World Academy of Science, Engineering and Technology
International Journal of Humanities and Social Sciences
Vol:3, No:5, 2009

Simulation of Ethical Behavior in Urban Transportation

Ali Reza Honarvar , Naser Ghasem Agaee

***Abstract*—**For controlling urban transportations, traffic lights show similar behavior for different kinds of vehicles at intersections. Emergency vehicles need special behavior at intersections, so traffic lights should behave in different manner when emergency vehicles approach them. At the present time, intelligent traffic lights control urban transportations intelligently. In this paper the ethical aspect of this topic is considered. A model is proposed for adding special component to emergency vehicles and traffic lights for controlling traffic in ethical manner. The proposed model is simulated by JADE.

***Keywords*—**Ethical traffic control, intelligent transportation, Ethical agent, Multi-agent system.

I. Introduction

TENDENCY toward intelligent system is increasing. Attention to intelligent traffic control system has been becoming so important in order to increase a speedup of traffic. Using intelligent autonomous system for traffic control is useful. Recently, as the autonomous property of artificial intelligent agents that act on behalf of us in most duties has been increasing, the discussion of ethical dimension of intelligent autonomous system is considered. For simulating intelligent transportation, it is good idea to use intelligent autonomous system and multi-agent system. So, I use multi-agent approach for simulating my proposed model.

II. Autonomous Intelligent Agent and Multi-Agent

Autonomous intelligent systems are entities which act intelligently without interference or guidance of other entities and decide by themselves. Autonomous artificial agent is a computer system that is situated, and that is capable of autonomous action in this environment in order to meet its design objectives [1]. Figure 1 gives an abstract view of an agent. In this figure, we can see the action output generated by the agent in order to affect its environment.

Ali Reza Honarvar is with Sheikh Bahaei University. (Phone: +98-917-704-8898; e-mail: AliReza_Honarvar@yahoo.co.uk).

Naser Ghasem Agaee, is professor of Computer Engineering, University of Isfahan. (Phone: +98-311-7934065; e-mail: aghaee@eng.ui.ac.ir).

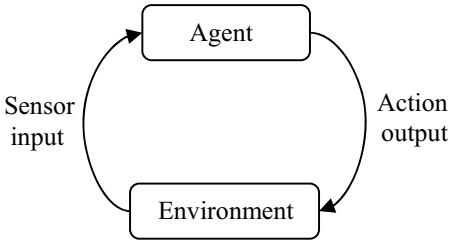

Fig. 1 Intelligent agent

Each intelligent agent has three core capabilities [2]:

1. Reactivity:
   Intelligent agents are able to perceive their environment, and respond in a timely fashion to changes that occur in it in order to satisfy their design objectives.

2. Proactive:
   Intelligent agents are able to exhibit goal-directed behavior by taking the initiative in order to satisfy their design objectives.

3. Social-ability:
   Intelligent agents are capable of interacting with other agents or humans in order to satisfy their design objectives.

An autonomous intelligent system is a system, which senses its environment, and acts on it in pursuit of its own agenda, when it wants to do something, it makes decision for itself without the guidance or interference of others.

A multi-agent system is a system composed of multiple interacting intelligent agents. Multi-agent systems can be used to solve problems which are difficult or impossible for an individual to solve [1].

Why we use intelligent agent and multi-agent approach? On the basis of the description of autonomous intelligent system and multi-agent system, it is a good idea to use autonomous intelligent agent and multi-agent system for simulating the behavior of autonomous intelligent system. at the present moment, many researchers work on projects like expert systems which can assist physicians for diagnosing malady of patient, warplanes which can be operated and used without

human operators in war, autonomous driverless vehicles which can be used for urban transportation, and suchlike.

The common goal between these projects is augmentation of autonomy in behavior of such machines, as a consequence of this autonomy they can act on behalf of us without any interference and guidance, so it causes human comfort in their duties. But if we do not consider and control the autonomy of these entities, we will face serious problems because of the confidence in intelligence of autonomous system without any control and restriction on their operations.

III. MACHINE ETHICS AND INTELLIGENT ETHICAL AGENT

Anderson proposed Machine Ethics as a new issue which consider the consequence of machine's behavior on humanlike. The ideal and final goal of this issue is implementation of ethics in machines, as machines can autonomously detect the ethical effect of their behavior[3]. So with simulation of ethics in autonomous machine we can avoid the problems of autonomy in autonomous machines.

James Moor, a professor of philosophy at Dartmouth College, one of the founding figures in the field of computer ethics, has proposed a hierarchical schema for categorizing artificial ethical agent [4, 5]. At the lowest level is what he calls "ethical impact agents": basically any machine that can be evaluated for its ethical consequences. Moor's own rather nice example is the replacement of young boys with robot in the dangerous occupation of camel jockey in Qatar. In fact, it seems to us that all robots have ethical impacts, although in some cases they may be harder to discern than others.

At the next level are Moor calls "implicit ethical agents": machine whose designers have made an effort to design them so that they don't have negative ethical effects, by addressing safety and critical reliability concerns during the design process. Arguably, all robots should be engineered to be implicit ethical agents, insofar as designers are negligent if they fail to build in processes that assure safety and reliability.

Next come "explicit ethical agents": machines that reason about ethical using ethical categories as part of their internal programming, perhaps using various forms of deontic logic that have been developed for representing duties and obligations, or a variety of other techniques.

Beyond all these lie full ethical agents: those that can make explicit moral judgments and are generally quite component in justifying such decisions. This level of performance is often presumed to require a capacity for consciousness, intentionality, and free will.

IV. ETHICAL INTELLIGENT TRANSPORTATION MODEL

Recently, as the autonomous property of artificial intelligent agent that acts on behalf of us in most duties has been increasing, the discussion of ethical dimension of intelligent autonomous system is considered [6].

In proposed model for intelligent transportation, ethical aspect of this subject is considered and it is simulated with JADE (Java Agent Development framework). This model is called ETLA (Ethical Traffic Light Agent). ETLA is a kind of implicit ethical agent on the basis of Moor's taxonomy. In this model (ETLA), each traffic light is an Autonomous agent. Traffic lights communicate with each other by sending/receiving special signals. Vehicle divides into two categories: Normal vehicle and Emergency vehicle (like ambulance). This categorization is illustrated in figure 2.

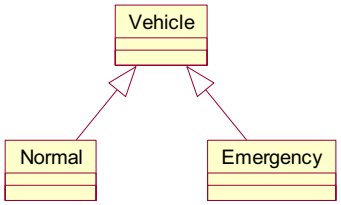

Fig. 2 A vehicle divides into normal and emergency categories

Each vehicle is an artificial agent. We do not pay attention to normal behavior of vehicle agent, because I focus on ethical aspect of intelligent transportation. The main idea in my proposed model is described below:

When emergency vehicle approaches traffic light, if its light is not green, it sends special signals to that traffic light and asks it for changing traffic light to green In order to continue its movement without any delay or at least make the traffic on its path lighter. With this action emergency vehicles ask traffic light agent to behave unnormally and behave in emergency and ethical manner (figure 3).

Fig. 3 Emergency vehicle asks traffic light agent to behave in emergency manner

When traffic light receives an emergent signal from emergency vehicle for changing its light to green and behave in emergency mode, or when traffic light detects an emergency vehicle, it traces the emergency vehicle in order to detect speed and direction of emergency vehicle. After detection of speed and direction of emergency vehicle, traffic light contacts another proper traffic light on the direction of emergent vehicle, Send necessary information and asks it to behave in emergency manner. Figure 4 illustrates the communications between traffic light agents for controlling urban traffic in emergency manner.

Fig. 4 Communications between traffic light agents for controlling traffic in emergency and ethical manner

Second traffic light in this time has to behave and control

traffic in special manner in order to make the traffic on emergency vehicle's path lighter than previous. The main aim at this method of traffic control is to make traffic lighter on the movement path of emergency vehicle.

V. IMPLEMENTATION OF ETLA

V. For implementation of the ETLA model I used JADE (Java Agent DEvelopment Framework). JADE is a software Framework fully implemented in Java language. It simplifies the implementation of multi-agent systems through a middle-ware that complies with the FIPA specifications and through a set of graphical tools that supports the debugging and deployment phases. In implementation that was done, for simulating the behavior and graphic interface of vehicles, traffic lights and the environment in which they act, I have implemented needed object classes. Classes of this project divided into categories of graphic interface design and behavior simulation design. In graphic interface design section I have implemented trafficLightTableModel.java class and CellRenderer.java class for simulating the environment in which the movement and behavior of vehicles, the behavior of traffic lights and the communications of traffic lights and vehicles was simulated. In this section, TrafficLight.java class have used for showing the status of traffic light in red and green, Vehicle.java class have used for showing the movement of vehicles in simulated environment, Environment.java class have used for interaction of users with simulated environment for adding emergency vehicles or normal vehicles to simulated environment and configuring the speed of these vehicles in that environment. In Environment.java class, JADE platform will be run and simulated artificial agents (vehicle agent and traffic light agent) will be added to this platform for operation and on the basis of my proposed model.

Classes which simulate the behavior of traffic light agents and vehicle (normal and emergency) agents are:

CarInfo.java class maintains the state information of each vehicle such as speed, direction and kind of vehicles (emergency or normal). TrafficLightAgent.java class contains the main behaviors of traffic light. Traffic light agent shows five kinds of behaviors:

1. Communicates with the graphic interface for visualizing its behavior.
2. 2. controls the normal behavior of each traffic light
4. Manages traffic light. traffic light operates in two modes: emergency and normal. As a traffic light agent receives a message or signal from emergency vehicles, it changes its mode to emergency in order to behave in emergency manner for controlling traffic
5. Detects the direction and speed of emergency vehicles and contacts another traffic light in emergency vehicle's path and asks it to behave in emergency mode.
6. Receives the message from other traffic lights for controlling traffic in emergency manner in order to make the traffic lighter in the emergency vehicles' path.

VehicleAgent.java class implements the main behavior of vehicle agents, this class use CarBehaviour.java class for showing vehicle's behavior in the Ethical intelligent transportation. CarBehaviour.java class implements the main part of vehicle's behavior in simulated environment. The behaviors which are implemented by this class are:

1. Senses the environment and decides for normal movement such as rotating, stopping and so on
2. Normal vehicle Contacts traffic light at intersection for asking the status of traffic light in order to make decision about its behavior at intersection on the basis of traffic light status
3. emergency vehicle Contacts traffic light at intersection and asks it to change its mode to emergency mode

VI. CONCLUSION

In this paper ETLA proposed and simulated as a model for controlling urban transportation in ethical manner. So, with the aid of this model, emergency vehicles will be considered special behavior in controlling of urban transportation. The main idea in this model can be used in driver-less vehicles projects, in order to increase the confidence of human in operations of these vehicles and made them more human like.

REFERENCES

[1] Stuart Russell, Peter Norving, Artificial Intelligence A Modern Approach, Prentice Hall Publishing, 2003.
[2] Michael Wooldridge, An introduction to Multiagent Systems, JOHN WILEY & SONS, March 2005.
[3] M. Anderson, S. Anderson, and C. Armen, "Toward Machine Ethics: Implementing Two Action-Based Ethical Theories," Proc. AAAI 2005 Fall Symp. Machine Ethics, AAAI Press, pp. 1–16, 2005.
[4] Wendell Wallach, Colin Allen, Moral Machines: Teaching Robot Right from Wrong, OXFORD UNIVERSITY press, 2009.
[5] Moor, J. H. "The nature, importance, and difficulty of Machine Ethics", IEEE Intelligent Systems Special Issue on Machine Ethics, vol. 21 ,no. 4,pp. 18–21,2006.
[6] Colin Allen, Wendell Wallach, Iva Smith, "Why Machine Ethics?", IEEE Intelligent Systems Special Issue on Machine Ethics, IEEE Computer Society, vol. 21 ,no. 4,pp 12-17 ,2006.