Conceptual Design of a Generic Nodal Abstraction (GNA) for a Human-Agent Collaboration Systems

IOP Conf. Series: Materials Science and Engineering **551** (2019) 012043 doi:10.1088/1757-899X/551/1/012043

Conceptual Design of a Generic Nodal Abstraction (GNA) for a Human-Agent Collaboration Systems

Khudhair Abbas Mohammed[1], Mazlina Abdul Majid[1] and Mohd Sharifuddin Ahmad[2]

[1]Faculty of Computer Systems & Software Engineering, University Malaysia Pahang, Kuantan, Pahang, Malaysia.
[2]College of Computer Science and Information Technology, Universiti Tenaga Nasional, 43000 Kajang, Selangor, Malaysia.

E-mail: khudhair86@outlook.com

Abstract. The issues of modelling software agents in collaborative systems present some problems and difficulties caused by the diversity of tasks and the procedures attached to them. Consequently, such diversity poses a critical challenge to implement scheduled tasks. In this paper, we propose collaborative human-agent system in which a software agent collaborates and cooperates with its human counterpart in several job positions of an organization. The goal of the GNA approach is to improve collaboration between humans when performing tasks within a workflow process. The GNA is built based on the concept of a node which comprises of a human, agents, and their shared functions. This concept espouses the notion that agents could be deployed to assist humans in many common workflow processes and to handle mundane tasks. Furthermore, a multi-agent system is advocated as an application or platform for managing distributed data. Specifically, this paper describes a conceptual design of a generic approach based on the notion of nodes to construct a Generic Nodal Abstraction (GNA) approach that is deployable as a modeling and simulation platform for organizational processes.

1. Introduction

An agent is a software entity having autonomous behaviour that provides convenient outcomes in several domains such as transportations, e-commerce, and healthcare. The software agent technology could be applied in a collaborative process to resolve problems that humans face while performing their jobs (e.g. heavy workloads). Developing an agent system that possesses the ability to collaborate in a natural way with humans is considered as a fundamental challenge [1].

Nowadays, many organizations work with complex software systems which have become gradually incapable to deal with the huge amount of information. Therefore, there has been a demand to deploy software agents to assist humans in performing their tasks automatically. For instance, autonomous agents infer their own decisions based on stored resources in a wide range of areas. This ability could be exploited to transform "modular" software toward its model of perfection and enable a system to be mainly self-managing, as they can be provided with the knowledge to deal with special situations [2].

Collaborative agents work together to implement some work processes that leads to the achievements of some common goal. Subsequently, to design a collaborative agent, there are critical factors that need to be considered such as the cognitive model of the agent and the execution of reasoning tasks. For example, Huang et al. proposed a self-awareness agent model that contains two

personality traits (super-ego and ego) and includes an external learning mechanism and internal cognitive capacity [3]. The model claims to provide better collaborative performance over classical agent models and improved agent reasoning capabilities.

Consequently, in this paper, we propose Generic Nodal Abstraction (GNA) approach of agents that assist humans in doing their jobs based on the concept of nodes. The term, "nodal abstraction" comprises a human and one or more software agents with their mediator agent, both work collaboratively in a virtual workspace, i.e. a node. This paper also shows how such node is deployed to develop an applicable human-agent model. This approach should be able to arrange several agents to perform tasks cooperatively and achieve the goal more efficiently.

The paper is organized as follows: In Section 2, we highlight and describe the related work in this area. In Section 3, we describe a preliminary concept of a node, with which a model of collaboration is built and present an example of interacting nodes. Finally, in Section 4, we conclude the paper with a brief discussion of future research extensions to improve our system.

2. Related Work

The literature offers a plethora of approaches that have been proposed to model a multi-agent system, but there is no unique method for agent modelling. Therefore, researchers have continuously work on the conceptualization of complex systems, which composed of several agents. However, some models only attempt to emulate the external process of a system and neglect the internal processes which involve how humans and agents collaboration within the environment.

2.1 Agent Modelling

In mid-1950's, the concept of the agent was started by John McCarthy [4] and established by Oliver G. Selfridge and several years later by [5]. Usually, an architecture of an agent defines its main structure so that every agent has a specific internal architecture which is different from other agents. Consequently, the internal architectures of such agents are presented by many modelling languages, for instance, the Unified Modelling Language (UML) [6]. Therefore, a new abstraction of distributed management system is required to fill the gap due to centralized approaches drawbacks. In the current work, a Generic Nodal Abstraction (GNA) approach for a human-agent collaboration system process is presented for the management work flow process.

Humans aspire to collaborate in order to achieve their commons goals, but they may face a less risky, less challenging level of relationship. As their relationships improved over time, these might enable them to collaborate on other issues. For these different levels of relationships, humans' willingness is needed before choosing the most realistic level for a given set of participants. When humans need to join a venture, they hold themselves accountable to a level of relationship that is beyond their current capabilities.

3. The Generic Nodal Abstraction (GNA) Approach

In this approach, the key points discussed are the importance of modelling a generic architecture for intelligent agents, which has the ability to develop any kind of agent-based systems. Additionally, we propose an innovative model that consists of intelligent nodes. Each node comprises a human and one or more agents to build flexible human-agent collaboration, utilizing multi-agent systems (MAS) benefits and promote human-agent communication.

Our approach operates based on collaborative nodes which consist of a model of a human's job position within an organization, software agents, workflow, and resources. The collaborative nodes enactment architecture realizes the human position and its functions with selected functions of agents. The functions are modelled as actions with which intelligent agents perform to assist its human counterpart in cooperative processes.

A high-level general flowchart of the proposed approach shown in figure 1 illustrates the significant steps to establish the nodes.

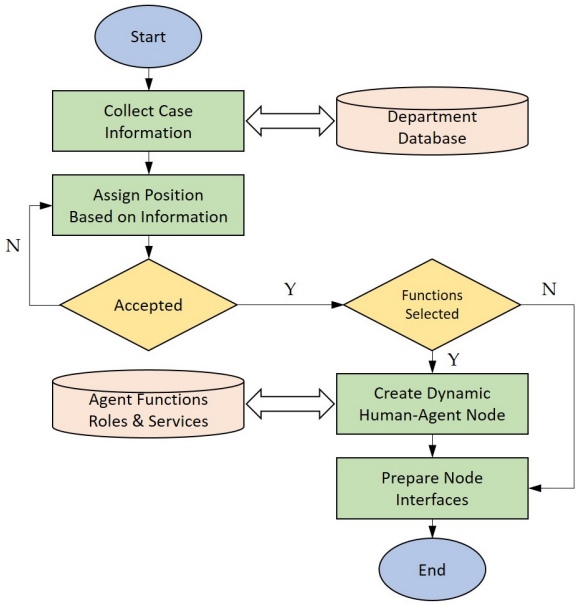

Figure. 1. Flowchart of GNA approach

The outcome of implementing the GNA approach is a human-agent collaborative model which espouses the notion that agents could be deployed to assist humans in many common workflow processes to handle mundane tasks. Progressively, agents with their mediator agent are tightly coupled to their human counterpart. The human-mediator agent together embodies a symbiotic relationship between a human and his/her agents. Note that, the Mediator agent in the node acts as consultant for its human counterpart and it is a link between the human and a number of agents created in the node. We model such symbiosis as a virtual node which consists of the human and one or more agents with services of the mediator agent. Figure 2 shows the concept of a virtual node which constitutes the human-mediator agent and his/her agents.

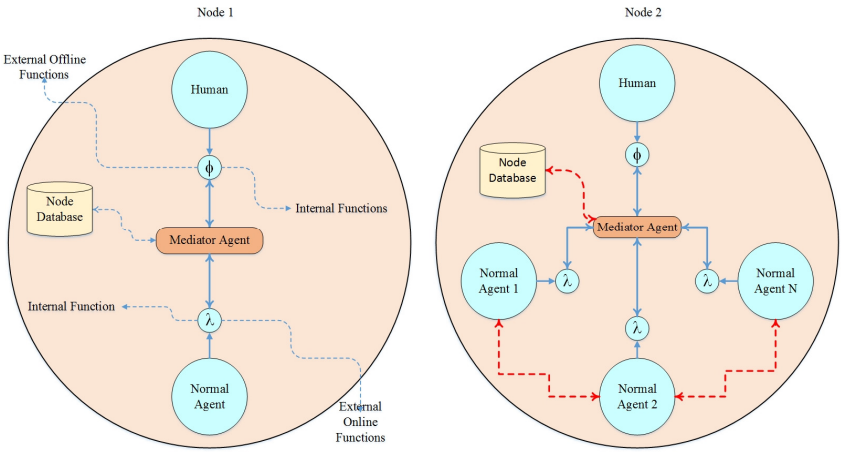

Figure.2. Generic Nodal Approach Concept

In Node 1 of the figure, ϕ represents a human's set of functions and λ represents an agent's set of functions. Node 1 shows a human with only one assistant agent via a mediator agent, presumably to handle all the mundane tasks of its human counterpart. In Node 2, the human is assisted by three agents, the number of agent is selected according the node mediator agent which handles one or more specific tasks for its human counterpart. The human's and agents' functions are selected during the create mode, in which relevant human and agent functions are selected to instantiate a node. Depending on the functions selected, the node represents a unique intelligent entity, which behaves and operates within a collection of other unique nodes to achieve some common goals. Consequently, in the create mode, a user could define the following nodes:

- Node 1 (NH): A human-only node, when no agent's functions are selected,
- Node 2 (MDA): A mediator agent with one agent node, when no human's functions are selected,
- Node 3 (HMDA): A human-mediator agent with one agent node, when relevant human's and an agent's functions are selected,
- Node 4 (HMDAs): A human-mediator agent with various agents node, when relevant human's and many agents' functions are selected.

The significant roles of mediator agents are to meet its design objectives, ability to receive data from the environment, choose suitable agent or many agents, and act to change such an environment. Accordingly, the objectives and tasks assigned to the mediator agents are performed when such agents follow the 'route' of the target step-by-step. Almost all the route is searched over the Internet, which can be a proactive search or by using the Semantic web.

4. Conclusion And Further Work

A software agent is considered as an indispensable application in most workflow processes management. The issues of modelling software agents face critical obstacles and difficulties. Initially, the design started from architectural step until it becomes a comprehensive model. Several challenges occur to determine agent tasks especially when the model implements scheduled tasks practically. However, the architectural design of the Generic Nodal Abstraction (GNA) approach is presented to be a fundamental solution. Moreover, our GNA approach significantly reduces the workload process by implementing a multi-agent system in order to assist its human counterpart. Additionally, this approach offers a solution for the traditional agent modelling which being applied in various organizations. In our future work, we shall develop a variety of nodes and implement several workflows to animate some business processes

Acknowledgements

This study is supported and financed under Postgraduate Research Scheme Grand (PGRS 160319) from University Malaysia Pahang (UMP).

References

[1] Chen W *et al* 2007 *Proc. of the AAAI, Distributed Intel Sys,* Virginia, USA, 38.
[2] Albus J S 2001 *Eng of Mind : An Intro to the Sci of Intel Syss.*
[3] Huang C Y *et al* 2011 *9th World Congress on Intel Control and Automation,* Taipei.759.
[4] Bradshaw J M 1997 *Software agents*: MIT press.
[5] Kim M *et al* 1999 *IEEE Int Fuzzy Sys. Conf Proc* Seoul, South Korea. **1** 321.
[6] Gonçalves E J T *et al* 2015 *J. of Sys and Soft*. **108** 77.