

Review on Industry 4.0 and its Elements

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Abstract – The main Objective of this paper is to show the rapid development in current industrial digitalization and intelligentization and also the current trends in manufacturing and process Industries. The term Industry 4.0 stands for Fourth Industrial revolution, which is the highest standard in the Automation Society. Even though Industry 4.0 is an imaginary concept there are few concepts such as Industrial Internet of Things, Smart manufacturing, Cloud based manufacturing used in current world. This paper provides an overview on the elements of Industry 4.0, its challenges and issues and also their applications used in current era.

Key Words: Cyber Physical Systems, Big Data, Cloud Computing.

1. INTRODUCTION

In recent times the industrial revolution shifted from the third revolution to the fourth revolution which is from use of industrial controllers to Cyber-Physical Systems. The term Industry 4.0 stands for smart factory in which smart devices are networked in such a way that they can communicate with the field device. In such a factory, robots and men are equally working with the high degree of Artificial Intelligence.

2. INDUSTRY 4.0 AND ITS ELEMENTS

In the first Industrial revolution which began in 1784, the process was completely done through mechanization using steam power and hydro power. In the second Industrial revolution, with the help of electrical energy mass production and assembly line was introduced. In the third Industrial revolution Programmable logic controllers (PLC), were introduced for enhanced automatization in production. In the Fourth Industrial Revolution Cyber physical Systems played a major role in transforming the current industrial systems.

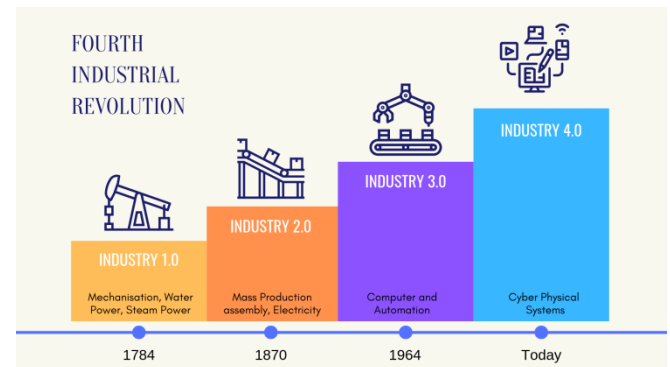


Fig – 1: Industrial Revolution

2.1 DESIGN PRINCIPLE OF INDUSTRY 4.0

There are six design principles for a Industry 4.0 system.

- (1) Interoperability: The ability of work piece carriers, assembly stations, products, humans, smart factories to connect and communicate with each other with the help of internet of Things and Internet of Services.
- (2) Virtualization: A virtual copy of the smart factory is created with the help of linking sensor data acquired from monitoring physical process with virtual plant models and simulation models.
- (3) Decentralization: It is the ability of Cyber Physical Systems which is incorporated within the smart factory to make their own decisions.
- (4) Real-Time Capability: It is the capability to collect and analyze data and provide the insights immediately.
- (5) Service Orientation: The Industry 4.0 offers services to the Cyber Physical Systems with the help of Internet of Services.
- (6) Modularity: It is the flexible adaptation of smart factories for changing requirements of individual model.

2.2 ELEMENTS OF INDUSTRY 4.0

- (1) Autonomous Robots
- (2) Simulation
- (3) Horizontal and Vertical system Integration
- (4) Industrial Internet of Things
- (5) Cyber security and Cyber physical system
- (6) Additive Manufacturing
- (7) Augmented Reality
- (8) Big Data Analytics
- (9) Cloud Computing

2.3 AUTONOMOUS ROBOTS

In today's world a lot of autonomous robots are used because of its flexibility and interactive with the humans in work space. These robots are used for autonomous production method and placed in work where the humans are restricted. These robots can complete the given task in time with precision and mainly focuses on safety, flexibility, versatility, and collaborative.

2.4 SIMULATION

In most of the process industries simulation is extensively used to monitor real-time data to match with the physical world with the help of a virtual model. It helps to reduce the cost for planning new facilities and moreover utilizes maximum amount of manufacturing resources. Decision making has become ease in industries with the help of simulations.

2.5 HORIZONTAL AND VERTICAL SYSTEM INTEGRATION

The two major mechanisms used in Industrial organisations are integration and self optimization. It is the backbone in which smart Factories are built. Industry 4.0 provides connected networks of cyber physical and enterprise systems which produce unmatched levels of automation, flexibility and efficiency.

2.6 INDUSTRIAL INTERNET OF THINGS

IIOT is a part of Internet of Things which mainly focuses on industrial applications. It is mainly concerned about connecting one machine to another machine or data management and the optimization and productivity in order to make it a smart factory. IIOT also has Internet of Services, Internet of Manufacturing Services, Internet of people. IIOT is used to make the value chain agile and intelligent.

2.7 CYBER PHYSICAL SYSTEMS

Due to the enormous use of connectivity and increased demand in Internet based services which parallelly increases the need for protection of certain industrial systems from cyber security threats. Cyber physical systems which has cyber security incorporated in it prevents from malicious attacks and detects intrusion.

2.8 ADDITIVE MANUFACTURING

Additive manufacturing is one of the key element in Industry 4.0 because it helps to develop the non-traditional manufacturing techniques. In order to make the production faster and cheaper additive manufacturing methodology is used in Industry 4.0.

2.9 AUGMENTED REALITY

Another important element of Industry 4.0 is augmented reality which provides lot of services from selecting a part from the warehouse to send instructions when a fault occurs through mobile devices. Industries are making use of augmented reality to provide industry workers with real time information and providing decision making and work procedure. It bridges the gap between the digital and physical world by superimposing virtual objects on physical world.

2.10 BIG DATA ANALYTICS

The data which are collected from the IoT devices are called as Big Data. These data are mainly collected from the cloud and enterprise applications, websites and from sensors which are the field devices. There are four dimensions in Big Data namely, Volume of the data, Variety of the data, Velocity of data and the value of data.

2.11 CLOUD COMPUTING

The data generated from the IoT devices are of large volumes and need to be stored in a safe place. Cloud Computing is a tool used to store these big data generated by the IoT devices. The main objective of cloud computing is to provide scalable computing resources and storage space. There are three cloud computing services namely, Software-as-a-service (SaaS), Platform-as-a-service (PaaS), Infrastructure-as-a-service (IaaS).



Fig - 2 Cloud Computing



Fig - 3 Autonomous robots used in warehouse

3. KEY CHALLENGES IN INDUSTRY 4.0

- (1) There is a shortage of skills and resistance to outsourcing.
- (2) There is a lack of access for proof points.
- (3) There is a need for large scale investment.
- (4) Data and cyber security concerns.
- (5) Lack of culture of collaboration.
- (6) Rarely a clear phased strategic plan.

4. APPLICATIONS OF INDUSTRY 4.0

There are many business organizations still wondering how Industry 4.0 could be a major impact on their business methodology by adapting smart machines in their workplace. There are lot of applications used in this current world.

4.1 Autonomous Robots

Autonomous robots are widely used in manufacturing industries to increase the speed and production of the process. They work side-by-side with humans to increase the efficiency and also reduce the risk of injuries to employees in dangerous environment. Due to the improved sensor, dexterity, artificial intelligent and trainability in autonomous robots they are becoming faster and collaboratively working with humans. They are also used to improve the supply chain by reducing the manufacturing cost, providing labour and utilization cost and reducing error state.

4.2 Health 4.0

Industry 4.0 plays a major role in healthcare. They are used to convert a hospital digital by providing better information management with the help of IoT. They store data of patients report, medical samples and laboratory identifications. With the help of digital technologies in Industry 4.0 it is easy to identify the symptoms and cause of disease. Industry 4.0 plays a major role in designing and manufacturing of medical tools and devices in lesser time. Health care 4.0 uses highly accurate and precise sensors which reduce the risk of patients during a surgery. Patient monitoring robots are deployed for complete monitor of a patient and all those data are stored securely.



Fig - 4 Patient Monitoring in Hospital

4.3 Agriculture 4.0

Agriculture 4.0 is the next emerging trend by the Industry 4.0. IoT sensors and role of big data plays a major role in agriculture 4.0 by increasing the efficiency and business methods by the face of increasing population and climate change. Big data helps in improvising the supply chain and farmers can view the insights and can cultivate the right crop at right rates. IoT sensors are deployed in the farming land to measure the pH value of the soil, nutrition level, seeding rate and moisture level. These devices can communicate with

each other and share information. Scout drones are used for scouting pests.

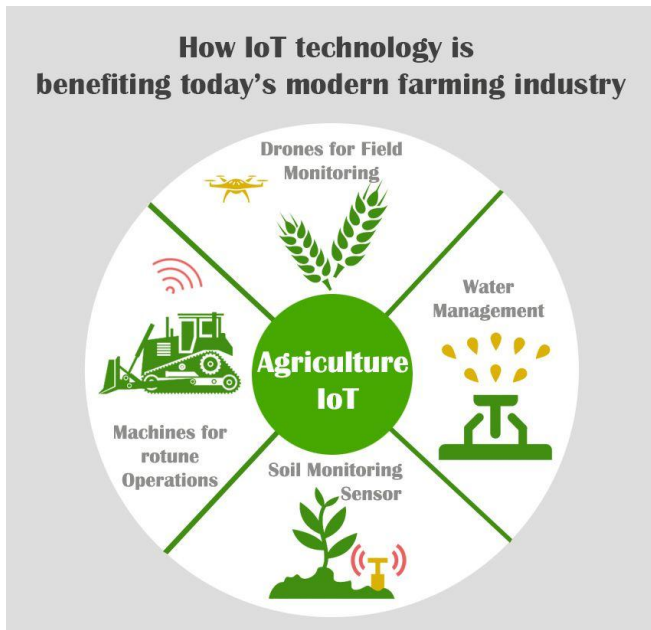


Fig - 5 Agriculture 4.0

5. CONCLUSION

Hence this paper gives a detailed review about Industry 4.0 and the elements of Industry 4.0 which are used in current industrial world. This paper introduces methods such as cloud computing and big data analytics which are the emerging elements of Industry 4.0. This paper gives a detailed view on the applications of Industry 4.0 in manufacturing industries, healthcare and agriculture.

6. REFERENCES

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