Engineering an Agent-based Approach to Ambient Assisted Living

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Abstract. This paper aims to discuss engineering aspects for an agent-based ambient assisted living system for the home environment. The special requirements of our system are to provide a platform with cost-effective specialized assisted living services for the elderly people having cognitive problems, which will significantly improve the quality of their home life, extend its duration and at the same time reinforce social networking. The proposed architecture is based on an agent platform with specialized agents that can cooperate in order to service users with more than one type of problems.

1 Introduction

This paper addresses the non-trivial task [1] of engineering an AAL information system addressing the needs of the elderly suffering from dementia (Alzheimer Disease) with identified risk factors as well as having cognitive problems (referred to as users from now on). This application domain is about offering indoor assistance aiming to enhance the autonomy and quality of life of the user. A number of challenges are related to engineering such systems [2]:

- Adaptivity. No two human beings have the same needs or everyday life habits. An AAL system must be able to adapt to a particular user.
- Natural and anticipatory Human-Computer Interaction (HCI). The people that need assistance very often have limitations and handicaps.
- Heterogeneity. AAL systems are expected to be capable of being integrated with several subsystems developed by different manufacturers (sensors, etc).

The system we present in this paper will be developed in the context of a project funded by the first call of the transnational program AAL-2008-1 (see e.g. http://www.aal-europe.eu). The requirements for the system named as "home services for specialised elderly assisted living" (referred here-in as HERA) are to provide three main categories of services:

- Cognitive and physical reinforcement services (offered as a supplement of non-medical therapeutical interventions).

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– Patient specific home care services (including services for social reinforcement, reality orientation support and monitoring several Alzheimer related risk factors).
– General home care services for elderly (such as medication reminder services, information services, alarm services in cases of abnormal health conditions).

Previous works in this area ([3, 4]) introduced agent based systems for AmI for assisting in taking care of people with Alzheimer but they on one hand required the aid of a nurse or caregiver and on the other hand used RFID tags [4] or NFC technology [3]. Both technologies identify the location of the user using radio frequency identification technology that requires the use of sensors in different places at home and the use of another sensor on the user's body. Thus, the user's location is identified when he approaches one of the in-house sensors. Our aim in the HERA project is to increase the autonomy of the user, to automate the ambient assistance (without requiring the use of managers or schedulers), to act unobtrusively and to minimize the use of hardware, aiming to a commercial solution to home care for people suffering from dementia and having cognitive problems.

2 System Architecture

For defining the system architecture the first step was to identify the stakeholders that participate in the HERA value chain along with their goals:

– Elderly person or user. Needs help to manage his daily life.
– Relative. Needs to be notified in case of emergency or if the user feels lonely.
– Health service provider (Hospitals, Specialised centers).Needs to be assisted in its task to take care of a large number of patients.
– ISP (or telco) - Service provider. Needs to expand its client base.
– Data center. Data centers are where content providers lease computational and storage resources. It needs to expand its client base.

In order to satisfy the needs of the stakeholders, the requirements presented in the previous section and the challenges related to the development of such systems we identified the architecture shown in Figure 1 A.

– The TVset/Set-Top-Box (including a remote control) is the main user interface for the elderly, providing multimodal web-based user interfaces based on Text-To-Speech (TTS) and Speech Recognition (SR) techniques.
– The Bluetooth medical sensors (blood pressure, body weight, oxygen saturation and heart rate monitor) communicate directly with the STB over Bluetooth.
– The Health center information server accepts messages from the HERA system regarding emergency needs of the users or major changes in their situation.
– The relatives home PCs and other terminals including mobile phones.
– The HERA Services platform that hosts all the applications.

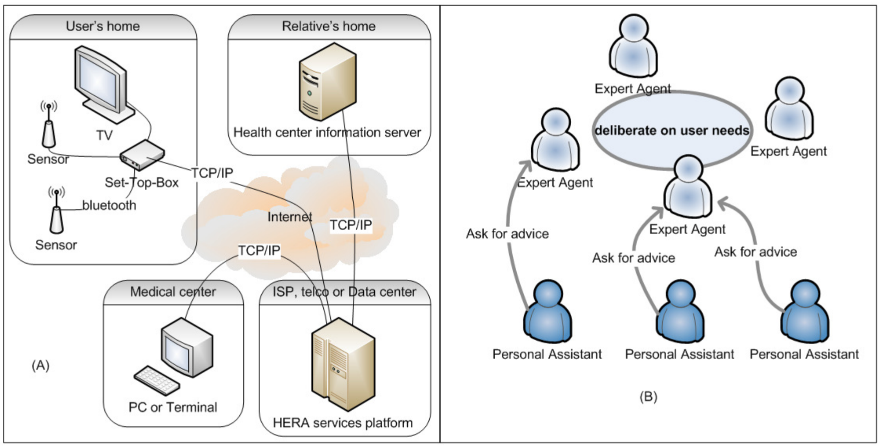

Fig. 1. The HERA network topology (A) and the agent sub-system (B).

The heart of the HERA services platform is the agent-based sub-system, which is shown in Figure 1 (B). A personal assistant (PA) agent will serve a specific user and will have access to the user's profile data. This agent will be proactive in the sense that he will be always active following the user's agenda and providing support and advice by taking action whenever needed. For example he will be able to send a message to the user for reminding him to take his pills, to receive sensor information about the user and consult the Expert Agents (EAs) for:

- The best cognitive reinforcement games for a specific user by selecting games from a list annotated with information based on the user's mental profile
- The best physical reinforcement games for a specific user by selecting games from a list annotated with information based on the user's medical data and weight
- The dosage of drugs based on the medical prescription and the context in which a user is in
- The person that should receive an alarm signal, should it be a relative, the user's doctor, the medical center or first aid?

The HERA's knowledge regarding the needs of different chronic conditions types can be quite large and it can sometimes conflict. In HERA we define it separately for each chronic condition type. Then, for a person with more than one type of chronic conditions, a coalition of agents-each with knowledge of a different chronic condition type- the expert agents (EAs), will deliberate on the user's needs. They will interact through an argumentation-based communication protocol. Argumentation deals with conflicting situations that may arise, incorporating contextual knowledge. For example, an expert agent may suggest a specific dosage of a pill for each day depending on a user's condition. Another expert may suggest that a pill dosage is not more than a specific threshold, if the temperature is too high. Through the definition of rule priorities (which can be context based) argumentation allows to reach a valid decision in these situations. Thus, the system can exhibit emerging behavior as it will be able to accommodate any combination of chronic diseases (it will be capable to service even combinations not tested during the system verification phase). For this purpose we will use the argumentation framework proposed in [5], which has already been applied for similar situations, e.g. for the proposal of services for people having several impairments (see [6] for more details).

3 Conclusion

In this paper we presented the HERA system requirements and proposed an agent-based architecture to address the challenges of a) adaptability as a group of expert agents on specific user types are instantiated according to the identified types of the user (e.g. an elderly person with mild dementia and diabetes will entail the cooperation of three expert agents), b) HCI where the use of the TV set is ensuring a quick learning curve for our users, and , c) heterogeneity with the use of a service oriented architecture such as OSGi that allows the different subsystems to be connected in a plug and play standardized way. There are specific advantages of our approach compared with previous works ([3, 4]). Firstly, the autonomy of the user is increased and the ambient assistance is automated. Secondly, the use of argumentation allows for decision making even in cases when a user has more than one chronic situation.

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