ADVANCEMENTS OF INTELLIGENT AGENT IN MODERN WORLD

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Abstract: The human civilization has evolved a lot since ancient times and is still evolving. We humans have succeeded in finding many ways that can ease our work and everyday task. One of the greatest achievements of human civilization have been industrialization. When the machines came into existence the idea was to make our work as less as possible and as fast as possible. Over time we have developed software agents to do this task and the study of this field is coined as “Artificial Intelligence”. Artificial Intelligence is a very vast field and a number of advancements have already been made in many ways. One of such advancements was introduction of intelligent agents. In this paper we will be discussing about what an intelligent agent is, how it came into existence and its advancements in modern world. To explain the existence of intelligent we first defined how the idea of artificial intelligence first came. How the need of agents arose and finally how the term intelligent agent was publicised and use as we know it today. We will be discussing about how the agent’s utility has increased over time and how far can it go. Recently, agent technology has been considered as an important approach for developing industrial distributed systems. Such systems consist of multiple interacting intelligent software agents.

Keywords: Artificial intelligence, intelligent agent, intelligent agent environment, Development of Intelligent agent.

I. INTRODUCTION

Since the ancient times the Greek myths incorporated the idea of intelligent robots and artificial beings. The classical philosophers have always wondered about how human beings think and searched for a way to mechanize the process of human thinking. In 1950, Alan Turing proposes the Turing Test as a measure of machine intelligence [1]. Pamela McCorduck, in “machines who think” (2004), wrote AI began with “an ancient wish to forge the gods”. In the Dartmouth Conference of 1956, organized by Marvin Minsky, John McCarthy and two senior scientists: Claude Shannon and Nathan Rochester of IBM, McCarthy convinced the attendees to accept the term “Artificial Intelligence” as the name of the field that dealt with “every aspect of learning any other feature of intelligence can be so precisely described that a machine can be made to stimulate it”[2]. An important goal of AI search was to communicate with humans in natural languages i.e. languages that we speak and understand like English. Daniel Bobrow’s program STUDENT was the first program that could solve mathematical word problems, making it self the first program that could understand human language.

As the research in the field of Artificial Intelligence grew, a need of agents was generated. Over 50 years ago, Vannevar Bush (Bush 1945) imagined a machine called the Memex that allowed users to steer through bulk of data and information. In the 1958, John McCarthy proposed in his paper “Programs with Common Sense”; a hypothetical program “The Advice Taker”; it was probably the first proposal to use logic to represent information in a computer, (much like today’s Internet). The study of agents deals with integrating the components of intelligence (e.g., learning ability, planning) therefore, in the early 1990s, these software agents were also called intelligent agents. An intelligent agent is a system that perceives its environments and takes actions that would increase its chances of success. This paradigm allowed researches to study isolated problems and find their solutions.

II. INTELLIGENT AGENT

An intelligent agent can be defined as a software program that can perceive valuable data from its environment, update its knowledge base and act accordingly. The process of perceiving, thinking and acting will run in a loop. This process imitates humans. We perceive our environment through sense organs, think about it and then act using our body parts. An intelligent agent is one that exhibits flexible autonomy, which consists of three key characteristics:

- Reactivity: an intelligent agent is able to react to changes in its environment in a timely fashion, and takes some action based on those changes and the function it is designed to achieve.
- Pro-activeness: intelligent agents exhibit goal-directed behaviour. Goal-directed behaviour connotes that an agent will dynamically change its behaviour in order to achieve its goals. For example, if an agent loses communication with another agent whose services it requires to fulfil its goals, it will search for another agent that provides the same services. Wooldridge describes this pro-activeness as an agent’s ability to “take the initiative.”
- Social ability: intelligent agents are able to interact with other intelligent agents. Social ability connotes more than the simple passing of data between different software and hardware entities, something many traditional systems do. It connotes the ability to negotiate and interact in a cooperative manner. That ability is normally underpinned
by an agent communication language (ACL), which allows agents to converse rather than simply pass data.

To satisfy real world use cases, the Artificial Intelligence itself needs to have a wide range of intelligent agents. This introduces diversity in the types of agents and the environments we have. Intelligent agents have following characteristics:-

- Can update problem solving rules.
- Adapt to its surroundings both online and in real time
- Learn and improve its set of rules.
- Can infer information from bulk of data
- Has short term and long term memory and can represent aging problems

### III. Class of Intelligent Agents

There are 4 classes of agents that can be defined as the level of intelligence:

- **Simple reflex agents:**
  
  These agents, as shown in figure 2, work on immediate percept. They sense the current state, process the information and perform the action. These agents do not store any history of percept neither do they process the consequences of their actions. The agent function is based on the “condition-action rule”: if condition then action. Therefore, they can only work in fully observable environments. Example: Mail sorting robot

- **Model-based reflex agents:**

  These agents keep a track of previous percept. They use these percept to know how the world is evolving by their actions and approximate how it will evolve, if they take a particular action. This knowledge about “how the environment works” is called model of the environment, hence the name “model based agents” (refer figure 3). Therefore they can work on partially observable environment. Example: Robot vacuum cleaner

- **Goal-based agents:**

  These agents work to achieve a goal. They consider the possibilities of all the actions and choose the best action that will help in achieving that goal as shown in figure 4. These agents work on the cases where actions do not depend on current state of environment only but also on the goal. Goal based agents are modification in model based reflex agents as they use “goal” information to choose among multiple possibilities and selecting one which reaches a goal state. Example: Robot maid.

- **Utility-based agents:**

  Goal based agents only distinguished between goal states and non-goal states. Utility based agents use a utility function to choose the best path that leads to goal state. These agents work were achieving the goal is not enough but they also need to consider the cost of achieving the goal as described in figure 5. A utility agent will choose the action that will give us an optimal solution to achieve the goal. For example, traveling salesman problem, where reaching the destination is not enough but cost is also a factor in choosing paths. Example: Automated car.
Organized Conference environment it will be used in. Following are the types:

- **An intelligent agent** is designed keeping in mind the type of environment it will be used in. Following are the types:

  - **Discrete and Continuous**: "If there are limited number of distinct, clearly defined, states of the environment, the environment is discrete" [3]. An environment where there are limited choices and limited possible states is a discrete environment where as an environment having infinite choices and possible states is continuous environment. Example: chess is discrete, driving is continuous.
  - **Single agent and Multi-agent**: "The environment may contain other agents which may be of the same or different kind as that of the agent" [3]. Environment that needs just one agent is single agent environment where as an environment needing more than on same or different kinds of agents in known as multi-agent environment. Example: chess is multi agent while 8-puzzle is single agent.

V. DEVELOPING OF INTELLIGENT AGENTS

As the research in the direction of intelligent agents grew, the BDI model was developed to solve the problems that arose in development of intelligent agents. The Belief-Desire-Intension software model uses the concepts of belief, desires and intentions to solve a particular problem in agent programming. It provides a way to separate the activity of selecting a path from execution of currently active plans.

The BDI model: This model is mostly used for developing intelligent agents. It provides basic in flesh concept of logical theory which defines the mental attitude of Belief, Desire and intention using model logic. Example: PRS, JAM, dMars, JACK [4].

- **Beliefs**: Gives informative data about surroundings. Beliefs can include inference of rules, allowing those rules to infer new beliefs. The word belief is used instead of knowledge this signifies that whatever the agent beliefs need not be always true. The database were agent’s beliefs are stored known as belief set.
- **Desires**: Prioritized associated objectives. Desires tell about the motivational state of agent. They represent goals or states that agent would like to do.
- **Goals**: Goal is a desire that has been adopted for active pursuit by the agent. Usage of the term goals adds the further restriction that the set of active desires must be consistent. For example, one should not have concurrent goals to go to a party and stay at home even though both could be desirable [5]. In other words we can say that a goal is a set of states that an agent wants to reach.
- **Intension**: Action based on the current choices. Intention represent the state that agent would like to achieve i.e. what the agent was made for accomplishing.
- **Clients**: plans are an abstract specification of both the means of achieving certain desires and options available to the agents [4].

It is assumed that the BDI model have been developed approximately 15 years ago from now which justifies the relationship between the practical and theoretical work. But still there are some limitation and criticism about BDI software model like Learning, Three attitudes, Logics, Multiagents and Explicit look ahead. Some of the models that are implemented on BDI model are: JACK, GOAL, 3APL.

VI. INTELLIGENT AGENT IN MODERN WORLD:-

1. **Remote Sensing**
   - Remote sensing is the acquiring of information about an object without making any actual contact with the object and thus in contrast to onsite observation. In beginning of 60s and 70s with the development of image processing orbital platform collect the data and transmit it from different part of the electromagnetic spectrum. According to NOAA, the most used application among Asian academics groups are as follows- ERDAS 36%, ESRI 30%, ITT visual information solution 17% and MapInfo 17%.

2. **Autonomous car**
   - The first truly autonomous prototype of cars appeared in the 80s, with Carnegie Mellon University’s Navlab [6]. In SAE’s autonomy level definitions, “driving mode” means a type of driving outline.

Learning agents start working in an environment which is unknown to them and as they fetch data they infer rules to its knowledge base (refer figure 6). Learning agents have “learning element” that is responsible to making improvements, and “performance element” that is responsible for selecting external actions. Learning element uses feedback from the “critic” to determine its performance. The performance element takes precepts and decides its actions. Example: Taxi Driver.

IV. TYPE OF ENVIRONMENTS

An intelligent agent is designed keeping in mind the type of environment it will be used in. Following are the types:

- **Fully observable and partially observable**: If agent’s sensors give full information of the current state environment then the environment is said to be fully observable otherwise it is partially observable.
- **Deterministic and Stochastic**: If the next state of the environment depends totally upon the current state then the environment is said to be deterministic. If the current state does not determine next state completely then it is stochastic. For example, 8-puzzle has a deterministic environment, but driverless car does not.
- **Static and Dynamic**: “If the environment does not change while an agent is acting, then is it static; otherwise it is dynamic” [3]. If the environment remains constant or unchanged when it is being observed then it is called static else dynamic.
- **Discrete and Continuous**: “if there are limitd number of distinct, clearly defined, states of the environment, the environment is discrete” [3]. An environment where there are limited choices and limited possible states is a discrete environment whereas an environment having infinite
- Level 0: warnings may momentarily intervene but no permanent vehicles control.
- Level 1 ("hands on") - the control is shared by both automated system and driver. The driver should be ready to take over full control anytime.
- Level 2 ("hands off") - the driver is needed only to monitor the driving and intervene only at the time of any failure. Full control of vehicles is under the automated system.
- Level 3 ("eyes off") - the vehicle can handle all the emergency situations itself and the driver can safely turn their attention away.
- Level 4 ("mind off") - driver is not needed for monitoring: its need comes only at special circumstances like traffic jams.
- Level 5 ("steering wheel optional") - no human intervention is needed at all.

Modern self-driving cars generally use Bayesian Simultaneous localization and mapping (SLAM) algorithms [7], which fuse data and gives current location estimates and map updates.

3. Virtual assistant:-
A virtual assistant is a software agent that can perform tasks or services for an individual. The first tool enabled to perform digital speech recognition was the IBM Shoebox, presented in 1962. Virtual assistants use natural language processing (NLP) to match user text or voice input to executable commands. Virtual assistants make work via:

Text- Messaging app or any other app.
Voice- Example, Siri on iphone.

The market for speech recognition technology is predicted to grow at a CAGR of 34.9% globally over the period of 2016 to 2024 and thereby surpass a global market size of USD 7.5 billion by 2024 [8].

4. Part Picking Robot:-
Used for pick and place work, application of operation and handling machine tools. “An automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either, fixed in place or mobile for use in industrial automation applications.” [9,10].

<table>
<thead>
<tr>
<th>Agent Type</th>
<th>Precepts</th>
<th>Actions</th>
<th>Goals (Performance measure)</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite image analysis system</td>
<td>Pixels of varying intensity, colour</td>
<td>Print a categorization of scene</td>
<td>Correct categorization</td>
<td>Images from orbit satellites</td>
</tr>
<tr>
<td>Part picking robot</td>
<td>Pixels of varying intensity</td>
<td>Pick up parts and sort into bins</td>
<td>Place part in correct bins</td>
<td>Conveyor belt</td>
</tr>
<tr>
<td>Automated taxi driver</td>
<td>Camera, speedometer, GPS, sonar, microphone</td>
<td>Steer, accelerate, brake, talk to passenger</td>
<td>Safe, fast, legal, comfortable trip, maximize profits</td>
<td>Roads, other traffic, pedestrians, customer</td>
</tr>
</tbody>
</table>

VII. METHODOLOGY:-
Most of the previous researches on intelligent agent were investigating the agents with respect to its challenges, reason, application and trends [11]. Also researchers present an open question for the future of intelligent agent spreading and the ability to stimulate this global environment. Artificial intelligence and their intelligent agents introduce a solution for such situations.

VIII. CONCLUSION:-
In this quick review we aimed for presenting the advancement in intelligent agents. We should also stress out that several issues still deserve more attention and up gradation. The vision of the future of intelligent agent can be considered as multitasking humanoids that will assist a human in their daily chores.

IX. REFERENCES:-
[1,2]- McCarthy et al. 1995. Also see Crevier 1993, p. 48 where Crevier states'[the proposal] later became known as the ‘physical symbol system hypothesis’.
[3]- Michael Winikoff, Lin Padgham and James Harland RMIT University, Melbourne, Australia. Simplifying the Development of Intelligent Agent