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Active aging: a user centred approach for designing a virtual village network architecture

Abstract

Currently many solutions for domotic housing have been created to provide a better autonomous life for older people and to reduce health and care giving costs [3]. Unfortunately, assistive technology is often not accepted by old users. This may be due to the technology-oriented approach adopted in designing such systems, which does not consider enough the users' needs. This paper proposes a procedure to design an AAL(Ambient Assisted Living) system to support active aging based on the User-Centred Design approach. A virtual network architecture integrating different solutions have been designed involving final users from the very beginning of the planning stage. The result is a high usable and flexible platform that allows creating user-friendly products as well as services and realizing also high-level functions by integrating data from completely different contexts.

Keywords — Virtual Village Network; Active aging; Ambient Assisted Living (AAL); User-Centred Design (UCD) Approach.

Introduction

Currently about 20% of the Europe population is aged 65 or over. According to the baseline projection of Eurostat [1], this percentage will almost arrive to more than 29% in the year 2050 and there will be more than 41 million people 80 and over with various needs for care with costs that grow exponentially.

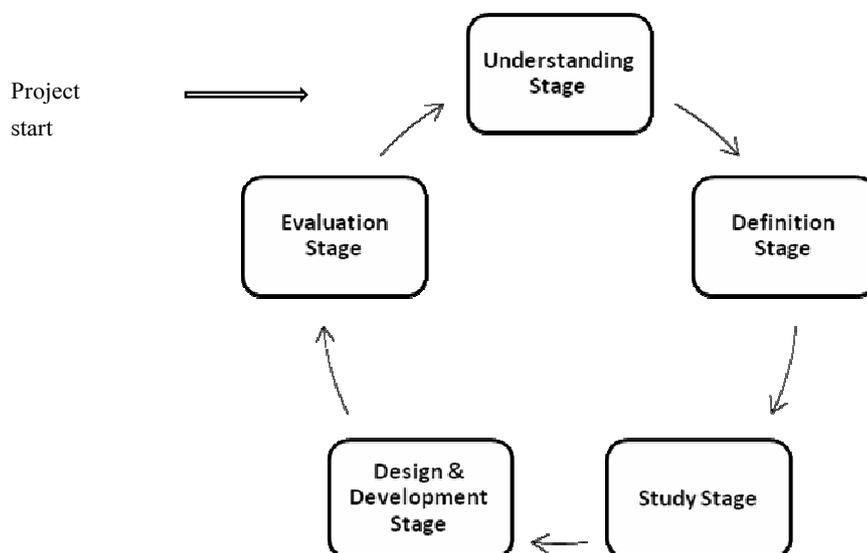


Figure 1.The User Centred Design Approach Stages

In the last years, some attempts have been made to explore the use of ICT based solutions enabling elderly people to live longer at home by monitoring their actions to support an independent living, to increase their autonomy, and to provide care only in case of need. Older people are increasingly at risk of having functional difficulties in areas such as mobility, vision, hearing and in some aspects of cognitive performance: the design of specific ICT based assistive technologies can be of great benefit. But unfortunately, the adoption and application of ICT systems to real elderly home are still limited. The main barriers to their diffusion are represented by low system usability and low acceptance by final users. These issues are directly connected to the system design that

often is highly technology-oriented instead of being user-oriented. Indeed, skilled and healthy people that are not deeply involved and fully aware about how frail people live and think design systems starting from the analysis of available technologies rather than from the users' needs. Studies conducted on elderly people usage of ICT technologies (PC, mobile phones, Internet, etc.), for instance, show how the reluctance of adopting new technologies is not only due to a lack of skills but, also, to the absence of perceived advantages and benefits. Acceptance of ICT is a complex and multifaceted issue. To be effective in use, an ICT system has to be in keeping with the employment the final users will make of it. In recent years, the Human- Computer Interaction community developed methodologies to design systems incrementally: the User-Centred Design (UCD) approaches the users' characteristics are analysed and information to guide the technological development is collected in order to optimize the human-machine interaction [8]. In this paper we describe the design of an assistive ICT-platform to support active aging for elderly and frail people by using a UCD approach. Final users are involved from the very beginning of the planning stage: this procedure helps preventing serious mistakes and forces designers to think in terms of acceptability, utility and usability. Benefits of the user-centred approach are also related to time and cost saving during development, completeness of system functionality, repair effort saving, as well as user satisfaction [6]. This work has been funded by the NINFA (iNtelligent Integrated Network For Aged people) Project with in the Italian National Research Council Project on Aging 2012-20.

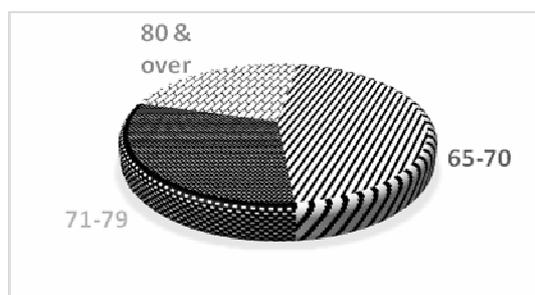


Figure 2. Age distribution of the investigated sample

The user-centred design approach

Within the UCD approach, the whole process is based on empirical knowledge of the user behaviour. First of all, it is necessary to understand who will use the system, why, where, how, and to do what. Then, the system can be designed by iterating the stages shown in figure 1 where each stage is described as follows.

1. **Understanding Stage:** Learning about the users: what can be acceptable and usable for frail people.
2. **Definition Stage:** Defining requirement based on user needs and constraints.
3. **Study Stage:** Search of possible answers to needs and constraints of elderly people and choice of design approaches.
4. **Design Stage:** Design and development of solutions to meet user-driven requirements.
5. **Evaluation Stage:** Evaluation of the results from stage 4 based on the elderly user's feedback.

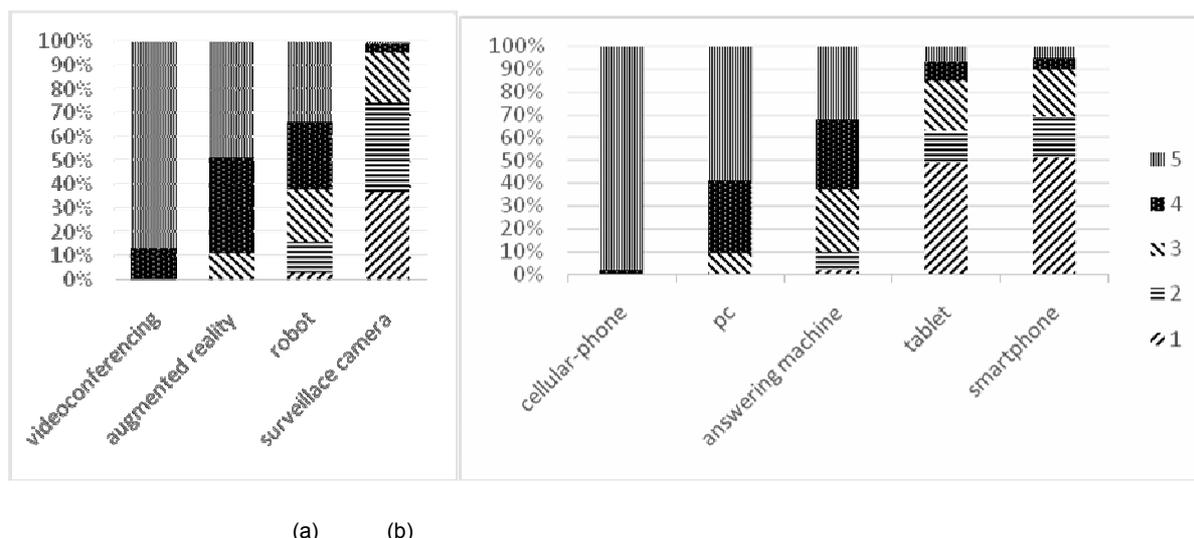


Figure 3. Examples of acceptability rates for some ICT tools/interfaces for AAL resulting from the interviews to elderly people.

Understanding stage

An extensive analysis phase at an early stage of the project can provide a deeper understanding of the target group: their abilities, their limitations and the context of use in which they will interact with the system. While the young generation (under 25 year) are growing up familiar with digital information, older generations today do not

easily embrace new technology [3]. This includes information on the physical as well as on the social environment and allows deducting requirements that serve as a guideline for the whole development process. We used face to face interviews to elderly people living autonomously. We adopted a questionnaire for understanding the user attitude towards technology and their use of ICT tools, for investigating the acceptability of technological issue and for eliciting the requirements of the elderly. We asked for the elderly' acceptance of current services and activities as well as the related problems and worked out possible solutions for the beforehand defined problems as well as future perspectives for the domotic system. Within the NINFA Project a questionnaire has been submitted to 100 volunteer elderly people aging from 65 to 85 years living at home. Age distribution of the investigated sample is shown in figure 2. Questionnaires were completely anonymous and respectful of privacy. After some questions used to evaluate the technological competence of the interviewed, each participant was asked to rate (from 1-low to 5-high) the acceptability of many different ICT tools described verbally or through picture. In figure 3 some results are summarized. In Figure 3(a) we can see that the best accepted interface is the videoconference interface that allows a visual contact with other human people; it is followed by the augmented reality games. While a robot can still be considered as acceptable as tool for assistance, the presence of a camera in each room is often considered too intrusive. This is interesting because most of the remote home ICT services are based on surveillance camera. In figure 3(b) another interesting result suggests that while cellular phone is very popular within elderly people, smartphones and tablets (usually evaluated better tools for young people) are considered more negatively. Probably this is due to the larger complexity of these interfaces.

Definition stage

The ability to live at home is an issue of quality of life. This cannot be measured through simple healthcare or medical parameters, but need more empiric and complex evaluations. To avoid starting from scratch we integrated results from other research projects [3] and collected established design principles for the design for elderly [6]. Since the target group of elderly is very heterogeneous and the technology acceptance depends to large extend on personal experiences of potential users, we organized 15 brains forming groups on eligible users to deepen the knowledge of their real needs, their critical life and health state, their personal resources and their expectations. The brains forming technique provides a free and open environment that encourages everyone to participate.

Problems and needs were mostly focused on:

- Fear of loneliness, need of human relationship.
- Fear of losing autonomy.
- Need of non-invasive care giving support.
- Need of filling spurred on being active.
- Need of retrieving a social role.

Finally, we evaluated the quantitative and qualitative data and derived requirements to make them applicable, traceable and testable. Some interesting out come are the following:

- System should be in similar infrastructures with existing home devices, which users are familiar with.
- The interaction with the system should be integrated into user's daily activity.
- Only essential information should be communicated.
- The attachments on users, for instance, measuring electrodes, should be minimized.
- The system's interface should neither be boring for users, nor should it be viewed as a handicap or as prosthesis, but as a helpful companion.
- The automation of the house shouldn't risk to take away the few social contacts user still have with human being.
- The new ICT tool should not increase the loneliness. Solitude is one of the worst enemies for old people.

Study stage

The ICT System should be oriented to improve the quality of life of elderly people at home. It has to be characterized by different levels of intervention that vary and adapt to the improving situation of the elderly person. Its final goal is facilitating an independent and not isolated, social life, inside one's home as long as possible. Contextually the system is supposed to facilitate the job of caregivers allowing the communication with the elders and supplying the attendance with a smaller workload and smaller assistance costs. As "Facilitate direct social contacts – Virtual contacts cannot replace direct social contacts." was found to be one central requirement a scenario along the friendship enrichment program should be selected. The friendship enrichment sessions aim at preventing people from getting lonely by improving existing friendships and developing new ones. The new system architecture is inspired by social life organization in the old Italian village. In the past, within these villages, a physical social network of personal relationships allowed even lonely old people to be integrated in the area where they were living. They could live and take advantage of different kindness and communications from familiar and friend environment. If an old peasant had some problem, the village community could noticed it (i.e. because he did not go to chat at dusk on the door step) and could check for the causes giving an indirect surveillance. This ICT approach allows the monitoring and the automatic objective evaluation of the wellness status [1], with a minimum impact on the user. Specification of the proposed system can be resumed as follows:

- Equipment for the elderly people's houses are planned as modular, organic and adaptive sets and not as a set of independently designed devices assembled later.
- The system is "elastic", i.e. it can adapt both to the growing critical life and health states of the subject living at home and to modifications of environmental conditions
- the technological interface must be user friendly, safe, looking familiar, but not boring, in order to avoid the risk that the elderly person turns off the device.
- The interfaces should be kept as simple as possible.
- The ICT system should respect privacy, and it should be psychologically acceptable (it should not mirror a devaluating image of old person) and should be perceived more as a multi-user "game" than as an aid kit.
- the system is trustworthy and 'secure' according to availability, safety, privacy, integrity and authentication.

Design& development stage

These requirements are then implemented in the Virtual Village Network Architecture (VVN) connecting groups of elder users, as "virtual neighbours", to allow the access to AAL solutions at home.

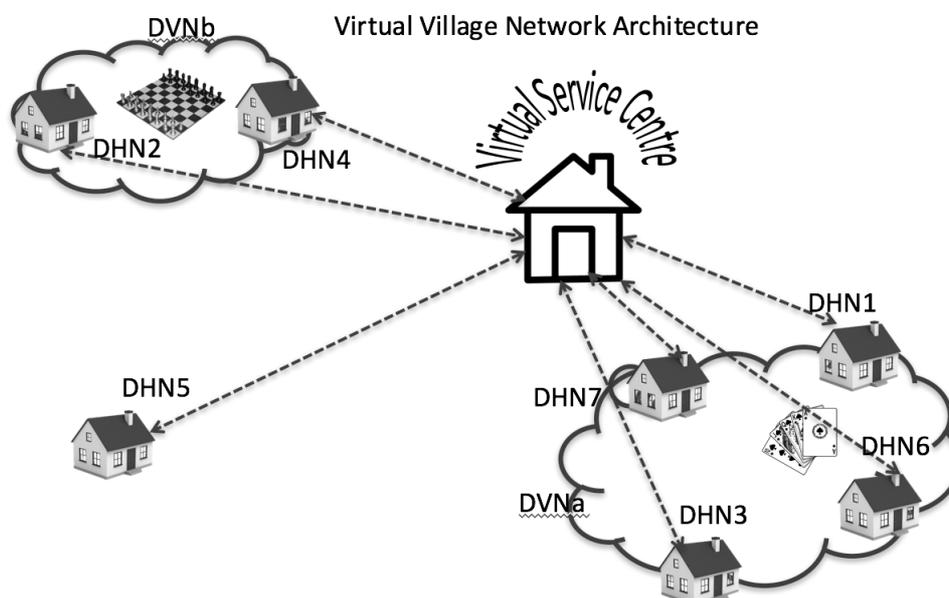


Figure 4. The Virtual Village Network Architecture. DHN: Domotic Health Network, DVN Dynamical Virtual Network .

In this framework the NINFA Architecture aims to promote the maintenance of health, physical and cognitive capabilities and the identification of new architectures and instruments to improve the elderly's autonomy in the home environment, their quality of life and the prevention of critical events. The Virtual Village Network Architecture (VVN) is a network structure organized on 3 levels:

- Domotic Health Network (DHN), a domotic network that delivers specific "at home" services (e.g. as motor/cognitive rehabilitation exercises, social networking , gaming, remote assistance, critical life events prevention, conferencing);
- Virtual Service Centre (VSC) that, through a proper home interface, can carry out the support, monitoring, prevention and social facilitation.
- Dynamical Village Network, (DVN) a network of "virtual neighbours" with a series of relationships able to have a positive influence on the interactive abilities and self-image of the elderly, and to prevent or overcome solitude and isolation, and the effects of these on the elderly person's overall quality of life and health.

This architecture meets user driven requirements under many point of view:

- Services provide technology to meet a 'need', but users (and their caregivers) will most readily use technology that is desirable because it enhances their social status as well as enables them to do things or lets them feel better. Because the design for elder people at home has to be based on real needs, not an assumption of needs, much research in this field is currently aimed at exploring acceptance.
- Adaptability: The system will be adaptable: for instance, as soon as the independence and the mobility of the old user diminish, new sensors will be automatically selected and added to the network.

- Acceptability. Great attention will be put in the architecture and in the implementation choices so that the user
 - maintains /augments his/her social contacts
 - can live this system as help and not as a prosthesis
 - is solicited to the social participation
- Security and safety: The sensitivity of data, together with the need of sharing information internally and externally, is going to dramatically increase due to the advent of citizen-focused care. Keeping the integrity of data in multi-user environments as well as ensuring accountability of actions are essential for citizen safety guarantee.
- Intelligent sensor selection: AI, neural networks etc. techniques will be used to extract information from sensors to help the caregivers
- Communication facility: The village network shall help reducing the feelings of loneliness. It shall allow the elderly to practice their mind and overall allows a reciprocal control that is similar to that that happened in the villages in the past centuries.
- Personalized e-services: Global access to information on personalized care raises problems in terms of overflow of data. The new paradigm of e-services requires dynamic creation of user profiles and metadata definitions with the capacity to relate the social and long-term care with personal preferences and needs that need to be packaged into new services [3].As an example, all communication could go through a TV set and a remote controller.
- The activation actions and the service modes should be investigated together with the user: i.e. some "Open university" type of courses can be launched. Each user become active in participating to classes, but also in conducting them on topics where he/she is expert. This will spur elderly people to be active and to create new relationship.

Evaluation stage

Early evaluations are important steps in the UCD to enable potential users to experience the system at an early stage of the project. Due to the complexity of the system, for the first cycle, we created the functional architecture scenario described above. This was useful to enable potential users to understand the concepts and to give valuable user feedback. The feedback analysis has been conducted with one-on-one usability test sessions and we used feedbacks to tune the characteristics of each service. Valuable feedback from them led to improvements of the first version of the system architecture and gave input for the further development of the system.

Conclusion

In this paper the design process of an ICT architecture for remote assistance of elderly people by using a User Centred Design Approach has been described. The results of the first iteration process in one year project gave already very interesting results. The UCD approach forced the designing team to stay focused on the users' needs and constraints throughout the whole development process. The result is a high acceptable and flexible platform architecture that allows creating user-friendly products as well as useful services and realizing also high-level functions by integrating data from completely different contexts. User experience and user acceptance studies at the end of each iteration circle ensured that the development team was still "on track" concerning the users' needs and mental models.

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