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Big Data, Internet of Things in Industry 4.0

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***Abstract*— Industry 4.0 enables the industries to deal with the challenges in the production in terms of time deadlines and higher quality thereby making them intelligent factories. In industry 4.0 resources are interconnected with each other so that they can communicate called as the Cyber-physical system, with the help of sensors, they can sense and with the help of analytical tools they can analyse data and act accordingly in the environment. To understand this concept properly, this paper provides a review of components of industry 4.0 such as the Internet of things, Big Data.**

***Keywords*— intelligent factories, Industry 4.0, Cyber-physical system, IoT, Big Data**

I. Introduction

Industry 4.0 is a vision of tomorrow's manufacturing products finding their independent way through the production process. In intelligent factories machines and products communicates with each other cooperatively driving production raw materials and machines are interconnected with each other using Internet of things. The Objective of this system is to have highly flexible individualized and resource friendly mass production.

The Fourth Industrial Revolution motivates us to understand about the manufacturing process, value chain, distribution and customer service processes. For the time being, the future of education Indicates the extensive need to look above these areas and to use the "Internet of Things" to prepare for the upcoming challenges.

Industry 4.0 means better efficiency and flexibility for manufacturing companies with the help of yhis companies can attend previously not attended capabilities. The ability to economically produce small-batch "one-off" production runs without regard to the economies of scale is just one of the benefits that will accrue from the new order.

As approaches like Industry 4.0 gain popularity, the characteristics of data to be analyzed change. Some processes require high-speed data whose value diminishes over time. Heterogeneous IoT devices and sensors produce unstandardized and unstructured data. IT industry continuously comes up with new models which can use distributed architectures to process data more quickly and efficiently. However, available analysis methods are insufficient to use high-speed data flowing from various sources due to their lower level complexities and shortcomings [1]

II. History of Industrial Revolution

At the end of 18th century, the first steam engines and the intelligent use of hydropower revolutionized production. The late 19th century saw the rise of electrical engineering and mass production. The 1st moving belt conveyor was used as long as 1870 and slaughterhouse. In the mid-1970's electronics and information technology began to expand rapidly into an industry. Siemens develop 1st production that was based on computer-assisted controls. 4th industrial revolution is still vision experts believe that it will become reality within next 20 years. In intelligent factories, everything is interconnected wirelessly.

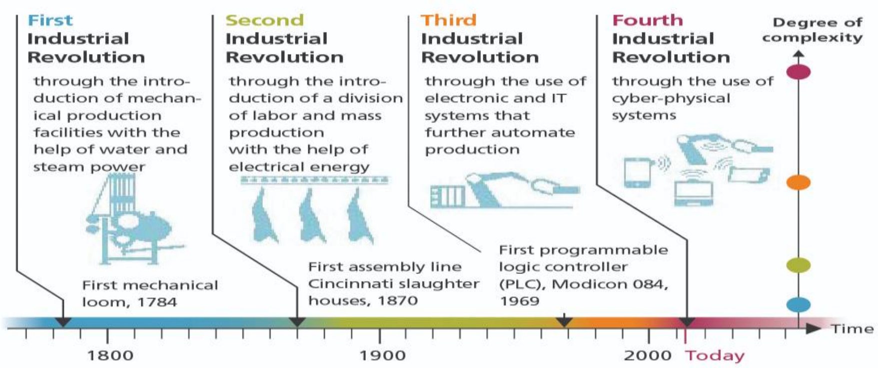

Fig. 1 Evolution of industrial automation. A Graphics source is DFKI

III. ORIGINS OF INDUSTRY 4.0

The birth of the fourth industrial revolution, namely Industry 4.0, is assumed to coincide with the Industry 4.0 initiative [2]. Industry 4.0 is a strategic initiative included by the German government as part of its High-Tech Strategy 2020 Action Plan, according to which the Internet-based technologies are used to improve all industrial processes, from manufacturing to distribution, from sales to post-sales. In the same period, similar initiatives were undertaken by other countries, such as Internet + in China [3] and Industrial Internet in the USA [4]. All of them moved from the consideration that new paradigms such as Internet of Things (IoT), Cyber-Physical Systems (CPS), crowd sensing, crowdsourcing, cloud computing and Big data, which were already being used to turn "normal" environments into smart environments (e.g., Smart Homes, Smart Cities), could be integrated with industry-related processes to enhance their performance.

Intelligence had been already introduced in industries thanks to embedded systems, i.e., systems made of devices where sensors and actuators are embedded and connected to a control unit via field buses [5]. However, traditional embedded systems are conceived as stand-alone systems. The technologies introduced by Industry 4.0 enable communication and cooperation among devices and stand-alone systems so that a higher level of intelligence can be provided to industrial processes [5,6]. More specifically, there are two ways in which communication can provide intelligence to objects: (i) less capable objects can leverage the resources of smarter objects, whether they are located nearby or remotely (e.g., cloud computing). Accordingly, less powerful objects typical of the industrial scenario, such as sensors and RFID (Radio Frequency Identification) tags, can cooperate with other more powerful objects to perform smarter applications; (ii) communication can be used by objects that are already smart, such as smartphones, to "augment" their intelligence thanks to information collected by distributed objects, whether it is objective, coming from measures collected by sensors, or subjective, provided by humans. This is the concept on the basis of crowdsensing and crowdsourcing, where big amounts of data gathered by multiple nodes are processed to get more complex information.

According to these considerations, seamless ubiquitous Internet access, communication between intelligent machines and advanced analytics methods are to be considered the pillars of Industry 4.0 Future Internet 2018, 10, 24 3 of 14 revolutions [3], fostered by the IIoT [7,5] and CPPS [8] paradigms.

IV. COMPONENTS OF INDUSTRY 4.0

1. Simulation- Ideal for machinery and scenario planning
2. Autonomous system- program machinery and robots to CT autonomously
3. Cloud computing- user's remote servers to store, manage and process data for faster access
4. Additive manufacturing- digital 3D design data builds in layers by depositing materials
5. Big data- It can determine the action and improve the process
6. Cybersecurity- It protects manufacturer's most valuable data
7. IoT- It connects the Internet to a machine to send and receive process data.
8. Horizontal and vertical system integration- It enables truly automated value chains.

V. WHAT MAKES A FACTORY INDUSTRY 4.0

1. Interoperability- machines, devices, and people connect and communicate with each other.
2. Information transparency- system create a virtual copy of physical world through sensor data.
3. Decentralized decision making- cyber-physical system make simple decisions to become as autonomous as possible.
4. Technical assistance- System to support humans in making decisions and solving problems and assist with the task.

VI. BIG DATA

This is the big thing in computing and generates value from very large datasets that cannot be analysed by traditional computer technique. The quantity of computer data generated on the planet is growing very rapidly for many reasons. Retailers are building a vast database of recorded customer activity. Organisations working in logistics financial services, healthcare, and many other sectors are also capturing a vast amount of digital materials. As vision recognition improves it becomes possible for the computer to extract meaningful information from images and videos as more go online. Big Data is also being generated by an expanding IoT and finally, several areas of scientific advancement are starting to generate and rely on vast quantities of data that were almost unimaginable until Big Data came in the picture.

Big Data is characterized by 3 V's of velocity, volume, and variety. (science direct)

- Velocity- Data analysis is carried out on Big Data in real time, as the correct conclusions from the constantly flowing and charging data need to be implemented on an ongoing basis.
- Volume- Big data refers to a large amount of data whose size is very vast and it is not possible for traditional tools to collect, store and analyze data. It is connected with the capabilities to manage these data.
- Variety- These vast amounts of data come from many sources such as the Internet, social media or transactional system. These data include videos, audios, images collected from social networking sites. These data are mostly unstructured and changes dynamically. Such data cannot be handled by the traditional system and are not suited to analysis.

All these data need to be processed in short amount of time. By using this information companies can boost their sales and generates more revenue. By using a traditional computer system, we wouldn't be able to accomplish this task within given timeframe as the resources for a traditional computer system wouldn't sufficient for processing and storing such huge amount of data.

Industrial Big data is produced by the plant equipment of plant and the products so it is totally different from Internet Big data generated by social media blogs etc. So industrial Big data will be used and interconnected with other platforms such as service mobile devices and on-premise system. In the 4th industrial revolution, all the things are connected to the internet and can be considered as a cyber-physical system. With precision data collected from devices it possible to carry out advanced analysis. With this data predictive maintenance and real-time monitoring can be realized with industrial Big data then the probability of an occurrence of a failure is detected and maintenance can be carried out in advance.

Consider an example to understand how Big data works in an industry, maintenance engineer is working at a large manufacturing company for 2 decades. His job has been to ensure that the machine operates as smoothly as possible until recently his Day-to-day work was characterized by tasks with high time frames maintaining machine and then to check whether the process runs as required. His another maintenance friend has recently installed predictive maintenance solution. Such system can send a message saying that a problem is started arriving the important thing is the machine is still working. This intelligence system works as

case 1: suppose machine dispenses thermal conduction based on continuously analysing production data which detects that target temperature cannot be reached. It consults the quality database and identifies the appropriate set to get the machine back into stable operation. Managers approve this and machine adjusts itself accordingly.

Case 2: predictive maintenance solution can focus on solving a problem that requires experience. The solution offers the manager a transparent maintenance process. With this company can work on improving the system by continuously supplementing the expert database with newly identified solutions.

VII. INTERNET OF THINGS

IoT has the potential to increase global productivity up to 25% by 2025. Industries like manufacturing are using the potential of IoT. Many production facilities are already using process and supervisory control system with connectivity. The IoT for manufacturing is family of solution that combines the capabilities of analytics cognitive computing and IoT platforms to drive operational efficiency across the factory value chain. This solution benefits the manufacturing company in three ways 1. It helps gets 100% efficiency of their equipment by identifying and solving issues before they cause delay.2. It makes operations and processes cognitive so plants can produce maximum quality and yield from raw materials and manufactured components 3. It helps plant managers to better manage resources, improve worker expertise and provide a safe working environment. Advances in these three areas define a new wave of connected manufacturing one that revolves around the process.

To fully understand the scale of the phenomenon and the number of devices that can be found within the Internet of Things, below is a list of potential areas where the use of IoT solutions can be seen, according to the classification adopted by O. Vermes and P. Friess [9]:

1. (Smart) environment is a category of solutions, Internet of Things, which from the daily consumer perspective are the least visible. However, these are the basis for the safe operation of the entire anthropogenic environment (manmade – e.g. Urban, industrial areas, agricultural areas) that make the ecosystem friendly to economic development and the functioning of societies.

2. (Smart) water management, a wide range of issues related to the administration and management of key resources for the functioning of the environment. This category includes, for example, The impact of water resources on the environment, their use and protection deficits, regulation of rivers and protection against floods, waterways, hydropower or security.

3. (Smart) industry is entering the area of the Internet of Things in solutions related to particular sectors of the national economy.

4. (Smart) production as well as intelligent industry, includes solutions that fall within specific sectors of the economy. These are both issues related to agriculture (e.g. Temperature control and irrigation to prevent drought or the formation of fungi), breeding (monitoring living conditions and grazing livestock), and control of production lines (readers, sensors, video surveillance – useful in the management and inspections) as well as control of the rotation of products on store shelves and in warehouses.

5. (Smart) transport should be – apart from the above mentioned – a key element of supporting the economy. This category includes issues such as the location of transported goods (e.g. checking routes of hazardous, delicate or precious materials) control of the conditions of transport (e.g. shock) or storage conditions (e.g. flammable materials).

6. (Smart) energy includes a number of solutions that enable management of utilities. These include the monitoring of individual consumption, as well as the processes for its production and use (e.g. solar systems, windmills and water management).

7.(Smart) cities are another area in which the Internet Things can play an increasingly important role. Its capabilities promise a lot of applications – from the organization of pedestrians and traffic (e.g. monitoring traffic congestion, parking spaces, intelligent roads, providing information about the state of roads, traffic problems, monitoring of weather or accidents on the road), the diagnosis of safety threats (e.g. vibrations and strength of materials in buildings, bridges, historic buildings), noise, lighting (e.g. adaptive to the level of cloud cover) and waste management (e.g. filling level of containers).

8. (Smart) buildings are a whole range of facilities, which can be used both at the individual as well as industrial level: monitoring the property (e.g. fences, windows, and doors), motion sensors, smart irrigation, learning thermostats.

9. (Smart) apartments is a category of equipment, which are typically for individual application, e.g. refrigerators (informing content, shelf life, the need to replenish), remote machines (allowing use of energy at lower tariffs), cookers (for remote setting of the oven)

10. (Smart) health covers a wide range of applications used in the monitoring of health and physical activity (e.g. the elderly), vitality (e.g. people active in sport), patient safety (both in the hospital and at home)

11. (Smart) life is a whole range of consumer solutions aimed at comfort and safety.

Consider an example, to understand how IoT helps manager, Jony is the manager in manufacturing company. He oversees the production of the key company. His top priorities are meeting with production deadlines and producing parts safely and efficiently. One of his client's needs to move up their delivery date by 3 months. Jony and his team use IoT for manufacturing that will help them to deliver product earlier than previously planned. equipment analytic solution identities problems with equipment health and performance before they happen and prescribes maintenance so Jony and team can avoid equipment failure and downtime getting max effectiveness out of their equipment to ensure that components are meeting quality standards along with the production line. Jony uses the quality analytics tool to identify variability in the manufacturing process in real time. This allows equipment operators to make an adjustment to process parameters based on plant condition that could affect the quality of production. By monitoring quality in real time Jony and team can avoid producing faulty components ultimately saving time and money.

Another issue for Jony is the safety of his plant workers the cognitive IoT platform includes workers, safety technology that monitors things like exposure to extreme heat or toxic gas open flames and operating dangerous machinery. The plant workers wear sensors in their helmets with a wristband that provide real-time alerts on working conditions, this allows Jony to track all of this IoT data in real-time. He can be confident that the production equipment tools and an employee will be able to work safely.

VIII. CONCLUSIONS

The main objective of this paper was to provide a review of Industry 4.0. Technologies that come under Industry 4.0 such as IoT, Big Data. After Analysis we can say that Machines in the industry can communicate with each other, They can send and receive data. They can sense things using IOT technology. Big Data is useful in predictive maintenance in which any problem in machines can be detected and resolved before it becomes too big to solve.

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