptive home environment system to enable the elderly to maintain an active, healthy, and independent lifestyle. It targets seniors' need for safety and protection by means of a remote monitoring service. A range of distributed sensors register activities inside the home, which are processed by a context-aware reasoning engine. This reasoning engine identifies potential critical incidents and in response alerts

Picture 2: CareLab Dining Room

Picture 3: CareLab Living Room

Picture 4: CareLab Bedroom

Picture 5: Contextual Monitoring

Picture 6: Social Interaction

Picture 7: Two seniors eat lunch ordered using the lifestyle assistant

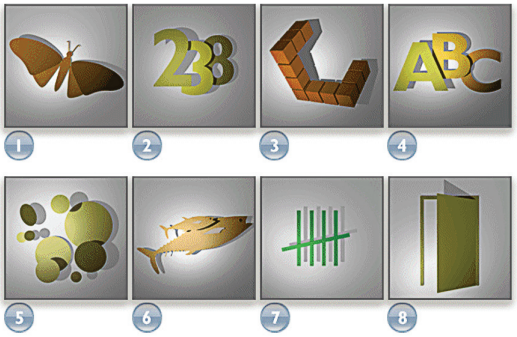


Figure 1: An example of cognitive stimulation

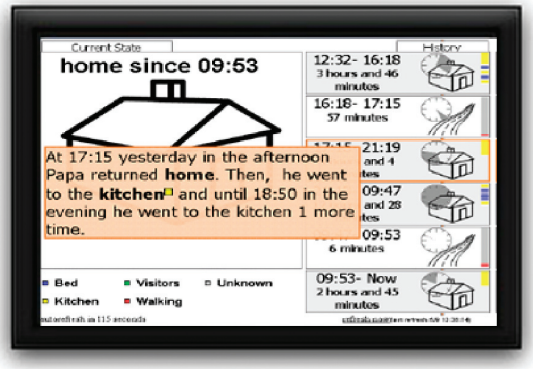


Figure 2: A CMC diary

care centers or relatives. In addition, the Life Style Assistant system offers several interactive comfort services for elderly, such as meal ordering (Picture 7).

Cognitive stimulation. Cognitive performance is known to decline as a result of aging. It is also known that mental activity can positively affect people's cognitive performance [2]. An interactive service proposition can train the elderly in several distinct aspects of their cognitive capacities. A community view representing members' frequency of playing induces a social motivation to further stimulate participation. This promotes a feeling of participation in society, while diminishing experienced loneliness and decelerating cognitive decline, hence promoting healthy and independent aging. The platform for this service is an IP-TV to allow for integration of multiple services and functionalities through a device that is familiar for the elderly. Our ongoing empirical studies have indicated that elderly people experience this as an attractive proposition, while there are quantitative indications that such training enhances their performance on tasks related to, for example, selective attention and stimulus discrimination.

Social connectedness. As humans we have a strong need for feeling connected to our social environment. Starting in early childhood development, social interest drives our personal and social development. Given the significant lifestyle changes (e.g., retirement, reduced mobility, losing a partner) that come with normal aging, there is a need for the elderly to feel included in society. This feeling can be elicited by means of awareness systems. Awareness systems are a class of computer-mediated communication (CMC) systems that help individuals or groups build and maintain a peripheral awareness of each other. In a social context, interpersonal awareness can be considered as an understanding of the activities and status of one's social relations, derived from social interactions and communication with them. Technology-mediated awareness is achieved not by direct interaction or sharing a physical space, but by means of CMC technology. Using a sensor network we have designed such an awareness system. This system captures and interprets contextual information related to the daily activities of elderly people and presents automated diaries on a picture frame as

awareness information for their children living at a remote location.

Our empirical studies (both in the CareLab setting and in field tests) have indicated that there is a significant increase in feelings of connectedness between elderly and their children (as reported by the "Affective Benefits of Being Connected" questionnaire), while the elderly report a significant reduction in the number of subjective complaints (as assessed by the "Symptom Check List-90" questionnaire) when having the awareness system in their home environment.

FUTURE RESEARCH DIRECTIONS

Besides continuing our research into technological solutions for enhancing *safety and protection* of the personal environment and the *stimulation and enabling* of the elderly to maintain an active lifestyle, future research within the CareLab is focusing on (i) end-user programming, (ii) ambient awareness, and (iii) motivation and behavioral change.

In order to fully tailor the functionalities and benefits of an intelligent environment to individual needs and preferences, end-user programming techniques are being developed for seniors. With these end-user programming or end-user development (EUD) techniques, elders can easily set up the system according to their own requirements. Although the proposed AmI concepts will contribute to the quality of life for the elderly, it is essential to create end user acceptance by providing the elderly a sense of control over the AmI concepts and technologies End-user programming techniques require research into user models and software component infrastructures [1]. With financial support of the European Commission, a research roadmap into the development of EUD solutions was generated. Started in 2002, the EUD Net Network of Excellence on End-User Development helped the European Commission prepare a research agenda in the end-user development field.

Providing end users with a feeling of reassurance with regard to the well-being of remote friends and family requires some level of contextual awareness between people. Research into the semantics for capturing and rendering contextual information is essential in furthering the realization of Ambient Awareness systems.

As AmI concepts and technologies are becoming more integrated into our daily lives, it is expected that these systems will go beyond providing entertaining experiences and move into the domain of inducing behavioral change. These AmI concepts and technologies will have to master techniques for motivating people to change the way they live in order to promote enhanced healthcare and well-being.

In the coming decades, "safety and protection" and "stimulation and enabling" will be imminent areas for AmI concepts and technologies. In order to fully meet the demands of the elderly target group, it is essential to understand acceptance issues and user needs regarding, for example, end-user programming, ambient awareness, and behavioral change. Integration of services addressing various user needs will stimulate acceptance and hence, market uptake.

ABOUT THE AUTHORS *Boris de Ruyter has more than 11 years of experience in heading international and multidisciplinary research projects. After graduating, de Ruyter worked as a research assistant in experimental psychology at the University of Antwerp. Since 1994 he has been with Philips Research, where he works on user-system interaction research. His research focuses on user modeling and psychometrics. He is an author of multiple international publications and owns numerous patents. Since 2006 he has been appointed principal scientist and is coordinating the research of domain interactive healthcare at Philips Research Laboratories Eindhoven.*

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