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Evolution of industrial IoT & Its future aspects

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Abstract
Nowadays the world is surviving the fourth industrial revolution named Industry 4.0, which combines physical world of real things with their "virtual twins". The man with his intellect, creativity and will lies beyond this ideology. Now the image of a new paradigm of Industry 5.0 could be seen. It involves the penetration of Artificial Intelligence in man's common life, their "cooperation" with the aim of enhancing the man capacity and the return of the man at the "Centre of the Universe".

Keywords: Industry 5.0; Fifth Industrial Revolution, Artificial Intelligence; Business Change; Industry 4.0; Digitalization

Introduction

"We are on the cusp of the Fourth Industrial Revolution, or Industry 4.0" mentioned Bernhard Marr, a strategic business and technology advisor to governments and companies (Marr, 2018).

Although many companies are still hard working on the digitalization of their business to achieve the competitive advantages of the Industry 4.0 like: scalability, process automation and thereby improved productivity, improved efficiency, support of flexibility and agility to generate a better customer experience, higher revenues and an increased profitability (Moran, 2018). Despite the continuing transformation process by digitalization within Industry 4.0 there are some entrepreneurs who are looking into the future and do not see the business processes and the organizations as they are but as they could be with the future industry (Industry 5.0). In addition, the technological developments grow with high speed, so fast that Industry 5.0 is already becoming part of the business landscape (Atwell, 2017).

Nevertheless, digitalization, globalization, utilization, customer centricity and many more business parameters ensure the ongoing development, transition and transformation of companies. The enterprise, who will find and anticipate future trends and the related changes need are defined as innovative and will succeed in the next step of Industrial Revolution. Companies should consider this opportunity.

Industrial Revolutions

Industry 1.0: The First Industrial Revolution began in the late 18th century through the use of steam power and mechanization of production. The use of steam power for industrial purposes was the greatest breakthrough for increasing human productivity. Water and steam powered machines were developed to help workers in the mass production of goods. The first weaving loom was introduced in 1784. With the increase in production efficiency and scale, small businesses grew from serving a limited number of customers to large organizations with owners, manager and employees serving a larger number. Industry 1.0 can also be deemed as the beginning of the industry culture which focused equally on quality, efficiency and scale. [6]

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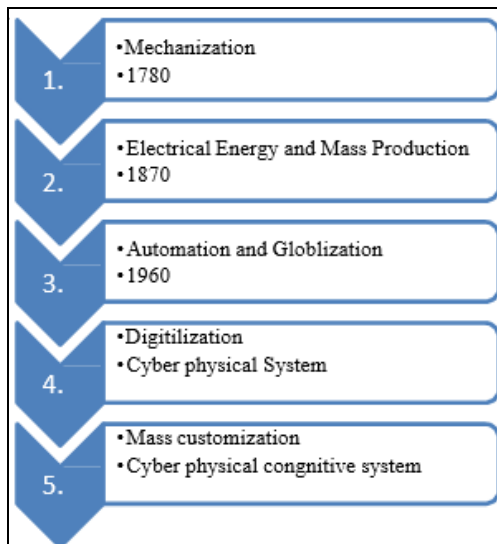Department of ECE, CIST
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Fig 1: Industrial Revolutions

Industry 2.0: The Second Industrial Revolution began in the 19th century through the discovery of electricity and assembly line production. The main contributor to this revolution was the development of machines running on electrical energy. Electrical energy was already being used as a primary source of power. Electrical machines were more efficient to operate and maintain both in terms of cost and effort unlike the water and steam based machines which were comparatively inefficient and resource hungry. Mass production of goods using assembly line became a standard practice. [6]

This period also saw the development of a number of management programs that made it possible to increase the efficiency and effectiveness of manufacturing facilities. Division of labor, where each worker does a part of the total job, increased productivity. Mass production of goods using assembly lines became commonplace. American mechanical engineer Frederick Taylor introduced approaches of studying jobs to optimize worker and workplace methods. Lastly, just-in-time and lean manufacturing principles further refined the way in which manufacturing companies could improve their quality and output [5].

Industry 3.0: The next industrial revolution resulting in Industry 3.0 was brought about and spurred by the advances in the electronics industry in the last few decades of the 20th century. The invention and manufacturing of a variety electronic devices including transistor and integrated circuits auto- mated the machines substantially which resulted in reduced effort, increased speed, greater accuracy and even complete replacement of the human agent in some cases. Programmable Logic Controller (PLC), which was first built in 1960s was one of the landmark invention that signified automation using electronics. The integration of electronics hardware into the manufacturing systems also created a requirement of software systems to enable these electronic devices, consequentially fueling the software development market as well. [3]

Apart from controlling the hardware, the software systems also enabled many management processes such as enterprise resource planning, inventory management, shipping logistics, product flow scheduling and tracking throughout the factory. The entire industry was further automated using electronics and IT. The automation processes and software systems have continuously evolved with the advances in the electronics and IT industry since then. The pressure to further reduce costs forced many manufacturers to move to low-cost countries. The dispersion of geographical location of manufacturing led to the formation of the concept of Supply Chain Management.

Industry 4.0: The Fourth Industrial Revolution is characterized by the application of information and communication technologies to industry and is also known as "Industry 4.0". It builds on the developments of the Third Industrial Revolution. Production systems that already have computer technology are expanded by a network connection and have a digital twin on the Internet so to speak. These allow communication with other facilities and the output of information about themselves. This is the next step in production automation. The networking of all systems leads to "cyber- physical production systems" and therefore smart factories, in which production systems, components and people communicate via a network and production is nearly autonomous. [2]

Cyber Physical Systems (CPSs) have further blurred this boundary resulting in numerous rapid technological disruptions in the industry. CPSs allow the machines to communicate more intelligently with each other with almost no physical or geographical barriers.

The Industry 4.0 using Cyber Physical Systems to share analyze and guide intelligent actions for various processes in the industry to make the machines smarter. These smart machines can continuously monitor, detect and predict faults to suggest preventive measures and remedial action. This allows better preparedness and lower downtime for industries. The same dynamic approach can be translated to other aspects in the industry such as logistics, production scheduling and optimization of throughput times, quality control, capacity utilization and efficiency boosting. CPPs also allow an industry to be completely virtually visualized, monitored and managed from a remote location and thus adding a new dimension to the manufacturing process. It puts machines, people, processes and infrastructure into a single networked loop making the overall management highly efficient. [4]

It also incorporates cutting-edge technologies including additive manufacturing, robotics, artificial intelligence and other cognitive technologies, advanced materials, and augmented reality, according to the article "Industry 4.0 and Manufacturing Ecosystems" by Deloitte University Press.

Industry 5.0: Less than a decade has passed since talk of Industry 4.0 first surfaced in manufacturing circles, yet visionaries are already forecasting the next revolution — Industry 5.0. If the current revolution emphasizes the transformation of factories into IoT-enabled smart facilities that utilize cognitive computing and interconnect via cloud servers, Industry 5.0 is set to focus on the return of human hands and minds into the industrial framework. [1]

Industry 5.0 is the revolution in which man and machine reconcile and find ways to work together to improve the means and efficiency of production. Funny enough, the fifth revolution could already be underway among the companies that are just now adopting the principles of Industry 4.0. Even when manufacturers start using advanced technologies, they are not instantly firing vast swaths of their workforce and becoming entirely computerized. [7]

Industry 4.0 is about automating processes and introducing edge computing in a distributed and intelligent manner. Its sole focus is to improve the efficiency of the process, and it thereby inadvertently ignores the human cost resulting from the optimization of processes. This is the biggest problem that will be evident in a few years when the full effect of Industry 4.0 comes into play. Consequently, it will face resistance from labor unions and politicians, which will see some of the benefits of Industry 4.0 neutralized as pressure to improve the employment number increases. However, it is not really necessary to be on the back foot when it comes to introducing process efficiency by means of introducing advanced technologies. It is proposed that Industry 5.0 is the solution we will need to achieve this once the backward push begins [8].

Furthermore, the world has seen a massive increase in environmental pollution beginning from the Second Industrial Revolution. However, unlike in the past several decades, the manufacturing industry is now more focused on controlling different aspects of waste generation and management and on reducing adverse impacts on the environment from its operation. Having environmental awareness is often considered a competitive edge due to the vast amount of support from government; international organizations like the UN, WHO, etc.; and even an ever-growing niche customer base that supports environmentally friendly companies. Unfortunately, Industry 4.0 does not have a strong focus on environmental protection, nor has it focused technologies to improve the environmental sustainability of the Earth, even though many different AI algorithms have been used to investigate from the perspective of sustainability in the last decade. While the existing studies linking AI algorithms with environmental management have paved the way, the lack of strong focus and action leads to the need for a better technological solution to save the environment and increase sustainability. We envisage this solution to come out of Industry 5.0.

Conclusion

As technological innovations become ever more rapid, revolutions could ultimately follow one another in quick succession over the next 10 years and beyond. Whereas the first three industrial revolutions took decades to play out, today's revolutions last only as long as it takes for industry-wide implementation to complete itself. It's important to note that Manufacturing 5.0 is an upgrade of 4.0 and not entirely new.

Overall, the development of Industry 5.0 could prove to be the full realization of what the architects of Industry 4.0 had only dreamed of at the dawn of the 2010s. As artificial intelligence improves and factory robots assume more human- like capabilities, the interaction between computers, robots and human workers will ultimately become more meaningful and mutually enlightening.

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