

# Artificial Intelligence and Cyber-Physical Systems: A Short Review and Perspectives for the Future

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## Abstract

Modern society is living a moment of paradigms changes. In part, these changes have been fomented by the new technologies, which are providing high performance computing capacities, cloud computing, almost instantly change of information world widely, big-data pipelines that enable the creation of complex Artificial Intelligence systems. Those developments are allowing the emergence of new Cyber Systems where the data constantly generated are leveraged to build Artificial Intelligence models to perform specialized task. All those developments are recent and have the potential to change the future of society. While, on one hand, the isolated application of the cyber systems starts to be wild spread, on the other hand, their synchronically integration with other cyber system to build a concise and cognitive structure that can interact deeply and autonomously with a physical system is still a completely open question, only addressed in some works from the philosophical point of view. Perhaps this is the next technological revolution, the advent of large-scale and complex Cyber-physical Cognitive systems.

**Keywords:** Artificial Intelligence; Cyber-physical Systems; Industry 4.0

## Introduction

Technological developments lead to several paradigm shifts in nowadays society. These developments allowed for extremely fast computing capacities, almost instantly exchange of information worldwide, massive data generation, cloud data storage systems, etc. It also allowed the emergence of new Cyber Systems in which the constantly generated data pipelines are used to perform specialized tasks [1-4]. For example, some cities are using Artificial Intelligence (AI) models to make use of the constant images generated by video security on the streets to identify criminals or potential crimes [5,6]. Also, autonomous AI systems are used in healthcare [7], providing the identification of diseases in record time such as covid-19 diagnosis. Several other examples can be found also in the chemical industry [8,9]. All those developments are recent and have the potential to change the future of society. While the isolated application of the Cyber Systems begins to spread, their synchronically integration with other Cyber Systems to build a concise structure that can interact deeply and autonomously with a physical system is new in the academia and industry. This development of the extremely complex Cyber-Physical Systems (CPS) is expected to bring revolutionary and disruptive changes in several sectors, such as transportation, energy, health, and production [10]. In this short review I would like to point out some key points that should provide a disruptive breakthrough in several industrial fields, changing completely the way that we produce goods.

## Cyber-Physical Systems Enabled by AI

The AI is a key technology to enable large scale cognitive CPS. It provides an essential skill for the system, the cognition, allowing to model, represent and learn complex behaviours and interactions between the system components and from its data. Moreover, the AI models are able to constantly learn from the system, conferring an evolutionary potential to the CPS. Therefore, there is an increasing necessity for investigation about the development and integration of large-scale AI networks. Furthermore, the identification of AI for dynamics systems is still an open issue. Even though the AI/ Deep Artificial Neural Networks field is in continuous growth, its application to address dynamic problems is still a recent issue [11-13]. In addition, techniques from distributed AI are also an enabling technology for self-managing, cooperation, and virtualization abilities desired for the large-scale cognitive CPSs.

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## Digital Twins

Complementary, the digitalization of the complete CPS in a virtual clone allows the existence of a virtual entity that is a mirror of the cyber and physical systems, which can be a useful tool for the system development, optimization, and monitoring. This is called the twinning processes or the built of a digital twin. This concept was first proposed by Michael Grieves and John Vickers from NASA [14], which was in the last decade one of the first enterprises to make use of the concept of digital twins applying it for space exploration missions. A quick review of the literature shows that digital-twins are pointed out as an essential technology of the new industrial revolution [15-17]. Since 2017 the number of publications addressing the digital-twin issue [17] grew significantly, mostly from manufacturing and product life cycle assessment areas.

The Digital twins plays an important role in the advent of complex advent of large-scale and complex Cyber-physical Cognitive systems. Based on this technology it is possible to explore several scenarios with precision and reliability and without a physical system. It is a breakthrough technology because it frees us from some traditional.

## Conclusion

Nowadays industry placed in a scenario of intense renovation, with issues concerning the integration of physical space with enabling technologies of the Industry 4.0. The dynamics of the modern society is pushing us towards the increasing necessity of complex Cyber-physical systems with cognitive abilities, which confers to these systems autonomy from human intervention. It is possible to catch a glimpse of a new industrial revolution, that will free human work from mechanical, repetitive, stressful tasks and even decision-making tasks. The technologies for that are mostly available, it now requires efforts to build a technological platform that allows their integration, intercommunication, and cooperation.

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