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Review on Industry 4.0 Technologies

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Abstract: *The aim of this article is to provide an overview of industry 4.0. Our goal is to give a perspective of what Industry 4.0 is, its challenges in today's context, and present how we have to design and implement future business organizations. Industry 4.0 is revolutionizing the way companies manufacture, improve and distribute their products. Manufacturers are integrating new technologies, including Internet of Things (IoT), cloud computing and analytics, and AI and machine learning into their production facilities and throughout their operations.*

Keywords: Industry 4.0; CPS

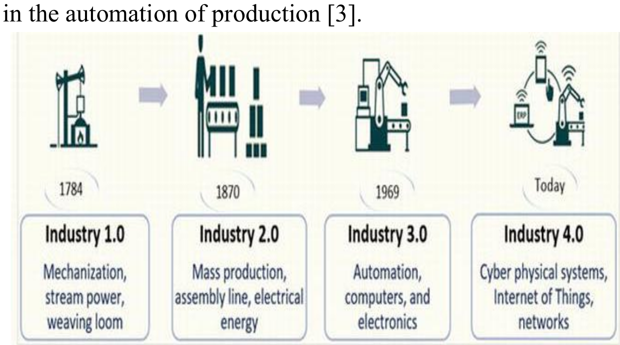
I. Introduction

1.1 An Overview of Industry 4.0

There have been three earlier industrial revolutions that have resulted in a transformation in manufacturing patterns: mechanization via water and steam power, mass production in assembly lines, and automating through computer and information technology [1].

The first industrial revolution (Industry 1.0) was developed in the United Kingdom at the end of 18th century with the advent of water and steam power and mechanization of production. It was the most significant advancement in human productivity, which considerably aided mechanical production and greatly improved agriculture and trade. Where steam engines could be used for power. Developments such as the steamship or the steam-powered locomotive brought about further massive changes because humans and goods could move great distances in fewer hours [2]. Then, it was followed by the second one (Industry 2.0) at the beginning of 19th century which introduced the electrically powered machines and assembly line production, which is described as the period when mass manufacturing became the dominant style of production in general. The introduction of railways into the industrial system was assisted by steel mass manufacturing, which in turn assisted mass production [5]. The third industrial revolution (Industry 3.0) took a place in the 1970s by adopting electronics and devices within the machines, which led to developing automation and robots within the manufacturing process. Industry 3.0 developed with the introduction of the Digital Revolution, which is more well-known than Industry 1.0 and 2.0, since most people today are familiar with industries that rely on digital technology in production [2].

The Fourth Industrial Revolution is presently being implemented. This is also known as “Industry 4.0,” and it is defined by the use of information and communication technology in the industry. It is based on the Third Industrial Revolution’s advancements. Production systems using computer technology are enhanced by a network link and, in a sense, have a digital twin on the Internet. These enable communications with other systems as well as the production of data about themselves. This is the next phase in the automation of production [3].



All systems are connected, resulting in "cyber-physical production systems" and, as a result, smart factories, in which production systems, components, and people interact through a network and production is almost autonomous. When these enablers are combined, Industry 4.0 has the potential to offer some amazing improvements in manufacturing environments. Machines that can foresee faults and initiate maintenance operations on their own, for example, or self-organized logistics that adapt to unexpected changes in production are examples (Figure 1) [4].

II. Industry 4.0 Technologies

2.1 Internet of Things (IoT)

The Internet of Things (IoT) refers to the interconnection of physical devices, cars, buildings, and other entities that are equipped with electronics, software, sensors, actuators, and network connections to gather and share data to create a smart manufacturing environment, also known as a smart factory [6]. Additionally, the concept of "The Internet of Services (IoS)" takes a similar approach to IoT but applies it to services rather than physical assets. The Internet of Services (IoS) idea will open up new prospects for the service sector by providing a commercial and technological foundation for the construction of business networks between service providers and clients [2].
The growing interest in this field, which is widely regarded as one of the primary drivers of Industry 4.0, has produced the development of a number of visions and definitions for (IoT) [1].

2.2 Cloud Computing

Cloud computing is a cornerstone of any Industry 4.0 strategy. Full realization of smart manufacturing demands connectivity and integration of engineering, supply chain, production, sales and distribution, and service. Cloud helps make that possible. The term "cloud" is utilized for applications, for instance, remote services, color management, and performance benchmarking applications. It has taken remarkable attention from the IT community, and its role in other business areas will continue to grow. Machines, data management, and functionality will continue to transition away from traditional ways and toward cloud-based solutions as technology improves. The cloud enables significantly faster distribution than standalone systems, as well as quick upgrades, current performance models, and other delivery possibilities [7].

2.3 AI and Machine Learning

AI and machine learning allow manufacturing companies to take full advantage of the volume of information generated not just on the factory floor, but across their business units, and even from partners and third-party sources. AI and machine learning can create insights providing visibility, predictability and automation of operations and business processes. For instance: Industrial machines are prone to breaking down during the production process. Using data collected from these assets can help businesses perform predictive maintenance based on machine learning algorithms, resulting in more uptime and higher efficiency.

2.4 Intelligent Robotics

Every day, new goods and systems emerge as a result of technological advancements. Flying automobiles, holographic television, and hundreds of electrical devices to be implanted into the human body are all possibilities [8]. Humanoid robots will be a part of everyday life in the not-too-distant future. Recent innovations have brought about skills that empower robots to control their environment. Artificial intelligence will contribute to the development of having robot teams cooperating and collaborating in achieving certain tasks defined for a specific purpose [9].

III. Cyber-Physical System (CPS)

Manufacturing companies have not always considered the importance of cybersecurity or cyber-physical systems. However, the same connectivity of operational equipment in the factory or field (OT) that enables more efficient manufacturing processes also exposes new entry paths for malicious attacks and malware. [10] The evolution of a CPS is characterized by three phases. Identification technologies are included in first-generation CPS. Second-generation CPS is equipped with some sensors and actuators with a limited number of functions. In the third-generation CPS, data is kept and analyzed in addition to setting up the equipment. The CPS has many sensors and actuators and is meant to be network compatible. CPSs offer various features [7].

3.1 Digital Twin

The digital transformation offered by Industry 4.0 has allowed manufacturers to create digital twins that are virtual replicas of processes, production lines, factories and supply chains. A digital twin is created by pulling data from IoT sensors, devices, PLCs and other objects connected to the internet. Manufacturers can use digital twins to help increase productivity, improve workflows and design new products. By simulating a production process, for example, manufacturers can test changes to the process to find ways to minimize downtime or improve capacity.

IV. Conclusion

This study contributes to bridging the critical gap, by discussing the key components, characteristics, effects on many dimensions, drivers, barriers, and other implementation challenges of Industry 4.0, the fourth industrial revolution describes a future production system's vision. Industry 4.0 is an inevitable revolution covering a wide range of innovative technologies, such as cyber-physical systems, RFID technologies, IoT, cloud computing, big data analytics, advanced robotics, smart factories, etc. The Industry 4.0 paradigm is transforming business in many industries, e.g., automotive, logistics, aerospace, and energy sectors, etc. Industry 4.0 realizes the development and integration of information and communication technologies into business processes.

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