International Support of a Common Awareness and Knowledge Platform for Studying and Enabling Independent Living

UGDIST (Eds.)

Deliverable 4.22
M9

Software and Interfaces Including Assessment of Existing Technologies from US, Japan and EU WIKI Activities

Version	Edited by	Changes
V.01	UGDIST	FirstDraft

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INTRODUCTION

Up to now a very huge amount of commercial solutions are simple devices for simplifying daily life activity, such as pill organizers, walker accessories or personal care facilities.
Even if simple, these accessories allow the elder to preserve the independence in daily life activity, just where there are no strong motor impairments or cognitive diseases. In these cases, even if the disease is not in an advanced stadium, the general approach is different and more related to human assistance, at home or in a specific residence, for monitoring the disease or supply to the impairment; in both cases this means a sensible reduction of independence.
For this reason it is important to study solutions that, for example:

- allow automatic monitoring of cognitive degeneration,
- support training activities (e.g. motoric exercises),
- give automatic hints or reminds (for medicines or diet) and
- are able to evaluate the effect of the therapy.

The main requirements for these instruments are related to non-invasive intrusion in domestic context and their usability. For this purpose we introduced a new Capsil in the Wiki, the *User Centered Design for Independent Living* theme, that aims to identify requirements and needs of the technologies for supporting elder, including aspects as acceptance of technology, learning and usability. A particular area, in this context, is covered by the study on Robotic Systems for helping impaired people at home. Since also this aspect is very important a dedicated section, *Robots for the Aged Society*, in the Wiki has been added and here reported.

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USER CENTERED DESIGN FOR INDEPENDENT LIVING (UGDIST)

As indicated by C. Magnusson in “Enaction and Enactive Interfaces: a Handbook of Terms”, User Centered Design can be defined as “an approach to guarantee the usability of interactive systems, by actively involving the end-user”. This means that the main focus in User Centered Design is on interaction and on end-users’ needs and skills. In the case of Ambient Assisted Living (AAL), systems should be designed for different classes of end-users having different needs and skills. Such different classes include:

Elders or impaired people, needing e.g., for support for therapy, support in daily activities, self-monitoring, systems helping them in overcoming specific impairments, flexible systems adapting to user’s functional limitations; it is particularly important that systems can be transparent to the user;

Caregivers, needing e.g., systems for daily monitoring of physiological signals, including alarms in case of possible dangers;

Clinicians, needing e.g., systems for periodical monitoring of specific medical data supporting evaluation of advancement of the pathological conditions and response to therapy; filtering of large amounts of data in order to focus attention on relevant aspects;

These requirements can be satisfied by a system whose interfaces adapt to the different kind of end-users. In Human Computer Interaction HCI the user interface is the part of the program that is directly in contact with humans, i.e., it is the part of the application which is most responsible of usability and interaction. The design of the interfaces plays a key role in the access to technology and in its comprehension. In AAL interfaces have to be particularly simple, adaptable, intuitive as defined by Baerentsen: “An intuitive interface may be defined as an interface, which is immediately understandable to all users, without the need neither for special knowledge by the user not the initiation of special educational measures”. To this aim, interfaces can exploit several communication channels and human mechanisms of non-verbal communication. In other words, AAL systems need adaptable and intuitive multimodal interfaces.

Usability in AAL has a crucial role and for the seniors it is strongly related to their functional limitations. The experience of interaction with a computer can be compromised, for example, by reduced cognitive and /or motoric capabilities as a consequence of diseases affecting elder people. On the one hand, a bad design of an application can hurt the elder user until to inducting computer anxiety, rejection of the technology, perception of isolation with respect to the society, and depression. On the other hand, a good design of the interface can encourage the elder in technology usage highlighting the benefices as to improve mental and physical wellbeing and to enhance the social connection and consciousness. Furthermore, a good design can also compensate some of the functional limitations, for example by means of multimodal interaction i.e., analyzing the multimodal communication of humans (e.g voice and gestures) and producing multimodal feedback (e.g. acoustic and visual).

Issue

There are many aspects to consider in the design of an interface for independent living, from limitations in cognitive, motoric and audio-visual abilities of elder people, to the interaction with different categories of subjects (seniors, clinicians and so on). In particular a user centered interface for AAL needs:

- novel multimodal interfaces and novel behavior descriptors to monitor more carefully elder patients;
- novel approaches for rehabilitation exercises based on « aesthetical resonance » paradigms. The aim is to develop interactive therapeutic exercises based on multimodal interaction and interactive multimedia (audiovisual) stimulation in real-time;
- a better support, especially for clinicians, by automated quantitative and qualitative measures of the evolution over time of the therapy and/or the performance of motor tasks;
- novel paradigms of interaction that allow to simplify the interaction with home systems and devices and/or to support social interaction, e.g., with new possibilities to exchange experiences or enjoy the time (see for details the Wiki entry Social_Connectedness).

Functional limitations

The design of interfaces for elder users should consider the well known limitations of motoric response and the sensory-perceptual process. For example, a correct design of the position and size of icons can improve performance in the reaching problem, a common problem also for children. There are a number of studies on this topic, here we report just an overview on some functional limitations. It is important to highlight that at the time being elders have not the same expertise in using technologies than younger people, and that in some cases they do not have any experience at all. Functional limitations that need to be taken into account in designing interfaces include:

1. Visual ability. Excluding singular ocular pathology, elder people shows a reduction of dynamic visual acuity, a reduction in the range of visual accommodation and, finally, reduction in colour sensitivity. Usually, there is a loss of contrast sensitivity and dark adaptation.

2. Auditory ability. In subject over 60 there is a decline in auditory acuity, i.e. in the sensitivity for pure tones and high frequency tones. There are problems in localizing sound and binocular hearing.
3. Motoric impairments. Limitations in motoric skills include:
    a. slower response;
    b. reduction in ability to maintain continuous movement;
    c. reduction in coordination and in balance (usually, this is a consequence of the before-mentioned limitations) ;
    d. loss of flexibility.
4. Cognitive process decline, e.g. limitation of the attention or difficult in remembering information (for examples see the Wiki entry Dementia)…

Research

The research effort on centered design for independent living up to now is mainly devoted to create solution for remote monitoring of seniors at home or to allow self monitoring. For a generalized overview on the research activities there is the Institute for Human Centre Design that try to support the community and disseminate results. A good example of software platform that address the requirements of flexibility, adaptability, and multimodality of a system and its interface is the EyesWeb Mobile application developed by InfoMus Lab – DIST - University of Genova.

A parallel approach is related to the design of multi-functional Robotic systems, able to supply daily assistance on health-support and daily life activities (DLA). These Robotic systems are designed to interact with humans using high level information, meaning that such Robots can sense Kansei factors from humans and try to use the same communication channel for communicating with humans.

See the Capsil entry Robotics of the wiki for more details.

EyesWeb XMI Server and EywRAD client

The EyesWeb XMI server exploits the EyesWeb XMI open platform and the EyesWeb Expressive Gesture Processing Library to provide services related to multimodal, including physiological, signals. EyesWeb XMI manages the real-time synchronization of multimodal streams of data having different clocks. The EyesWeb XMI server can thus analyze simultaneously, and in a transparent way for the user, signals from a wide range of devices (e.g., video cameras, microphones, physiological sensors, shock sensors, accelerometers). As a result from such analysis, the EyesWeb XMI server can provide in real time metadata related to embodiment, expressivity, and gesture. The EyesWeb Mobile client is an application for both desktop computers and mobile devices running Windows Mobile operating system. In its current form, it is a user interface for the remote control of EyesWeb applications running on EyesWeb XMI servers. The EyesWeb Mobile client can support the transmission of the sensor inputs available on the mobile device (e.g., webcam, audio input, accelerometers, gps, etc.) and can also exploit EyesWeb services to perform some processing of such data on the mobile device itself (this may reduce the data to be transmitted, with benefit e.g. in battery duration in the mobile). The EyesWeb Mobile client comes with a design and authoring tool that enables users to draw the user interface for a specific EyesWeb XMI patch. The designer tool enables the design and implementation of user interfaces to control one or more EyesWeb XMI patches, using simple commands and widgets, and to have a simple visualization of complex data or video streams. Using these technologies it is possible to access to an unique application in different way (i.e. using Palm or monitor or mobile phones) and/or looking to different data set In this way for example a clinician can check all the medical parameters and the subject can access to just to the subset he/she can understood.

Adaptive Environments

Adaptive Environments, Institute for Human Centre Design, is an international non-profit organization, based in Boston. Its activities are mainly devoted to promote design that works for everyone across the spectrum of ability and age and to enhance human experience. Adaptive Environments provides easy access to information and guidance about the civil rights laws and codes that provide a bedrock of accessibility in the US. Adaptive Environments provides education and consultation about strategies, precedents and best practices that go beyond legal requirements to design places, things, communication and policy that integrate solutions to the reality of human diversity.

Commercial

The few commercial solutions find are more oriented to the health monitoring or home care. Examples are:

http://www.instantatlas.com/health.xhtml commercial platform for monitoring and reporting of general health data. It is a general platform that works on statistical data and maps, not only indoor.

http://www.microsystems.it/index.php/ita/Azienda/Divisioni/Webcare Italian commercial solution for home care. It uses a core station receiving the physiological data, a jacket with ECG sensors a blood pressure measurement wireless connected to the core station. There are also possibilities for a mobile core station.

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ROBOTS FOR THE AGED SOCIETY (WASEDA)

The International Organization for Standardization, in ISO 8373, gives the definition of robot as: "an automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications." [1]

There were more than one million robots in operation worldwide in the first half of 2008, with roughly half in Asia, 32% in Europe, 16% in North America, 1% in Australasia and 1% in Africa. [2]

Robots can be roughly classified into two categories; industrial and non-industrial. Non-industrial robots are generally focused on a service, or a job they are needed to do. The former includes tasks which a robot can do with greater productivity, accuracy, or endurance than a human. Currently, many factory jobs are performed by robots that enable us to provide cheaper mass-produced good, for instance, automobiles and electronics. Robotic applications often consist of dirty, dangerous, or dull jobs which humans find undesirable. The expected application fields of such robots include domestic works, medical surgery, rehabilitation assistance and care service for the aged.

Issues

The average age of population is increasing in many countries, especially in Japan, meaning that there are more elderly people to care for with fewer people available to do so. In response to this, there has been a push in the development of rehabilitation robots to support the physical and mental aspects involved in care for the elderly and disabled. It is envisioned that robots will provide not only a reduction in the cost of providing care, but also an improvement in the quality of human life.

However, there are concerns involved in robotic care systems:
1. Availability of robots (due to social/financial inequality)
2. Robot are not human, and so a component of danger is possible
3. Acceptance by elderly and disabled people
5. Acceptance by user (caregiver)
6. Technical difficulty (possibility of breakdowns)
7. Trouble related to vested group on developing

Justification

Population aging is constituted by a shift in the distribution of a country's population towards greater ages. Thus an increase in the population's mean or median age, a decline in the fraction of the population composed of children, or a rise in the fraction of the population that is elderly are all aspects of population aging. Many countries in the world are facing aging society as shown table 1. We are facing lack of labor and various fields of industry, especially care service. In order to solve these problems, a robot attracted attention as an alternative. Consequently, such social environment leads a person to use robot in daily life.

	1950	2000	2050
World	5.2%	6.9%	19.3%
Africa	3.2%	3.3%	6.9%
Latin America and the Caribbean	3.7%	5.4%	16.9%
China	4.5%	6.9%	22.7%
India	3.3%	5.0%	14.8%
Japan	4.9%	17.2%	36.4%
Europe	8.2%	14.7%	29.2%
Italy	8.3%	18.1%	35.9%
Germany	9.7%	16.4%	31.0%
Sweden	10.3%	17.4%	30.4%
U.S.A.	8.3%	12.3%	21.1%

Table 1. Dynamics of Population Aging in the Modern World [3] Observed and Forecasted Percentages of the Elderly (65+ years) in Selected Areas, Regions, and Countries of the World: 1950, 2000 and 2050. Source: United Nations 2001.

[3] Gavrilov L.A., Heuveline P. Aging of Population. In: Paul Demeny and Geoffrey McNicoll (Eds.) The Encyclopedia of population. New York, Macmillan Reference USA, 2003, vol.1, 32-37.

Scientific Basis/efficacy/evidence)

1. Mechanical engineering (Body) / Materials, Structure, Control
2. Computer (Brain) /Architecture, Networks
3. Sensor technology (Sense) /Device, Signal processing
4. Information processing (Intelligence) /Recognition, Communication, Interface

Research projects

Research of service robot for aged people is being conducted by universities and institutes. Some examples are:

1) TWENDY-ONE

TWENDY-ONE is a sophisticated human-symbiotic-robot which equips all the functions described above. The special feature of TWENDY-ONE is the combination function of the dexterity with passivity and the high-power output. TWENDY-ONE equips high output actuators with the simple mechanical passive impedance mechanism. When TWENDY-ONE manipulates an object with various shapes, it is easy for TWENDY-ONE to adapt to the object by passivity to absorb external force generated by the positioning deviation. In the same way, TWENDY-ONE can adapt to human motion and hold a human. As a result, TWENDY-ONE can manipulate an object dexterously as well as support a human.

2) RI-MAN

Someday, robots could replace humans as nurse's aides, but first they will need a little sensitivity training. Japan's Ri-Man is headed in the right direction. With sensors that enable it to see, smell and hear its environment, it also has some 320 pressure points on its arms and chest that allow it to sense the exact position of whatever it's holding. The bot can lift 80 lbs. today, but researchers hope to strengthen the motors in Ri-Man's arms without increasing their size, so they still resemble those of a man, not a monster.

Players

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Funding

1. The Robotics Industry Development Council

2. New Enegry and Industrial Technology Development Organization

3. Ministry of Health, Labor and Welfare

4. Industry Science Technology Foundation

5. Shimane Industrial Promotion Foundation (for enterprise only)

Commercial Products

1) WAKAMARU
Wakamaru is a Japanese domestic robot made by Mitsubishi Heavy Industries, primarily intended to provide companionship to elderly and disabled people.

2) PARO

Recent advances in robotics have been applied to automation in industrial manufacturing with the primary purpose of optimizing practical systems in terms of such objective measures as accuracy, speed, and cost. However, the resulting robots are mostly kept away from human beings because people can be injured during their everyday functioning. Unlike industrial robots, "Mental Commitment Robots" are developed to interact with human beings and to make them feel emotional attachment to the robots. Rather than using objective measures, these robots trigger more subjective evaluations, evoking psychological impressions such as "cuteness" and comfort. Mental Commitment Robots are designed to provide 3 types of effects: psychological, such as relaxation and motivation, physiological, such as improvement in vital signs, and social effects such as instigating communication among inpatients and caregivers.

3) PAPERO

The PaPeRo is a personal robot being developed by Japanese firm, NEC Corporation. It is noted for its cute appearance and its facial recognition system. The robot's development began in 1997 with the first prototype, the R100, and adopted the name PaPeRo, which stands for "Partner-type-Personal-Robot" in 2001. The PaPeRo has been researched and developed with the intention of its being a partner with human beings and its being able to live together with them. For this reason, it has various basic functions for the purpose of interacting with people. Here we introduce the essential elements and functions needed for that interaction.

4) HAL

HAL has developed to expand and improve physical capabilities. The power units are attached on each joint of HAL. The torque of power units are converted from HAL to wearer's limb through the mold fastening equipments. Potentiometers are attached to the each joint in order to measure the joint angles. The FRF sensors are embedded into shoes to detect the CoP (Center of Point). The bioelectrical signal sensors are detected to the signals such as myoelectricity. In addition, a computer and batteries are attached on a wearer's waist, so the wearer can move in stand-alone mode.

5) MY SPOON

Eating is a basic motion for humans. MY SPOON, as meal-assistance robot, assists the physically handicapped person to eat by him/herself.

Players

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