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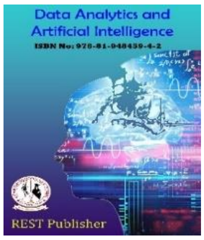

Manufacturing systems based on Industrial Artificial Intelligence for I-4.0

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Abstract: *The importance of artificial intelligence (AI) and the need for a well-thought-out plan and strategic investment in this field have grown in recent years. For artificial intelligence (AI) to truly have an impact on Industry 4.0, the next generation of industrial systems, methodical AI development and application are urgently needed. This essay offers an overview of the state of AI technology today and the ecosystem needed to fully utilize AI's potential in industrial settings.*

1. INTRODUCTION TO INDUSTRIAL ARTIFICIAL INTELLIGENCE

The cognitive science of artificial intelligence (AI) is abuzz with research endeavors in robotics, machine learning, natural language processing, image processing, and other fields. The experience and preferences of a developer have a big impact on how well machine learning algorithms work. Thus, artificial intelligence hasn't had much success in industrial applications. Industrial AI, on the other hand, is a methodical field that focuses on creating, testing, and implementing different machine learning algorithms for industrial applications that have long-term performance. It serves as a bridge between academic AI research findings and industry practitioners, acting as a methodical approach and discipline to deliver solutions for industrial applications. Automation powered by AI hasn't yet had a statistically significant effect on productivity. In addition, industries today face fresh difficulties with regard to market demand and rivalry. They require the drastic shift known as Industry 4.0. Businesses will be able to operate in a flexible, effective, and environmentally friendly manner thanks to the integration of AI with recently developed technologies like cloud computing, big data analytics, and the Internet of Things (IoT). As industrial AI is still in its early stages, it is crucial to outline its methods, structure, and difficulties in order to provide a foundation for its application in business. In order to do this, we created an industrial AI ecosystem that includes the key components and offers guidelines for a deeper comprehension and application of the technology.

2. KEY ELEMENTS OF INDUSTRIAL AI

The key elements in Industrial AI can be characterized by: Analytical technology, Big data and Cloud technology, Domain knowledge and Evidence. The foundation of AI is analytics, which is only useful when combined with other components. The foundational components of Industrial AI are big data and cloud technologies, which offer the data source and a platform. Domain knowledge is key in the following aspects: 1) to understand the problem and focus the power of industrial AI to solve it; 2) to understand the system so that the right data can be collected at the right quality; 3) to understand the physical meaning of the parameters and how they relate to the physical characteristics of the system or process; and 4) to understand how these parameters vary between machines.

3. INDUSTRIAL AI ECO-SYSTEM

The Industrial AI ecosystem that has been suggested outlines a methodical approach to addressing requirements, obstacles, technologies, and development processes for creating revolutionary AI systems for the industrial sector. This diagram can be used by practitioners as a methodical roadmap for creating and implementing an industrial

AI strategy. This ecosystem outlines the common needs, such as resilience, self-awareness, self-comparison, self-predict, and self-optimization, within the targeted industry. The four primary enabling technologies shown in this chart are operations technology (OT), platform technology (PT), analytical technology (AT), and data technology (DT). These four technologies—DT, AT, PT, and OT—are what make Connection, Conversion, Cyber, Cognition, and Configuration successful, as Fig. 1 illustrates. A brief description of each of the technologies mentioned is given in this section of the paper.

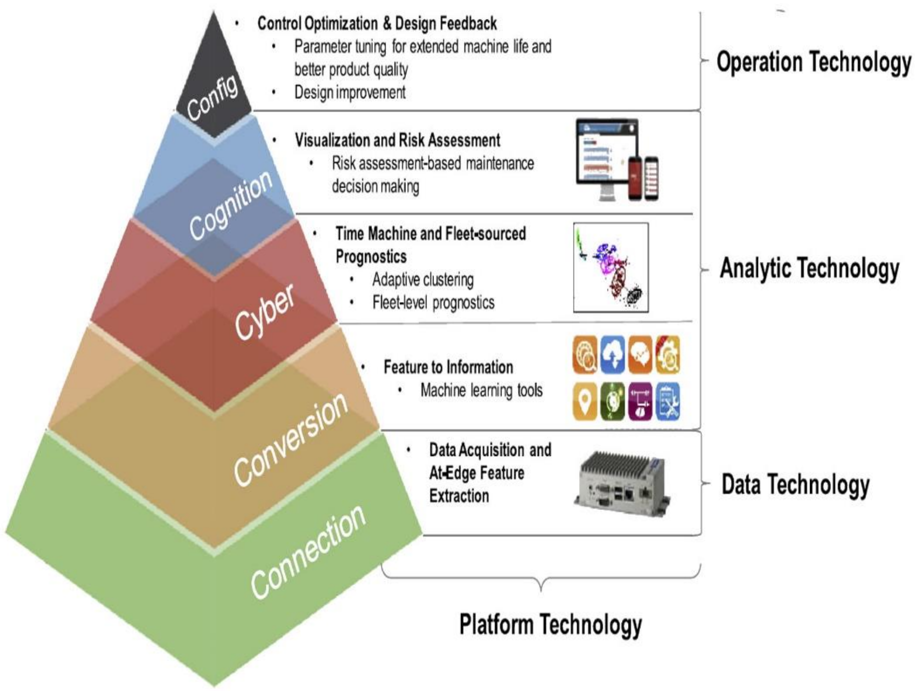

FIGURE 1. Computer-based Production System – Technologies involved

3.1. Data technology (DT):Data technologies are those that make it possible to successfully acquire meaningful data with important performance metrics in a variety of dimensions. As a result, it contributes to the 5C architecture's "Smart Connection" step by determining the right tools and methods for gathering insightful data. Data communication is the additional facet of data technologies. In the context of Smart Manufacturing, communication goes beyond the comparatively simple transfer of obtained data from its source to the analysis point. It entails: 1) The physical interaction of manufacturing resources. 2) Moving and storing data from factory floors and machines to the cloud. 3) Interaction between cyberspace and physical space. 4) Information exchange between virtual and real worlds.

3.2. Analytics technology (AT):

Analytics technology transforms critical component sensory data into actionable insights. Data-driven modeling allows manufacturing systems to reveal useful information such as unknown correlations and hidden patterns. By creating a health value or a remaining useful life value, which can be used for machine prognostics and health management, this information can be used to predict the health of an asset. Analytic Technology will integrate this information with the other technologies to improve production.

3.3. Platform technology (PT):

The hardware architecture used in data storage, analysis, and feedback manufacturing is an example of platform technologies. Realizing smart manufacturing features like agility and complex-event processing depends heavily on having a platform architecture that is compatible for data analysis. In terms of computational, storage, and servitization capabilities, cloud computing represents a major breakthrough in information and communication technologies. Rapid service deployment, extensive customization, knowledge integration, and efficient visualization with high scalability are all possible with the cloud platform.

3.4. Operations technology (OT):

In this context, "operation technology" refers to a sequence of choices and actions made in light of data extraction information. While providing operators with machine and process health information is important, an Industry 4.0 factory goes above and beyond by empowering machines to communicate and make decisions using the insight they are given. This machine-to-machine cooperation can occur between two machines located on the same shop floor or between machines located in two distant factories. They can discuss how modifying particular parameters can maximize performance and modify their output in response to other machines' availability.

In an intelligent factory, Operations technology is the final stage to achieve: 1) Self-aware 2) Self-predict, 3) Self-Configure and 4) Self-Compare.

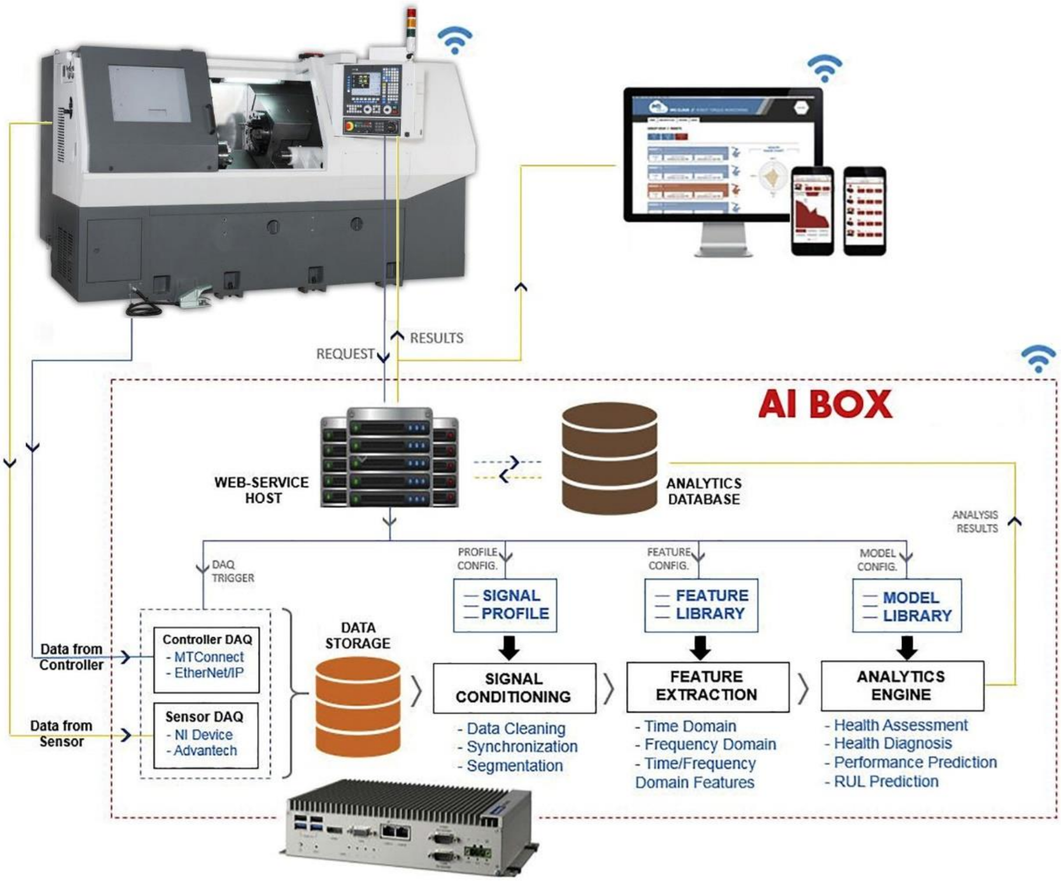

FIGURE 2. Technologies for an Intelligent Spindle

4. CHALLENGES OF INDUSTRIAL ARTIFICIAL INTELLIGENCE

There are high and varied expectations for industrial AI, and even if some of these were met, there would still be significant obstacles in the way of using AI in various industries. The following are the challenges and complexities that currently exist that are more important and priority:

4.1. Machine-to-machine interactions:

Although AI algorithms are capable of precisely mapping a set of inputs to a set of outputs, they are also vulnerable to minute differences in inputs resulting from machine-to-machine variations. Eventually, it must make sure that no single AI solution disrupts or interferes with the operation of any other systems.

4.2. Data quality:

AI algorithms need large, uncontaminated data sets with low bias. Inadequate or erroneous data sets can lead to flawed downstream results when learning from them.

4.3. Cybersecurity:

The smart manufacturing system is susceptible to cyber threats due to the growing utilization of connected technologies. The industry is not ready for the current security threats, and the extent of this vulnerability is currently underestimated.

5. CONCLUSION

There is an urgent need for methodical AI development and application as it moves from science fiction to the forefront of game-changing technologies in order to observe its true impact in Industry 4.0, the next generation of industrial systems. With reference to the Industry 4.0 paradigm, this study attempts to define the term "industrial AI." Furthermore, this paper seeks to offer a framework for planning the strategies for achieving the realization of Industrial AI systems by summarizing the Industrial AI eco-system in today's manufacturing.

REFERENCES

[1]. Lee J, Bagheri B, Kao HA. “A cyber-physical systems architecture for industry 4.0-based manufacturing systems,” Manuf Lett 2015; 3:18–23.
[2]. Da Xu L, He W, Li S. “Internet of things in industries: A survey,” IEEE Trans Ind Inf 2014; 10(4):2233–43.
[3]. Lee J, Lapira E, Bagheri B, Kao HA. “Recent advances and trends in predictive manufacturing systems in big data environment,” Manuf Lett 2013;1(1):38–41.
[4]. Shi J, Wan J, Yan H, Suo H. November. “A survey of cyber-physical systems. In: Wireless Communications and Signal Processing (WCSP),” 2011 International Conference on. IEEE. 2011. p. 1–6.
[5]. Lee J, Ardakani HD, Yang S, Bagheri B. “Industrial big data analytics and cyberphysical systems for future maintenance & service innovation,” Procedia CIRP 2015;38:3–7.
[6]. Zhang L, Luo Y, Tao F, Li BH, Ren L, Zhang X, et al. “Cloud manufacturing: a new manufacturing paradigm,” Enterprise Inf Syst 2014;8(2):167–87.
[7]. Wu D, Greer MJ, Rosen DW, Schaefer D. “Cloud manufacturing: Strategic vision and state-of-the-art,” J Manuf Syst 2013;32(4):564–79.
[8]. Yang S, Bagheri B, Kao HA, Lee J. “A unified framework and platform for designing of cloud-based machine health monitoring and manufacturing systems,” J Manuf Sci Eng 2015;137(4):040914.
[9]. Baheti R, Gill H. “Cyber-physical systems,” Impact Control Technol 2011;12 (1):161–6.
[10]. Leitao P, Karnouskos S, Ribeiro L, Lee J, Strasser T, Colombo AW. “Smart agents in industrial cyber–physical systems,” Proc IEEE 2016;104(5):1086–101.
[11]. Tuptuk N, Hailes S. “Security of smart manufacturing systems,” J Manuf Syst 2018;47:93–106.