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Intelligent Communicating Agent and Their Performance for Multi-Agent Based Traffic Controller-A New Approach for Roads Using JADE

[1]K.L. Shunmuganathan, [2]V. Vasudevan and [3]P. Yogesh
[1]Department of Information Technology, Anna University, India
[2]Department of Information Technology, Arulmigu Kalasalingam College of Engineering, India
[3]College of Engineering, Anna University, Chennai, India

Abstract: Road traffic is very much affected by time based traffic light controllers. When waiting for a traffic light, the driver looses time and the vehicle uses fuel. Hence, reducing waiting times before traffic lights can save billions of dollars annually. Agent is a concept derived from Artificial intelligence. Agent is a computer system capable of autonomous action in some environment. In certain applications like web browsing, single agent can't do a task. In such situations we go for multiple agents. For many computer environments, witness the Internet, Social ability in agents is the ability to interact with other agents through Agent Communication Language (ACL). In this study, a multi-agent based traffic light controller system is simulated and its efficiency is tested against ordinary time based traffic controller system and human traffic controlling system.

Key words: Multi-agent, ACL, autonomous action, artificial intelligence, JADE

INTRODUCTION

In the present traffic controller systems available in India either the time based control or human controlling the traffic it is frustrating for the road users because of the limited resources provided by current infrastructures lead to ever increasing traveling times. Multi-agent systems are very fit for representing those problems with multiply problem-solving methods, multiply views and multiply entities[1]. However, the majority of the agent systems are developed in an ad hoc fashion following little or no rigorous design methodology[2]. To make multi-agent systems more practical, we might adopt mainstream software engineering tools and techniques to multi-agent development.

JADE-an overview: JADE (Java Agent Development Framework) is a software developmentframework aimed at developing multi-agent systems and applications conforming to FIPA (Foundation for Intelligent Physical Agents)[3] standards for intelligent agents. JADE is a middleware that facilitates the development of multi-agent systems. It includes

- A runtime environment where JADE agents can live and that must be active on a given host before one or more agents can be executed on that host.
- A library of classes that programmers have to/can use (directly or by specializing them) to develop their agents.
- A suite of graphical tools that allows administrating and monitoring the activity of running agents.

Each running instance of the JADE runtime environment is called a Container as it can contain several agents. The set of active containers is called a Platform. A single special Main container must always be active in a platform and all other containers register with it as soon as they start. It follows that the first container to start in a platform must be a main container while all other containers must be normal (i.e. non-main) containers and must be told where to find (host and port) their main container (i.e. the main container to register with).

JADE agents are identified by a unique name and, provided they know each other's name, they can communicate transparently regardless of their actual location[4].

What are intelligent agents: Agent technology is a new concept within the Artificial Intelligence (AI). The agent paradigm in AI is based upon the notion of reactive, autonomous, internally motivated entities that inhabit dynamic, not necessarily fully predictable environments[5]. Autonomy is the ability to function as an independent unit over an e xtended period of time, performing a variety of actions necessary to achieve pre-designated objectives while responding to stimuli produced by integrally contained sensors[6]. Multi-Agent Systems can be characterized by the interaction of many agents trying to solve a variety of problems in a

Corresponding Author: K.L. Shunmuganathan, Department of Information Technology, Anna University, India

co-operative fashion[7]. Besides AI, intelligent agents should have some additional attributes to solve problems by itself in real-time; understand information; have goals and intentions; draw distinctions between situations; generalize; synthesize new concepts and/or ideas; model the world they operate in and plan and predict consequences of actions and evaluate alternatives. It may be obvious that finding a feasible solution is a necessity for an agent. Often local optima in decentralized systems are not the global optimum. This problem is not easily solved. The solution has to be found by tailoring the interaction mechanism or to have a supervising agent co-coordinating the optimization process of the other agents.

Model of agents: An agent can be used to denote a hardware or software-based computer system[8] situated in a specific environment, which has some properties such as autonomous, pro-active, social ability and reactive capability. An agent in multi-agent systems consists of components as follows.

- Mental attitudes, such as knowledge, belief, goal, intention, capability, perception, motivation and so on.
- Specifications of the agent's behaviors, for specifying the mode of the agent's behaviors.
- Interface of the agent. It is inevitable for an agent situated in a specific environment to interact with its outside world.
- Adaptation module. An agent is autonomous and pro-active and it can adjust itself to its environment.

Model of multi-agents: In multi-agent systems[9], people are concerned with how to collect existing agents to cooperate for some common purposes beyond an agent's competence[10] .A multi-agent system can be constructed by the following components.

- Multiply existing agents.
- Joint intentions among multiply agents, i.e. multiply agents jointly intent team actions that
- Common sense, i.e. common knowledge among agents.
- Common specifications for behaviors. Similarly to the specification for behaviors of a single agent, common specifications for behaviors specify actions that multiply agents should take to achieve their joint goals.
- The environment agents rely on, such as network facilities for agents' communication, other entities coexisting with agents and users interacting with agents.

Fig. 1: Simple agent based traffic controller

Multi-agent organizational model for intelligent traffic controller system: The Fig. 1 shows the multi-agent organizational model for intelligent traffic controller system. Here we have a route agent controlling several intersection agents, which in turn manage their intersection controls helped by Road Segment Agent (RSA). The Intelligent Traffic Signalling Agent (ITSA) is the agent that controls and operates one specific intersection of which it is completely informed. All ITSA's have direct communication with neighboring ITSA's, RSA's and all its traffic lights. Here we use the agent technology to implement a distributed planning algorithm. The route agents' tasks are controlling, coordinating and leading the ITSA's towards a more global optimum. Using all available information the ITSA recalculates the next, most optimal states and control strategy and operates the traffic signals accordingly. The ITSA can directly influence the control strategy of their intersection(s) and is able to get insight into on-coming traffic.

MATERIALS AND METHODS

Suppose there are a number of cars with their destination address standing before a crossing Fig. 2. All cars communicate to the traffic light their specific place in the queue. Now the traffic light has to decide which option (i.e., which lanes are to be put on green) is optimal to minimize the long-term average waiting time until all cars have arrived at their destination address[11]. The learning traffic light controllers solve this problem by estimating how long it would take for a car to arrive at its destination address (for which the car may need to pass many different traffic lights) when currently the light would be put on green and how long it would take if the light would be put on red. The difference between the

Fig. 2: Sample Screenshot for simulated multi-agent based traffic controller

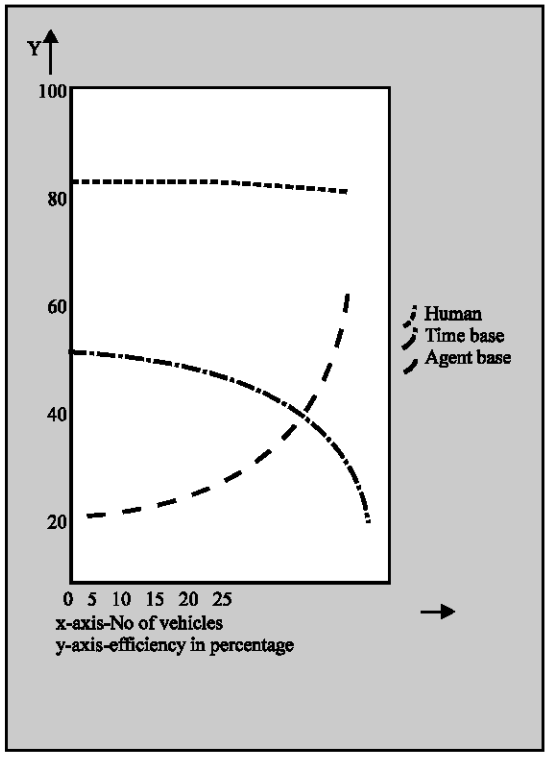

Fig. 3: Performance of multi-agent based traffic controller system vs time based system vs human controlled system

waiting time for red and the waiting time for green is the gain for the car. Now the traffic light controllers set the lights in such a way to maximize the average gain of all cars standing before the crossing.

To estimate the waiting times, we use reinforcement learning which keeps track of the waiting times of individual cars and uses a smart way to compute the long term average waiting times using dynamic programming algorithms. One nice feature is that the system is very fair; it never lets one car wait for a very long time, since then its gain of setting its own light to green becomes very large and the optimal decision of the traffic light will set his light to green. Furthermore, since we estimate waiting times before traffic lights until the destination of the road user has been reached, the road user can use this information to choose to which next traffic light to go, thereby improving its driving behavior through a city[12]. Note that we solve the traffic light control problem by using a distributed multi-agent system, where cooperation and coordination are done by communication, learning and voting mechanisms.

To allow for green waves during extremely busy situations, we combine our algorithm with a special bucket algorithm, which propagates gains from one traffic light to the next one, inducing stronger voting on the next traffic controller option.

Performance analysis:

CONCLUSION

In this study we described the design and development of Multi-Agent based Intelligent Traffic Light Controller System using JADE and its efficiency is compared with Time based Traffic Controller System and Human Controlled Traffic System.

The proposed system shows high performance than time based traffic controller system and human controlled traffic system and it will be good and easy method. Fig. 3 shows the performance analysis.

FUTURE ENHANCEMENTS

The multi-agent based traffic controller system at present cannot communicate with, traffic controller system across different places. Hence a more efficient traffic controller system would be one that transcends other agent based traffic controller systems to retrieve the data. Intelligent traffic light control does not only mean that traffic lights are set in order to minimize waiting times of road users, but also that road users receive information about how to drive through a city in order to minimize their waiting times. This means that we are coping with a complex multi-agent system, where communication and coordination play essential roles.

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