Ageing in a Networked Society – Social Inclusion and Mental Stimulation

John A. Waterworth[1], Soledad Ballesteros[2], Christian Peter[3,4], Gerald Bieber[4], Andreas Kreiner[5], Andreas Wiratanaya[6], Lazaros Polymenakos[7], Sophia Wanche-Politis[8], Michele Capobianco[9], Igone Etxeberria[10], Louise Lundholm[11]

[1] Dept. of Informatics, Umeå University, 901 87, Sweden, jwworth@informatik.umu.se

[2] Facultad de Psicología, UNED, 28040 Madrid, Spain, mballesteros@psi.uned.es

[3] Graz University of Technology, 8010 Graz, Austria, c.peter@cgv.tugraz.at

[4] Fraunhofer Institute for Computer Graphics, Rostock, Germany, {cpeter, gery}@igd-r.fraunhofer.de

[5] modernfamilies gmbh, 4040 Linz, Austria, andreas@familiekreiner.net

[6] CanControls, 52074 Aachen, Germany, wiratanaya@cancontrols.com

[7] Athens Information Technology (AIT), 11525 Athens, Greece, lcp@ait.edu.gr

[8] Kendro Merimnas Oikoyennias kai Pediou (KMOP), 10680 Athens, Greece, wanche-politis@kmop.gr

[9] Onda Communication S.P.A., Roveredo in Piano, Italy, mcapobianco@ondacommunication.com

[10] Fundacion Instituto Gerontologico Matia (INGEMA), 620002 San Sebastián, Spain, ietxeberria@fmatia.net

[11] Skellefteå kommun, 931 85 Skellefteå, Sweden, louise.lundholm@skelleftea.se

ABSTRACT

Research into ageing and cognition has demonstrated the close relationship of sensory functioning and social communication to maintaining cognitive performance and mood in the elderly, yet in modern societies elderly people are increasingly isolated and under-stimulated, both physically and psycho-socially. This situation results in accelerated cognitive decline and the suffering associated with loneliness and confusion. Health services cannot keep up with the demand for home visits and day care centres that can alleviate this problem. Incorporating new healthcare technologies for proactive health and elder care into everyday living environments can contribute significantly to support the elderly and their carers and is to become a major priority over the next decade. The approach followed in the AGNES project is to keep the elderly mentally and socially stimulated and in contact with others by combining state detection and social network technologies. This paper provides some scientific background for the chosen approach and describes the technological concept of the project.

Categories and Subject Descriptors

H.4 [Information Systems Applications]: Miscellaneous

H.5.2 [Information Interfaces and Presentation]: User Interfaces

H.5.3 [Group and Organization Interfaces]

General Terms

Management, Measurement, Human Factors, Verification.

Keywords

AGNES, Social Network, Activity Monitoring, User State Detection, Affect, Cognition, Pervasive Assistance, Sensor Fusion

1. INTRODUCTION

This paper presents a novel approach to counteract the progress of mild dementia as well as other consequences of elderly people living alone by leveraging the positive effects of social inclusion on mental fitness and subjective well-being. Today there is widespread awareness of the increasing numbers and proportion of elderly people in European societies. But in modern societies elderly people are increasingly isolated and under-stimulated due to increased mobility and consequential geographic distance of family members and friends, as confirmed by recent surveys. But isolation breeds loneliness, which in turn results in cognitive and physical decline [16], compromising the older person's capacity for continued independent living. Lack of social participation increases the risk of Alzheimer´s (AD) disease-like dementia [8], and loneliness resulting from social isolation is a serious risk factor for depression among home dwelling older adults [10]. AGNES answers this phenomenon by providing technological means to not only keep the elderly connected with significant others but by also actively informing caring persons on the elderly's state and well-being and evoking appropriate responses.

This approach is motivated by latest findings of social inclusion being similarly important and successful in slowing down the progress of mild dementia as is regular mental stimulation [9, 11, 13, 17, 20].

AGNES is a project funded in the frame of the European AAL initiative [1] to develop according technologies and to scientifically investigate the benefits of this approach. As the name suggests (**AG**eing in a **NE**tworked **S**ociety), core element is a web-based social network platform, enhanced with devices collecting data on the patient's activities, subjective state and well-being.

The next chapter introduces the AGNES idea in more detail and gives an overview on the planned technological realization.

2. THE AGNES APPROACH

2.1 Objective

The objective of the AGNES project is to provide a user-sensitive ICT-based home environment that supports a personalized and person-centric care process by detecting, communicating, and meaningfully responding to relevant states, situations, and activities of the elderly person with regard to mild cognitive impairment or dementia. Central to the proposed idea is the combination and integration of home-based information and communication technologies (ICT) and social networks, connecting the elderly person living at home with their families, friends and carers. The project will provide the technological means to leverage the power of social networks and the beneficial effect of social inclusion and activities on cognitive and mental processes. The ICT innovations developed will enhance mental and physical wellbeing by encouraging the older person to, for example, respond to physical, social and cognitive stimulation from outside, thus maintaining and even improving selective attention, memory span and prospective memory.

As a side-effect, communicating subjective states and activities of the elderly and communicating them to caring persons also allows for a much better tailored and timely response, attention and care. It gives the caring person a better peace of mind and reduces feelings of loneliness and insecurity of the cared-for person.

The aim is to prevent and manage chronic conditions such as cognitive impairment or dementia, by gentle and consistent social stimulation and timely response to detected states, situations or activities, so as to improve and maintain the well-being and independence of the elderly living in their own homes and to support caring staff or family members by timely and adequate information and easy-to-use means to communicate with the cared-for person.

The developed applications will respond sensitively and adaptively to the states and characteristics of the individual user. All interaction approaches and devices will be designed and tested in close cooperation with the prospective users, under supervision and scientific guidance from psychologists, gerontologists and sociologists.

2.2 Scientific background

Today, we have an excellent understanding on age-related changes in basic cognitive processes such as speed of processing, working memory, episodic memory, and sensory functions [7, 15, 19]. Moreover, recent advances in the neural understanding of age-related differences in cognitive functions have shown that older adults show additional frontal compensatory recruitment compared to young adults while performing memory tasks. Several findings suggest that there is considerably flexibility and reorganization in neural circuitry with ageing [12, 18]. Cognitive ageing researchers are seeking how can be used this knowledge to improve the functional well-being of the elderly. Traditional approaches have investigated how training those mental abilities that decay with age produce global cognitive enhancement. Thus far, instead of a global improvement in cognitive processes, disappointingly the improvement is limited to the trained ability [3]. More interestingly, other approaches that do not try to train a particular ability but to improve cognitive function by exploiting intact cognitive process (such as implicit memory [4-6], or by using broad-based intervention techniques of intellectual and social stimulation) result in a global increase in cognitive function [13].

Cognitive health in ageing depends on a mix of environment, genes, and life experiences. The social context of older adults is receiving renewed interest as a factor that mediates cognitive health and wellbeing. Social relations are considered important for emotional as well as physical and psychological health of the elderly and serve as a protective factor against risk of cognitive decline and dementia [9, 20]. There is a strong inverse relationship between the strength of social networks and the incidence of dementia among the aged [8, 11]. Prodromal cognitive decline may precipitate exclusion from existing social relationships. The AGNES project focuses on establishing and maintaining social inclusion and involvement in societal and family life for the older individual. In addition to the benefits of reduced social isolation new, stimulating environments can be expected to improve cognitive functioning [14]. The AGNES project focuses on finding optimal communicative interventions for older individuals.

AGNES will carry out novel interventions in an area that is emerging as a new frontier in ageing research, especially as we are taking advantage of those mental processes (such as implicit unconscious memory, vocabulary) preserved in ageing. The project will use scientifically based knowledge on ageing and innovative technology to intervene in the lives of target users in specific and carefully selected ways, and the effects of these interventions on cognitive functioning and quality of life will be evaluated, going beyond the existing state of the art. The results will provide significant new knowledge on the potential of new information technologies to delay, help deal with, and even prevent common chronic problems experienced by the elderly population; specifically, some degree of cognitive impairment and mild dementia.

Monitoring physical activity is another important facet of our holistic approach. As there is also evidence that physical activity may help people to maintain their cognitive abilities, AGNES' monitoring and scheduling possibilities allow to utilize the element of human activity [2]. As a side effect, activity monitoring combined with e.g. a daily calorie overview will help people to maintain a more healthy life style.

2.3 Technological Approach

AGNES will start by providing a basic ICT platform to create and maintain an easy-to-use web-based social network for individual elderly persons. This platform will be used to pass information back and forth from the social network to the elderly person and vice versa, so as to maintain the network and stimulate the elderly person (figure 1).

The in-home system will include technology to assess the subjective and objective states of the elderly person. Timely information will be passed to the network on the activities and subjective state of the inhabitant (e.g. presence, physical activity, state of wellness, etc.). The AGNES platform will also provide an information and communication channel to the elderly person from the network (news, updates on activities of close persons, reminders on birthdays etc.). To support these functions, easy-to-use ambient devices will be designed and tested, as a means of interaction between the network and the elderly person both ways, as well as to unobtrusively update the network on the person's wellbeing and activities.

The project will develop innovative applications based on these technologies to improve and maintain the well-being and independence of the elderly living in their own homes and to support the needs of family and carers.

The basic AGNES platform will be designed to be affordable, scalable and adjustable to the needs of users, and extendable from a basic configuration through a modular approach to application development.

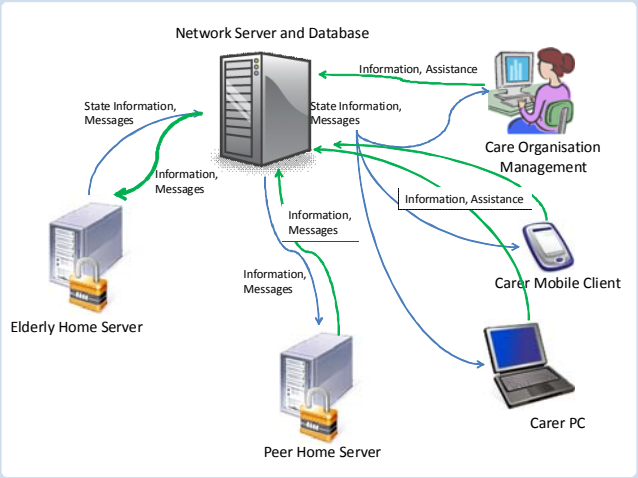

Figure 1. The AGNES setup

2.3.1 Detecting User States and Activities

While the basic system will work even without any sensory information by just providing timely information, family news and regular updates on activities of family members and other close persons, detecting particular states of the cared-for person will help to tailor information and improve inclusiveness of the system.

Opposed to standard approaches in which "states of interest" are often defined by the technology developers or external scientific experts, in AGNES we will define those states – as well as activities – together with the target group, i.e. the persons cared for, the caring family members, and, where appropriate, associated professional carers. Those states and activities will be found by interviews at the beginning of the project and validated and updated throughout the project by e.g. watching episodes of video recordings and talking to the people.

AGNES will use, enhance and investigate several technologies to realize these diverse and omni-prominent states of the elderly as well as activities. Those technologies are:

- Person position/motion detection and tracking
- Detection of gestures, body movement characteristics, and posture
- Face detection and facial expression analysis
- Interaction and activity interpretation

Those state detection technologies partly try to detect similar states in the user basing on different physical, logistical and temporal foundations. Main sensory information source will be cameras and motion sensors. Vision based algorithms will be used to discover specific trajectories in the course of the day (daily activities), body posture, gait, and gestures. As auxiliary information source we will analyse facial features where possible. Dedicated cameras will be used at selected locations, for instance on top of a digital message board. Particularly when using the technology we can assume the user facing the device as well as potentially being in need of assistance. Close-up facial feature information will be a valuable information source in this situation.

Motion sensors which are included in the mobile phones we will use as mobile interaction devices will be used to identify movement patterns (related to gait), enhance the visual motion based algorithms, and provide additional information for motion-based services such as calorie counter and therapeutic exercise assistance. The results of the different technologies will be fused into one view using sensor fusion techniques.

Since interactions with other persons in the home or via the network as well as regular independent activities in the home are the central goal of this project, interaction and activity patterns will be used as a further information source on the user to adjust the different components to optimize their mutual efforts. This novel user-centric approach will give new insights in interaction patterns of elderly and how they can be positively influenced by use of ICT.

We will develop a person-detection and -tracking system that will use only mass-market devices like low-end, commodity webcams and mobile phones with integrated motion sensors. While the state of the art of motion detection with sensors relies on multiple dedicated motion sensors which need to be carried by the user, we will develop methods to infer a person's activities using just a single motion sensor which might be integrated in e.g. a mobile phone. The resulting system will be very robust using two independent methodologies i.e. cameras and motion sensors. Using the same equipment we will investigate how specific hand, arm and head gestures, body movement characteristics like gait, and postures correspond with the chosen user states, and exploit those results.

2.3.2 Social Network

A novel feature of our approach to managing the chronic conditions of cognitive impairment is how we engage the elderly person and mobilize their social and support network to provide emotional, informational and practical support. The problem in a nutshell is that elderly tend to live alone but should live embedded in a caring personal network - this is the most effective way to ensure successful ageing (not just longevity, but a good quality of life in the face of high probability of chronic physical and cognitive impairment). Elderly people also often suffer from reduced sensoric performance (hearing, seeing or walking capabilities etc.) which can in part be compensated by modern technologies.

The collected data on the elderly's activities and states will be analysed in the home of the person (see figure 1). Analysis results only will be relayed to the network server and stored in a database. An extensive set of rules and unique algorithms will be used to determine if the person is in need of help, information, social contact or other kind of assistance. If personal intervention is assessed to be suitable, appropriate qualitative relationships within the network will be computed taking into account the states and activities of affiliated network members and relevant information will be communicated to them. Thus, based on the activities and well-being of the elderly, the network might inform other network members, provide information, or suggest physical or social activities to the elderly. AGNES here also supports the needs of the helpers, providing tools and infrastructure to retain the connectedness of elderly people to the individual community.

The network offers a two-way communication between the elderly and the caring persons. So the elderly can receive information from e.g. family members as well as get in touch with them on her own and, for instance, tell a story, ask a question, or just notify on current activities or plans (going out, having a nap). With this pro-active approach users at both sides of the network will see the system not as a "big brother" -like threat but as tool that helps to keep in touch as desired.

2.3.3 Ambient Interaction and Devices

The elderly person will be connected to others through the social networking technology. This connection works in two ways: information such as messages or stories from family members and others will reach the elderly in an ambient form (speech, visual cues) via display devices, and the responses, states and activity reports of the elderly person will travel back. As ambient devices for display and interaction, we will use the latest in European technology on the market (for example, Nabaztag from Violet) as well as specifically designed small prototypes that, like Nabaztag, are simple to use and potentially cheap to construct.

We will also make use of sensor-equipped mobile phones as additional front-end to the network. Depending on the elderly's preferences it could simply display notifications of new messages and information on the preferred display, show reminders, news or social updates directly on its display, but also offer specific assistance, e.g. in form of activity-based applications (mileage/calorie counter) or outside GPS location and orientation assistance. A side effect that we aspire to with this application is that the elderly will want to carry the mobile phone with them due to its appreciated added value. The exemplary mobile application will be developed based on opinions, wishes and concerns of the involved users to guarantee a high level of acceptance in the target group.

2.4 Users

AGNES addresses the needs of primary and secondary end-users while keeping the focus on the elderly as primary user. They will use the system actively by assessing information, sending messages or requesting services. The elderly at home will also be a passive user with the system serving them gently by e.g. displaying suitable information or establishing communication with connected persons.

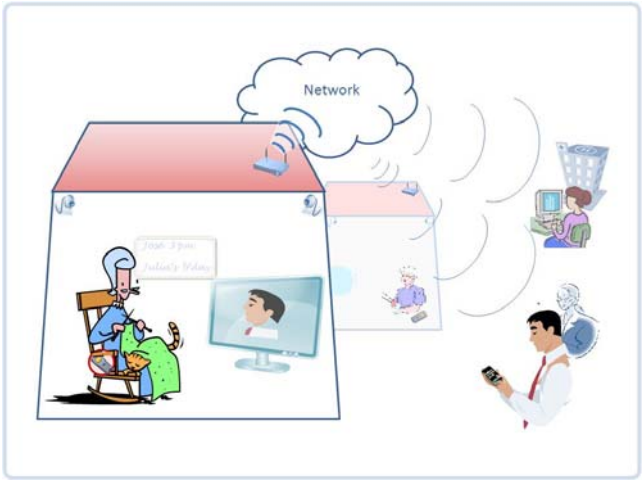

Figure 2. User Integration in AGNES

Secondary users are people caring for the elderly such as family members or close friends. They can actively connect to the network and access information on the elderly's well-being and activities (if approved by the elderly) to get a picture on the cared-for's state. They also get informed from the system if urgent action is recommended and possible for that person. Thanks to this information caring persons can better schedule their usually busy days, getting in touch when needed or wanted or attend to other activities. Secondary users in AGNES are represented by three care organisations from Greece, Spain and Sweden.

3. CONCLUSIONS

Cognitive impairment in the elderly is a widespread and chronic problem throughout Europe. It compromises the capacity of older persons to live independently in their own home, as well as increase the burden placed on formal and informal carers. Preventing or alleviating the negative impact of cognitive impairments such as mild dementia, by reducing these negative consequences, could also have a major effect on cost effectiveness of care organizations – thus easing the pressure of increasing costs in European social and healthcare systems. Increased self-management and independence will also allow more effective use of limited resources and especially that of an increasingly scarce workforce. The situation of the older person living at home will become more sustainable, through the deployment of the ICT-based solution we will develop, as well as opening up new business opportunities.

4. REFERENCES

[1] AAL-Europe Initiative (2009). Web site of The Ambient Assisted Living (AAL) Joint Programme . http://www.aal-europe.eu/ , retrieved 24 Feb 2009.

[2] American Psychological Association (2006). Exercise Helps Sustain Mental Activity As We Age, May Prevent Dementia-like Illnesses. ScienceDaily. Retrieved July 22, 2008, from http://www.sciencedaily.com/releases/2006/08/060812090614.htm.

[3] Ball K, Berch DB Helmers KF, Jobe JB, Leveck MD Marsiske M, et al., (2002). Effects of cognitive training interventions with older adults – a randomized control trial. JAMA, 288, 2271-2281.

[4] Ballesteros, S., & Reales, J. M. (2004). Intact haptic priming in normal aging and Alzheimer´s disease: Evidence for dissociable memory systems. Neuropsychologia, 44, 1063-1070.

[5] Ballesteros, S., Reales, J. M., & Mayas, J. (2007). Picture priming in aging and dementia. Psicothema, 2, 239-244.

[6] Ballesteros, S., Gonzalez, M., Mayas, J., Reales, J. M., & Garcia, B. (2009). Crossmodal object priming in young and older adults: Multisensory processing in vision, touch, and audition. European Journal of Cognitive Psychology, 21.

[7] Baltes, P. B., & Lindenberger, U. (1997). Emergence of a powerful connection between sensory and cognitive functions across the adult lifespan: A new window to the study of cognitive ageing? Psychology and Ageing, 12, 12-21.

[8] Barclay, L. (2007). Loneliness increases risk for AD-like dementia. Archives General Psychiatry, 64, 234-240.

[9] Cacioppo, J.T., Hughes, M. E., Waite, L.J. Hawkley, L.C., Thisted, R.A. (2006). Loneliness as a specific risk factor for depressive symptoms: Cross-sectional and longitudinal analyses. Psychology and Aging, 21, 140-141.

[10] Fiske, A., & Jones, R. S. (2005). Depression. Cognitive changes across lifespan. In M. L. Johnson (Ed.), The Cambridge handbook of age and aging (pp. 245-251). Cambridge University Press: Cambridge, UK.

[11] Fratiglioni, L., Wang, H.K., Mayan, M., & Winblad, B. (2000). Influence of social network on occurrence of dementia: A community-based longitudinal study. The Lancet, 355, 1315-1319.

[12] Park, D. C., & Gutchess, A. H. (2004). Long-term memory and aging. In R. Cabeza, L. Nyberg, & D. C. Park (Eds), Cognitive neuroscience of aging: Linking cognitive and cerebral aging (pp. 218-245). New York: Oxford Press.

[13] Park, D. C., Gutchess, A. H., Meade, M. L., & Stine-Morrow, E. A. L. (2007). Improving cognitive function in older adults: Nontraditional approaches. Journal of Gerontology, 62B, 45-52.

[14] Park, DC; Minear, M. (2004). Cognitive Aging: New directions for old theories. In Dixon, R. A., Backman, L., & Nilsson, L. G (Eds.), New Frontiers in Cognitive Aging. New York: Oxford University Press.

[15] Park, D. C., Davidson, L., Lautenschlager, G., Smith, A. D., Smith, P., & Hedden, T. (2002). Models of visuoespatial and verbal memory across the adult lifespan. Psychology and Ageing, 17, 299-320.

[16] Rabbitt, P. (2005). Cognitive changes across lifespan. In M. L. Johnson (Ed.), The Cambridge handbook of age and aging (pp. 190-199). Cambridge University Press: Cambridge, UK.

[17] Reblin M., Uchino B.N. (2008). Social and emotional support and its implication for health. Curr Opin Psychiatry. 2008 (2), pp 201-5. NCBI, ISSN 0951-7367

[18] Reuter-Lorenz, P. A., & Lustig, C. (2005). Brain aging: Reorganizing discoveries about the aging mind. Current Opinions in Neurobiology, 15, 245-251.

[19] Salthause, T. A. (1996). The processing-speed theory of adult age differences in cognition. Psychological Review, 103, 403-428.

[20] Seeman, T.E. (1996). Social ties and health: The benefits of social integration. Annals of Epidemiology, 6, 442-451.