Formulation of Mandatory Task Algorithm Using Task Prioritization Technique

Sean Goh Ka Hong
College of Computer Science and Information Technology
Universiti Tenaga Nasional
Kajang, Malaysia
seangohkahong@hotmail.com

Azhana Ahmad, Alicia Tang Yee Chong
College of Computer Science and Information Technology
Universiti Tenaga Nasional
Kajang, Malaysia
{azhana, aliciat}@uniten.edu.my

***Abstract*— Task is defined as a set of actions in order to achieve a specific goal. A mandatory task is known as an important and urgent task that needs to be completed first before finishing other tasks. This study presents the formulation of an algorithm to assist and automate robotic appliances in selecting which incoming task needs to carried out first in real time without any much human intervention. The simulation using software agent technologies to simulate and predict real life events with human like precision. We use Analytical Hierarchy Process (AHP) technique to rank the goal, the incoming task and the mandatory task. We discovered that the algorithm has a higher consistency in task prioritization compared to the two other computer scheduling algorithm.**

Keywords—task complexity; mandatory task; goal; goal deliberation

I. INTRODUCTION

Task is defined as a set of actions that are carried out in order to achieve a specific goal. Determining which task that needs to be executed first is important as by completing the correct sequence tasks will enable task doers to complete all given tasks efficiently.

A goal task, *GT*, is the primary task to be completed from the beginning t_0 till the end of timeline t_n by carrying out a series of action including deciding which incoming conflicting task to carry out first. An incoming task, *IT*, is defined as new or additional task that is entering the task timeline at a specific time of t[i] with the limit from the beginning t_0 till the end of timeline t_n. A mandatory task, $MT \in IT$, is defined as a task or goal that is both important and urgent that must be completed. AHP is a decision making technique created by [1] used in assisting a person to choose between intangible choices

In our last publication [2] we discussed the components of a Mandatory Task (*MT*). The studies we looked into include the complexity and components that make up a MT and the factors that is used to determine if a task is mandatory. The factors include Task Difficulty (*TD*). Prior Knowledge (*PK*) and Time Pressure (*TP*). We also review some research areas such as task allocation techniques used in agent based system

In this paper, we discuss the conceptualization of Mandatory Task Classification Algorithm (MTCA) using AHP and comparing our algorithm with two other monochronic computer scheduling algorithm. Our discussion begins with Section II presenting related works and section III discusses about the formulation of the algorithm. Section IV presents the simulation setup and the discussion. The final section is the conclusion of this paper.

II. RELATED WORKS

Task complexity is defined as the study of task characteristic which can help in predicting human behavioural and performance.

A. Mandatory Task Conceptualization

Based on all the literature, Mandatory Task (*MT*) is defined as an important and urgent task that needs to be completed first before proceeding to complete other given tasks. We obtained the definition of *MT* by reviewing task and time management techniques. Based on the time and task management techniques, we determined that the task with the highest priority is both important and urgent [3]–[7].

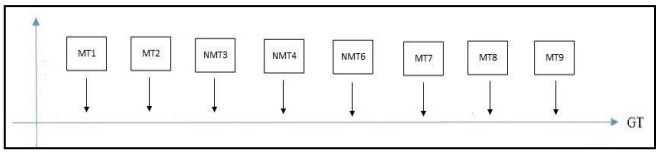

Fig. 1: MT occurences

Figure 1 shows MT may occur along the timeline. The task doer have to decided which task to be implemented first or to decided which mandatory task to attended first.

There are three main factors used to determine if a task is mandatory. These three factors are Task Difficulty (*TD*), Prior Knowledge (*PK*) and Time Pressure (*TP*). *TD* is defined as a person's perception of how much effort is needed to complete a task. *PK* is defined as previous knowledge or experience that task doers can recall to help assist carry out current task. *TP* is

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defined as a stress felt by task doers to achieve a goal under time constraints environment.

B. AHP Calculation

We review the literature relating to the calculation process of Analytical Hierarchy Process (AHP) [1]. We used AHP as part of calculation of intangible factor values of *TD*, *PK* and *TP*. AHP involves two separate stages of calculation, both involving the use of matrices. The end product of AHP are choices of alternatives that bear tangible values. In the end we looked into Modified Maximum Urgency First (MMUF) [8] and Deadline Monotonic Scheduling [9] as two other more monochronic algorithms to be compare to Mandatory Task Classification Algorithm. We compare all these three algorithm as part of fulfilment of our third objective of our study which is to simulate the mandatory task classification algorithm with the aim to show the advantages and disadvantages compared to conventional monotonic task prioritization algorithm.

III. FORMULATION OF THE ALGORITHM

In this formulation, there are three important parts in conceptualizing the mandatory task; goal task, incoming task and mandatory task.

A. Goal Task, Incoming Task and Mandatory Task

Goal Task (*GT)* is the primary task an agent aims to completer from the beginning will the end of task timeline by carry out specific actions including deciding which incoming task should be completed first. Incoming Task (*IT*) is defined as a new or additional task that is entering a task timeline in a specific time within the limit of the beginning and end of timeline. Mandatory tasks (MT) are tasks which are both important and urgent that must be completed first.

Based on the definitions provided, *GT* is the primary goal that is given to an agent that is to be completed in a certain time. The concept of setting a *GT* is because MTCA is a monochronic task prioritization algorithm. In a monochronic task prioritization scenario, an agent can only execute one task at a time, hence, we create the term of *GT*. *GT* is the current task an agent is trying to complete while deciding if any *IT* must be complete first. The situation where *GT* needs to decide to continue completing current task or execute an *IT* is important as without the presence of that situation, there is no need for a task prioritization process in a monochronic task prioritization scenario.

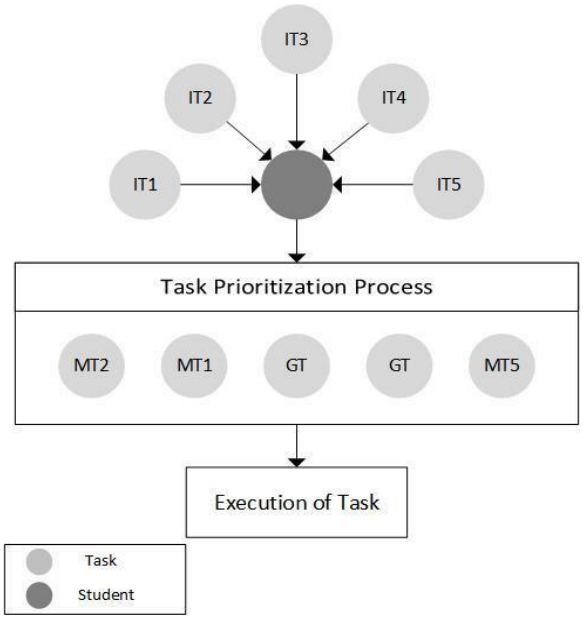

Figure 2: Task Prioritization Process

Figure 2 shows the conceptualisation process of *GT*, *IT* and *MT*. The execution part will execute the selected task in the timeline.

B. AHP Calculations

Analytic hierarchy process (AHP) is a ranking technique used in complex decision making [1]. Each *IT* in the will be rank one by one against *GT*. The main reason behind this action is to emulate the monochronic nature of task execution. The monochronic task execution is a form of human behavioural where a person will choose to execute one task at a time as supposed to multi-tasking several tasks in one time [10].

An example of AHP calculation is a person trying to purchase a car between three different alternatives. Each of these three alternatives includes three different criterions that are used to determine which alternative to be chosen. These three criterions are first pairwise, to determine a simple factorial value. After determining the factorial value, each criterion value from each alternative are pairwise to produce another set of value. These set of values are then multiplied with factorial values of criterion in order to determine which car the person should be buying based on their own chosen criteria.

IV. SIMULATION SETUP

The tool we choose to use to develop our simulation is Java Agent Development Framework (JADE) [11]. The reason we choose JADE as a development tool is for its ability to produce graphical representation of agent activities which is useful for the analysis of our simulation results.

The simulation compares two other different task scheduling algorithm to the MTCA. The two scheduling algorithm compared are the Modified Maximum Urgency First (MMUF) algorithm [8] and the Deadline Monotonic

Scheduling (DMS) [12]. Both MMUF and DMS are static priority pre-emptive scheduling techniques.

The basic principles of a scientific experiment involve three different variables, namely, manipulative, responsive and constant variable. Each experiment only has one manipulative and responsive variable. In our simulation of three different algorithms the manipulative variable is how each algorithm handles task prioritization. The responsive variable in our experiment is the amount of times agent choose to continue completing *GT*.

The constant variable in our experiment involves the alignment of all randomly generated values for all three factors. This is important as all three algorithms uses different factors in task prioritization process. Example, in MTCA uses Task Difficulty (*TD*), Prior Knowledge (*PK*) and Time Pressure (*TP*) while MMUF uses Task Criticality (*TC*), Task Deadline (*TDate*) and Task Importance (*TI*). Other than that, DMS is different from MTCA and MMUF which uses three factors for task prioritization process because DMS only uses one factor for task prioritization which is Urgency (*U*).

All three algorithms have different factors, therefore, it is important for us to realign randomly generated factor values to comply to basics constant variable in a scientific experiment.

V. Discussion

Figure 3, 4 and 5 show the result of the simulation of 3 different algorithms.

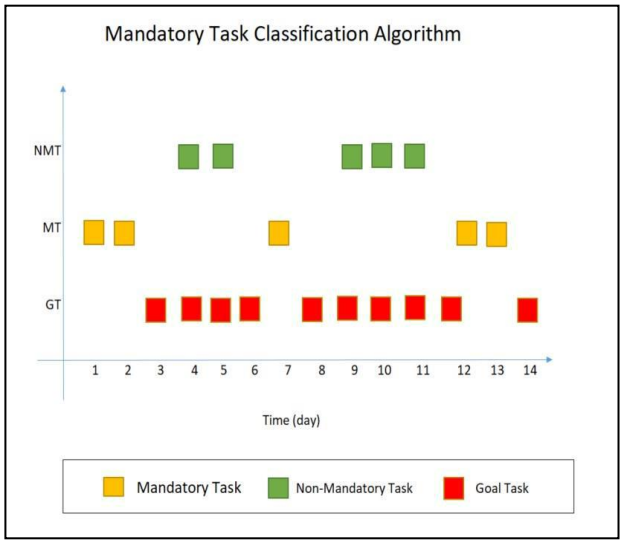

Fig 3: MTCA Simulation Result

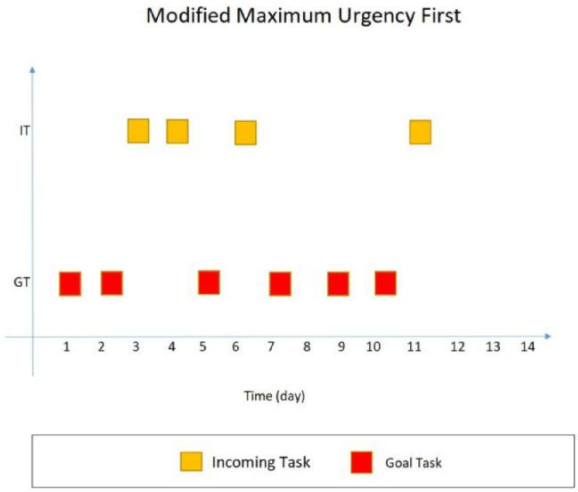

Fig 4: MMUF Simulation Result

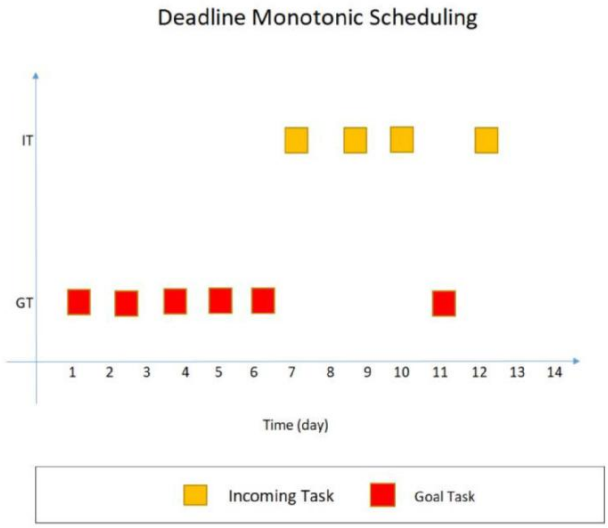

Fig 5: DMS Simulation Result

The results shows that MTCA has the same efficiency as MMUF and DMS but have a more humanlike task prioritization ability. The humanlike abilities exerted by MTCA is the ability to choose which IT to be complete by comparing all three deciding factors TP, PK and TD simultaneously. This is different compared MMUF and DMS which compare all deciding factors one at a time.

Besides that, the MTCA has the ability to tell agents which task to be executed first and which MT should be executed first. The ability to tell agent which high priority task should be completed first is different and advantages compared to MMUF and DMS as both of them used the First In First Out method to handle all high priority tasks. We also discovered MTCA has a higher consistency rate compared to MMUF and DMS. The higher consistency proves MTCA has a higher

robustness compare to MMUF and DMS. This higher amount of robustness gives MTCA the ability to choose the correct IT to be completed all the time compared to MMUF and DMS.

VI. CONCLUSION

In conclusion, the study of mandatory task can be beneficial to the development of more automated robotic appliances. This can be proven as the implementation of mandatory task type of task prioritization; a robotic appliance will not need much of human's input in deciding which given can be completed. The analysis of results obtained from the simulation shows that the MTCA has the same efficiency of handling task prioritization as the other two computer scheduling algorithm but with more human like behavior. We also found out that MTCA which MT should be completed first which can greatly improve the efficiency of finishing all given IT. Besides that, we also discovered MTCA has higher reliability compared to MMUF and DMS. This higher reliability enables MTCA to always choose the right IT to be executed all the time.

VII. ACKNOWLEDGEMENTS

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