I know the name but not the place. *e*-Tools for the senior and disabled citizens

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Abstract. In this paper we present our ideas about the integration of agent technology , as *a*-Buildings, with other AI and Information Society Technologies (IST) to build specific *e*-tools for the disabled and for the new generation of senior citizens. In particular, we aim to explore the benefits of the concept of *situated intelligence* to build intelligent artifacts that will enhance the autonomy of the target group during their daily life.

1 Introduction

While most of the current and previous generation of IT devices and software has focused on able-bodied people at the peak of their abilities, we believe that more research should be focused on affordable and effective agent-based technology to assist people with cognitive and physical disabilities in their everyday lives. This paper is about envisioning the future use of technologies (for instance *e*-Tools) in which agents and networks will be integrated into everyday environment, rendering access to a multitude of services and applications through easy-to-use interfaces, specially designed for the disabled and the senior citizens.

We are clearly thinking in applications that can be circumscribed to well-know quasi-structured domains (ie. places with predefined components such as a house, a hospital floor, etc) assuming that they are stable, that there exists enough information about them and that the environment somehow is able to interact with a computational system (for instance, by providing information to the system). Recent advances in embedded computing and wireless communication makes it possible to think in putting *intelligence* in every appliance, into the structure of hospitals, homes and, in the long term, even on every street corner (see [8]).

Specifically, the long term objectives of our research are:

- To develop the medical and social understanding necessary to apply Heterogeneous Embedded Intelligence technology to problems faced by the disabled and senior citizens population.
- To develop assistive technology for disabled and senior citizens.
- To investigate mechanisms by which physical and software agents effectively and securely coordinate sensing, cognition, reasoning, and actuation in well-known environments to support the target population.
- To investigate mechanisms to build flexible interfaces to support the interaction of people with different capabilities and needs.
- To disseminate information and promote the exchange of ideas and create awareness among relevant actors.

The use and creation of new technologies for the senior citizens and the disabled is crucial, as for these groups of people it is not merely a matter of doing the same things more quickly or in a simpler way with the aid of an *e*-tool. For them it is a matter of being able to perform those tasks independently and, maybe, to learn how to perform new tasks in order to enhance their own autonomy.

1.1 Organization

The organization of this paper is as follows. In §2 we address the possible uses of assistive technologies in building services for the senior citizens, and give our own proposals for this field. In §3 we present some of the technologies to be used. In particular, in §3.1 we introduce our idea of *a*-buildings to facilitate the communication of different types of agents. In §4 we explain some ideas of how to use *e*-Tools and *a*-Buildings to create intelligent monitoring systems to manage the patient's information.

And, finally, in §5, we make some reflections about the future of this technology .

2 Assistive technologies and the senior citizens

The senior citizens represent a fast growing proportion of the population, at least in the developed countries [4]. They are a heterogeneous group comprising a wide spectrum of function. This ranges from intact robust individuals to those with mild cognitive impairment and/or other disabilities, and to those with moderate to severe limitations. The latter group includes those with Alzheimers disease (AD) and other dementias, physical and other neurological diseases, who require medical assistance and/or institutional care [9].

While Mild Cognitive Impairment (MCI) refers to the clinical condition between normal aging and Alzheimer's disease (AD) in which persons experience memory loss to a greater extent than one would expect for age [12], an outstanding example of highly invalidating disease is represented by Alzheimer's disease, the principal cause of dementia in the elderly, affecting about 15 million

people worldwide. The earliest symptom is usually an insidious impairment of memory. As the disease progresses, there is increasing impairment of language and other cognitive functions. Problems occur with naming and word-finding, and later with verbal and written comprehension and expression. Visuo-spatial, analytic and abstract reasoning abilities, judgment, and insight become affected. Behavioral changes may include delusions, hallucinations, irritability, agitation, verbal or physical aggression, wandering, and disinhibition. Ultimately, there is loss of self-hygiene, eating, dressing, and ambulatory abilities, and incontinence and motor dysfunction. Last stages of the disease use to lead to an institutionalization in some kind of facility specialized to treat such cases. But this solution not only has a high cost (institutionalization accounts for more than 66% of the costs associated to people with severe dementia), but also is harmful for the patient, that is placed in a unknown environment with unknown people.

Assistive technology devices can be very useful to provide supportive services for individuals who require assistance with the tasks of daily living. Such supportive services can also aid informal carers (relatives, friends) to significantly lengthen the time spent by demented individuals in their own home postponing the requirement for institutionalization, to propose substitutes for nursing homes (i.e. Assisted Care Facilities).

Disability makes everyday life very complicated and the informal family support is usually not continuous. The use of technological aid to solve mobility and communication problems inside the patient's house may help to reduce his/her dependency (even from the psychological point-of-view) specially regarding the activity of daily life and improving his/her quality of life. For example, a challenge for many cognitively impaired or disabled persons –not only for blind people– is going from one point to another, even in a known route. Actually caregivers provide the necessary aid but an adaptable intelligent assistant may replace in this task the caregiver.

There are some active and promising lines of research (see [1]) in this field as:

- Assistive technology: devices that aid with mobility [10] [14], medication management, and household tasks.
- Cognitive Aids: technology that supports declining cognitive skills, including reminders, task instruction, and methods to reduce cognitive effort.
- Passive Monitoring: devices and reasoning systems that recognize the elder's activity and learn to detect abnormal situations (see §4).
- Decision-making: reasoning systems that respond to situations and the elder's needs by interacting with devices in his normal environment, interacting with the elder, or contacting caregivers.
- Human factors: interfaces that meet senior citizen's needs and capabilities - motor, sensory and cognitive [5].
- Adaptation: techniques to recognize the elder's changing capabilities.

3 Integrating technologies to provide assistance

There are several Information Society Technologies which are useful to provide assistive services for physical or cognitive-disabled people. Among those we have identified the following: the use of machine learning tools to design devices that learn from and adapt to user behavior and needs, user-computer interaction to build interfaces, devices and systems that efficiently support users in their tasks, mobile computing to support patients and caregivers and device mobility, data and knowledge management to represent, access, update, and protect information, sensing devices that monitor human activity and finally rapid prototyping of services in a sensor-rich environment, in a scalable and secure manner.

3.1 *a*-Buildings

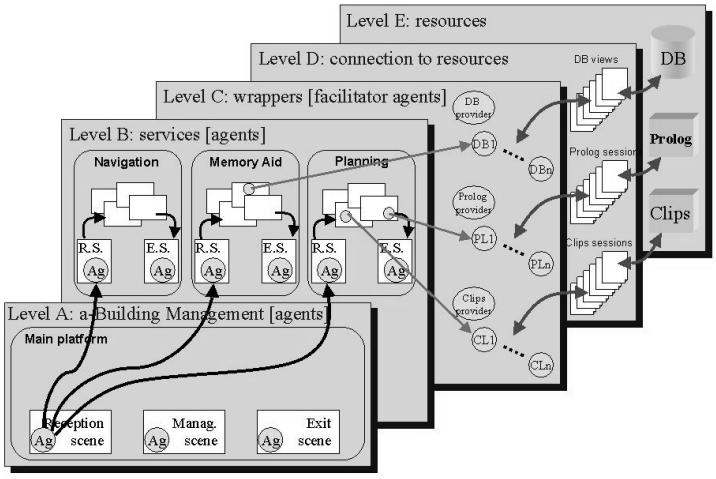

Fig. 1. *a*-Building architecture.

An *a-Building* [13] is an specification of a functional organization of agents. The aim of the proposed architecture is to ease the creation, installation, search and management of agent-mediated services. To do so the *a*-Buildings architecture creates a new level of abstraction on top of the standard FIPA [6] agent platform specification. Basically, an *a*-Building is a service-oriented platform which offers a set of *low level* services to the agents it hosts. We define *low level* services as those required services that are neccesary to create more complex (*high*

level) composed services. Each service specifies the resources it needs from the platform, and the platform offers such resources in the form of agent-mediated services. This agentification of the resources (such as Databases, heavyweight reasoning engines) allows to do an adaptive management of them, to compose resources as a composition of services and also to share those resources, avoiding to duplicate them for each service.

We are using here the idea of service composition that is the grounds of the Agentcities EU funded project[3]: using agent technologies not only to create intelligent service search systems but also to create adaptive services, that are able to negotiate, compete and/or cooperate with other services in order to increase their success, and even creating added-value services composed by several interacting services (eg. an airline booking service plus a hotel booking service).

3.2 Case Based Reasoning and Memory Aids

Decline in cognitive and sensory abilities manifest themselves as difficulties in performing many daily tasks, such as navigating in their normal environment, taking medication, preparing food, and operating household appliances. Many patients with mild cognitive impairments or AD patients, in a very initial stage, are able to follow simple instructions or plans, but many other common tasks require longer attention efforts and several check points, creating problems to the MCI persons. Case-Based techniques could be useful to keep trace of the actual development of a task or a plan and to provide unobtrusive remainders.

The idea behind the CBR Memory Aids is to collect a series of repetitive tasks that are part of user's daily routine and keep track of each one of the steps/actions and if-needed to propose plausible continuations. CBR has proven to be very effective in helping to solve problems using past experiences and also to adapt the actual solution to cope with changes. And this is *exactly* what the user needs in simple scenarios. As for example: creating a plan to back home (on time), from a *known* place, to have lunch, or to take the (adequate) medication (on time).

What is important is that many of these tasks/scenarios are performed by many MCI or disabled persons everyday so the Case Based repository could be shared –using the *a*-Building Knowledge Bases– and the systems could use different experiences to create *safe* solutions (see §4.1) and to improve the existing ones.

4 Intelligent assistive technology for patient monitoring

One of the most promising uses of the current technology is the creation of intelligent monitoring systems. Such systems track several body signals and have the reasoning capabilities to decide whether the patient is in a normal or acceptable state or if it is entering into a *danger zone*, even building a diagnosis of the possible causes.

With such devices, residential care facilities for elderly people and disabled persons can be provided with intelligent beds equipped with embedded instruments for acquiring not only vital parameters (blood pressure, glycaemia, pO2) but even with sensors to evaluate pressure at the body-bed interface to prevent pressure-ulcers.

A mobile version of the same technology consists on the creation of a portable device to do the tracking in persons that can move within an area. Such systems could track body signals and trigger alarms when a danger situation has been detected, even sending an automatic call to the caregivers by the use of automatic phone dialers and voice synthesizers. Another use of such portable devices, wirelessly interacting with devices attached to the room walls, is to monitor the patient movement inside the room, and identify behaviors like wandering as a symptom of dementia, or even detecting equilibrium loss to prevent falls.

4.1 Safe and Sound

As mentioned above, one of the most relevant properties of the domain of application is restricted to a quasi-structured, *situated environment* where *small* changes may appear but assistive agents should expect that the most important landmarks will remain stable for long periods. This does not exclude that the domain remains dynamic and therefore *unexpected* changes may arise so the system needs to solve these unforeseen situations. This kind of systems need to exhibit an intelligent goal-oriented behavior and yet still be responsive to changes in their circumstances.

But as observed by Fox & Das [7], the use of heuristics of rules of thumb to solve problems seems unlikely to inspire confidence. In this domain the safety of users imposes bigger restrictions and the systems must be extensively tested –may be off-line– to assure effectiveness and performance.

Software Agents could be used here to perform an active safety management layer by the introduction of *guardian agents*, as in [7], that in a proactive way look for possible hazards and anticipate an answer or send an alert signal to the manager. For example, an intelligent wheelchair must never obey an order asking it to drive the user to the stairs nor to allow the composition of plan to do that. But, it may override other conditions if the caregiver ask for it or in the case of an emergency –*i.e.* the agent should be able to recognize an emergency state or an alert signal received from the environment– or to ask for help in the case of an impasse. To do this it is necessary to build safety plans and be able to reasoning about them.

This is an open issue that has to be further discussed and that should be included in the new technologies for the disabled and senior citizens, as well as in any agent application for healthcare tools.

5 Conclusions

Although existing solutions that increase an independent living for senior citizens and disabled are currently available on the market those are oriented to solve

problems in a very poor manner and address a small subset of user's needs. As said in §1 most of them try to solve the teleassistance problems, as in [2]. Other just offer specialized information services for the elderly.

We are putting forward these proposals to provide support for disabled people and senior citizens. They may be applicable to a range of levels and kinds of needs, from use by intact healthy persons and those with mild cognitive limitation, to providing support for caregivers and families of elders suffering from moderate impairment and disability. Those agent systems are devised to provide aid in carrying out activities of daily living, and also performing tasks related to health care maintenance (including standardized behavioral assessments useful in medical monitoring). In addition, they will provide links to the outside world, including entertainment and information, and will facilitate communication with family and the environment. This may include existing technology and services.

While there seems to be several technically challenging problems ahead, developing distributed agent-based systems accessible to senior citizens and to the disabled persons is doubtlessly a worthwhile task. The creation of intelligent aids and the interaction of those *e*-tools with the normal environment of the user are a first step.

Among the most important obstacles that new technologies (such as software agents) find in real applications in medical informatics we have: user expectations and acceptance, security and trust issues, lack of standards and integration with pre-existing health-care systems. But acceptance of such systems will increase in the future, as senior citizens will be used to interact and rely on advanced technological devices.

We propose here real integration of heterogeneous technologies, using ideas like *a*-Buidings (see §3.1), to ease the creation of clusters of composed services in order to serve to disabled and senior citizens with problems in a non-intrusive way and securing the personal information of the users. Also it is important to notice that there are different efforts trying to solve small problems but an integral solution has not been approached yet.

This proposal is in line with the *Ambient Intelligence* key action I in the IST FP5 and the EU Telematics Initiative for Disabled and Elderly people (TIDE) through which the EU has been funding research for creating such an environment with an specific focus in the patient centered healthcare management, the disabled and, the senior citizens. Also, in the USA there is a strong research trend in this line [11].

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