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Smart Manufacturing with Robotic automation and Industry 4.0-A Review

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ABSTRACT: Industry 4.0 creates what has been called a smart factory, a name for the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things, cloud computing and cognitive computing. Industry 4.0 is commonly referred to as the fourth industrial revolution which started in Germany. The importance of industrial sector is in the development of the economy of a country and is the driver for growth and employment in the state.

This paper presents a review on the advancement in the development of manufacturing process by continuous enhancement in the robotic technology and control automation in achieving best results for any manufacturing process. Most Industries, research centers, and universities acknowledge that robotics and control automation technology is the basis of industrial manufacturing and an important driver for Industry 4.0.

KEYWORDS: Industry 4.0, robotics and automation, Internet of Things (IOT) , smart factories and smart production, Information Technology(IT).IIWA(intelligent industrial work assistant), autonomous mobile robots (AMR), Information and communication technologies (ICT).

I. INTRODUCTION

The development of manufacturing facility is important to every country's economy and have remained the driver of growth and employment for the country. Industry, which in this context focuses on manufacturing, provides added value through the transformation of materials into products[1]. Industry 4.0 becomes popular in 2011 where an association of business and academic representative promote the idea of strengthening the German manufacturing[3]. Germans have the most competitive manufacturing industrial setup in the world and are a global leader in the manufacturing equipment sector [4]. As soon as the German government announced Industry 4.0 as one of the key initiatives of its high-tech strategy in 2011, the topic of Industry 4.0 has gained more citation among many industries, research centers, and universities[3].The German Government have presented Industry 4.0 as an emerging structure where supply chain and manufacturing systems in the form of Cyber-Physical Production Systems (CPPS) intensively use the globally available information and communication network for an extensively automated exchange of information where production and business processes are matched together[5].

There are four design principles in Industry 4.0. which support companies in identifying and implementing Industry 4.0 scenarios.[1]

- **Interoperability:** The ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of Things (IOT).
- **Information transparency:** The ability of information systems to create a virtual copy of the physical world by enriching digital plant models with sensor data. This requires the aggregation of raw sensor data to higher-value context information.

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- **Technical assistance:** First, the ability of assistance systems to support humans by aggregating and visualizing information comprehensibly for making informed decisions and solving urgent problems on short notice. Second, the ability of cyber physical systems to physically support humans by conducting a range of tasks that are unpleasant, too exhausting, or unsafe for their human co-workers.
- **Decentralized decisions:** The ability of cyber physical systems to make decisions on their own and to perform their tasks as autonomously as possible. Only in the case of exceptions, interferences, or conflicting goals, are tasks delegated to a higher level.

II. PRESENT WORK ON INDUSTRY 4.0

“Industry 4.0” which is not well-known term in India and other manufacturing countries it is worth looking at comparable ideas from a global perspective [3]. Some commentator promotes a similar idea under the name of cyber physical systems, smart factory, smart production, machine-to-machine, advanced manufacturing, internet of things, internet of everything or industrial internet [6]. Industry 4.0 also refers upcoming phase in a digitization for manufacturing sector where the Internet of Things (IoT) will play a huge role that will have the potential to feed information into it and add value to manufacturing industry to realize a low-volume, high mix production in a cost-efficient way [1]. Industry 4.0 also updates the management of the entire value chain process of the manufacturing industry. A number of emerging Industries and many old set ups in India have been advocating Industry 4.0 concepts to create smarter factories [4]. Meanwhile, according to the idea of Industry 4.0, it includes a wide variety of devices, from smartphones, gadgets, televisions and watches and these are able to communicate with one another or exchange data via the Internet. According to forecasts of analysts at Gartner [7], 26 billion “things” will be connected to the Internet in the year 2020. Thus, based on the wide literature on the topic robotic Industry 4.0, the goal is mainly to develop a smart factory in which products are able to find their own way through production and establish alternatives in case of disturbances, as a technological basis serving cyberphysical systems and the “Internet of Things”.

III. HISTORIC VIEW OF INDUSTRIAL REVOLUTION

The first mechanical loom started back in 18th century and until now which is rough 250 years ago, where four stages of industrial revolution followed (Fig 1.0). The first industrial revolution occurred during the end of the 18th century where machines were dependent on mechanical production on the basis of steam and water. The second Industrial Revolution at the beginning of the 20th century happened with mass production and conveying systems being introduced. The third revolution started with the digital automation of production by means of electronics and information technology (IT) system. Today, the industrial landscape is again being transformed to the fourth stage with the rise of autonomous robots, contemporary automation, cyber-physical systems, the internet of things, the internet of services, and so on. Industrial robots, which are one of the key drivers in Industry 4.0, have evolved considerably since the last decades of the

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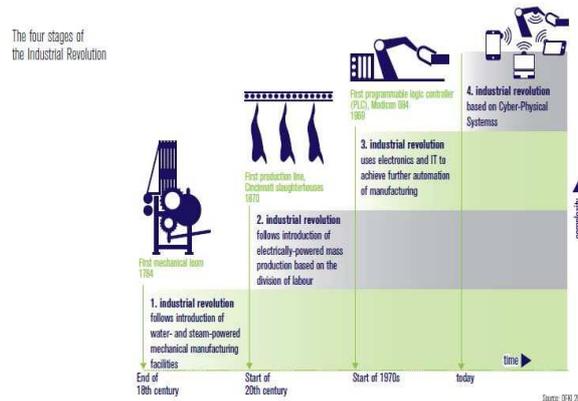


Figure 1.0

20th century. They are becoming more productive, flexible, versatile, safer, and collaborative and are thus creating an unprecedented level of value in the entire ecosystem.

IV. TECHNOLOGICAL EVOLUTION IN INDUSTRY 4.0

Industry 4.0 is evolving as the major area of interest to the researchers and scholars due to its flexibility and ability to keep electrified the automation and digitalization and actively picking up on new technology development [16]. Industry 4.0 represents a new level of organization and control of the entire value chain, across the life cycle of products and is increasingly geared to individualized customer wishes. This encompasses all phases from the idea and the order to development and production, delivery of a product to the end customer, even recycling and related services. Cyber-Physical Systems (CPS) is defined as transformative technologies for managing interconnected systems between its physical assets and computational capabilities. Industry 4.0 is now a new area of development where the IOT alongside cyber-physical systems interconnect with each other with the combination of software, sensors, processor and information technology together plays role for making "things" to have the potential to feed information into it and eventually adds value to manufacturing processes. The aim of Industry 4.0 is to construct an open, smart manufacturing platform for industrial-networked information system.

The expectation with industry 4.0 concept is that it will enable manufacturing facility to gain easy and affordable access to modelling and analytical technologies that can be customized to meet their needs. Industry 4.0 is best defined by the project's "smart manufacturing" (Fig 2.0) through the merging of the virtual and physical worlds through cyber-physical systems and the resulting fusion of technical and business processes [1]. The manufacturing life cycle in industry becomes more orientated towards the increasing customer demands and encompasses: the idea and the order for development and production, the distribution of products plus recycling. The interconnection of human beings, objects and systems leads to dynamic, real time optimized and self-organized inter-company value creation systems which are evaluated and optimized using criteria such as costs, availability and resource efficiency. Industry 4.0 emphasizes the idea of consistent digitization and linking of all productive units in an economy. There are several technological areas that underpin Industry 4.0, which are horizontal and vertical system integration, the internet of things, cybersecurity, cloud, big data analytics, simulation, additive manufacturing, augmented reality, and robotics [8]. The figure below shows the technologies related to Industry 4.0

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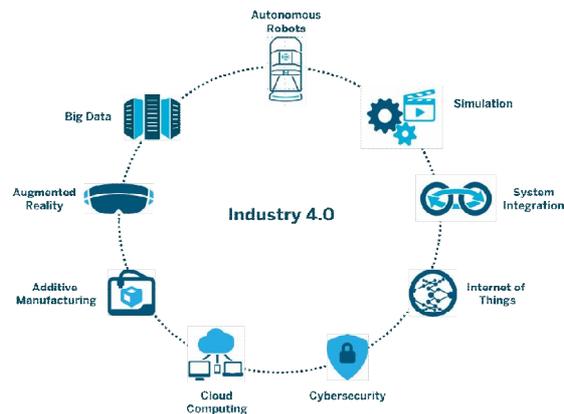


Figure 2.0

In Industry 4.0, integration in horizontal and vertical system among factories, departments, functions, and capabilities will be more cohesive, as cross-company, universal data-integration networks evolve and enable truly automated value chains. The Industrial Internet of Things will also enrich more devices with embedded computing and will be interconnected using standard technologies. This allows field devices to communicate and interact both with one another and with a more centralized controller, as necessary. Industry 4.0 also decentralizes analytics and decision making, enabling real-time response by machinery.

With the improved performance of technology, machine data and functionality will increasingly be deployed to the cloud and further to ERP, enabling more data-driven services for production system. More production-related undertakings in Industry 4.0 will require increased data sharing and loading the useful data in cloud and ERP system. For a smart manufacturing process it is important to fetch the most reliable and accurate data samples from the equipment and its sub equipment's which comprises of developing the stepping stone for the cyber physical system. The collected data is fed directly the ERP software usually SAP, SAP HANA is equipped with the feature supporting cyber physical security and industry 4.0 application. The data collected may or may not have some flaws in the system, now to ensure the reliability and accuracy, the meaningful data will be fetched and processed for further calculation and analysis. Having massive information gathered, specific analytics have to be used to extract additional information that provide better insight over the status of individual machines among the fleet. These analytics provide machines with self-comparison ability, where the performance of a single machine can be compared with and rated among the fleet.

Industry 4.0, as the next step, integrates cyber-physical production systems. Consumer input determines how and when manufacturers produce their products [17]. Information and communication technology (ICT) and smart automation connect and enable the integration of embedded production systems and processes, creating intelligent, object-oriented (OO) networking, moving from centralized to decentralized models, and evolving into cyber-physical design and simulation by using models and intelligent software. Big data and analytics enables the collection and comprehensive evaluation of data from many different sources and customer to support real-time decision making, optimizes production quality, saves energy, and improves equipment service.

V. ROBOTIC AUTOMATION IN INDUSTRY 4.0

Robots are the key drivers in successful implementation of industry 4.0 in manufacturing facility. The most essential face of Industry 4.0 revolution is autonomous production methods which are powered by intelligent robots which can complete tasks with safety, flexibility, versatility and reliability. Without the need to isolate the robot work zone, it becomes more economical and productive to integrate into human workspaces, and opens up many possible

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applications. Smart robots will replace humans in simply structured workflows within closed areas. In this industrial revolution, the robots will work along with humans hand in hand, on interlinking tasks and using smart sensor human-machine interfaces. The use of robots is increasing tremendously to include various functions, like production, logistics, and office management so that they can be controlled remotely. If a problem occurs, the Operator will receive a message on his mobile which will be governed by the workflow module which is linked to a remote device, so that he can understand the problem and give instructions to let the production continue until he comes back the next day. Thus, the plant is operating 24 hours/day while Operators are only there during the day [18].

Several robot making companies are manufacturing the robots with latest technology to be the pioneer in Industry 4.0. A lightweight robot for industrial applications can be designed for safe close cooperation between human and robot on highly sensitive tasks. IIWA can learn from its human colleagues and can independently check, optimize, and document the results of its own work while connected to the cloud [19]. Bosch also introduces the APAS family robot system which includes APAS assistant, APAS inspector, and APAS base for an agile and flexible production concepts based on quickly and easily retooled production systems [20].

VI. INDUSTRIAL ROBOTS CURRENT STATE IN INDIA

India is taking steady strides on the path of automation and the world, has understood that the speed, skill, consistency and accuracy of robots cannot be matched by humans. Moreover automation can take care of tasks which humans cannot perform specially in danger zones in an industry. Cost of robots has gone down and quality has vastly improved, the payback time of robots is now around one to two years, so even small and mid-size industries are looking toward automation to beat the rising competition. According to the International Federation of Robotics (IFR), in 2014, 2100 industrial robots were sold in India and it is estimated that this number could rise to 6000 in 2018[21]. The operational stock of multipurpose industrial robots in India was 11760 in 2014[21]. In 2015 the estimated figure was 14300 and it is expected to rise to 27100 by 2018[21]. Tata motors uses industrial robotics and automation for production. Reports reveal that the production force in Tata Motors came down by 20%. At the same time its turnover increased by 250%. In a single plant in Pune, Tata is said to have installed 100 robots. The "Make in India" campaign is a shot in the arm for Indian manufacturing and startups. So as more industries come up in the country, industrial robotics is likely to flourish industrial robotics promises opening up of several career avenues in the country in engineering design, development, research and management. It makes available wide range of entrepreneurial opportunities as well.

VII. IMPORTANCE OF ROBOTIC AUTOMATION IN INDUSTRY 4.0

Industry 4.0 involves the heavy use of automation and data exchange in manufacturing environments, encompassing areas such as cyber-physical systems, the Internet of Things(IOT) and cloud computing, among others. With Industry 4.0, manufacturers will be able to operate "smarter" factories, in which they can more easily tailor products for specific customers[22].An essential facet of Industry 4.0 is autonomous production methods powered by a concept referred to as the "Internet of Things" (IOT), an idea that by harnessing a connected mesh of objects, devices and computers machines can communicate with each other. And autonomous robots are a seminal example across countless industries, including manufacturing. By connecting to a central server or database, the actions of robots can be coordinated and automated to a greater extent than ever before. They can complete tasks intelligently, with minimal human input. Materials can be transported across the factory floor via autonomous mobile robots (AMRs), avoiding obstacles, coordinating with fleet mates, and identifying where pickups and drop-offs are needed in real-time.

Industry 4.0 has various methods for increasing the productivity by utilizing advanced analytics in predictive maintenance programs, by avoiding the breakdown of machinery on the factory floor and results in reducing the downtime and increased productivity.

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VIII. CONCLUSION

This paper reviews the present trend of robotic automation technology and its role in Industry 4.0 or a similar idea. With the advent of (ICT), economic development of the countries around the world has increases dramatically. Germans intends to become the leading market for Industry 4.0 solutions, while India being a developing state has many plans for development of the industrial set up and many countries are stepping forward to install the manufacturing facility in India keeping the Industry 4.0 concept. The fourth industrial Revolution will be based on cyber-physical systems, the IOT and Internet of Service. Many industries around the globe are joining hands together with different approach so as to benefit from the productivity and economic gains. Smart manufacturing is now important because it saves time and enable the collection of machine data and secure this in the ERP system which helps the management to decide for the future expansion of the industry by understanding the growth or the loss company is bearing.

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