MULTIAGENT SYSTEM FOR THE PREVENTION OF ACCIDENTS OF PEOPLE LIVING ALONE

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Abstract: This paper describes a multiagent system designed for assisting elderly and disabled people living alone in their homes. The main objective of this system is to prevent risky situations by monitoring key variables of daily life. This system is conceived as pro-active advancing warnings issued to the user, but also, if necessary, to the caretaker and the corresponding assistance services. This multi-agent system has been designed to be easily extended and adapted to different user requirements. The agents have different roles related to the acquisition of information, the processing of it and communication to the different human agents.

1 INTRODUCTION

At present an important demographic change is taking place regarding the mean age of our society. The increase of the population aged 60 years or older is very significant. This is a world wide phenomenon as observed by the United Nations (United Nations, 2007).

Also, there is an increasing sensibility in society and a desire from different public Administrations to improve the quality of life of elderly people and, in general, of disabled people. For example, when elderly people are healthy, but with typical problems due to ageing, the best recommendation is that they spend as much time as possible enjoying their life within their family and social environment, without the need to abandon their home, but under a social program providing continuous care from them.

Important research projects have been completed and are in progresses that try to assist people living alone but with some kind of dependence, using the important tools that the new information technologies can offer for remote monitoring and assistance.

In order to try to solve this problem, several organizations and companies offer teleassistance. The most part of this type of services are based on the demand of the user by simply pushing a button on a small device that he/she carries on him/her (Aguilera, 2003). A specialized call centre attends any request from the user 24 hours a day, and also, the call centre can contact the user periodically in order to know that everything is going well. All these services are very helpful, but they require inputs based on human decisions taken by the user or people attending the call centre. It seems that a further step is needed in order to try to monitor some daily activities of such elderly or disabled people. Important advances have been made in the use of new information technologies for monitoring some activities of elderly people at home (Jih, 2006), (Giansanti, 2006), (Marschollek, 2007), (Reyna, 2005) for assistance to find the way, if one is disoriented (Liu, 2006) and to monitor some important biological parameters (Pollack, 2005). Also, some technological platforms have been developed which are able to integrate different kinds of services for remote assistance to elderly people (Robocare, 2009). In this field and direction this paper describes new features added to an intelligent multi-agent system named SIAM previously published by the authors (Pascual, 2008).

This paper is organised in the following sections: first in section 2 the objectives of the system and main strategy are presented, next in section 3 the architecture is presented and the rest of the sections are centred on presenting new features added to SIAM. Section 4 presents the method for fall detection used by SIAM, and Section 5 describes a special agent for real time vision. Finally, section 6

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describes a method of communication based on the use of the television (TV) controller.

2 SIAM OBJECTIVES

The main objective of SIAM is to monitor key activities of elderly people living alone at home in order to prevent some situations that could be dangerous in their daily activities. In the case that an abnormal situation is detected, SIAM takes the decision to call the caretaker and/or the corresponding assistance services. The main features of SIAM are the following:

- continuous monitoring of certain variables that could be important for risk detection in daily activities at home. Examples of possible risk situations are: a sudden fall of the person on to the dining room floor, unattended gas open in the kitchen, unattended water running in the bath, etc.
- facilitating reminders to complete specific tasks
- easy communication with the user and also with the external world using several alternative methods.
- if necessary, automatically calling the caretaker and/or emergency services, for example contacting the caretaker, the family, and/or the CMD (Central Monitoring Department).
- remote vision of a scenery and communication with the user at home only when an exceptional alarm is issued

The working context expected by SIAM contains the following four types of actors: the user or elderly person, the CMD, the caretaker and SIAM itself. This is represented in Figure 1.

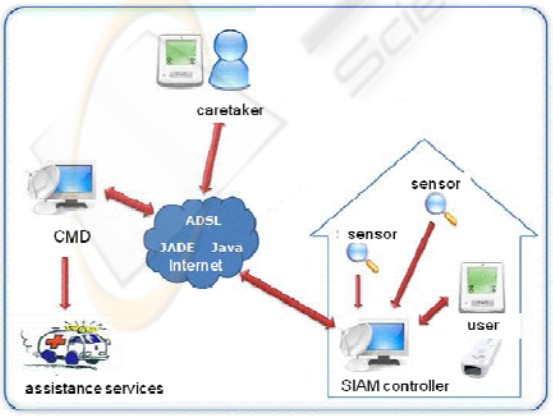

Figure 1: SIAM actors and relationships among them.

Usually, SIAM collects information from sensors installed in the home of the elderly person in order to detect if a possible risky situation is caused by an action or event when the person is at home carrying out his/her activities. In the case that some anomaly or risk is detected, SIAM will first try to contact the elderly person and, if an answer is not received, this will be notified to the CMD and/or to the caretaker. Also, from Figure 1, it is possible to observe that the user can activate a request to the CMD and to the caretaker and vice verse.

3 SIAM ARCHITECTURE

SIAM is a multiagent system developed in JAVA and JADE (JADE, 2009). It has been elaborated using a typical methodology of development (Bresciani, 2004). It contains the following types of agents:

- USER. This is the method of communication between SIAM and the person at home in both directions. This agent can be installed in two alternative modes either in a mobile device that the person carries on him/her, such as a PDA, or using the TV remote control when a digital television transmission is available.
- DATA COLLECTOR. This agent is in charge of the collection of information from sensors located at key locations in the house. They are used for monitoring certain activities that can be or can cause certain risks for the person. These agents are located in the house being monitored.
- HOME CONTROLLER. This agent collaborates with the other agents and performs a pre-analysis of the situation in order to obtain a global view of the activities in the house and to detect possible anomalies or risk situations. This agent is located in the house being monitored.
- DIAGNOSTIC. This agent performs the diagnosis of possible risks in the house of the elderly person according to the information collected and specialized knowledge previously stored in the knowledge base of an expert system. This agent is located in the CMD responsible for taking care of a group of elderly people using the SIAM platform.
- CARETAKER. Its objective is taking care of all the communications from SIAM to the caretaker and vice verse. This agent is located in a mobile device that the caretaker carries on him or her. At the moment this agent is installed in a PDA.

- VIEWER. Its objective is to facilitate a real time image of the person when special circumstances are detected that suggest that there is an emergency situation. This agent is based on a low cost robot.

Figure 2 shows the multi-agent architecture. As can be observed, the diagnostic agent is physically located at the CMD. The CMD is conceived as a specialized centre that could be a nursing home or in general a company dedicated to taking care of elderly people. The CMD can monitor several houses, each one having its own diagnostic agent.

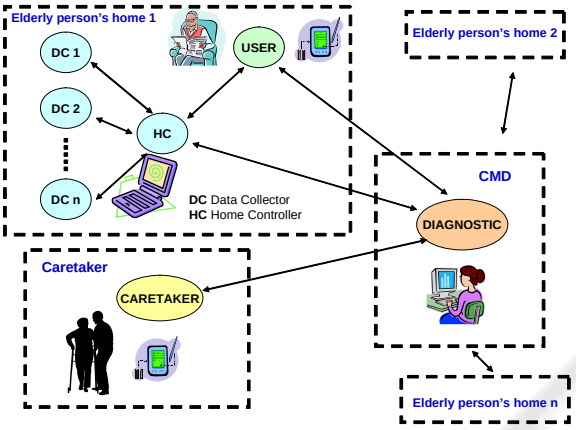

Figure 2: SIAM architecture of agents.

The data collector agents and the home controller have to be located in a computer in the house of the elderly person. This computer does not require attention by the person and no screen associated to the PC is needed if it is not required by the user. The maintenance of the SIAM agents must be done by remote control from the CMD.

The caretaker agent is in a mobile device that could be supported by another PDA in the home of the caretaker or by another form of communication.

4 SIAM FALL DETECTION SYSTEM METHOD

One of the activities monitored by SIAM is the detection of possible cases of the assisted person falling. After investigation of several devices and existing systems for fall detection, it was decided to use an easy and inexpensive device that is possible to find in a wide spectrum of shops. The device selected was the wii controller wiimote connected to a sensor agent of SIAM through a Bluetooth communication. This device allows for two functions in SIAM: requesting help from the person and the most important, the automatic fall detection. The purser of the device will be used by the user for requesting attention from SIAM or to communicate his/her situation. The signals coming from the three accelerometers of the wiimote will be used for fall detection. The information supplied is in the range of +5G to -5G corresponding to the maximum force in the same axis of the direction observed, -5G corresponds to the maximum force in the opposite direction to the axis and 0 corresponds to no force measured. An example of the values collected from a sample of 6 seconds from the three accelerometers is shown in Figure 3.

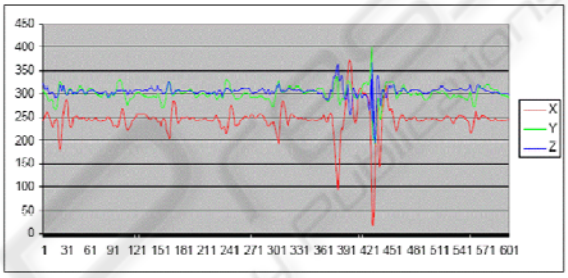

Figure 3: Information coming from a wiimote.

Figure 4 shows different types of movement observed through the information collected from a wiimote device using its accelerometers. In this figure three kinds of movements can be observed: no movement corresponding to repos, the person is seated, the movement corresponding to the person walking and two situations of the person falling. The amplitudes observed are different and this suggests the development of patterns for the detection of movements, and in particular, possible falls.

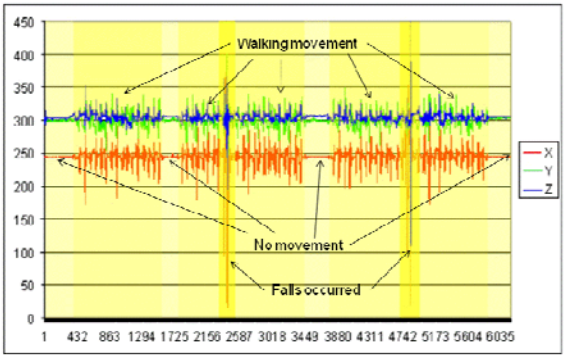

Figure 4: Different movement situations.

After a deep analysis for the characterization of the different movements to be detected, a self-organised map was trained using as inputs the information coming from the three accelerometers and their

standard deviations in a temporal window of 150 samples that correspond to approximately 1,5 seconds. Several simulations of different movements were performed in order to configure a training set of examples.

5 VIEWER AGENT

One special agent added recently to SIAM is the viewer agent that facilitates a remote view in real-time of a scene of the situation of the person when an emergency situation is detected.

This agent has two components hardware and software. It is mainly based on a small and low cost robot that includes a camera. The image taken is transmitted by wireless communication to the VIEWER agent where it is made available for the other agents for the processing that is required according to the role of each agent. The robot has been designed to be non-intrusive in the daily activities of the person and to be only active in exceptional situations when SIAM has a high indication of an emergency occurring.

Some situations considered to be an emergency by SIAM could be better evaluated if a real image was available of what is really happening. This is only an option of SIAM, but considered to be an important value added over the rest of the agents.

The robot can operate automatically commanded by the SIAM agents and also, can be manually commanded through the caretaker or the CMD agents.

Figure 5 shows the camera used for taking images. It is a camera model Sony 1/3" CCD CCTV 480 TV Line.

Figure 5: Camera of the VIEWER agent.

The camera is mounted on a low cost robot especially designed for SIAM. This is presented in Figure 6. Also, in this figure an antenna is observed on the right side of the image. This is used for wireless communication of the images taken and for the remote control of the robot from the SIAM platform.

Figure 7 shows a graphical scheme of the components of the robot and the main flow of information used between the robot and the VIEWER agent of SIAM.

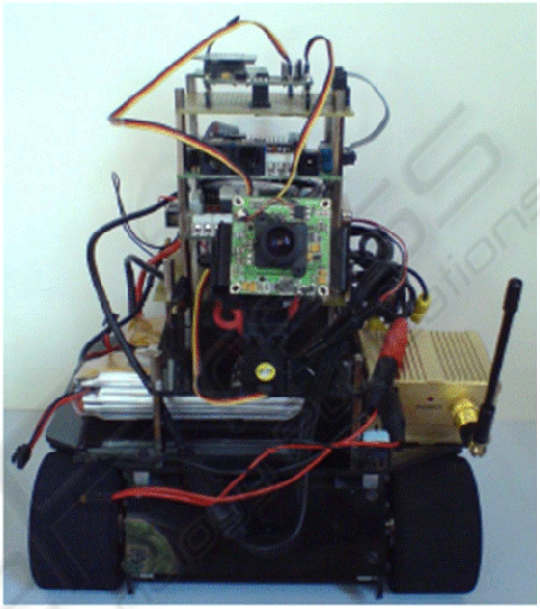

Figure 6: Robot commanded by the VIEWER agent.

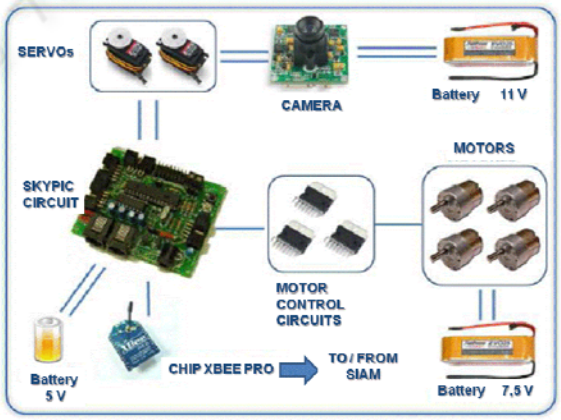

Figure 7: Flow of information and main elements of the VIEWER agent.

An important problem that is presently analysed is charging the batteries of the robot. A design for an automatic recharge with a special device for plugging in the electrical network is being planned.

6 COMMUNICATION WITH THE USER

SIAM offers two ways of communications with the user and vice verse using the type of agent USER. In the original version of SIAM the user agent is running in a mobile device such as PDA. It has an interface which is extremely simple to use with big symbols to communicate to and from the elderly person. The user can activate one of three large icons: emergency situation, communication with the caretaker and asking some questions to the CMD. Figures 8.a and 8.b show how the user observes these icons.

8.a

8.b

Figure 8: Basic interface for the user agent.

Also, the user can receive warnings represented by large icons about the need to review something in the house that could be a risk for the person. Figure 8.b shows an example of a warning telling the user to turn off the gas. The structure and interfaces of the caretaker agent are similar to those of the user agent, and also, it is ready for running on a PDA.

A new and easy method of communication between SIAM and the elderly person has been added recently through a new SIAM agent. The objective and information is similar to that previously described but using the digital TV as a mean of communication.

7 CONCLUSIONS

This paper describes the main features of the multi-agent system SIAM. It has been designed for an automatic detection and prevention of possible risks that could occur during the daily activities of elderly people at home. SIAM will contribute to extending the amount of time as much as possible that elderly people can reside in their own homes assisted continuously by an intelligent agent and using new information technologies.

SIAM is a project which is continuously being improving and this paper focused on the new features added. The first feature described was a fall detection system based on an inexpensive cheap and easy to find device and a neural network for pattern recognition of movements. Another feature described in the paper was the remote view of a scene when an emergency situation has been detected using a camera mounted on a low cost mobile robot. Finally, a new method of communication between SIAM and the user through digital TV has been presented. New features are planned to be added to SIAM in future works and the existing ones are being improved and reviewed.

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