

A Survey on Artificial Intelligence and Robotics

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Abstract: Today many multi-national companies or organizations are adopting the use of automation. Automation means replacing the human by intelligent robots or machines which are capable to work as human (may be better than human). Artificial intelligence is a way of making machines, robots or software to think like human. As the concept of artificial intelligence is use in robotics, it is necessary to understand the basic functions which are required for robots to think and work like human. These functions are planning, acting, monitoring, perceiving and goal reasoning. These functions help robots to develop its skills and implement it. Since robotics is a rapidly growing field from last decade, it is important to learn and improve the basic functionality of robots and make it more useful and user-friendly.

Keywords: Artificial Intelligence (AI), robotics, sensors, reasoning capabilities, intelligent machines etc.

I. INTRODUCTION

AI[1] and robotics[2] have a common root and a (relatively) long history of interaction and scientific discussion. The birth of AI and robotics takes place in the same period ('50), and initially there was no clear distinction between the two disciplines. The reason is that the notion of "intelligent machine"[3] naturally leads to robots and robotics. One might argue that not every machine is a robot, and certainly AI is concerned also with virtual agents[4] (i.e. agents that are not embodied in a physical machine). On the other hand, many technical problems and solutions that are needed in order to design robots are not deal with AI research. A clear separation between the fields can be seen in the '70, when robotics becomes more focused on industrial automation, while AI uses robots to demonstrate that machines can act also in everyday environments. Later, the difficulties encountered in the design of robotic systems capable to act in unconstrained environments led AI researchers to dismiss robotics as a preferred test bed for AI.

Conversely, the research in robotics led to the development of more and more sophisticated industrial robots. This state of affairs changed in the '90s, when robots begun to populate again AI laboratories and robotics specifically addressed also less controlled environments. In particular, robot competitions started: indeed they played a major role in reestablishing a strict relationship between AI and robotics, which are nowadays one of the most promising developments of research both in the national context and at

the European level. Summarizing, the borderline between the work in AI and robotics is certainly very difficult to establish; however, the problems to be addressed in order to build intelligent robots are clearly identified by the research community, and the development of robots is again viewed as a prototypical case of AI system[5].

II. LITERATURE SURVEY

The field of AI is generally held to have started at a conference in July 1956 at Dartmouth College when the phrase "Artificial Intelligence" was first used. Two main approaches were developed for general AI; the "top down" approach which started with the higher level functions and implemented those, and the "bottom up" approach which looked at the neuron level and worked up to create higher level functions. By 1956, Allen Newell [6] had developed the "Logic Theorist" which was a theorem-proving program

By the 1980's AI researchers were beginning to understand that creating artificial intelligence was a lot more complicated than first thought. Given this, Brooks came to believe that the way forward in consciousness was for researchers to focus on creating individual modules based on different aspects of the human brain, such as a planning module, a memory module etc., which could later be combined together to create intelligence.

In the recent past, with the improvement of the technologies associated with computing and robots, there has been a broad based attempt to build embodied intelligences. But the peculiar nature of this field has resulted in the many attempts being almost entirely

unconnected. Because of the difficulty and lack of success in building physical robots, there has been a tendency towards computer simulation, termed “Artificial General Intelligence” where virtual agents in a virtual reality world attempt to achieve intelligent behavior.

Following are the research done by the different authors.

Sr. no.	Authors	Year	Theory/Work
1	Dennett	1984	discussed the frame problem and how it relates to the difficulties arising from attempting to give robots common sense[7].
2	Chalmers	1995	described the “hard problem”, that of raw feeling, and how difficult it is to implement this; and the “easy problem“, which covers the functional areas of consciousness such as planning, memory etc of robots[8].
3	Kitamura	1999	developed CBA (Conscious Based Architecture) to determine at what level an autonomous robot can operate without requiring the ability to learn[9].
4	Cowley,	2008	believed that a robot looks like human and the extent to which it is able to move similarly to humans determines how close it can get “human intelligence”[10].
5	G. Koch, R. Zemel, R. Salakhutdinov	2017	One shot learning for image recognition[11].

Table 1: List of authors and their work/theory

III. RELATED WORK

The concept of AI and robotics are use in various fields[12] such as

- **Gaming**

AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.

- **Natural Language Processing**

It is possible to interact with the computer that understands natural language spoken by humans.

- **Expert Systems**

There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users. These are the systems which are capable of performing various logical tasks which can handle by the experts who design the system.

- **Vision Systems**

These systems understand, interpret, and comprehend visual input on the computer. For example,

- o A spying airplane takes photographs which are used to figure out spatial information or map of the areas.
- o Doctors use clinical expert system to diagnose the patient.
- o Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.

- **Speech Recognition**

Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human’s noise due to cold, etc.

- **Handwriting Recognition**

The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

- **Intelligent Robots**

Robots[13] are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment.

IV. PROPOSED FUNCTIONS IN ROBOTICS

Deliberation refers as purposeful, chosen or planned actions, carried out in order to achieve some objectives. Many robotics applications do not require deliberation capabilities, e.g. fixed robots in manufacturing and other well-modeled environments; vacuum cleaning and other devices limited to a single task; surgical and other tele-operated robots. Deliberation is a critical functionality for an autonomous robot facing a variety of environments and a diversity of tasks. Several functions can be required for acting deliberately. The frontiers between these functions may depend on specific implementations and architectures, but it is clarifying to distinguish the following five deliberation functions, schematically depicted in following Fig. 1[14]:

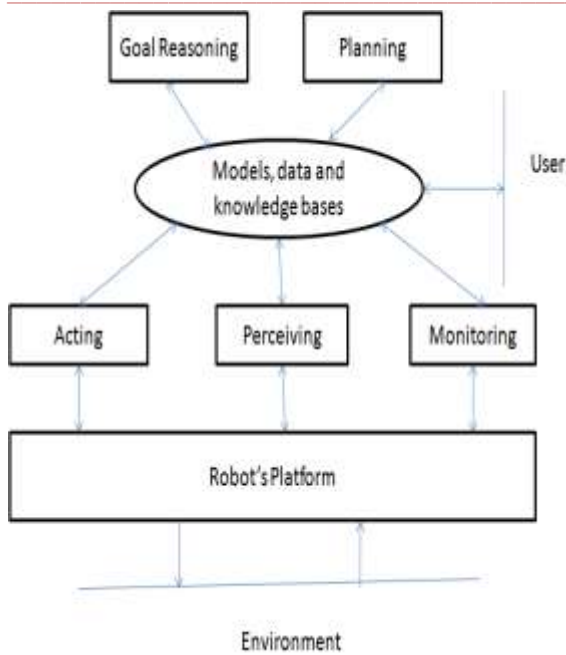


Fig.1. Schematic view of deliberation functions

- **Planning:** combines prediction and search to synthesize a trajectory in an abstract action space, using predictive models of feasible actions and of the environment[15].
- **Acting:** implements on-line close-loop feedback functions that process streams of sensors stimulus to actuators commands in order to refine and control the achievement of planned actions[16].
- **Perceiving:** extracts environment features to identify states, events, and situations relevant for the task. It combines bottom-up sensing, from sensors to meaningful data, with top-down focus mechanisms, sensing actions and planning for in-formation gathering[17].
- **Monitoring:** compares and detects discrepancies between predictions and observations, performs diagnosis and triggers recovery actions to control the machine[18].
- **Goal reasoning:** keeps current commitments and goals into perspective, assessing their relevance given observed evolutions, opportunities, constraints or failures, deciding about commitments to be abandoned, and goals to be updated to achieve desire target or goal of given machine[19].

These deliberation functions interact within a complex architecture (not depicted in Fig. 1). They are interfaced with the environment through the robot's platform functions, i.e., devices offering sensing and actuating capabilities, including signal processing and low-level control functions. The frontier between sensory-motor and deliberation functions are depend on how variable are the environments and the tasks. For example, motion control along a predefined path is usually a platform function, but navigation to some destination requires one or several deliberation skills, integrating path planning, localization, collision avoidance etc.

Learning capabilities change this frontier, e.g., in a familiar environment a navigation skill is compiled down into a low-level control with pre cached parameters. A meta-reasoning function is also needed for trading of deliberation time for action time, critical tasks require careful deliberation, while less important or more urgent ones may not need, or allow for, more than fast approximate solutions, at least for a first reaction.

A) Planning

Motion and manipulation planning are key capabilities for a robot, requiring specific representations for geometry, kinematics and dynamics. Probabilistic Roadmaps and Rapid Random Trees are well developed and mature techniques for motion planners that scale up efficiently and allow for numerous extensions [20]. The basic idea is to randomly sample the configuration space of the robot (i.e., the vector space of its kinematics parameters) into a graph where each vertex is a free configuration (away from obstacles) and each edge a direct link in the free space between two configurations. Initial and goal configurations are added to this graph, between which a path is computed. This path is then transformed into a smooth trajectory. Manipulation planning requires finding feasible sequences of grasping positions, each of which is a partial constraint on the robot configuration that change its kinematics [21].

B) Acting

Acting is one of the most important functions and any robot system can't work without it. Planning deals with only preconditions of given robot system while acting deals with the number of actions, skills and commands that are needed to work robot into given environment. Acting has to handle many tasks such as noisy sensors and imperfect models..

Fig. 2 gives the basic idea about refining actions into skills which tells that skill into which an action is refined may change during that action execution.

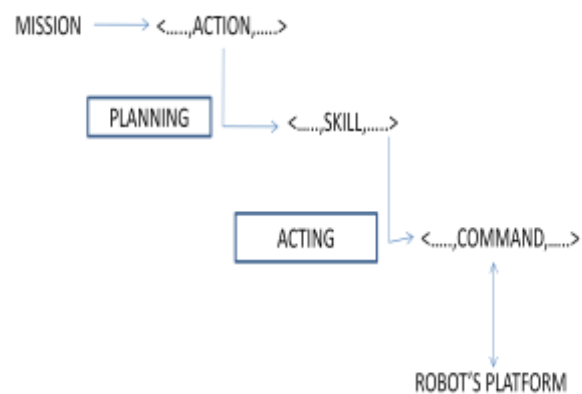


Fig. 2. Refining actions into skills

. Following are the computational techniques that are used to design a deliberate acting system.

Refinement: Sometimes it is not possible to execute given plan as same way as robot system designer planned. For example, suppose any robot get command to go into room1. In order to complete these command robot must have to think about how to accomplish it. It consist of skills such as finding the shortest path between robot and room1, avoid the collision with any obstacles, navigate itself in correct direction etc. That means refinement deals with the proper set of actions or skills that helps robot to complete its task using correct ways.

Instantiation/Propagation: From Fig. 2, it is clear that propagation of actions can happen while the time of designing robot system. That is, actions are propagated in skills while skills further propagated in commands. This propagation helps system to develop its skill using previous actions and execute the given commands by using the skills.

Time management/Coordination: Along with the completion of given task or number of tasks, it is important to complete given tasks within given time limits or deadlines. Suppose there is any robot which complete all the tasks, but if it take so much time to achieve its goals that robot become useless. Hence time management is also essential with accuracy. There are also several cases in which coordination between two or more actions are needed. When any robot follows the number of actions, every action of it must coordinate with other actions.

Handling non-determinism and uncertainty: Some actions of robot are not needed or that actions are unable to produce any useful work create uncertainty into given systems. Uncertainty and any non- deterministic actions degrade the performance of given system. Hence always try to avoid or eliminate this type of uncertainty.

Plan repair: It is not always necessary that whatever the plan planned by robot system designer must apply into given system. Sometimes it becomes need to repair given plan or derive new plan to make robot system more convenient to use. Plan repairing is depend on the changes or improvements in preconditions and objectives It must have to made in such a way that, it can fulfill all the results or goals of given robot system.

C) Monitoring

Monitoring function deals with find out the number of mismatch between predictions and observations. When particular predictions are not working properly into given system, it becomes essential to correct it to achieve desire goal. If it is not possible to correct given system problems in one attempt, classify it according to the type of problem and try to solve them individually. These help the system to recover from problems and make system more convenient to use.

D) Perceiving

As any robot system consist of number of actions and skills, it is important to execute the correct actions at correct time. Perceiving function works on same type of strategy. When robot system receive signal to perform particular task, perceiving function collect all the actions or information gathered into given system and perform actions which helps robot to achieve its task. It also determines the state of given system in which it become stable.

E) Goal Reasoning

The last but most important function of any robot system is the goal reasoning. This function indicates that whether the given system accomplished its task or not. If given system fails to fulfill some or all the objectives, it becomes necessary to develop the new plan or make some changes into it. Goal reasoning tells about the performance of given system and modifications which are required to increase the overall performance of it. If given system is able to handle or satisfy all the objectives for which it is made then it can be say as given system is in proper state of work. The success of goal reasoning is depends on the proper utilization of previous four functions.

V. CONCLUSION

The field of artificial intelligence gives the ability to the machines to think analytically, using concepts. Tremendous contribution to the various areas has been made by the AI techniques from the last 2 decades. AI will continue to play an increasingly important role in the various fields. Autonomous robots facing a variety of open environments and a diversity of tasks cannot rely on the decision making capabilities of a human designer or tale-operator. To achieve their missions, they have to exhibit complex reasoning which are capabilities required to understand their environment and current context, and to act deliberately, in a purposeful, intentional manner. These reasoning capabilities are called as deliberation functions, closely interconnected within a complex architecture.

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REFERENCES

- [1] A. Chella, M. Frixione, and S. Gaglio. "Understanding dynamic scenes. Artificial Intelligence", 123:89–132, 2000.
- [2] J. Hallam and H. Bruyninckx. "An ontology of robotics science". In H.I. Christensen, editor, European Robotics Symposium 2006, pages 1–14, Berlin, Heidelberg, 2006. Springer-Verlag.

- [3] A. Chella, S. Gaglio, and R. Pirrone. "Conceptual representations of actions for autonomous robots". *Robotics and Autonomous Systems*, 34:251–263, 2001.
- [4] P. I. Corke. "Visual Control of Robots: High Performance Visual Servoing". Wiley, New York, 1996.
- [5] S.J. Russell and P. Norvig. "Artificial Intelligence: A Modern Approach". Pearson Education, 2003.
- [6] A. Newell and H. A. Simon, "The logic theory machine a complex information processing system", The Rand Corporation, Santa Monica, available at <http://shelf1.library.cmu.edu/IMLS/MindModels/logictheorymachine.pdf>, 1956.
- [7] D. C. Dennett, "Cognitive wheels: the frame problem of AI" in "Mind, Machines, and Evolution", Cambridge University Press, Cambridge, pp. 129-151, 1984.
- [8] D. J. Chalmers, "Facing up to the problem of consciousness", *Journal of Consciousness Studies*, vol. 2, pp. 200-219, 1995.
- [9] T. Kitamura, "Can a robot's adaptive behavior be animal-like without a learning algorithm?", IEEE Systems, Man, and Cybernetics Conference, Tokyo, 1999.
- [10] M. Cowley, "The relevance of intent to human-android strategic interaction and artificial consciousness", 15th IEEE International Symposium on Robot and Human Interactive Communication, Hatfield UK, 2008.
- [11] G. Koch, R. Zemel, R. Salakhutdinov, "Siamese Neural Networks for One-shot Image Recognition". University of Toronto, Ontario, Canada 2017.
- [12] E. Pagello et al. "RoboCup-2003: New Scientific and Technical Advances". *AI Magazine*, 25:81–98, 2004
- [13] L. Sciavicco and B. Siciliano. "Modelling and Control of Robot Manipulators", 2nd ed. Springer-Verlag, Berlin Heidelberg, 2000.
- [14] Felix Ingrand, Malik Ghallab. "Robotics and Artificial Intelligence: a Perspective on Deliberation Functions". LAAS CNRS, Toulouse, France, 2014.
- [15] M. Ghallab, D. Nau, and P. Traverso. "Automated Planning: Theory and Practice". Morgann Kaufmann, October 2004.
- [16] M. Hauskrecht, N. Meuleau, L. P. Kaelbling, T. Dean and C. Boutilier. "Hierarchical solution of Markov decision processes using macro-actions". In *Proceedings of the Conference on Uncertainty in Artificial Intelligence*, pages 220-229, 1998.
- [17] F. Chaumette and S. Hutchinson. "Visual servo control, part ii: Advanced approaches". *IEEE Robotics and Automation Magazine*, 14(1):109{118, 2007.
- [18] R. Fikes. "Monitored Execution of Robot Plans Produced by STRIPS". In *IFIP Congress*, Ljubljana, Yugoslavia, August 1971.
- [19] M. Pollack and J. Horty. "There's more to life than making plans: plan management in dynamic, multi-agent environments". *AI Magazine*, 20(4):71, 1999.
- [20] S. LaValle. "Planning Algorithms". Cambridge University Press, 2006.
- [21] T. Simeon, J-P. Laumond, J. Cortes, and A. Sahbani. "Manipulation planning with probabilistic roadmaps". *International Journal of Robotics Research*, 23(7-8):729{746, 2004}.