A Multi-Agent Approach to Assist with Dressing in a Smart Environment

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Abstract. This paper proposes an approach to offer assistance with dressing for those persons with a form of cognitive impairment. The main underlying technical component in the solution is the use of a multi-agent system. A prototype was implemented, consisting of six agents, which received input in the form of simulated data. The system then has the ability to offer a recommendation as a person leaves their home environment in the form of a clothing suggestion. The decision for this is based partially on the external temperature and their current apparel. The long term aspiration of this work is to support persons with cognitive impairment to dress appropriately for environmental and social conditions.

Keywords: Activities of Daily Living, Cognitive Impairment, Dressing, Multi-agent System, Smart Environment.

1 Introduction

One of the biggest challenges in current research is to find ways to allow the growing population of elderly people to live more independently for longer within their own homes. Previous research has considered the use of technology as a popular solution to assist those with cognitive impairment [1]. Systems can be developed that aim to monitor and track Activities of Daily Living (ADLs) and subsequently remind or alert users or carers if required. This has the benefit of taking the burden off family members or carers who would otherwise have to personally assist the patient more frequently in addition to providing an increased level of independence for the person suffering from the impairment [2]. Through researching current systems and assistance already available to help in these cases, the ADL of dressing has to date received very little attention, from a technology solution perspective.

Systems developed make use of sensors and actuators to identify and monitor the environment to recognise the actions taking place and to adapt the environment accordingly. In order to do this they have assigned goals and decisions to fulfil; this also enables them to be known as software agents [3]. When agents are combined in order to work together to solve problems, they become a Multi-Agent System (MAS).

As a result more complex, effective systems, providing improved scalability and cooperation, can be developed [4]. This paper proposes a solution to assisting with the ADL of dressing through the use of a MAS.

In Section 2 a review of related work and relevant studies is provided. Work carried out to date is presented in Section 3 followed by a discussion of limitations faced and Future Works in Section 4.

2 Related Work

A study by Benhaji *et al.* developed a MAS dedicated to manage and control the movement of patients in medical care facilities. Patients and hospital resources, such as physicians and nurses, were represented by agents with their focus on creating a patient-centred system. A heterarchical architecture was used to ensure communication was achieved through negotiation, cooperation and coordination and that agents could be added or removed without major impact on structure or performance. Within this there are only two levels, the top containing the patient agent as the central component of the system and the bottom containing all other agents. The system allows the hospital to see where patients are assigned to and where free places may be. Limitations with this approach lay amongst the negotiation mechanism as conflict issues were found to cause problems for the system [4].

Matic *et al.* devised a system to monitor the activity of dressing and to identify common failures using a combination of RFID and computer vision. The 'AID-ME' system, standing for 'Automatic Identification of Dressing failures through Monitoring of patients and activity Evaluation' aimed to non-intrusively recognise and evaluate the accuracy of dressing through using information gained from the RFID tags and vision combined. They found that there were limitations when these systems were used on their own, however, once fused they found it provided a 10% higher recognition rate for detecting the incorrect order of dressing. In conclusion they stated that the integration of the two systems was required for the improvement in efficiency [5].

This research proposes a MAS to assist dementia patients with dressing in a smart environment. Whilst MAS have been used for processing data within smart environments, most have concentrated on low abstraction levels or domain-specific tasks [6]. Nevertheless, it would offer additional advantages to be able to build the context at a higher level, via the processing of raw data. This allows the agents to understand the semantic information, in turn enabling them to make the relevant decisions required to meet their goals.

3 Methodology

To date, a software solution has been created to expedite the prototyping, consisting of six agents: Decision, GUI, Door, Coat, Temperature and Template (Fig. 1 shows the methods and attributes of each agent). The Decision agent receives information from the Door, Coat and Temperature agents, making decisions based on their current states. The GUI agent's focus relates to the layout of the user interface as it contains buttons representing the door and coat, in addition to an input for temperature. Through the Door, Coat and Temperature agents' information, the Decision agent will decide upon an alert or action to be taken. Both the Door and Coat agents contain rules for their corresponding tasks. The state of these tasks is communicated to the Decision agent. If the state is 'true', this indicates that the door has been opened and 'false' if it is closed. The states of the Coat are represented as 'true' for taken and 'false' if it has not been taken. The Temperature agent contains the rules required to identify if the temperature input values exceed a predefined threshold value. It is set to represent 'true' if it is over 23 degrees and 'false' if it is below, indicating that it is cold. Finally the template agent, which simply exists to assign the layout and size of the GUI. An example of the system in action is as follows: if the Decision agent is told that the Coat state is true whilst the Temperature is true and the Door state is also true, the GUI will be told by the Decision agent to alert the user that it is too warm for a coat. These agents will communicate in order to make a joint decision on the appropriate alert or action to take (Fig. 2 shows the communication flow between each agent). Looking at the scenario where patients may dress inappropriately for the weather; for example, if the patient prepares to leave their home on a cold day without their coat, they would be alerted to lift a coat before they leave. This infrastructure has been put in place and example tested upon, using simulated data input by a human expert, in order to validate that everything is working as expected.

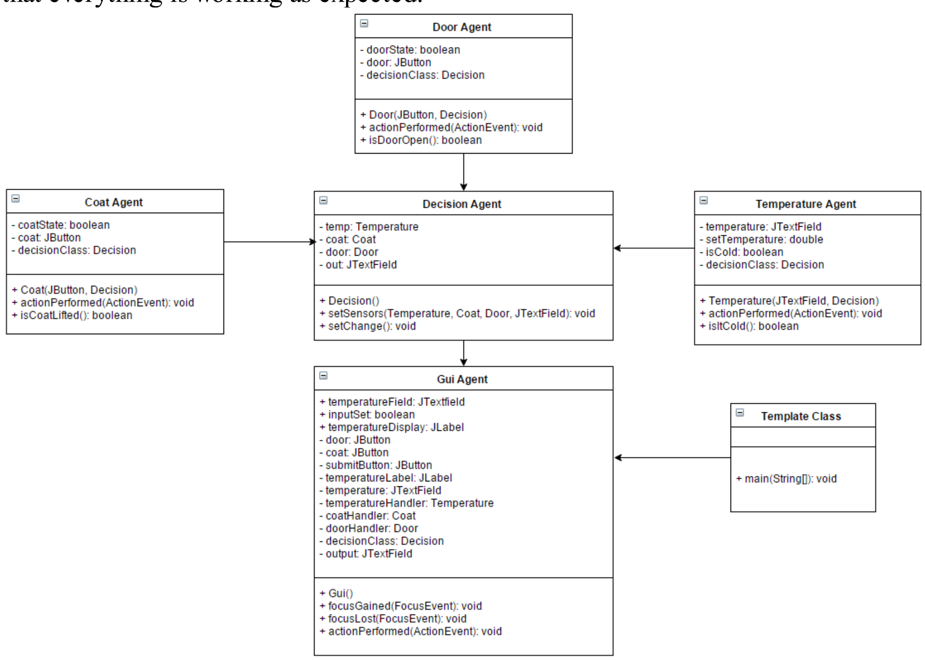

Fig. 1. Class Diagram showing the methods and attributes within each agent.

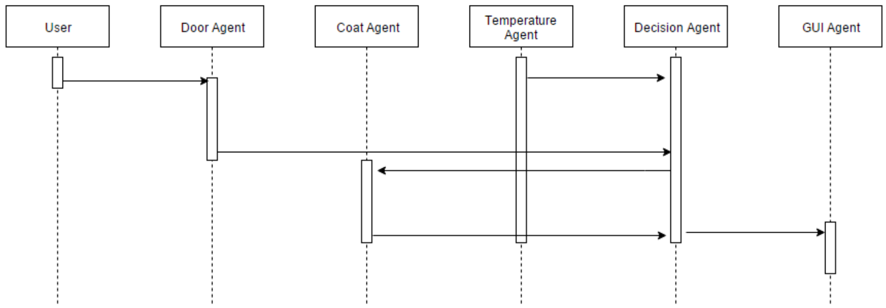

Fig. 2. Sequence diagram showing the communication between each agent and the user.

4 Discussion & Conclusion

This research aims to develop a MAS in a smart environment that will be able to assist with dressing for persons with cognitive impairment. It is hoped that it will advance not only help with dressing, however, also the implementation and use of MAS in smart environments on a large scale. Due to this work being at an early stage, limitations are present. This system is only partially created, before being able to implement this in a real life environment, sensors are the next step. The proposed solution will include a thermometer in place of the thermometer input; an RFID tag in a coat in place of the simulated coat event and a movement sensor on a door in place of the simulated door event. Once implemented, this system should address the issues previously highlighted in the Related Work section in that no conflicts should occur and the system will work efficiently with good coordination and communication among agents.

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