Designing Interactions for the Ageing Populations

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Organizers

Sayan Sarcar
Cosmin Munteanu
Jussi Jokinen
Antti Oulasvitra
Neil Charness
Mark Dunlop
Xiangshi Ren

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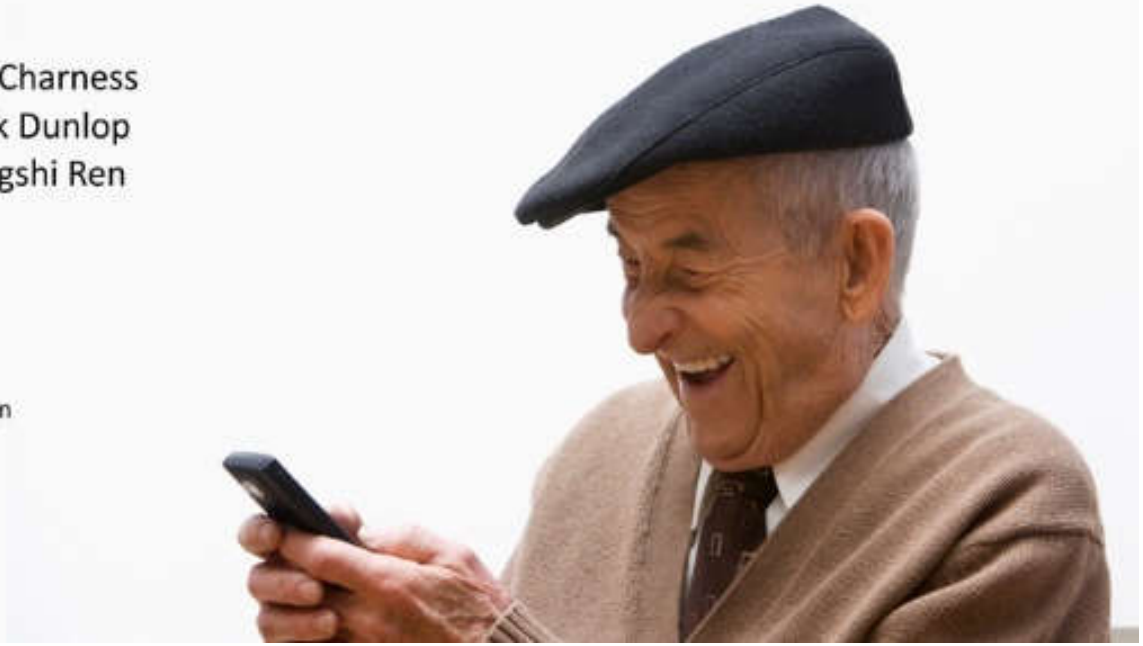

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Towards Personalizable Lights to Support Elderly Autonomy

Fabio Paternò
Carmen Santoro
Marco Manca
CNR-ISTI, HIIS Laboratory
Via G. Moruzzi, 1
56124 Pisa, ITALY
fabio.paterno@isti.cnr.it
carmen.santoro@isti.cnr.it
marco.manca@isti.cnr.it

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Abstract
The objective of our research is to design a platform able to increase elderly autonomy and assist them in carrying out activities of daily living. We aim to support the elderly with useful and usable means to increase their awareness and control of current lifestyle by providing them with relevant and tailored information in an intuitive and natural manner. For this purpose, the intelligent platform is able to monitor their behaviour and support personalized support and control of lights and appliances in their environment. Personalization is obtained through Web-based tools to allow caregivers to specify relevant events and associated actions that generate effects in the elderly home and their devices. We discuss motivations and the approach we propose for reaching such goals.

Author Keywords
Personalization, End-User Development, AAL

ACM Classification Keywords
H.5.2 User Interfaces

Introduction
Depending on the severity of the disease, elderly people require frequent or full-time assistance from other people (e.g. formal/informal caregivers, relatives) for their daily needs and care.

While providing such assistance can be very burdensome for trained professional caregivers, the responsibilities and duties of caring for elderly people can be overwhelming for informal caregivers, who often do not have enough time, resources and medical and psychological knowledge to fulfil their needs. We propose a solution that aims to make elderly more independent and with less need of care. For this purpose, the technological platform aims to provide guidance to elderly in their daily activities, improving their life style by exploiting a number of different devices and modalities, with particular attention to the lighting system. The resulting intelligent environment can be capable of providing proactive solutions anticipating the needs of elderly, regularizing their daily activities, promoting a more active life and improving their navigation and mobility.

Moreover, by using a user-centred approach we also aim to provide caregivers with intuitive tools through which they can easily tailor interactive services to the various needs, requirements and tasks of the elderly they care for. In addition, the existence of an intelligent environment performing residential monitoring of elderly can have a positive impact not only on their own perception of living safely alone but also on their caregivers/relatives. In fact, the possibility to access the remote services to keep them informed at any time about the activities of the elderly can improve the quality of life of caregivers (especially for the informal ones) limiting anxiety/stress, reducing the time/personnel costs and thus indirectly leading to reduced economic burden for all society. Our research aims to provide support by reducing the complexity of the interaction between the proposed solution and the possible users; and incorporating personalization technology to better match the solution with the user's capabilities.

Related Work

The use of lights to support elderly life has been considered in some previous work. The Guidinglight project has considered how to enhance the activity and mobility by supporting a circadian rhythm with specific lighting parameters [5]. However, the solution proposed in that project once deployed in the elderly home was difficult to change in terms of the rules driving the automatic modification of the lights parameters, and such changes required the intervention of specialised technicians, while in our solution such rules can be specified even by people without programming experience.

Morris et al. [6] have proposed a solution to allow individuals to configure the lights in one another's homes as well as their own but they considered and they explored possible scenarios to use them for supporting remote communication without considering the specific aspects that should be considered in order to obtain elderly support. Similar topics were explored by Clark and Dutta [2] who investigated how Internet of Things can be exploited to support subtle ambient and incidental exchanges between people who live in different home, for example using lights synchronised across houses.

A different way to explore light-based support has been investigated in [3], where the authors explore how to use interactive lighting for feedback during gesture interaction, illuminating the space around devices for feedback, for example in the case of gestural interaction with a thermostat.

Possible Problems in Elderly Behaviour

We address various issues in the elderly behaviour.

Temporal Orientation

Human time experience involves several aspects: simultaneity and successiveness, movement time, duration experience, and circadian rhythm. Orientation disorders of the elderly often include difficulty in temporal orientation. They may have problems with rough estimation of the time that elapses since their last activity and with correct chronological classification of time of day, weekdays, and seasons. In particular, circadian rhythm, an endogenously driven roughly 24-hour cycle in humans, is affected by age. Although circadian rhythms are endogenous they are adjusted to the environment by external cues, the primary one being light. For older people, light exposure might be insufficient for maintaining optimal circadian rhythm regulation. We want to help older people to enhance their temporal orientation by using effective personalisation rules that mainly exploit light to induce an improved sense of time.

Spatial orientation

Elderly people may have difficulty with spatial orientation and with questions such as, where am I at the moment? and how can I find a certain location? Elderly people may show spatial disorientation even in familiar places or forget intended destinations, e.g. they can get lost in their own home and are unable to find the bathroom or bedroom. We want to facilitate spatial orientation and help elderly people to find their way, e.g. through different light quality coding of rooms and drawing the attention by saliently illuminating subsequent locations during locomotion. Hence, a further important success criteria for our light wayguidance system is an increased desire for movement and spatial ability of older persons with spatial orientation problems.

Spatio-temporal orientation

Another aspect of orientation is to know what, where and when to perform different activities of daily living. With increasing age and together with some age-related diseases, elderly people have problems to stay orientated to what's going on in their immediate environment. A common example is that elderly people may lose sense of time and locality, and either not remember to eat, or not remember that they have just eaten, and want another meal. We want to help elderly people stay orientated to what is going on or to what they should do at a specific place and time of day, e.g. through directing individual attention in a timely manner (e.g. signalling the best time to go outdoors), by implementing orientation lights to reach the goals on time, and switching on and off other home appliances at scheduled times automatically.

Individuality in orientation

Since humans show great individuality in their daily routines, we need to facilitate orientation very carefully and prudently. In general, there is no uniform everyday structure among elderly people. Even in very limited age groups, a highly individualized organization of the day exists (e.g. flexible time to sleep in and treat themselves with a nice breakfast). Therefore, standardisation of the activities of daily living may lead to restricted self-determination and goes hand in hand with a loss of daily involvement, which can lead to apathy . For this reason, our adaptive assistance platform operates in a highly personalised manner and is implemented by smooth and unobtrusive technological interventions.

The Personalisation Architecture

Our methodology is characterised by strong user-orientation and a modular approach to achieve the highest possible degree of usability and flexibility. The platform is based upon the availability of a network of devices, appliances, and sensors aimed to monitor person's behaviour, and is able to adaptively control the devices in patients' home in order to guide the elderly while performing their daily home activities. We consider devices such as room sensors, wireless body sensors, standalone measurement equipment, electronic home appliances as well as electric installation for lighting, security and communication techniques.

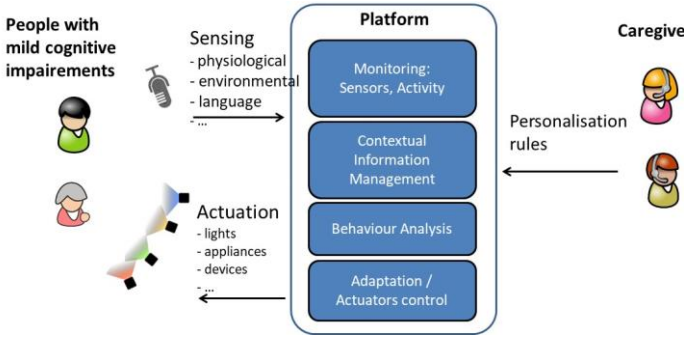

Figure 1: The PETAL Platform

In particular, elderly **monitoring** (Figure 1) is performed by using ubiquitous and unobtrusive **sensing** to capture comprehensive information about what, where and when residents are performing different activities of daily living. Sensing devices that are considered in the residential scenario we address are sensors for movement, occupancy, position, carbon dioxide, light, and temperature; we also consider sensors for detecting use of home appliances, as well as monitoring other relevant sources of information associated with elderly like e.g. body sensors, sensors to gather language and communication-related data and social activity. Resident monitoring will also take into account vital data from non-invasive measuring equipment that are commonly applied by elderly (e.g. pulse, blood pressure and blood sugar). Results from continuous monitoring are used for intelligent control system and to derive certain measured values of patients (e.g. general mobility, dynamics of body movement, communication/language skills). Such sensors and/or external services continuously provide the **Contextual Information Management** module with updated information gathered in the current context of the patient. Such data will be analysed by the **Behaviour Analysis** module in order to derive knowledge about patients that can be helpful for e.g. caregivers to derive suitable actions to do for better structuring the life of their patients. People belonging to the relevant elderly community (e.g. caregivers, family members, physicians), by using suitable authoring tools developed in the project, are able to express relevant **personalisation rules** to configure/specify in an individualised manner the behaviour of the system –in particular manner of the lighting system and of the smart environment surrounding the elderly, to effectively support and increase their wellbeing, based on the elderly's specific conditions/needs. The rules are expressed in a trigger-action format, where triggers can be relevant events and/or conditions occurred in the elderly context. Such personalisation rules represent a main input for the **Adaptation/Actuators control** module which drives accordingly the modification/adaptation of the properties of the living space (e.g. circadian lighting variations, orientation lights, switching on and off home appliances at scheduled time). Sophistically varying chronological

states of the device and appliances in older person's home will help seniors in structuring their daily activities and improving mental orientation in time and space. Caregivers can specify such rules to control the intelligent lighting assistance by means of easy-to-use tools/controls supported by different devices and interaction modalities. The system can also facilitate communication of all involved people in order to support social inclusion of the elderly.

Conclusions and Future Work

The platform that we use in this research is an evolution of the platform for end-user development of internet of things applications presented in [4], which has already started to be used in another ambient-assisted living project (PersonAAL) [2]. In this new research we aim to focus on support for elderly with mild cognitive impairments, and we pay particular attention to the use of lights to stimulate their behaviour. Subjects with mild cognitive impairments show objective deficit in one single (e.g. memory) or multiple cognitive domains, but are not part of a declarative form of dementia. They can have difficulties during complex functional tasks, or have experienced of a cognitive performance decrease, but maintain their independence during the daily life, with a minimum need of aid or assistance. This means that they need support but they also are able to interact with modern devices and appliances.

In the project we have carried out a survey with elderly with MCI and caregivers in order to better identify relevant requirements for our platform. The interviewed sample of caregivers confirms the actual lighting situation in the houses of seniors is mainly limited to normal white light and eventually night light. The majority thinks that night light, automatic light and signal and alerting light should play a more important role in the houses of the elderly than it actually is the case. The same is true for the positive effects that light could have on sleeping quality and on the prevention of falling. They also provided some indications of aspects that need to be carefully considered in order to better design the introduction of lights in the remote support, such as the potential irritation that can be stimulated by blinking lights or the possible difficulties to interpret the light colours if they have specific meanings.

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