A Context and Situational Aware Multi-Agent System for Ambient Assisted Living Assistance and Support

A Context and Situational aware Multi-Agent system for Ambient Assisted Living assistance and support

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Abstract. Ambient Assisted Living solutions can potentially reduce the problem of the ageing population demographic. Software can be implemented using a Multi-Agent system (MAS). This can be both context and situational aware so that interventions offered may be specifically tailored to the individual and their environment. In particular, sensor deficits require significant attention to the issue of human computer interaction with older users. We provide an overview of current research in relation to situational awareness and assistive technologies. A generalized architecture and a selection of implementation scenarios are provided. This produces outputs which we analyze with respect to context and situational awareness.

Keywords. Ambient Assisted Living, multi-agent systems, human computer interaction, context awareness, situational awareness

Introduction

As part of an ongoing research project, a Multi-Agent System (MAS) is being developed that is being designed to augment and in some cases replace the care provided by a caregiver through tailored interventions and interaction methods. It will be able to self-configure interventions which are tailored to a specific individual based on their current requirements, the detected context and situational changes. Decisions will be made regarding the types of interventions and the most appropriate method to present these interventions to the individual through a multi-model interface will be chosen.

The extended abstract outlines the research and development that has been conducted into a Multi-Agent system (MAS) to help to support indivuals in an Ambient Assisted Living (AAL) scenario through a multi-model interface. It outlines the research areas which will be detailed and the research articles that will be discussed. A discussion on the motivation behind and the perceived contribution of the book chapter and the research and development that has been conducted is provided. There is an overview of the MAS including the agents and the repositories that will be further detailed. Sample requirements that an individual may have are outlined by Table 1. An overview of the results that will be detailed is provided.

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1. Research Areas that will be detailed

Examples of the research areas which are touched upon include Ambient Assisted Living (AAL) [1], [2], [3] and [4], Multi-Agent Systems (MAS) [5], [6], [7], [8], Human Computer Interaction (HCI) [9], [10], [11] and [12], Context Awareness [13], [14], [15] and [16] and Situational Awareness. [17], [18], [19], [20]. Further research areas may be discussed including quality of context [21], [22], [23], [24] data quality [25], [26], [27], [28] and sensor data fusion [29], [30].

2. Motivation and Contributions

The MAS is being developed to provide assistance and support to indivuals during the day and when they may be more vulnerable during the night. The research will build upon the research that has been carried out into situational awareness and provide an insight into how it may be applied to a Multi-Agent System (MAS) in an AAL environment so that interventions may self-configured and tailored to a specific individual and the correct method of interaction may be chosen.

2.1. Assisted Living assistance and support

One of the main motivations behind the research being conducted is to provide a means to provide assistance and support to indivuals such as older people in an assisted living scenario. As worldwide populations are predicted to increase over the coming years, it is becoming increasingly important to research, design and develop a means to provide safe, cost effective and worthwhile means to provide assistance and support in a home environment. It is thought that Multi-Agent systems may provide the best means to offer this and the MAS may be linked to several homes at a time. The MAS that is being researched and developed is designed to operate in an assisted living scenario to augment and in some cases replace the support that may be provided by a care person.

2.2. Scenarios being considered and relevance

It is thought that these example scenarios and others which are being developed are relevant as they help to illustrate what may occur in a real world assisted living scenario and will provide a means to test and validate the MAS. The scenarios are built from anonymized real world sensor data that has been gathered from an ongoing research project NOCTURNAL [31], which is investigating assisted living in relation to night time health care and dementia. The scenarios include ‘an individual getting out of bed and wandering,’ ‘entering kitchen, opening back door and leaving the kitchen with back door left open’ and ‘ an individual being restless during the night.’

3. Conceptual Architecture

The Multi-Agent system (MAS) architecture that will be detailed in the book chapter currently consists of several software agents and it is implemented in the Java Agent Development Framework (JADE) [32]. The MAS has several architectural layers

including the Context and Situational layer (reasoning across space and time), Information layers (maintaining relationships between space and time), Data layer (captures data from the sensors) and the AAL Environment Base Layer (communication protocols, activity, location and vital sensing, actuators and interfaces). These will be further discussed and the relationships between the agents and the layers shown. A brief overview of the agents is provided by Section 3.1. Other expected content includes state charts to show the changing states of the agents, conceptual architecture diagrams and figures showing the interactions that occur between agents which will be based on the Prometheus Methodology [33].

3.1. The agents

The Profile agent determines the method that will be used to carry out interactions with the individual. During the initial installation of the MAS, the individual or the MAS administrator inputs key profile data. This data includes visual and auditory aliments that the individual may be affected by and sample requirements are detailed by Table 1.

The sensor agent extracts sensor data from the sensor database and sends a formatted message to the context agent which contains details of the sensor event which has occurred. The context agent determines how the context has changed and updates the contextual knowledge repository and it also determines what situation changes have occurred. A contextual/ situational event message detailing the contextual and situational changes is sent to the Intervention Agent. The Intervention Agent determines the types of interventions which may be required and these are further tailored based on the current situation and individual requirements. Once the correct interventions have been determined, the intervention agent sends intervention messages to the Interaction Agent. The Interaction Agent makes use of the Intervention message and selects the most appropriate method to convey the intervention to the individual through an interface. The content of the interface is therefore selected by the Interaction agent. The interaction agent checks that the correct profile has been selected so that any interactions that may occur are worthwhile and meaningful to the individual.

3.2. The individuals requirements

In order for the individual to be able to respond to interventions and interactions it is thought to be important to consider the possible requirements that they may have. Example requirements that are being considered are outlined by Table 1 below. Once the requirements have been established, the profile agent is programmed with these requirements so that the method, in which interventions are put forward through the interface, may be tailored to the indivuals specific requirements.

Table 1 – Individual requirements being considered

Requirements	Explanation	Interaction Methods
No Sight	The individual may not able to see and therefore relies on auditory interactions	Auditory based interactions through the multi-model interface.
Limited – Moderate Sight	The individual may have issues with sight and may not be able to read standard sized text.	Combination of large text and icons, neutral colours and sound
Not able to hear	The individual may not be able to hear sounds or spoken dialogue.	Visual interactions, may include on screen dialogue, icons and text
Limited – Moderate hearing	The individual may have issues with hearing and may not be able to hear spoken dialogue.	A combination of visual interactions and loud auditory interactions
No specific requirements	The indivuals does not have any specific auditory or visual requirements	A combination of visual and auditory interactions

4. Results to be discussed in the book chapter

This section will outline the scenarios which were used for testing and detail the results and an example scenario that is being used for testing the MAS follows. *The person opens the back door and a door opening event is retrieved by database agent, the corresponding message is sent to the sensor agent as a sensor ("Back-Door, door contact, door opening, 15:45:00;"), this is sent to the context agent which extracts the relevant information Back door, door opening and a message is displayed, "Door opened." This message is sent to the intervention agent, which retrieves the correct intervention, in this case "alert that back door is open," this is sent as a message to the interface agent which chooses the correct means to interact with the indivuals and put the intervention forward, in this case a message is displayed "door is open.* The underlying data that has been used to build the scenario is consumed by the MAS and once this has occurred, the messages sent, message outputs, interactions and actions of the agents are observed and recorded to see if they match what is expected.

4.1. Message passing

The agents which form the MAS pass ACL Messages [34] to each other detailing what they perceive to be occurring. These are thought to be of importance because if the messages which are sent between the agents are incorrect, missing key information or not properly formatted then the MAS will not function. Key information regarding the Sensor events that have occurred, changes of context, required interventions and correct interactions to convey these interventions would not be available.

4.2. Responding to changes of context and current situation

From the devised scenarios it is possible to determine what had occurred in the environment and to extract any changes of context and situational. The data that that was used to devise the scenarios is consumed by the MAS and the messages which are sent between agents in response to this data is recorded. From this is it possible to see if

the agents have responded correctly to the contextual and situational changes. For example, during a scenario, an individual may open the back door, this should trigger the MAS to detect that the doors state has changed from a closed state to an open state. The expected response is for the MAS to put forward a door opening intervention through the multi-model interface.

4.3. Being aware of the time of day or night and tailoring interaction methods and types of intervention accordingly

Depending on the time of day and whether it is day or night, the types of interventions that occur and how they are put forward to the indivuals through the interface may change. As an example, if it is currently night time and the indivuals is detected to be restless, the interventions which take place will be designed to aid in helping the individual return to sleep. The interaction method used to convey the interventions will not cause sleep to be further broken and therefore will be based around playing calming music and providing gentle illumination of the room. This will be tested by changing the current time and observing how the MAS responds to the changes of time, what intervention messages are sent and what types of interactions occur.

4.4. Choosing the correct intervention and interaction method in response to the sensor events which have been detected

The sensor events that trigger an intervention, the intervention that will occur in response to a specific sensor event and the resulting messages that will be exchanged between the agents of the MAS will be detailed. This will be used to assess how the agents respond to the datasets which are consumed and the resulting intervention messages which are outputted by the intervention agent. In order to ensure that the correct method of interaction is chosen, each of the profiles (see Table 1) will be tested with several scenarios. For example, when testing the interaction methods under the ‘door opening scenario’ in the case of a person who has no sight, audio based interaction will be carried out. In comparison, if the individual has no specific requirements.

5. Future Work

The next version of the MAS may be able to consume sensor data from a different Assisted Living projects and scenarios. It is envisaged that this may be achieved by adding intelligence to the MAS so that it may operate with sensors and subsequent sensor data from different AAL environments. Current thinking behind this includes making use of the various context management tools, examples including the context management toolkit [35] and the Java Context Framework [36] to add a means to manage context and carry out reasoning on this context. Another area which will be discussed is how to handle multiple events which occur in quick succession so that the MAS does not respond to each individual event and instead can intelligently decide on which events to respond to.

Conclusion

Research into Multi-Agent Systems (MAS) can help to support an individual's routine through positive interactions and therapeutic interventions. Situational and context awareness are thought to be important aspects of this research. The MAS is being designed to operate in an assisted living scenario and it is required to provide worthwhile, adequate and tailored assistance and support to an individual. In order to achieve this, the MAS needs to be aware of any changes with the individual's current situation, situational changes which occur in the environment and be aware of changes of context so that the interventions offered are tailored to the activity which is taking place. By combining the outlined research areas with a Multi-Agent System (MAS), interventions which are carried out can be self-configured and tailored based on the current situation, detected context and the individual's requirements. This is thought to be important in providing adequate and worthwhile assistance and support in an Assisted Living scenario. The book chapter will detail the research behind the development of the Multi-Agent System for Ambient Assisted Living and provide an insight into the results that have been obtained.

Research in this area is thought to be worthwhile as worldwide older populations are continuing to grow and it is becoming increasingly important to develop Assisted Living solutions which are able to provide tailored assistance and support.

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