Implementation of Industry 4.0 in Traditional Factories and Comparison

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Abstract— Industry 4.0 is the latest technology of the production system with the application of Internet of Things, Industrial network and big data, the fourth stage of industrialization, alluded to as Industry 4.0, and is accepted to be approaching. As, the needs of people are changing, the existing traditional factories lacking in producing the goods according to the need of the people. So there is the need of modernization of the existing factories. In this paper, we focus on the implementation of flexible and reconfigurable smart factory in traditional factories. We first propose a brief framework that incorporates industrial wireless networks and cloud with smart systems such as machines, products, and conveyors. Then, we explained the implementation concept of industry 4.0 in traditional factories, based on the concept of industrial network of systems and cloud based on the big data storage systems. In addition, we outline the differences by comparing some elements of industry 4.0 with traditional factories and some beneficial outcomes are also present.

Keywords—industry 4.0, internet of things, big data, industrial network, smart factory.

I. INTRODUCTION

Industry 4.0 is the emerging technology of the production systems, which is the combination of Internet of Things (IoT), wireless sensor networks, big data, embedded system and Cloud computing. These are being implementing in the production environment, which is referred as fourth industrial revolution.

This technology is a strategic initiative called "Industry 4.0" was proposed and was adopted as part of the "High-Tech Strategy 2020" of the German government [5]. The Industry 4.0 is the technology which describes the production Cyber-Physical Systems (CPS) that integrates production facilities, storage systems, logistics, and all the requirements of industry to establish the supply chain network [3]. The vertical integration is the process of implementing the industry 4.0 that is highly flexible. Therefore, the smart factory is to produce customized and small-lot products efficiently and profitably.

Before to the Industry 4.0, many advanced manufacturing systems have already been proposed for elimination of the drawbacks of the existing production. Among these, the multi-agent system (MAS) is the most representative [12]. In this the manufacturing systems are the intelligent systems that communicate with each other to achieve flexibility. However, it is difficult for the MAS to handle the complexity of these systems, so it still not implemented as the production strategy.

In our view, the cloud based industrial network (IN) is better suitable and support the smart factory by the use of IoT and big data. By this means, the smart systems can interact and communicate with each other through the IN to self-organize, and the massive data can be stored and sent to cloud and processed by it that has limited storage space and great computing ability for coordination.

In this article, we mainly focus on the strategy of industry 4.0 and the operational mechanism. The contributions of our work mainly include five aspects. First, we propose the industry 4.0 framework to integrate the IN, cloud, and terminals with the machines, products, products, and conveyors. Second, implementation of the industry 4.0 in traditional factories in the area of product, machine and handling system. Third, we compared the difference between the industry 4.0 and the traditional factories by considering different factors in the product, machine and material handling system.

The rest of this article is organized as follows. In Section 2, the strategy and main features of Industry 4.0 and its enabling technologies are discussed. We propose the framework and implementation of the smart factory and outline the main technical features and beneficial outcomes, discussed in sec.3, 4 and 5. Finally, the conclusion is given in Section 6.

II. STRATEGY OF INDUSTRY 4.0

The term Industry 4.0 means the fourth industrial revolution. It combines emerging technical improvements to advance industry to deal with some technical challenges. In this section, we present the need of industry 4.0, the industrial network, and the cloud technologies.

A. **Need of Industry 4.0**

The human culture craves a dynamic change of life quality. The business has been progressing to keep pace with this sort of necessities. At this point, it has encountered three progressive stages, that is, three mechanical revolutions. The business can proceed to enhance individuals' expectation for everyday comforts by giving tweaked also, top notch items to buyers and setting up a better workplace for representatives.

The current production paradigms not sustainable [1]. On one hand, the mechanical generation contributes a lot of the ecological interruption, for example, worldwide atmosphere warming and natural contamination. Then again, it expends tremendous a lot of non-renewable assets, for example, petroleum and coal. What's more, the industry endures an always contracting workforce supply due to populace maturing. In this way, the industry needs a radical change and it is the Industry 4.0 that addresses this change. The center thought of Industry 4.0 is to utilize the Big data innovations to execute IoT and administrations so business process and building procedure are integrated making generation work in an adaptable, effective, and green path with always top notch and ease.

B. **Industrial Network and Cloud**

The role of factory is preparing crude materials and semi-finished items to deliver completed items. Inside of the plant, different physical or informational systems are included during generation and administration. The material stream is along the settled generation lines that need flexibility of production.

The network, which integrates or connects the things throughout a system. It frames a sort of important infrastructure that enables between systems communications as well as interfaces the physical systems with the data cloud. The industrial network is better than the wired network, for example, industrial Ethernet considering the resilient features of the smart factory caused by, for example, the recently added machines or machine malfunction and the portable elements, for example, automated guided vehicles (AGVs) and items. The industrial network can accommodate these variations all the more easily because it can give more flexible and advantageous remote connections. In this manner, this network is accepted to be mandatory for smart factory.

It is another sort of important infrastructure that backings the smart factory. The term cloud is a striking expression for a network of servers that gives layered administrations as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS) [13]. With the distributed computing innovation, even the Internet can be virtualized as an enormous asset pool. Along these lines, the cloud gives an exceptionally elastic answer for big data application as in both the storage space and registering ability can be scaled on demand. Whenever operated, the smart systems may deliver massive data, which can be transferred to the cloud through the industrial network for information frameworks to handle. The big data analytics then can emotionally supportive network management and optimization including supervision and control.

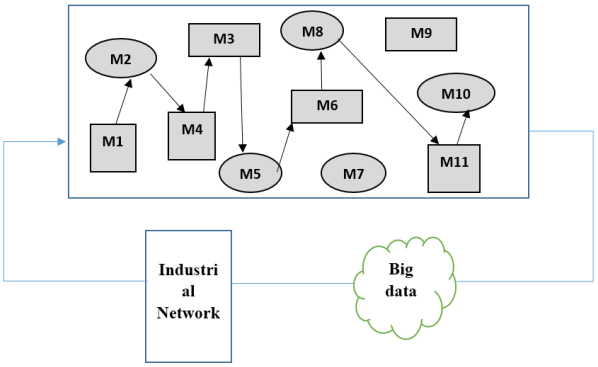

Figure 1. Smart Factory Mechanism

III. IMPLEMENTATION

The implementation in this aspect mean the modification of conversion of the existing factories to the industry 4.0. Implementation of this technology is not an easy task in the existing factories, as it should up of the internet of things, physical systems and big data. In, this process of implementation every system and every department of the factories should be considered as an individual object for integrating it. In this paper we focused on implementing industry 4.0 in the product, machine and material handling system.

A. **Product**

In this industry 4.0 technology the product is the key object in the whole process of production. Firstly, the initial product (raw material) which is giving as input in the production process is to be enabled with the Radio Frequency Identification (RFID). The RFID of the product works as the guide for the machines and systems in the industry as it communicates with each and every machine about the production process and the operations. The data about the production process and the operations are stored in the RFID of the product. The product contains the data of what operation to be done and which machine should do it, this data is stored initially by the production department. In this system the products will be produced quickly and efficiently i.e. without defects. The sensors installed in the production line of industry drives the products in the particular direction which the product has to move.

B. Machine

The purpose of the machine or the equipment is to perform a desired operation on the product. In the industry 4.0 technology the machines are the enabled with the sensors and scanners to control the inflow and outflow of products. The machine communicates with the product about the process and the operations which is to be done. The machine proceeds according to the data collected from the product and after the process of operation it forwards the product in the direction in which the next process is scheduled. The machines in the industry 4.0 are the flexible and multipurpose machines the can do different kinds of operations at the same time. The machines are interconnected with the cloud by the means of the Ethernet cables or wireless network for the communication with all the other systems this is called integration.

C. Material Handling System

The material handling system is the main mean of transportation of materials and products from machine to machine and other systems in the industry. Handling system in the traditional factories are the fixed and single purpose i.e. directional whereas the industry 4.0 has the advanced material handling system i.e. multipurpose and multi directional for the movement of the material throughout the system. In industry 4.0 the system can move multiple products to the multiple machines at the same time. As this system is the advanced and multipurpose system the movement of the products will be fast. This system mainly uses AGVs and conveyor belts.

IV. COMPARISON

The comparison is of different factors of the traditional factories and industry 4.0. The comparison is made on three aspects i.e. product, machine, and material handling system. This comparison will give the clear idea about the implementation and benefits of the industry 4.0 technology.

A. Comparison of Product

The tradition factory and industry 4.0 has much difference in the equipment's used and interaction of the systems. The product comparison shows much difference in the interaction, data management, types of production and material handling systems.

TABLE 1. COMPARISON OF PRODUCT

Factor	Traditional product	Industry 4.0 product
Interaction	Product do not have any interface to communicate with machines.	The product communicates with the machines by means of RFID.
Data	Product do not contain any data.	Product contains data of the production process and operations.
Types of Products	Only single type of products are produced.	Multiple types of products are produced.
Movement in Handling System	The product movement is very less.	The products are produced quickly as the machine breakdowns are very less.

B. Comparison of Machine

The machine in industry 4.0 has changed more when compared to the traditional environment. The machines have enabled with the sensors and is integrated under the industrial network in the industry 4.0 environment. The data management systems are also enabled in the industry 4.0 systems as the data acquisition is the main concept in industry 4.0, by using the bid data technology.

TABLE 2. COMPARISON OF MACHINE

Factor	Traditional Machine	Industry 4.0 Machine
Types of Operations	These are single purpose machine.	This is a multipurpose machine.
Machine Breakdown	Machine breakdowns are common in traditional industries.	The breakdown of machines occurs very rarely as it is a self-detection system.
Operation Rate and Accuracy	The operation rate and accuracy is very less.	The operation rate is very high i.e. products are produced quickly and accuracy is high.

C. Comparison of Material Handling System

Material handling system is the multipurpose and flexible system in the industry 4.0. It can move the material in multi directions where in traditional factory it cannot be done. The conveyor are the main means of the transportation of the material from the machine to machine in these factories. The comparison of the material handling system is shown in below figure.

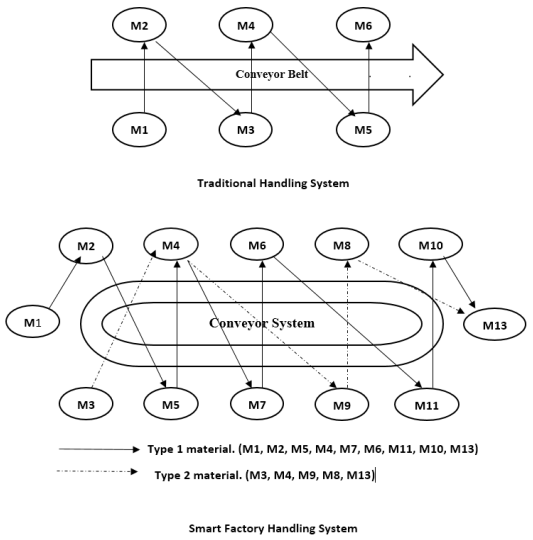

Figure 2. Comparison of Material Handling System

TABLE 3. COMPARISON OF MATERIAL HANDLING SYSTEM

Factor	Traditional Handling System	Industry 4.0 Handling System
Routing	These are Fixed production lines in single route.	This is a Flexible system in which has different routes.
Product movement	One type of products are handled.	Multiple products of different types can be handled.
Means of Handling	Conveyor belts and AGVs	Conveyor belts

V. BENEFICIAL OUTCOMES

Industry 4.0 high-tech strategy and technology have to produce smart products by using the smart infrastructure, smart machines and smart production system. The transformation of the traditional factories to industry 4.0 will give the benefits as it is the advancement of existing factories. Some of the benefits are listed in Table below.

TABLE 4. BENEFICIAL OUTCOMES OF INDUSTRY 4.0

S. No.	Outcomes	Benefit
1	**Flexibility**	As this is a flexible system different types of products can be produced at the same time.
2	**Productivity**	As the system is flexible the productivity will be more it leads to fast production.
3	**Resource and Energy Efficiencies**	This system is efficient the resources used by this system will be low i.e. less wastage and it can save energy.
4	**Transparency**	As this system is integrated and intelligent system it automatically identifies the problems and also gives the solution.

VI. CONCLUSION

Industry 4.0 factory is an environment in which all systems are interconnected and sharing information with each other. Here the advantage is the needed information is available with the product. This approach is by the automation of the cyber physical production systems for integrating the systems. In this cyber physical system environment, the production systems are linked among themselves for easy accessing and fast exchange of data. However, only the less number of industries having installed cyber physical systems, that are integrated systems. For this reason this paper presents an implementation of the Industry 4.0 factory in the existing traditional factories by considering the product, machine and material handling system. The approach mainly consists of enabling the industrial network and connecting them throughout the factory for communication of man, machine, and product. First the establishment and connection of industrial network that allows integrating systems, their communication interfaces and cloud is explained. The comparison of the traditional factories and industry 4.0, some expected beneficial outcomes are also listed.

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