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GR-MAS: Multi-Agent System for Geriatric Residences

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Abstract. This paper presents a multiagent architecture (GR-MAS) developed for facilitating health care in geriatric residences. GR-MAS (Geriatric Residence Multi-Agent System) contains different agent types and takes into account the integration within RFID, Wi-Fi technologies and handheld devices. The core of GR-MAS is an autonomous deliberative case-based planner agent called GerAg (Geriatric Agent for monitoring alzheimer patients). This agent, which allows adaptation and learning capabilities, has been designed to plan the nurses' working time dynamically, to maintain the standard working reports about the nurses' activities, and to guarantee that the patients assigned to the nurses are given the right care. A description of GerAg, its relationship with the complementary agents, and preliminary results of the multi-agent system prototype in a real environment are presented.

1 INTRODUCTION

There is an ever growing need to supply constant care and support to the disabled and elderly and the drive to find more effective ways to provide such care has become a major challenge for the scientific community [3]. During the last three decades the number of Europeans over 60 years old has risen by about 50%. Today they represent more than 25% of the population and it is estimated that in 20 years this percentage will rise to one third of the population, meaning 100 millions of citizens [3]. In the USA, people over 65 years old are the fastest growing segment of the population and it is expected that in 2020 they will represent about 1 of 6 citizens totaling 69 million by 2030. Furthermore, over 20% of people over 85 years old have a limited capacity for independent living, requiring continuous monitoring and daily care.

The importance of developing new and more reliable ways to provide care and support to the elderly is underlined by this trend [3], and the creation of mechanisms for monitoring and optimizing health care will become vital. Some authors consider that tomorrow's health care institutions will be equipped with intelligent systems capable of interacting with humans. Multiagent systems and architectures based on intelligent devices have recently been explored as supervision systems for medical care for the elderly patients, these intelligent systems aim to support them in all aspects of daily life, predicting potential hazardous situations and delivering physical and cognitive support. Multiagent systems together with the use of RFID and Wi-Fi technologies, and handheld devices offer new possibilities and open new fields such as the ambient intelligence that may facilitate the integration of distributed intelligence software applications in our daily life.

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2 GR-MAS: A MULTIAGENT SYSTEM FOR GERIATRIC RESIDENCES

GR-MAS (Geriatric Residence Multi-Agent System) is a multiagent architecture proposed for improving health care services and its integration within the complementary technologies. The GerAg agent, which is a deliberative planning agent, is the core of GR-MAS, and incorporates a planning mechanism that improves the medical assistance in geriatric residences by optimizing the visiting schedules. GR-MAS is a dynamic system for the management of different aspects of the geriatric center. This distributed system uses Radio Frequency Identification (RFID) technology for ascertaining patients' location in order to maximize their safety or to generate medical staff plans. The development of such multiagent system has been motivated for one of the more distinctive characteristics of geriatric or alzheimer residences, which is their dynamism, in the sense that the patients change very frequently (new patients arrive and others pass away), while the staff rotation is also relatively high and they normally work in shifts of eight hours. GR-MAS uses mobile devices and Wi-Fi technology to provide the personnel of the residence with updated information about the center and the patients, to provide the working plan, information about alarms or potential problems and to keep track of their movements and actions within the center. From the user's point of view the complexity of the solution has been reduced with the help of friendly user interfaces and a robust and easy to use multiagent system.

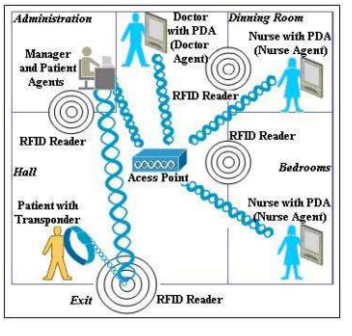

Figure 1. GR-MAS wireless technology organization schema

GR-MAS is composed of four different types of agent, as can be seen in Figure 1: Patient agent manages the patient's personal data and behaviour (monitoring, location, daily tasks, and anomalies); Manager agent plays two roles, the security control and the management of the medical record database; Doctor GerAg agent treats patients; and GerAg agent schedules the nurse's working day obtaining dynamic plans depending on the tasks needed for each assigned patient.

3 GERAG: AUTONOMOUS PLANNER AGENT FOR GERIATRIC RESIDENCES

GerAg is an autonomous deliberative case-based planner (CBP-BDI) agent [2] developed for integration within a multi-agent system named GR-MAS. The goal of this agent is to provide efficient working schedules, in execution time, for geriatric residences staff and therefore to improve the quality of health care and the supervision of patients in geriatric residences. Each of the GerAg agents is assigned to a nurse or a doctor of a residence, and provides also information about patient locations, historical data and alarms. As the members of the staff are carrying out their duties (following the plan provided by the agent) the initial proposed plan may need to be modified due for example to delays or alarms, in this case the agent is capable of re-planning in execution time. The CBP planner used by the GerAg agent identifies a plan, for a given nurse, to provide daily nursing care in the residence. It is very important to maintain a map with the location of the different patients at the time of planning or re-planning, which is why RFID technology is used to facilitate the location and identification of patients, nurses and doctors. The CBP Agent calculates the most re-plan-able intention (MRPI) as shown in [4], which is the plan than can be easily substituted by other in case the initial plan gets interrupted. In a dynamic environment, to have an alternative plan it is important to maintain the efficiency of the system. This agent follows the 4 stages of a CBR system (Retrieval, Reuse, Review and Retain) [1].

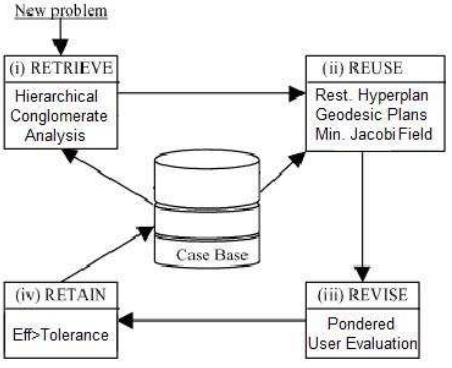

Figure 2. Case-based planning cycle

Figure 2 shows the steps carried out in each of the stages of the CBP system. When an interruption occurs, the system initiates a new CBP cycle, taking into account the tasks previously accomplished. That is, in the new retrieval stage, plans with a similar problem description to the current situation (after the interruption) will be recovered. The MRPI guarantees that at least some of the plans closest to the initial geodesic plan will be recovered (the rest of the plans are not valid anymore because of the restrictions, that the tasks have already accomplished, etc.) together with new plans.

4 RESULTS OBTAINED

The GR-MAS system has been tested over the last few months. During the testing period the system usefulness has been evaluated from different points of view. Figure 3 shows the average number of nurses working simultaneously (each of the 24 hours of the day) at the Residence before and after the implantation of the system prototype, with data collected from October 2006 to March 2007. The prototype was adopted on January 15th, 2007. The average number of patients was the same before and after the implementation. To test the system 30 patient agents, 10 GerAg nurse agents, 2 doctor agents and 1 manager agent were instantiated. The tests have focused on the GerAg nurse agents. As can be seen in Figure 3, the pointed line represents the average number of nurses required in the residence each hour of a day without GR-MAS. The vertical bars represent the same measure but after the implementation. As can be seen, the GR-MAS multiagent system helps the nurses to gain time, which can be dedicated to the care of special patients, to learn or to prepare new activities. The time spent on supervision and control tasks has been reduced substantially, as well as the time spent attending false alarms, while the time for direct patient care has been increased.

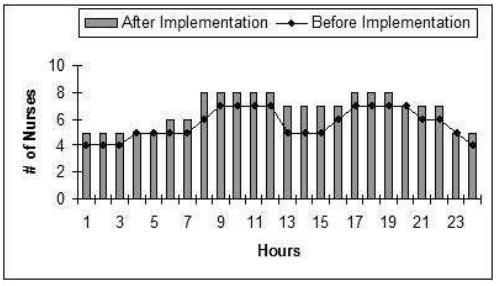

Figure 3. Number of nurses working simultaneously

5 CONCLUSION

In the future, health care for Alzheimer's patients, the elderly and people with other disabilities will require the use of new technologies that allow medical personnel to carry out their tasks more efficiently. One of the possibilities is the use of multiagent systems. We have shown the potential of deliberative GerAg agents in a distributed GR-MAS on health care, providing a way to respond to some challenges of health care, related for example to the identification, control and health care planning. In addition, the use of RFID technology on people provides a high level of interaction among users and patients through the system and is fundamental in the construction of the intelligent environment. Furthermore, the use of mobile devices, when used well, can facilitate social interactions and knowledge transfer.

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