Ambient Intelligence for people with disabilities and elderly people

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ABSTRACT
Recent advancements experienced by diverse network technologies, such as wireless personal and local area networks and wired networks, interacting with location systems, make possible the development of intelligent environments [4]. Elderly and disabled people compose a segment of the population that would profit very much from Ambient Intelligence if it is accessible. This is only possible if accessibility barriers are early detected in the evolution of the Ambient Intelligence concept and opportune standardization measures are provided.

Author Keywords
Ambient Intelligence, elderly and disabled users, design guidelines, standards, ethic and social issues.

INTRODUCTION
Autonomy and quality of life of elderly and disabled people living in smart private or public homes designed under the Ambient Intelligence paradigm can experience significant enhancements due to the increased support received from the environment. This support includes facilities for environmental control, information access, communication, monitoring, etc., built over diverse technologies and using different operation ways. Nevertheless, users can find accessibility barriers frequently related to the diverse user interfaces with heterogeneous devices and procedures. These problems include both, physical difficulties to handle the devices, and cognitive barriers to understand use procedures and navigation. Consequently, accessible unified interfaces to control all the appliances and services are needed. This is only possible if the network technology used for smart homes is able to support interoperability and systems integration.

In this paper, we argue that the needs of senior and disabled users can only be provided by means of interoperable systems in an integrated intelligent environment. Therefore, only a convergence policy based on inclusive design guidelines and standards (when they are possible), can guaranty the accessibility of the future intelligent ambient.

FACTORS INFLUENCING THE AVAILABILITY OF NEW NETWORK TECHNOLOGY
There are many factors that influence the availability of technologies supporting smart homes. For instance, the diversity of available wired and wireless technologies is under the influence of the market. Future networks will emerge from their concurrence or convergence. In addition other technologies can also have a big impact in smart houses. E.g., leisure networks (e.g. cable TV) may be very adequate to provide some tele-services.

Probably a single type of network will not be able to provide solutions for all the needs, making necessary the coexistence of diverse technologies. This must encourage the development of bridges in order to guarantee the interoperation of heterogeneous networks.

On the other hand, the availability of novel interaction devices promoted by wearable computation, and the influence of mobile and ubiquitous computing will have a big impact in Ambient Intelligence.

However, universal accessibility issues will be not solved by the market. Many aspects of this technology require regulation to be accessible. Therefore, there is a need for standards to define technical specifications in Ambient Intelligence, but also for accessibility laws to avoid social exclusion and ethical problems.

INTEROPERABILITY AND CONVERGENCE OF CONTROL AND COMMUNICATION FUNCTIONS
The terms 'interoperability' and 'convergence' play a key role in the present and future technology, form diverse points of view [2]. The first one is the 'convergence of media' that means a merge of TV and individual forms of communication like telephony and/or the internet. This kind of convergence is now under development.

Another type of interoperability combines communication and control functions. In this case, we have, among others, the problem of very different bit rates. For example, the control of sensors and actuators require some hundred bit/s while the telephone bit rate is 64000 bit/s and TV is in the order of Mbit/s. Nevertheless, it could be the best solution (also from the economic point of view) to have one high speed bus system and one type

of socket for all devices (be it a low bit sensor or a TV set), because we only need one protocol and, on the other hand, the transmission medium (if wired) is powerful enough for a wideband transmission.

Nevertheless, in the midterm we will probably see a set of different networks with a set of simple networks connected through a set of simple gateway devices. The development of heterogeneous personal and local networks (PAN, LAN) is the objective of many R+D projects[1].

To ensure interoperability two components are necessary:

- Hardware bridges between the diverse networks to physically interconnect them and to adjust their respective protocols. Some bridges are now commercially available, while others are under development.
- A middleware level that provides the applications with an interface to network services. It also makes the application independent of the network.

While bridges are dependant on the network technologies that are interconnected, the middleware level could be standardized to provide the application designers with a common virtual machine hiding the physical network.

TECHNOLOGICAL ADVANCEMENTS SUITABLE FOR AMBIENT INTELLIGENCE ORIENTED TO ELDERLY AND DISABLED USERS

Location technology

Location technology has first and foremost been used in globally, long-distance contexts like GPS-based GIS for observation and control of natural resources, surveying, military use, road finding and other geographically oriented applications. GPS-based applications can only be used outdoor, because of the satellite based location technique, and give a precision of about 1 meter. Many disabled and elderly users need to be precisely located for safety reasons. Therefore, location technology for Ambient Intelligence is mostly oriented to indoor use and with a much higher precision [3]. This also opens up for completely new application areas in education, entertainment, healthcare, and other indoor activities, based in new concepts such as tangible [6] and ubiquitous and context aware [7] computing.

Emergency calls /alarm systems

Alarm systems played a very important role in smart home applications. However, the systems, existing so far, are very often too complicated or not reliable enough. Frequently the bottleneck lies in the triggering of the alarm. If the user has an accident (fall, injury, a fire, unconsciousness…), there is normally no time or possibility to operate a telephone or even an alarm button on s/his wrist or around s/his neck. Although many useful alarm systems and several research projects exist, there is still a large knowledge gap on how persons react in a dramatic situation, for instance, being in panic or having a collapse or simply because they are in confusion or have memory problems (not remembering that they wear an alarm button). The best solution for this case is probably passive alarms. Passive means a remote control based on polling methods. For example, vital functions (pulse, blood pressure etc.) are read out in short time intervals using a wrist transmitter with a probe. The information is sent to an evaluation system, which automatically sends an alarm signal to the emergency service station, in case of strong deviations of standard values. It is important to state that this type of remote monitoring has also many ethical questions [1]. For this reason, it can be only acceptable for specific cases in special conditions and it should be avoided as a general solution.

Wearable computers and smart clothes

Very small computers, which can be embedded in clothing or carried in some other unobtrusive way, are essential to the development of a flexible smart home infrastructure. Good examples of this necessity can be found in the ISTAG report “Scenarios for Ambient Intelligence in 2010” [4] which currently inspires several ideas behind the EU 6th framework program, where *smart homes* are a part of the concept of ambient intelligence. Carrying, somehow, a small, personalised device that can communicate with the network infrastructure (home, office, global…) can be very helpful to tailor the environment to user preferences, and to help the user whenever this is required. As an example, passive alarm systems (as mentioned before) that fire when some set of biomedical parameters are out of range and call a support centre if necessary are just a very simple example of a wearable computer. It is clear that this area will greatly develop in the near future as small more personalised devices substitute current generation mobile phones, PDAs and remote controllers. The possibilities that these types of devices have for helping disabled and older users

[1] Let us mention two research projects where the author is involved: Domosilla ["Study, evaluation and design of an interconnection system between local network for wheelchairs (DXBus) control and domotic network (EHS)". TIC2000-0087-P4. U. of Seville, Bioingeniería Aragonesa and U. of the Basque Country] aims to communicate home buses and wheelchair control buses; and Heterorred ["Study and development of a heterogeneous personal area network for interoperability and access to wireless services and communications" No. TIC2001-1868-C03. U. of Seville, U. of Saragossa and U. of the Basque Country] aims to produce interconnections among diverse heterogeneous networks (such as Bluetooth, HomeRF, Powerline, etc.).

are enormous but it is also true that they could also create a "digital barrier" if these users are not considered in the design stages.

SOCIAL AND ETHICAL ISSUES

Some of the services provided by telematic and personal area networks can cause ethical questions. Location and monitoring of people can be of vital importance for the security of some disabled and elderly users but these techniques are very intrusive and must only be used with the permission of the user or s/his family. On the other hand, some remote services provided by telematic networks, such as tele-care, can contribute to personal isolation if they substitute to human care [1]. Therefore, to avoid abuses or intrusions it is necessary

- to provide the designers with guidelines that implement ethical design criteria
- to promulgate laws to protect autonomy and privacy and avoid social exclusion and isolation.
- to establish compensatory measurements to enhance socialization

Since most of these problems arise in the design phase, designers must be provided with design guidelines that are aware of ethical and social issues. This paper will provide some examples of this kind of guidelines.

STANDARDIZATION AND REGULATION NEEDS

The needs for regulation of several issues in Ambient Intelligence can be summarised as follows (see table 1):

- Production of inclusive design guidelines [5] for the Domotics field (the success obtained by WAI guidelines for web accessibility proves the interest of issuing clear guidelines for designers to avoid the inclusion of barriers in the design).
- Standardization of interoperation features. This would support the convergence of home buses
- Studies towards the standardization of middleware for heterogeneous networks
- Legal protection of privacy, autonomy, social inclusion, etc.

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Techno-logy	Remote communication	Emergency calls/ alarms	Environmental control	Localiza-tion	Standardization/ regulation needs
Domotic buses	Gateways to wider networks.	Through interconnection.	Command	Location awareness	Convergence. Interoperability
Wireless networks	Mobile telephony	activation devices	user interface. Ubiquitous control	Localization outdoors	Privacy protection, Interoperability
Wired (external) networks	Telephony, Text-telephony, Internet	Through wireless activation devices	Remote environmental control		Privacy protection, Interoperability.
Wearable devices	Interconnection, Gateways.	Sensors/activators	Devices for user interface	Emitters/ tags	Ethical issues. Autonomy protection.
Wheelchair buses	Gateways.	Through interconnection.	Interconnection.	Assisted Navigation	Interoperability with domotic buses

Table1: Regulation and standardization needs