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How Artificial Intelligence is Impacting Manufacturing Industry

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Abstract
In this survey, we study the impact of Artificial Intelligence (AI) on manufacturing sector. AI methods can be utilized to make new thoughts several ways: by delivering novel mixes of well-known thoughts; by investigating the capability of theoretical spaces; and by making changes that empower the era of unexplored thoughts. AI will have less trouble in displaying the era of new thoughts than in automating their assessment. We describe the advances that have been made on AI in manufacturing industry. We close with how to overcome the issues in this area.

Keywords: *Artificial Intelligence, Manufacturing Sector, Machine Learning, Neural Network.*

1. Introduction

Artificial intelligence, or AI is the field that studies the synthesis and analysis of computational agents that act intelligently. As per Charles Babbage's definition for a computer is by and large what computers are even today, despite advances in computing and programming one still should teach the computer everything, even then it does not exist in state of knowing or consciousness. In other words, it does not know what it knows and cannot use it on its own unless under your explicit directions or instructions. Different people have come up with different answers so we can come up with our own analysis. Most of the definitions have these in common.

Logic, abstract thought, understanding, self-awareness, communication, learning, emotional knowledge, memory, planning, creativity, and problem solving. Now each of these words in themselves can have multiple interpretations but just by looking at it you know what machines lack. Artificial Intelligence is intelligence that can be simulated by a machine once it has been described in such detail to encompass the entirety of human intelligence. Even though General intelligence or strong AI (the concept of artificial beings) are many years in the future it has become an interdisciplinary field of study and application and has resulted in some quasi intelligent approaches include probabilistic learning, statistical learning which are intensively used to sift through huge amounts of data.

To understand machine learning, consider the analogy of a newborn baby, when it is born it knows nothing, it gradually learns over the years to think, correlate, etc. Similarly, if we can make machines commit things to memory and learn through past experiences and draw inferences for our problems we can say that the machines are intelligent enough to perform a task. It can become "beings" if it attains self-consciousness and is self-sustainable and capable of ensuring its survival. Since our goals and objectives are mainly to use the computational power of computers to solve problems and obtain information from large amounts of data that are too huge for us to handle, people generally prefer machines that are subject to command and hence quasi intelligent.

Research on machine "beings" has various ethical issues. Many condemn this kind of research and say it is unnatural and akin to playing for god, and also there are others how think machines would replace human beings in the natural order of things as we have done too much of the planet already. Of course, there are two sides to every coin there are those who believe that intelligent machines are the next step in the process of evolution and will help answer questions beyond the capability of human understanding.

Just because people are debating over this controversial area of research doesn't mean that mankind is extremely close to creating artificial beings of intelligence. We have many good and effective machine learning and decision-making techniques that computers use but still none of it comes close to the efficient way that the human brain is capable of reason and thought maybe because we cannot characterize and break down our thought process efficiently enough to teach it to machines.

Neural network computing methods provide one approach to the development of adaptive and learning behavior in robotic systems for manufacturing. Computational neural networks have been demonstrated which exhibit capabilities for supervised learning, matching, and generalization for problems on an experimental scale. In this paper, we point to several issues in the manufacturing applications of robotics where these capabilities will be extremely important. Supervised learning could improve the efficiency of training and development of robotic systems. Matching provides a means to execute the learned behavior and will be important in areas such as industrial inspection and control and task execution functions.

AI is an interdisciplinary field of research that has immense potential as seen by the very broad and intensive use in many thousands of applications from automation of small repetitive, weather forecasting tasks to smart phones and primitive robots capable of basic social interactions.

2. Importance of Artificial Intelligence

The definitions of AI according to some text books are categorized into four approaches and are summarized in the table below:

Systems that think like humans "The exciting new effort to make computers think…machines with minds, in the full and literal sense."	**Systems that think rationally** "The study of mental faculties through the use of computer models."
Systems that act like humans "The art of creating machines that perform functions that require intelligence when performed by people."	**Systems that act rationally** "Computational intelligence is the study of the design of intelligent agents".

2.1 (a) Acting humanly: The Turing Test approach

The computer passes the test if a human interrogator, after poising some written questions, cannot tell whether the written responses come from a person or not. Programming a computer to pass, the computer need to possess the following capabilities:

Natural language processing: it enables to communicate successfully in English.

Knowledge representation to store what it knows or hears.

Automated Reasoning to use the stored information to answer questions and to draw new conclusions.

Machine Learning to adapt to new circumstances and to detect and extrapolate patterns.

To pass the complete Turing Test, the computer will need

- *Computer vision* to perceive the objects.
- *Robotics* to manipulate objects and move about.

(b) Thinking humanly: The Cognitive modelling approach

We need to get inside actual working of the human mind:

- through introspection-trying to capture our own thoughts as they go by;
- through psychological experiments.

Allen Newell and Herbert Simson, who developed GPS, the "General Problem Solver" tried to trace the reasoning steps to trace of human subjects solving the same problems. The interdisciplinary field of cognitive science brings together computer models from AI and experimental techniques from psychology to try to construct precise and testable theories of the workings of the human mind.

(c) Thinking rationally: The "laws of thought approach"

The Greek philosopher Aristotle was one of the first to attempt to codify" right thinking", that is irrefutable reasoning processes. His syllogism provided patterns for argument structures that always yielded correct conclusions when given correct premises-for example, "Socrates is man; all men are mortal. These laws of thought were supposed to govern the operation of the mind; their study initiated a field called logic.

(d) Acting rationally: The rational agent approach

An agent is something that acts. Computer agents are not mere programs, but they are expected to have the following attributes also: (a) operating under autonomous control, (b) perceiving their environment, (c) persisting over a prolonged time period, (e) adapting to change. A rational agent is one that acts so as to achieve the best outcome.

3. Automated Assembly

The key obstacle to making manufacturing systems work economically and efficiently in industry today is most often the overall systems coordination and not the control of specific devices. A robotic work cell consists of three robot arms, a movable work surface and fixturing, and several different types of sensors. The function of this assembly work cell is to acquire parts that are presented to the system, orient the parts in a prescribed manner, mate the parts into predetermined relationships, and fasten the parts into a final stable configuration. While such an assembly work cell depends on the speed and accuracy of its individual components, the overall capabilities are most closely related to its capacity as a system to reliably integrate functions of positioning, grasping, and sensing.

Currently, the difficulty in developing such systems for manufacturing applications is in the implementation, planning, programming, and coordination of the various devices to create a reliable system. The planning and programming that are required to design and implement an assembly work cell are usually organized into a hierarchical set of levels. The highest level of implementation involves the planning of the task itself and this is directly related to a representation or description of the product and its parts. The decomposition of the task must then be coordinated with the available set of resources such as robots, fixtures, and sensors. This decomposed set of tasks is mapped onto a control architecture that defines the coordination and sequencing relationships among the various devices.

Most planning and programming tasks for industrial applications are currently carried out manually. In many cases, the product design, the manufacturing systems plan, and the final manufacturing systems implementation may be carried out by different organizations. The evolution of improved tools and methods to carry out these processes will have an important impact on the effectiveness of manufacturing organizations to respond to new technical and economic opportunities. A key to the development of such improved tools and environments will be the incorporation of both generic methods for computation and reasoning with applications specific knowledge and representation of tasks.

The successful utilization of neural networks techniques in the planning and control of manufacturing systems will depend upon the detailed domain specific understanding of the applications area at hand. The demonstration of effective neural network approaches to task planning, sequencing, scheduling, routing, discrete control, sensor-based control, fine motion control, or error recovery for a given task domain such as assembly or machining would represent a significant achievement and would emphasize the importance of these computational approaches.

The development of a demonstration of computational performance for a domain specific problem such as assembly requires careful attention to the issue of task representation, including assumptions and constraints which are inherent to that manufacturing domain. There exists relational models of product parts geometry and relationships which enables the manufacturer to reason, about the feasibility of task operations and, therefore, successfully generate and evaluate alternative feasible sequences for accomplishing the assembly goals. In the assembly problem, the task decomposes into a sequence of subassembly mating operations, each of which is governed by geometric and mechanical constraints. In another task domain such as machining, the task may decompose into a sequence of alternative milling or cutting operations, each of which also has its own geometric and mechanical constraints. In each of these problem domains, the search over alternative sequences of operations is closely coupled to the evaluation of feasibility predicates which incorporate geometrical and physical reasoning problems.

4. Issues and Opportunities

Issues are grouped into four separate areas: mechanisms, control, representation and planning, and architecture and implementation. While the mechanisms themselves are not directly related to the implementation of adaptive and learning systems, improvements in sensing technology, motor technology, and new mechanisms such as flexible arms and sophisticated hands, will place increasingly strong demands on the corresponding control and planning systems to incorporate adaptive capabilities for utilization in specific tasks.

The previous section described an example of the hierarchical system of planning and control which is typical of many manufacturing systems, and suggested ways in which neural net computation might provide an effective tool at the levels of planning, discrete control, continuous control, and sensing.

The use of these computational tools will be effective only if they meet needs or expectations of the users. The manufacturer has several key practical performance goals which he requires from any system which is being developed.

Typically, systems speed, throughput, accuracy, and overall costs of both implementation and operation are factors which he must consider. The flexibility of a system is the ability to change functionality and respond to new requirements, and is an increasingly important component of such systems. The ability to efficiently implement a system, to operate the system reliably, and provide a degree of flexibility which permits an evolution of the manufacturing system in accord with product changes, are important elements which influence the effectiveness of automation in manufacturing today.

5. Role of Neural Networks in Robotics for Manufacturing

An example which is feasible in the short term, would be parameter learning within the structure of an existing robot program as was illustrated earlier. In this case, the parameter adaptation is essentially a smooth adaptation to local changes and might be handled efficiently by existing neural network techniques. Kinematic path planning is another area of promise, but is in general more difficult because of the dimensionality of the geometric representations required, and the resulting complexity of a neural net implementation.

GENERAL	**SHORT TERM**
Auto-association/Matching Classification Generalization Learning	Sensor-Based Inspection-Easily Trained Sensor Interpretation and Abstraction Calibration/Identification Parameter Learning in Stereotyped Tasks Kinematic Path Planning
LONG TERM	**OPPORTUNITY**
Task Planning Task Learning in Complex Systems Reasoning with Uncertainty Learning in dynamic Control	Application Domains Improve Reliability Through Adaptive Behaviour Improve Implementation Tools Through Trainable Systems

6. Conclusions

In the longer term, there are many opportunities for the application of learning systems to task-planning and task-reasoning problems, particularly those that confront the issue of uncertainty in the task environment.

The integration of sensory information into an adaptive robot control structure will be an important element of future robot systems. This will require adaptive systems which both converge quickly, maintain stability, and handle the growing dimensionality of the problem. Learning systems may improve the capabilities of planning and execution of fine motion operations such as detailed force control and grasping.

An important element in the development of these adaptive and learning techniques and in their evaluation, will be the recognition that robotics is experimental in nature. Development often requires the building of systems and the testing of new tools on real systems to evaluate their effectiveness. In applications areas such as manufacturing, this experimental demonstration becomes even more critical since the functional capability of these tools is related most to their ability to compensate for characteristics which are not entirely predictable or which cannot be modeled. Neural network computing systems with capabilities for supervised learning, matching, and generalization are being developed and explored in a variety of simulated and experimental contexts.

Robotic systems offer a promising domain for this exploration since the practical application of complex robotic systems may require adaptive and a learning behavior to achieve their desired functionality. In manufacturing, these capabilities may improve the implementation efficiency, increase the reliability of the system, and improve the performance and accuracy of inspection and control functions. The hierarchical nature of a manufacturing systems architecture lends itself to the integration of these techniques into real systems, the use of neural network techniques in off-line planning, systems design, and product design is an area of promise. Neural network principles need to be better understood, and convergence, computational efficiency, and stability characterized more completely. Robotics and automation provide an opportunity for evaluation of these capabilities, and a setting for the development of practical tools to enhance the functionality of robotic systems in manufacturing applications.

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