

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES THE ERA OF ARTIFICIAL INTELLIGENCE: MAKING MANUFACTURING INTELLIGENT

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ABSTRACT

Global competition and rapidly changing customer requirements are demanding increasing changes in manufacturing environments. Enterprises are required to constantly redesign their products and continuously reconfigure their manufacturing systems. Traditional approaches to manufacturing systems do not fully satisfy this new situation. Based on research into the applications of artificial intelligence (AI) technology in the manufacturing industry in recent years, the paper aims at analyzing the rapid development of core technologies in the new era of 'Internet plus AI', which is triggering a great change in the models, means, and ecosystems of the manufacturing industry, as well as in the development of AI.

In addition, the paper attempts to study the perspectives of intelligent manufacturing application technology, industry, and application demonstration, the current development in intelligent manufacturing. The paper finally give suggestions for the application of AI in intelligent manufacturing.

Key words: Artificial intelligence; intelligent manufacturing; intelligent manufacturing system

I. INTRODUCTION

The new technological revolution and the new industrial revolution are growing rapidly. The new era of 'Internet plus artificial intelligence (AI)', characterized by ubiquitous networks, data-drivenness, shared services, cross-border integration, automatic intelligence, and mass innovation, is coming. The rapid development and fusion of new AI technologies with Internet technologies, new-generation information technologies, new energy technologies, materials technology, and biotechnology is an essential part of this new era, which in turn will enable the game-changing trans-formation of models, means, and ecosystems in terms of their application to the national economy, well-being, and national security.

The manufacturing industry is a cornerstone of national economy, people's livelihood, and national security. The deep fusion of manufacturing technology with information communication technology, intelligent technology, and product-related expertise in particular, is enabling a game-changing transformation in terms of manufacturing models, manufacturing approaches, and its ecosystems.

Modern manufacturing technology is interdisciplinary in nature and allows the application of different knowledge from other scientific fields such as manufacturing, computer science, management, marketing and control systems. Manufacturing has also shifted from mass production, to a more controlled one where products are only produced if there is a market for them, and when there is a market, they must be manufactured quickly, e.g. JIT manufacturing. We need also to look at all aspects of the process before manufacturing a product. We have to make sure that we can do it right, efficiently and cost effectively if we want to make any profit. Therefore control on the manufacturing process should not be only on machines but should also include human aspects. Another shift of modern manufacturing is from a localized level to total plant-wide control. There is a need to predict how the system will perform under certain circumstances.

II. RESEARCH OBJECTIVES

The research is undertaken with an objective of finding out

1. The present status of artificial intelligence in Manufacturing Sector.

2. The benefits of artificial intelligence in making Manufacturing Intelligent
3. To study the future trends of artificial Intelligence in Manufacturing Sector

III. RESEARCH METHODOLOGY

It is descriptive in nature and secondary sources of data were used to get a depiction of Artificial Intelligence in manufacturing sector by means of the published source like related previous research in journals, research reports, newspaper, and related bodies published reports and internet and website portals.

Section 1 : Review of Literature

Since its emergence in the 50s, AI has provided several techniques with applications in manufacturing. In the early years, knowledge based systems attracted many attention. Recently neural networks, case-based reasoning, genetic algorithms and fuzzy logic have attracted more attention and have been successfully employed in manufacturing. Karwowski and Evans (1986) identified three key reasons why fuzzy logic is relevant to production management; this can be generalized to all AI techniques:

- (1) Imprecision and vagueness are inherent to the decision maker's mental model
- (2) In the production management environment, the information required formulating a model's objective; decision variables, constraints and parameters may be vague or not precisely measurable.
- (3) Imprecision and vagueness as a result of personal bias and subjective opinion may further dampen the quality and quantity of available information.

The application of AI in manufacturing has been the subject of extensive research in the last two decades.

This surge in the application of AI in manufacturing is mainly due to the availability of powerful computers. This paper reports mainly on the journals where most of the research has been published. Other journals that contain papers on the use of artificial intelligence in manufacturing, and have been consulted, include Robotics and Integrated Manufacturing, IEEE Transactions on Robotics and Automation, Integrated Manufacturing Systems and Computers, Computers and Industrial Engineering and Operations Research. This review focuses on the use of the following AI techniques:

expert systems, neural networks, genetic algorithms, fuzzy logic, case-based reasoning and any combination of these techniques.

Section 2: Artificial Intelligence and Manufacturing sector

The manufacturing industry has always been available to embrace the innovative technologies. Drones and industrial robots have been a part of the manufacturing industry since 1960's. The following automation revolution is just around. With the implementation of AI, if organisations can keep inventories lean and reduce the cost, there is a high probability that the Manufacturing Industry will encounter an empowering development. Having said that, the manufacturing sector has to be prepared for organized manufacturing plants where supply chain, design team, production line, and quality control are very coordinated into an intelligent engine that provides noteworthy insights of knowledge.

Section 2.1 Artificial Intelligence facilitates the development of intelligent manufacturing

Intelligent manufacturing is a new manufacturing model and the technical means by which new information and communication technology, intelligent science and technology, large manufacturing technology (including design, production, management, testing, and integration), system engineering technology, and related product technology are integrated with the whole system and lifecycle of product development. The life cycle of manufacturing thus uses autonomous sensing, inter-connection, collaboration, learning, analysis, cognition, decision-making, control, and the execution of human, machine, material, and environmental information to enable the integration and optimization of various aspects of a manufacturing enterprise or group, including three elements (people/organizations, operational management, and equipment and technology) and five flows (information flow, logistics flow, capital flow, knowledge flow, and service flow). This facilitates production and provides a high efficiency, high quality, cost-effective, and environment- friendly service for users, and therefore improves the market competitiveness of the manufacturing enterprise or group.

AI technology facilitates the development of new models, means, and forms, system architecture, and technology systems in the domain of intelligent manufacturing (Li *et al.*, 2014; NMSAC and SAC-CAE, 2016).

AI facilitates to conquer many internal challenges that have been around in the industry: from expertise shortage to complexity in decision making, issues related to integration, and overloaded information. Making use of AI in manufacturing plants enables businesses to completely transform their proceedings. Followings are the ways in which AI is helping the manufacturing sector to accomplish:

- **Directed Automation:**

The utilisation of AI and robots is particularly observed in industrial manufacturing as they revolutionize mass-production. Robots are capable of doing recurring activities, designing the production model, rising competence, building automation solutions, eradicating human error and delivering superior levels of quality assurance.

- **24x7 Production:**

While humans are forced to work in 3 shifts for ensuring continuous production, while robots are capable to work for 24/7 in the production line. Businesses can be witnessed to expand in terms of production capabilities and meet the high demand of customers worldwide.

- **Safer Operational Environment:**

With several errors taking place on the manufacturing plant, a step towards AI means less human resource have to carry out dangerous and overly laborious work. As robots replace humans and perform normal and risky activities, the number of workplace accidents will decrease all across.

- **Novel Opportunities for Humans:**

As AI takes over the manufacturing plant and automates boring and ordinary human tasks, workers will get to focus on complex and innovative tasks. While AI takes care of unskilled labor, humans can focus on driving innovation and routing their business to advanced levels.

- **Condensed Operating Costs:**

Although, bringing AI onto the manufacturing industry would necessitate a huge capital investment, the ROI is significantly high. As intelligent machines start taking care of day-to-day-activities, businesses can enjoy considerably lower operating cost.

Added Benefits of AI

AI and industrial automation have advanced considerably in the recent years. Development in machine learning techniques, advances in sensors and therefore, the growth of computing power has helped produce a brand new generation of robots. AI helps allows machines to gather and extract data, acknowledge patterns, learn and adapt to new things or environments through machine intelligence, learning and speech recognition. Using AI, manufacturers will be able to:

- Create rapid, data determined decisions
- Facilitate enhanced production outcomes
- Advance process effectiveness
- Minimize operational costs
- Facilitate superior scalability
- Facilitate product development

Moreover, AI is quite good at understanding the natural language and translating it, this will turn out to be simpler for workers and managers to communicate with software. For example, software users often have a preference to look for things rather than navigate a complex menu. AI makes the software comprehend the user's intentions, which make the system more spontaneous, which leads to superior output and fewer errors.

Section 3: The Trends of Manufacturing Industry with Emerging AI:

AI will impact manufacturing in ways we have not yet anticipated. .

The continued enhancement in computer visualization has long been used for quality assurance by detecting product defects in real time. But now that manufacturing involves more information than ever integrated with the fact that plant managers do not want to pay employees to enter information—AI with computer vision can rationalize how information gets apprehended. A factory worker should be able to acquire raw materials reserve from the shelf and

have the stock transaction created automatically based on a camera observing the process. This will be the natural user interface, just carrying out the task at hand not inputting or scanning things into a system.

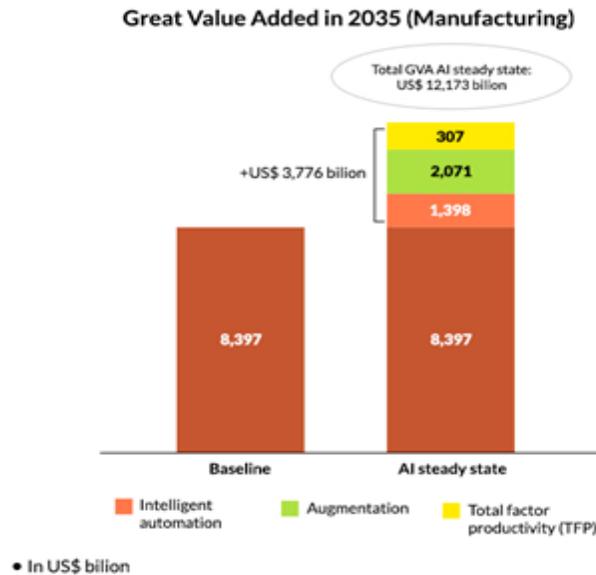
Secondly, AI will impact is with the Internet of Things (IoT). IoT will give a way to deliver supplies and services to customers who might not comprehend that they are required. Additionally, IoT can send in-depth telemetry back to producers and distributors to scrutinize quality and factors that might drive failures. IoT is an inward tsunami of information that AI can utilize to reason over and evolve. This will facilitate augmented generative design processes where products are re-imagined in ways more similar to evolution.

Some Important Statistical Information of AI in Different Sectors:

By 2035 AI technologies have the impending to rise in production 40% or more.

AI will boost the economic growth an average of 1.7% across 16 industries by 2035

Great value added by 2035 with respect to manufacturing sector



Section 4: Current Global Development of Intelligent Manufacturing

Overseas development

Developed countries, such as the US and Germany in particular, have drafted innovative strategies and policies on intelligent manufacturing, such as the ‘Advanced Manufacturing Partnership Plan’ (2011) and ‘Industrial Internet’ (2012) in the US, and the ‘Industry 4.0 Plan’ (2013) in Germany.

In 2012, GE in the US proposed the concept of ‘Industrial Internet’, which can connect intelligent equipment, people, and data and analyze such data in an intelligent manner to enable smarter decision-making by humans and machines. The three major components of the Industrial Internet are intelligent equipment, intelligent systems and intelligent decision-making. The Industrial Internet may be seen as the circulation among, and interaction between, data, hardware, software, and intelligence. It can store, analyze, and visualize data acquired through intelligent equipment and networks for final intelligent decision-making based on intelligent information. The maximal potential of the Industrial Internet will be realized through the holistic integration of the three components—intelligent equipment, intelligent systems, and intelligent decisions—with machines, equipment sets, facilities, and system networks (Evans and Annunziata, 2012).

In 2013, Germany launched its Industry 4.0 plan, where the strategic idea of ‘one core, two topics, three-dimensional integration, and eight plans’ is proposed, with special emphasis on intelligent factories and intelligent production Cyber physical system (CPS) networks and the construction of correspondent intelligent equipment systems became main concerns. In Industry 4.0, intelligent manufacturing systems can perceive and monitor massive data in real time, generated in the process of production, and realize intelligent analysis and decision-making so as to transform production mode into intelligent manufacturing, cloud-end collaborative manufacturing, and customer tailored production, and realize the integration of more production factors in a more scientific manner. It is obvious that the development of technologies, industries, and applications in intelligent manufacturing became the main concern in each country’s strategic plan.

CPS-based intelligent manufacturing technology in Germany has achieved milestone results, and Industrial Internet based intelligent manufacturing technology in the US has also accomplished initial outcomes.

The intelligent manufacturing industries in Germany and the US have begun to take shape with the development of intelligent manufacturing system tools and platforms such as the industrial Internet platform Predix developed by GE in the US and the digital cloud service platform Sinalytics built by Siemens in Germany.

IV. CONCLUSION AND SUGGESTIONS

A good manufacturing unit is the main building block of any industry. The industrial revolution led to speed up the manufacturing process to many times. Now, it is the time for the fourth industrial revolution and it is said that artificial intelligence is going to play a major role in this revolution. Artificial intelligence applications have given more power and intelligence to the machines.

Today’s consumers have a lot of options to choose from. They demand the best and customized product over generalized products. Local manufacturers have to match the quality and standard with that of global manufacturers. These factories, manufacturing, and power plants have to take the help of artificial intelligence automation in order to improve the quality of the product and cope with the rising competition.

Manufacturing units also have to face challenges like reducing the cost of production. Due to huge competition in the market, manufacturers have to reduce their cost of production of every unit to gain the profit margin. Machine learning applications automate the tasks and this helps in reducing the human task force. The efficiency is also improved as machines have a less margin of error.

Manufacturing units can’t just keep on manufacturing the products without forecasting the demand for the product. This is because in future if due to any factor the demand of the product gets reduced, the organization has to incur a huge loss. For better optimization of the resources, it is necessary to forecast the future demand for the product. Artificial intelligence services are helping in better forecasting the demand for the product.

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