

A Workload Manager: The Pre-assessment in Sincere Software Agent Environment

Nur Huda Jaafar

*Faculty of Computer and
Mathematical Sciences,*

*Universiti Teknologi MARA Johor,
KM12, Jalan Muar, 85009, Segamat,
Johor, Malaysia*

nurhu378@johor.uitm.edu.my

Azhana Ahmad,

Mohd Sharifuddin Ahmad

*College of Computer Science and
Information Technology,*

*Universiti Tenaga Nasional,
Putrajaya Campus, Jalan IKRAM-
UNITEN, 43000 Kajang, Selangor
{azhana, sharif}@uniten.edu.my*

Nurzeatul Hamimah Abdul Hamid

*Faculty of Computer and Mathematical
Sciences,*

*Universiti Teknologi MARA,
40450 Shah Alam,
Selangor, Malaysia*

nurzeatul@tmsk.uitm.edu.my

Abstract—Instilling an ethical behaviour in software agent environment can influence the agent to do ethical and rational actions that brings about positive impacts towards its environment. Sincerity is one of an ethical behaviour that can be considered for instilling in software agent environment, especially for encouraging the cooperation in completing tasks within an agent community. However, a mechanism to avoid imbalance in workload between software agents should be established to avoid the sincere agent from taking many tasks from its teammates until it cannot timely complete its own task. In our study, we present three evaluators in Workload Manager: (1) permission of getting favour evaluator, (2) workload calculator and (3) the progress of a worker agent's current task. These evaluators are used to evaluate the capability of an agent before taking any task from its teammate and also to determine the right time for the agent to offer the favour to its teammate. The interaction of the Workload Manager and the agent community is presented to show how it works in sincere software agent environment.

Keywords—*software agent; sincerity; workload manager; teamwork; Task delegation*

I. INTRODUCTION

In the modern world, autonomous systems are all the rage. The prevalence of autonomous systems in society shows that they have been widely accepted by humans, especially in assisting humans to perform their tasks [1]. The growing capabilities of this kind of systems are leading to an increased potential for impact on human society [2]. For example, the unmanned vehicle technology such as drone brings many benefits towards human life. The characteristics of drone help human in many areas such as military, surveillance, agricultural and construction [3].

Software agent is a technology that supports the growth of autonomous systems. The capabilities of agents that can perform certain actions on behalf of humans motivate

researchers and developers to exploit these capabilities [4]. It also has the capability to work in teams to save time for completing scheduled tasks [5]. On behalf of humans, software agents can make decisions on certain conditions. This capability helps to ease the burden on humans, but if it is not properly reconciled, it would negatively impact humans. For example, if a military drone carrying explosives detects movements on the ground and drops a bomb, it may demolish the wrong target.

Our responsibility as a software agent developer or researcher is to prevent agents from performing unwanted actions. A design error could cost many lives and destruction to properties [1]. So, instilling ethical behaviour in software agents would prevent agents from performing any wrong actions. The adaption of human moral values such as sincerity in performing task in software agents is a sound strategy to avoid agents from making wrong decisions [1].

Although instilling of human ethical behaviour in a software agent environment may bring about positive impacts for humans, a mechanism to balance the roles of agents in the community is necessary. Our research proposes a Workload Manager for this purpose. This feature is created to provide a pre-assessment operation for agents before they start a new task or help their teammates to complete the task. The reason for this pre-assessment is to ensure that agents are capable of completing all their current tasks while at the same time receiving a new workload.

This paper presents the latest work-in-progress in modeling sincerity in a software agent environment. The next section discusses the related work in this area. Then, we show the interaction between the Workload Manager and the agent community in sincere software agent environment and the formulas involved in formulating a Workload Manager before we conclude the paper.

II. RELATED WORK

Software agent is a technology that primarily plays its role as an assistant to humans in performing a certain task [6], [7]. The capability of a software agent to cooperate with its team members, coordinate its works within the community [8]–[10] are advantages of the agent to react to any situation in a dynamic environment. By having these capabilities, it also gains the human's trust as an authority in decision making at a certain stage of execution. This situation encourages the research in autonomous systems in various fields to explore further for commercial purposes.

Although the number of autonomous systems that has been commercialized is increasing and showing positive growth, we need to consider the issues of negative impact requiring control of the agent to be on the right track of its role. The negative actions of agent can be controlled by instilling ethical elements in software agent environment [11], [12]. Ethical behaviour in systems is also known as machine ethics, which is an applied ethics proposed by researchers to develop systems that perform its functions ethically [11].

Many research in machine ethics have adapted human behaviour in the studies for implementing ethical behaviour in software agent environments. Previous research in this field prove that the instilling of human behaviour in machine environment such as software agent environment brings many benefits; especially in assisting human to performs tasks [6], [13].

Sincerity is one of the human ethical behaviours that we can consider to be instilled in a software agent environment. In the real world, it has been proven that sincerity produces positive impacts on a human community. Sincerity offers inherent control of humans from committing the wrong actions [14], [15]. By having this behaviour, it can improve the quality of live for ourselves, communities and organizations [16]–[19].

However, to instill a human ethical behaviour like sincerity in a software agent environment, we need to consider the technical aspects of it. Understanding the characteristics of a software agent and its environment is very important in instilling sincere behaviour in an agent environment. The concept of belief-desire-intention (BDI) architecture of an agent needs to be considered [20] to design the rules for enforcing sincerity behaviour in the environment as it is the agent's main component that determines the agent's actions based on the current conditions and its utility.

The pre-assessment feature that connects to the Belief-Desire-Intention (BDI) agent architecture is a good strategy for evaluating the capability of agents in taking up certain tasks. This is to protect the agents from committing certain unintended actions that would create negative impacts on the services. In software agent environment, it uses the BDI as abstraction for the description of a system's behaviour [21]. Using the BDI, the deontic logic, epistemic logic and action logic can be constructed [22]. The deontic logic covers the concept of obligation, permission and forbidden. The epistemic logic shows the thing that agent knows and belief, while the action logic allows agent to reason about an action.

III. INTERACTIONS BETWEEN WORKLOAD MANAGER AND AGENT COMMUNITY

The interactions between the Workload Manager and the agent community are shown in Figure 1. These interactions determine when the agents receive signals from the software agent environment for allowing them to get or offer a favour.

A. Agent Community

There are three types of agents in the agent community; head of department agent; A_{HOD} , worker agent; A_w and teammate agent; A_{tm} . The highest level in the agent community is the A_{HOD} . An A_{HOD} is the head of department in a sincere software agent environment. Its role is to monitor the work performance of all agents under its responsibility. A_{HOD} has the authority to give instruction to its agents to do any tasks. It needs to ensure that all tasks under its department complete on schedule. So, it has the authority to instruct the agents under its supervision to take over a task from a teammate agent in case the agent appears to have a problem of completing the task on time. Besides that, the A_{HOD} also has the authority to decide whether to allow or deny its agents to offer help to the agents from other departments.

A_w and A_{tm} have the same responsibility and authority. Both need to perform and complete their tasks in a certain duration of time. We describe the A_{tm} as a teammate of A_w . In certain conditions, they need to work together to complete a task. There are two types of tasks they need to perform; routine task and special task. A routine task is a regular task that the agents need to perform based on their job scopes. This kind of task is assigned to the agents automatically after considering the workload calculation for each agent. A special task is a non-regular task that is not assigned automatically. By having special tasks, agents have heavy workloads because the tasks are given without considering the workload calculation. The A_w and the A_{tm} offer help to its teammate in order to ensure that the tasks are completed on schedule. However, they can only offer their help after a Workload Manager evaluates their capabilities in performing their current tasks.

B. Workload Manager

The function of a Workload Manager in a sincere agent environment is to monitor the performance of agents in completing their tasks. It evaluates whether an A_w is capable of having other tasks either a new task or a task from an A_{tm} . The Workload Manager controls when the A_w may get help from its teammates and the A_w offers help to its teammate based on the evaluators in the Workload Manager. The Workload Manager needs the progress of task for each agent for running all evaluators. The evaluators in the Workload Manager are explained in the next section. The role of a Workload Manager is very important in order to ensure that the A_w can complete its tasks while giving help to A_{tm} . It is also to avoid the A_w from overly relying on its A_{tm} for completing the tasks.

C. The Progress of A_w 's Current Task; PT_c

PT_c is a formula for evaluating the progress of an A_w 's current tasks. The purpose of this assessment is to evaluate the A_w 's capability to complete all its tasks on schedule while at the same time handling its teammate's task. The A_w can only handle the task from its teammate if:

1. Each of its current task, T_c , completed $\geq 60\%$
2. The remaining days to complete the task, $D_c \geq 50\%$

So, based on the above conditions, we formulate the PT_c as:

$$T_c \text{ complete} \geq 60\% \wedge D_c \geq 50\% \rightarrow PT_c \quad (3)$$

V. CONCLUSION AND FUTURE WORK

The Workload Manager is one of the important components in sincere agent environment. There are three evaluators in the Workload Manager: (1) permission of getting favour evaluator, (2) workload calculator and (3) the progress of A_w 's current task. With these evaluators, it plays the role in evaluating the capabilities of agents in accepting a new task or taking over its teammate's task.

These assessments are very important for balancing the tasks distribution within the agent community. The objective of instilling sincerity behaviour in an agent environment is to reduce the selfish behaviour in agents. Although working in teams and the concept of cooperation has been existing in agent environment, a rational agent without sincerity only helps its teammate if they have the same goal. By instilling the sincerity behaviour in an agent environment, it encourages the agents to offer help to its teammate although they do not have the same goal. However, a mechanism to control the agent from offering help while neglecting its own tasks must be established to avoid other problems that negatively impact the quality of products or delivery of services.

By having the Workload Manager in sincere agent environment, it ensures that an agent is able to complete all its tasks while helping out its teammate's task. It also avoids the agent from having the attitude of relying on its teammate because the Workload Manager only allows the agent to get help from its teammate if it meets certain conditions.

In our future work, we shall implement a suitable belief-desire-intention architecture for sincere agent environment and connecting it with the Workload Manager. The integration of the Workload Manager and sincerity evaluator must also be done to complete the structure of sincere agent environment.

VI. ACKNOWLEDGEMENTS

This work is supported by the UNITEN BOLD Project. Grant Ref. No. 10289176/B/9/2017/30.

REFERENCES

- [1] S. Omohundro, "Autonomous Technology and the Greater Human Good," *J. Exp. Theor. Artif. Intell.*, vol. 26, no. Issue 3, pp. 303–315, 2014.
- [2] S. Russell, D. Dewey, and M. Tegmark, "Research Priorities for Robust and Beneficial Artificial Intelligence Stuart," *AI Magazine*, pp. 105–114, 2015.
- [3] D. Floreano and R. J. Wood, "Science, technology and the future of small autonomous drones," *Nature*, vol. 521, no. 7553, pp. 460–466, 2015.
- [4] N. R. Jennings, L. Moreau, S. R. D. Nicholson, S. Roberts, and A. R. T. Rodden, "On Human Agent Collectives," *Commun. ACM*, vol. 57, no. 12, pp. 80–88, 2014.
- [5] S. A. Mostafa, M. S. Ahmad, A. Mustapha, and M. A. Mohammed, "A Concise Overview of Software Agent Research, Modeling, and Development," *Softw. Eng.*, vol. 5, no. 1, pp. 8–25, 2017.
- [6] A. Signoretti, A. Feitosa, A. M. Campos, A. M. Canuto, J. C. Xavier-Junior, and S. V. Fialho, "Using an Affective Attention Focus for Improving the Reasoning Process and Behavior of Intelligent Agents," in *2011 IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology*, 2011, pp. 97–100.
- [7] J. Saunier and H. Jones, "Mixed Agent / Social Dynamics for Emotion Computation," in *Proceedings of the 13th International Conference on Autonomous Agents and Multiagent Systems (AAMAS2014)*, 2014, pp. 645–652.
- [8] M. Borsato and M. Peruzzini, "Collaborative Engineering," in *Concurrent Engineering in the 21st Century: Foundations, Developments and Challenges*, J. Stjepandić, N. Wognum, and W. J. C. Verhagen, Eds. 2015, pp. 165–196.
- [9] Z. Yan, N. Jouandeau, and A. A. Cherif, "A Survey and Analysis of Multi-Robot Coordination," *Int. J. Adv. Robot. Syst.*, vol. 10, p. 1, 2013.
- [10] G. Jiang, B. Hu, and Y. Wang, "Agent-based simulation approach to understanding the interaction between employee behavior and dynamic tasks," *Simul. Trans. Soc. Model. Simul.*, vol. 87, no. 5, pp. 407–422, Oct. 2010.
- [11] M. Anderson and S. L. Anderson, "Robotics Robot Be Good," *Scientific American*, pp. 72–77, Oct-2010.
- [12] N. H. Jaafar, M. S. Ahmad, and A. Ahmad, "Operational Rules for Implementing Sincere Software Agents in Corrective and Preventive Actions Environment," *Comput. Intell. Inf. Syst.*, vol. 331, pp. 307–314, 2015.
- [13] W. Liu, L. Zhou, W. Xing, and B. Yuan, "Modeling human-like autonomous behaviors and movements of virtual humans in real-time virtual environment," *IEEE Symp. Comput. Commun.*, pp. 546–549, Jun. 2010.
- [14] J. Parrott, *Sincerity, Honesty and Goodwill in the Qur'an and Sunnah*. Center for Islam and Religious Freedom (CIRF), 2017.
- [15] A. M. Jamaluddin and A.-Q. Ad-Dimasqi, *Mutiara Ihyat' Ulumuddin: Hak Milik Muslim Imam Al-Ghazali*, 5th ed. Shah

Alam: Illusion Network, 2013.

- [16] A. Caza, G. Zhang, L. Wang, and Y. Bai, "How do you really feel? Effect of leaders' perceived emotional sincerity on followers' trust," *Leadersh. Q.*, vol. 26, no. 4, pp. 518–531, 2015.
- [17] Z. Mat, S. A. Basir, and J. Zanariah, "A Study on Practice of Islamic Professional Ethics in Shaping an Ethical Work Culture within Malaysian Civil Service Sector," *Asian Soc. Sci.*, vol. 11, no. 17, pp. 28–34, 2015.
- [18] J. P. D. Di Zhang, "Quality alone is not enough to be trustworthy: The mediating role of sincerity perception," *Int. J. Pharm. Healthc. Mark.*, vol. 8, no. 2, pp. 226–242, 2014.
- [19] A. Öztaş, S. S. Güzelsoy, and M. Tekinkuş, "Development of quality matrix to measure the effectiveness of quality management systems in Turkish construction industry," *Build. Environ.*, vol. 42, no. 3, pp. 1219–1228, Mar. 2007.
- [20] D. Vanderelst and A. Winfield, "An architecture for ethical robots inspired by the simulation theory of cognition," *Cogn. Syst. Res.*, vol. 48, pp. 56–66, 2018.
- [21] F. R. Meneguzzi, A. F. Zorzo, and M. Da Costa Móra, "Propositional planning in BDI agents," in *Proceedings of the 2004 ACM Symposium on Applied Computing*, 2004, pp. 58–63.
- [22] V. Wiegel, M. J. Van den Hoven, and G. J. C. Lokhorst, "Privacy, deontic epistemic action logic and software agents. An executable approach to modeling moral constraints in complex informational relationships," *Ethics Inf. Technol.*, vol. 7, no. 4, pp. 251–264, 2005.
- [23] N. H. Jaafar, M. S. Ahmad, and A. Ahmad, "The Rationality of Sincere Software Agent in Task Completion," in *The International Symposium on Agents, Multi-Agent Systems and Robotics 2016 (ISAMSR 2016)*, 2016.