User-sensitive Home-based Systems for Successful Ageing

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Abstract — **The AGNES project focuses on improving the mental and physical wellbeing of elderly people living alone at home, who often suffer the effects of social and physical isolation - including cognitive decline, low activity levels and poor mood states. AGNES will carry out novel technological interventions in an area that is emerging as the new frontier in ageing research. 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. This paper presents a short description of AGNES as a project in progress.**

***Keywords* — ageing, ambient, cognitive impairment, dementia, home-based, mental processes, quality of life, social isolation, user-sensitive.**

I. Introduction

THE main aim of AGNES is to prevent, delay and help manage common chronic conditions, such as mild cognitive impairment and dementia, to improve and maintain the well-being and independence of elderly people wishing to continue living in their own homes, as well as reduce healthcare costs. To achieve this, advanced but increasingly affordable home-based technologies will be integrated in new user friendly ways, connecting the elderly person with family, friends and carers. By detecting subjective states and activities of the elderly person, better-tailored and timely attention and care will be provided. Feelings of loneliness and insecurity will also be reduced.

AGNES is a new project, started in Spring 2009, which will develop systems and devices that can be turned into products two years after project completion in 2012, using a modular approach building on a basic social networking system. All implementations will be specifically designed for the target user populations, and extensively tested for practical, social and psychological impact and effectiveness in real users' home situations.

The project brings together 10 partners from six European countries, including two SMEs, a research institution, three universities, a consumer electronics company, and end-user organizations in Greece, Spain and Sweden. AGNES will be coordinated by researchers at the Department of Informatics, Umeå University. The overall proposed cost of AGNES is around 3,8 million euro, of which almost 2,5 million euro will come from the AAL program, jointly funded by the EU and national funding agencies in each participating country.

Financial support for AGNES is provided by the Ambient Assisted Living (AAL) Joint Programme, a new joint research and development (R&D) funding activity implemented by 20 European Member States and 3 Associated States with the financial support of the European Community based on article 169 of the EC treaty..

II. Slowing Cognitive Decline

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 elderly care into everyday living environments can contribute significantly to supporting the elderly and their carers and is to become a major priority over the next decade. Our proposed approach to keeping the elderly mentally and socially stimulated and in contact with others by combining state detection and social network technologies would constitute a significant breakthrough in the innovative application of technology to cognitive, social and personal needs of increasingly larger groups of such people in present and future societies across Europe.

AGNES is strongly motivated by recent research showing strong relationships between levels of social integration and mental stimulation and the maintenance of cognitive functioning and psychological wellbeing. 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

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and under-stimulated due to increased mobility and consequential geographic distance of family members and friends, as confirmed by recent surveys. Isolation breeds loneliness, which in turn results in cognitive and physical decline [1], compromising the older person's capacity for continued independent living. 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 person's state and well-being and evoking appropriate responses. Lack of social participation increases the risk of Alzheimer´s (AD) disease-like dementia [2], and loneliness resulting from social isolation is a serious risk factor for depression among home-dwelling older adults [3]. According to Cacciopo et al. [4], loneliness is characterized by: a) isolation (distant from relatives and friends; b) feelings of being disconnected (not having close friends); and c) feelings of not belonging (not identifying with or not feeling accepted by valued social groups). The main aim of AGNES is precisely to provide for the support older people need to overcome or avoid chronic loneliness and so achieve a better quality of life.

Monitoring physical activity is another important facet of our holistic approach. As there is also evidence that physical activity may help people maintain their cognitive abilities, AGNES' monitoring and scheduling options allow use of human activity. As a side effect, activity monitoring combined with a daily calorie overview among other things will help people to maintain a healthier lifestyle. Summarized Benefits of AGNES

III. Approach

AGNES will provide a user-sensitive home environment based on information and communication technologies (ICT), 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. Central to the proposed idea is the combination and integration of home-based ICT and social networks, connecting the elderly person living at home with their families, friends and carers, on various levels. The project will provide the technological means to exploit the power of social networks and the beneficial effect of social inclusion and activities on cognitive and mental processes. Detecting 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, at the same time reducing feelings of loneliness and insecurity. The aim is to prevent, delay and help manage chronic conditions such as mild cognitive impairment and dementia (and potentially pathological social isolation), by gentle, consistent social and cognitive 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 reduce healthcare costs.

The technological core of the system is an ICT platform to (manually and semi-automatically) create and maintain an easy-to-use web-based social network for individual 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 social network of that person and stimulate the elderly. The in-home system will be enhanced with technology to assess the subjective and objective states of the elderly person along carefully selected parameters. Timely information will be passed to the network on the activities and subjective state of the elderly person (e.g. presence, state of wellness, etc.). See Figure 1.

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, reminders of things "to do", notification of present and future location of close persons, etc.). To support these functions, easy-to-use ambient devices will be designed and tested, as a means of for information visualization and 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.

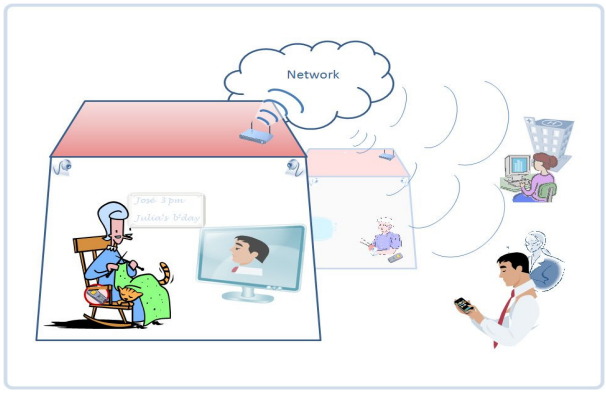

Fig. 1. The basic AGNES setup

The project will address chronic conditions such as mild cognitive impairment, and develop and test solutions to alleviate and/or prevent them. 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. Formal carers looking after elderly people in their homes will be assisted to manage their workload and better understand the needs of the elderly person, thus also providing improved communication and services. Informal carers, friends and family members will have greater access to information about the person, and those at a distance will be enabled to keep in touch and share activities with their elderly family member or friend, and to know their current condition. Social organizations and authorities will reduce costs and improve services.

The technological solutions will respond sensitively and adaptively to the states and characteristics of the individual

user. All interaction approaches and devices will be designed and tested (including psychological and sociological impact) by means of a strictly user-centred methodology, with intensive user involvement at all stages of the project.

AGNES technologies and services fall in the broader area of Ambient Assisted Living (AAL) and have a strong potential for significant technological and societal impact, as a result of the phenomena of falling birth rates (in an overall declining European population) and rising longevity. AAL services also constitute a growing market for vendors, service providers, integrators and application developers. A key technological challenge in this market is the need for universally designed products and services, which address the needs of broad ageing groups and can thus achieve high market penetration. At the same time highly populated ageing groups have particular needs that can only be addressed by specialized technological developments.

IV. Technological Advances

The project goes well beyond the state of the art in integrating diverse technologies and products into new innovative solutions, all in the service of helping to prevent and manage chronic conditions such as mild cognitive impairment and dementia in the elderly person still living in their own home. A growing body of evidence emphasizes the potential of new interactive technologies to maintain health and independent living, and even improve some cognitive functions in the elderly. 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.

A. *Integration of existing technology*

Although existing examples of most of the technologies to be used in the project can already be found, they have yet to be combined in a usable and affordable way, aimed directly at the needs of the elderly person living alone with, or at risk of, some degree of cognitive impairment - as will be done in this project. We see maintaining and supporting social integration as a necessary part of dealing with the chronic conditions of older people in a realistically sustainable and humane way, not as a separate issue, just as important as the function of detecting states and activities. Health, independence, dignified life and social contacts cannot be meaningfully separated.

The project takes an holistic approach, through which several different technologies and devices will be integrated to provide solutions aimed at the needs of the individual elderly person, as well as secondary users such as formal and informal carers (including family members and friends). These include:

- Innovative technologies for the unobtrusive detection of user states and activities, based on inexpensive mass-market components such as web-cams and mobile phones.
- A social networking technology platform specifically designed to meet the needs of, and be usable by, the elderly person, and providing the communications channel through which people and applications will communicate.
- Ambient devices for the display of information and events and for easy interaction with the home-based system and connected others.
- Diverse applications specifically aimed at the needs of the older person, to help deal with, or even prevent, the mild cognitive impairment that tends to be a chronic and worsening feature of this user population.
- Features that also support the needs of carers, both formal and informal, for information about the older person, their activities and current state.

V. The Human and the System

The target group of the project cannot be considered willing or even able to actively explore the functional possibilities of the system. Further, elder people tend to carry a certain skepticism about technologies new to them which they think they could do well without so far and often don't see the need to afford the cognitive work to familiarize themselves with such. Intense user involvement from the early beginning and throughout all phases of the project are hence crucial for the acceptance of the developed system and therefore for the success of the project.

A. *User involvement as central element*

The inclusion of a partner with deep expertise in the psychology of ageing, as well as with special knowledge in the area of maintaining cognitive functions, will ensure the validity of our approach to meeting the needs of our user group. Organizations focused on care will maintain the involvement and cooperation of actual users, and help ensure the relevance of the work for current and future care practices. Commercial and technical partners have competencies that complement each other in adapting, developing, and integrating these diverse elements.

The end users will be involved in all stages of the project, from requirements specification to the design process, and on to taking part in testing and evaluating implemented components and the developed prototype systems. Field evaluations of technical performance and user experiences will involve tests with end-users in their homes. In addition, social impact and psychological effects on the older person will be specifically assessed.

The evaluation of the developed systems will provide a wealth of new knowledge, centrally including the effects on the older people themselves, on their own wellbeing and their social relations with close relatives. This intensive and extensive approach to end user involvement is unusual, and will ensure that the technology that is developed is a good fit with the actual needs of the users. As we have partners in north, south and central Europe, we will even be able to ensure that our solutions are applicable throughout the region.

B. *Enabling a self-managed life*

The project will apply ICT in innovative ways to support a personalized and person-centric care process, emphasizing the role of the home as the care environment in which chronic conditions are largely self-managed. The aim is to allow the elderly person to retain their independence in the home by supporting their daily activities and maintaining their social relations, while also supporting the roles of both informal and formal carers. Tracking of physical activities will also assist the elderly and the carers to plan and perform exercises. Further, based on the observed physical activity of the elderly, the system might help the person to keep an appropriate diet. As well as bringing an improved standard of health and subjective wellbeing in old age, this will result in economic benefits for healthcare providers, families and older people themselves. As is well recognized, long-term care in institutions is a poor solution to extended longevity from many perspectives, not least economic. The systems developed in AGNES will contribute to increased personal independence, and prolonging active participation in society for the ageing population.

To protect privacy, no video data will be sent over the network or stored outside the patient's home. Data will be analysed and features extracted locally and only the feature parameters will be sent to the server. Additionally, data transmission of activity and user state data will be encrypted. In all cases, the elderly will decide who of their network will be provided with which information.

C. *Impact on care and the individual*

We believe that the integrated solution we will develop will have a significant impact not only on the individual level, but also on care organizations and the society as a whole. Assessing the psychological and social impact of the introduced technology is a key element of the project plan. Cognitive impairment in the elderly is a widespread and chronic problem through Europe. It compromises the capacity of the older person to live independently in their own home, as well as increasing the burden placed on formal and informal carers. Preventing or exacerbating the negative impact of mild but common cognitive impairments by reducing these negative consequences may have a major effect on cost effectiveness - 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 these ICT-based solutions, as well as opening up new business opportunities.

D. *A palette of new product possibilities*

The modular approach to applications developments, and the now inexpensive component technologies to be developed and integrated, will lead to a family of products that will be affordable in the short-term future economic circumstances - and also flexible in terms of the level of sophistication of service deployed. The ever-widening spread of broadband internet access, combined with the falling costs of access, components and consumer devices, suggest that our approach will be economically sustainable as new applications are developed in the future.

VI. CONCLUSIONS

AGNES is a new project funded under the Ambient Assisted Living Joint Programme. AGNES is a scientific and technological response to the growing numbers of elderly people living alone in their own homes, but in need of both social and practical support to maintain their daily activities, and their mental and physical wellbeing. The aim is to develop solutions which can be transformed to marketable products within two years after project completion. Intense user involvement will make sure that developed technologies achieve a high acceptability in the target group.

The anticipated benefits include the following:

- More cognitively agile, active and socially engaged elderly people with better mood states, enhanced perceived wellbeing and general health.
- Increase in quality of life for a growing proportion of the European population (more than 30% of people in the EU will be over 65 years old by 2050) (or 23% in 2025).
- Management and prevention of common chronic mental conditions, leading to an increase in sustainability of independent living amongst the elderly.
- Improved quality of service of care service providers due to better planning possibilities, intensified social communication between carers and clients, and better inclusion of the carer in the client's social network.
- Informal carers will have more time for themselves and other family members, increasing their life quality and giving them chance to better care for themselves, reducing future societal costs.
- Cost reduction of health services.

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