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Intelligent Agents and Autonomous Cars

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***Abstract*-One of the found techniques in Artificial Intelligence is intelligent agent technology. The concept of Agents has become important both in Artificial Intelligence and in mainstream of Computer Science. Artificial Intelligence is defined as the branch of Computer Science that deals in developing intelligent agents and consequently, Intelligent Agent is defined as an automated agent that can replicate the functioning of human beings. It perceives its environment, analyses it, and takes actions that will maximize the probability of its success intelligent agents continuously perform three functions: perception of dynamic conditions in the environment; reasoning to interpret perceptions, solve problems, draw inferences, and determine actions. In this paper, we begin with the basic terminologies related to intelligent agents, and then proceed towards the various environments that an agent may have to perceive. We discuss about the Multi Agent Systems then finally site the most extravagant intelligent agent i.e., Autonomous Cars with Google's driverless car technology.**

***Keywords* — Agent, intelligent agent, agent environment, multi agent system, autonomous car, driverless car.**

I. INTRODUCTION

The Encarta World English Dictionary says that the word Agent comes from the Latin word Agent, which word gave also the words act, active, agile, agitate etc. This etymologic approach is interesting to have a first idea of what it is. In general, we can view an agent to be an entity that performs some actions on behalf of others on request. In real life, we come across a number of human agents such as Travel agent, Business agent, Police agent etc. But here our concern is the study and development of computational automated agents that will replicate the functioning of human agents. More generally, in their book "Artificial intelligence, a modern approach", S. Russel and P. Norvig highlighted the importance of the environment, defining an agent as something which percepts through sensors and acts through effectors. A definition close to present-day reality is that of Ted Selker from the Figure-1 is a pictorial representation of functioning of an agent.

II. CHARACTERISTICS OF AGENTS

The idea of intelligent software agents has captured the popular imagination. Let's address the question of what makes an agent intelligent by explaining the characteristics of intelligent agents.

A Primary characteristic of agents The most important attributes of an agent are referred to as primary attributes less important or secondary attributes, are listed below. The primary attributes include the following—

- *Autonomy*:

Reflects the ability of agents to operate on their own, without immediate human guidance, although the latter is sometimes invaluable.

- *Co-operation*:

Refers to the ability to exchange high-level information with other agents: an attribute which is inherent in multiple agent systems (MAS).

- *Learning*:

Refers to the ability of agents to increase performance over time when interacting with the environment in which they are embedded.

- *Mobility*:

This refers to the property of the agent of being movable to and from various places.

B Secondary characteristics of agents can be classified according to a number of other attributes, which could be regarded as being secondary to the ones described above. Rather than a comprehensive list, some examples of secondary attributes that agents may exhibit will be given. Agents may be classified, for example, by their pro- active versatility – the degree to which they pursue a single goal or engage in a variety of tasks.

III. AGENT ENVIRONMENTS

The critical decision an agent faces is determining which action to perform to best satisfy its design objectives.

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Agent environments are classified based on different properties that can affect the complexity of the agent‘s decision- making process.

They include—

- *Accessible vs. inaccessible*

An accessible environment is one in which the agent can obtain complete, timely and accurate information about the state of the environment. *Deterministic vs. non-deterministic* Most reasonably, complex systems are non-deterministic – the state that will result from an action is not guaranteed even when the system is in a similar state before the action is applied. This uncertainty presents a greater challenge to the agent designer.

- *Episodic vs. non-episodic*

In an episodic environment, the actions of an agent depend on a number of discrete episodes with no link between the performances of the agent in different scenarios.

- *Static vs. dynamic*

Static environments remain unchanged except for the results produced by the actions of the agent. A dynamic environment has other processes operating on it thereby changing the environment outside the control of the agent. A dynamic environment obviously requires a more complex agent design.

- *Discrete vs. continuous*

If there are a fixed and finite number of actions and percepts, then the environment is discrete. A chess game is a discrete environment while driving a taxi is an example of a continuous one.

IV. TYPES OF AGENTS

Based on the way an agent handles a request or takes an action upon perceiving its environment, intelligent agents can be classified into four categories—

I. Simple reflex agents
II. Agents keeping track of the World
III. Goal based agents
IV. Utility based agents

We shall discuss each one of them in brief details.

A Simple reflex agents

A simple reflex agent is an agent that performs actions based on certain conditions being fulfilled. It monitors it environment, and performs the same action every time the same condition occurs.

A simple reflex agent can be implemented by the simple conditional clauses such as if‗. For example, for a car, we can implement the following condition—

If *car-in-front-is-braking* **then** *initiate- braking*

The above statement explains the fact that if the car running in front brakes and the brake lights are on, then the driver of the car behind this should initiate brakes to avoid collision.

The functioning of simple reflex agents has been depicted in figure-2.

Function SIMPLE –REFLEX-AGENT (percept) returns an action
Persistent rules, a set of condition-action rules
State ← INTERPRET-INPUT (percept) rule ←RULE-MATCH (state, rules) action ←rule, ACTION
return action

B Agents keeping track of the World

Updating this internal state information as time goes by requires two kinds of knowledge to be encoded in the agent program.First, weneed some information about how the world evolves independently of the agent—for example, that an overtaking car generally will be closer behind than it was a moment ago. Second, we need some information about how the agent‘s own actions affect the world—for example, that when the agent changes lanes to the right, there is a gap (at least temporarily) in the lane it was in before, or that after driving for five minutes northbound on the freeway one is usually about five miles north of where one was five minutes ago. Figure-3 shows the functioning of Agents that keep track of the World.

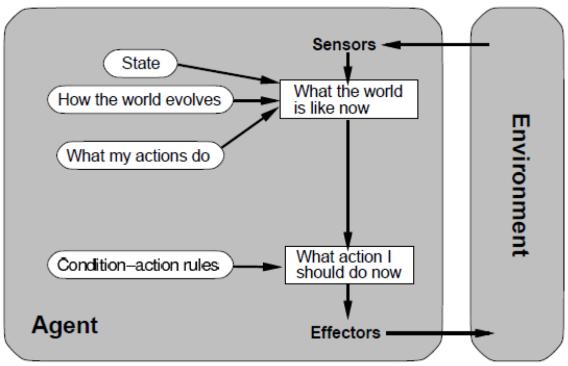

Figure 3: Agents keeping track of the World

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C Goal based agents

Knowing about the current state of the environment is not always enough to decide what to do. For example, at a road junction, the taxi can turn left, right, or go straight on. The right decision depends on where the taxi is trying to get to. In other words, as well as a current state description, the agent needs some sort of **goal** information, so that it can act accordingly to fulfill that goal.Figure-4 represents the functioning of a Goal based agent.

D Utility based agents

Goals alone are not really enough to generate high-quality behavior. For example, there are many action sequences that will get the taxi to its destination, thereby achieving the goal, but some are quicker, safer, more reliable, or cheaper than others. Goals just provide a crude distinction between

―happy‖ and ―unhappy‖ states,

whereas a more general performance measure should allow a comparison of different world states (or sequences of states) according to exactly how happy they would make the agent if they could be achieved. Because ―happy‖ does not sound very scientific, the customary terminology is to say that if one world state is preferred to another, then it has higher utility for the agent.

Utility is therefore a function that maps a state onto a real number, which describes the associated degree of happiness. pictorial representation of Utility based agents is shown in figure-5

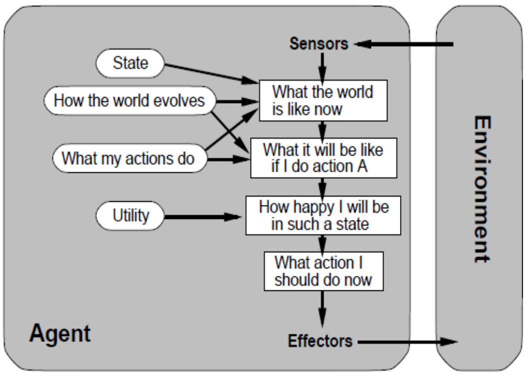

Figure 5: Utility based agents

V. Intelligence And Agents

By varying the extent of the learning attribute an agent‘s intelligence can range from more to less intelligent. By varying the extent of the attributes autonomy and co-operation an agent‘s agency can vary from no inter-activity with the environment to total inter- activity with the environment. In this case, intelligence relates to the way an agent interprets the information or knowledge to which it has access or which is presented to it. The most limited form of intelligence is restricted to the specification of preferences. Preferences are statements of desired behavior that describe a style or policy the agent needs to follow. The next higher form of intelligence is described as reasoning capability. With reasoning, preferences are combined with external events and external data in a decision- making process. The highest form of intelligence is called learning. Learning can be described as the modification of behavior as a result of experience.

VI. Multi-Agent System (MAS)

As the field of AI matured, it broadened its goals to the development and implementation of multi-agent systems (MASs) as it endeavored to attack more complex, realistic and large-scale problems which are beyond the capabilities of an individual agent. The capacity of an intelligent agent is limited by its knowledge, its computing resources, and its perspective. By forming communities of agents or agencies, a solution based on a modular design can be implemented where each member of the agency specializes in solving a particular aspect of the problem. Thus, the agents must be able to interoperate and coordinate with each other in peer-to-peer interactions. The characteristics of MASs are defined as follows—

- Each agent has incomplete information or capabilities for solving the problem and, thus, has a limited viewpoint
- There is no global control system
- Data are decentralized
- Computation is asynchronous

Agency relates to the way an agent can perceive its environment and act on it. Agency begins with asynchrony,

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Where the agent can be given a task which it performs asynchronously with respect to the user‘s requests.

The next phase of agency is user representation, where an agent has a model of the user‘s goals or agenda.

VIII. AUTONOMOUS CAR

An autonomous car, also known as robotic or informally as driverless or self-driving, is an autonomous vehicle capable of fulfilling the human transportation capabilities of a traditional car. As an autonomous vehicle, it is capable of sensing its environment and navigating on its own. A human may choose a destination, but is not required to perform any mechanical operation of the vehicle. Autonomous vehicles sense the world with such techniques as RADAR, LIDAR, GPS and computer vision. Advanced control systems interpret the information to identify appropriate navigation paths, as well as obstacles and relevant signage. Autonomous vehicles typically update their maps based on sensory input, such that they can navigate through uncharted environments.

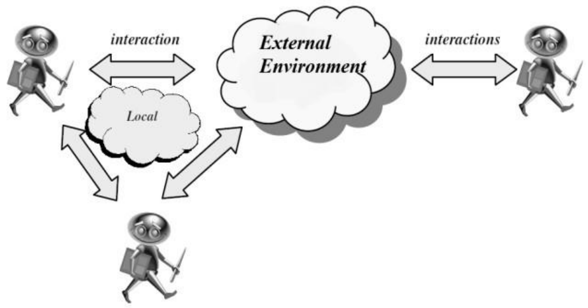

Figure 6: Multi-agent system

There have been several programs around the world. In June 2011 the state of Nevada was the first jurisdiction in the United States to pass a law concerning the operation of autonomous cars. The Nevada law went into effect on March 1, 2012, and the Nevada Department of Motor Vehicles issued the first license for a self-driven car in May 2012. The license was issued to a Toyota Prius modified with Google's experimental driverless technology. Three U.S. states have passed laws permitting driverless cars, as of September 2012: Nevada, Florida and California.

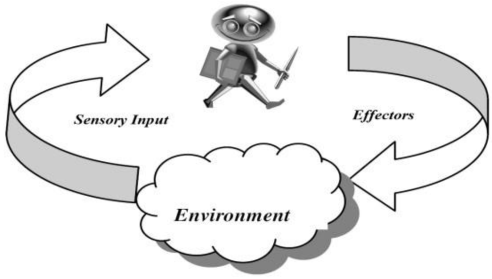

Figure 1: Functioning of an agent

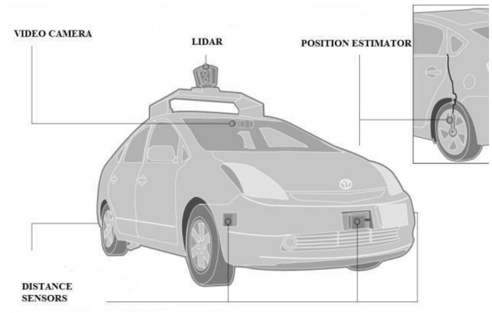

Figure 7: Google‘s driverless car technology

VII. CONCLUSION

The dream of creating artificial devices that reach or outperform human intelligence is many centuries old. The development of intelligent agents is making that dream come true for the researchers and as well as for the industry. A fundamental feature of agent systems is the ability to make decisions, and to manage the consequences of these decisions in complex dynamic environments. Agent technology is greatly hyped as a panacea for the current ills of system design and development, but the developer is cautioned to be aware of the pitfalls inherent in any new and untested technology. The potential is there but the full benefit is yet to be realized. Agent technology will achieve its true potential only if users understand its business value. Much work is yet to be done.

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