Development Trends and Challenges of Industrial Internet of Things

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Keywords: Industrial internet of things (IIoT), Definition, Characteristics, Development trends, Challenges.

Abstract. IIoT is mainly used in all aspects of the whole life cycle, such as design, production, management and services. It is an important component of China’s strategic emerging industries and contains enormous economic value. After the traditional industries are transformed by IIoT, it will bound to provide the economic value, promote the transformation of economic development mode from production driven to innovation driven as well as adjustment of China’s industrial structure. This paper mainly introduces the basic theories, development trend and challenges of industrial Internet of Things, which has a certain guiding role for the development of industrial manufacturing.

Introduction

IIoT is connected to the wireless network through radio frequency identification (RFID), sensors, two-dimensional codes and so on. The integration of IoT and traditional industries can accelerate the transformation and upgrading of industrial manufacturing. All countries in the world have released relevant strategic initiatives to seize a new round of development strategy opportunities. IIoT arises at the historic moment and becomes an important promoter of intelligent transformation of the global industrial system. IIoT is mainly used in all aspects of the whole life cycle, such as design, production, management and services. It is an important component of China's strategic emerging industries and contains enormous economic value. After the traditional industries are transformed by IIoT, it will increase the added value of the industry economy and promote the transformation of economic development from production driven to innovation driven as well as adjustment of China’s industrial structure [2].

Background and Significance

In recent years, China's manufacturing industry is facing a prominent problem and challenge is the rapid rise in labor costs. To a certain extent, this has prompted manufacturing enterprises to transfer production factories to countries and regions with lower labor costs such as Southeast Asia. For a long time, low labor cost has been an important advantage of the rise of China's manufacturing industry. However, as China's industrialization process enters a later stage, the demographic dividend gradually disappears and the population aging, the advantage of low-cost labor force in China is gradually losing. Intelligent manufacturing is a new production mode, penetrating into design, manufacturing, management, service and other links of manufacturing activities. In addition, the deployment and implementation of IIoT will lay foundation for intelligent manufacturing. Intelligent manufacturing will combine IIoT, rationally allocate the supply chain resources to enhance the efficiency of production, and realize the intelligent production and management of manufacturing industry.

IIoT is considered as one of the main trends affecting industrial enterprises today and in the future. Every industry is on the rise. Its purpose is to integrate modern systems and equipment into their workflow, because the use of these systems can help the industry comply with the relevant regulations. These systems also help keep up with changing markets and deal with disruptive technologies. Enterprises accepting industrial Internet of Things have significantly improved in terms of security, efficiency and profit.
It is predicted that the global industrial Internet of Things portal market will grow at a compound annual growth rate of 13.64% between 2019 and 2023. According to a recent World Bank estimate, the gross world product is $75.62 trillion, so IIoT can bring considerable profits and prosperity to many people. With the development of industrial Internet of Things in the next decade, trillions of dollars have been in jeopardy. On the one hand, IIoT involves sensors, networks and data, on the other hand, it is ultimately related to the capital and profits of specific industries. It is estimated that by 2030, the Internet of Things will increase global GDP by $1.42 trillion [3].

**Basic Theories**

The transformation and upgrading of industrial manufacturing brings important development opportunities for the promotion and deployment of the IOT. However, neither the international industry organization nor the standardization agency has given the definitive definition of IIoT. According to the development path of IIoT, IIoT is the application of the IoT in the industrial field, but it is not just as simple as the "industry + Internet of things". Firstly, the industrial control system lays the foundation for the interconnection and intercommunication of IIoT. Secondly, the industrial software system provides support for the application and development of IIoT. In addition, the harsh industrial environment brings challenges to the networking technology of IIoT. Hence, IIoT will have a richer connotation.

**Definition**

IIoT integrates all kinds of acquisition, control sensors or controllers with sensing and monitoring capabilities, as well as mobile communications and intelligent analysis technologies into all aspects of industrial production process. It can greatly improve manufacturing efficiency and product quality, and reduce product costs and resource consumption, and ultimately realize the upgrading of traditional industry to a new stage of intellectualization[1].

![Figure 1. Essence of IIoT.](image)

**Characteristic**

IIoT has six characteristics: intelligent perception, ubiquitous connectivity, precise control, digital modeling, real-time analysis and iterative optimization.

**Intelligent Perception**

Intelligent perception is the base of IIoT. The massive data generated from industrial production, logistics, sales and other industrial chain links are the information data of different dimensions in the industrial lifecycle obtained by IIoT in such perceptual means as the sensor and RFID,
including: State information about industrial resources, such as personnel, machines, raw materials, processes and environment.

**Ubiquitous Connectivity**

Ubiquitous connectivity is the precondition of IIoT. Industrial resources are connected or linked to the Internet through wired or wireless ways, forming a convenient and efficient information channel for IIoT and realizing interconnection and intercommunication of industrial resource data, and the breadth and depth of the connection between machines and machines, machines and people, machines and the environment are expanded.

**Digital Modeling**

Digital modeling is the method of IIoT. Digital modeling maps industrial resources into digital space, and simulates industrial production processes in a virtual world, which can realize the abstract modeling of all elements in industrial production process by virtue of the powerful information processing ability in digital space.

**Real-time Analysis**

Real-time analysis is the means of IIoT. The perceived industrial resource data can be processed in real time in digital space by means of technical analysis, to obtain the internal relationship between the state of industrial resources in the virtual and the real space; in addition, the abstract data can be further visualized to complete the real-time response.

**Precise Control**

Precise control is the purpose of IIoT. Through the processes of state perception, information interconnection, digital modeling, real-time analysis, etc. of industrial resources, the precise control can be converted into the control commands that the industrial resource entities can understand based on the decision formed in virtual space, and then practical operation shall be conducted to realize information interaction and optimize resources allocation.

**Iterative Optimization**

Iterative optimization is the effect of IIoT. IIoT system can learn and upgrade itself continuously. It can form effective and inheritable knowledge base, model base and resource base by processing, analyzing and storing industrial resource data. It can iterate and optimize till the optimal goal facing industrial resource manufacturing raw materials, manufacturing processes, manufacturing processes and manufacturing environment.

**Development Trends [4]**

(a) Intelligent hardware transformation is an important direction for the next development of China's IIoT. As far as hardware system is a single industry chain, the intelligent transformation of hardware system will create a lot of demand for the downstream hardware market. At the same time, the increasing downstream market demand will also drive the flourishing development of the upstream chip market.

(b) Promotion of service demand has become an important driving force for the ecological development of IIoT.

The development of China's industrial Internet of Things has gradually changed to the application needs, including customer personalized needs, flexible and dynamic business process needs, equipment output rate and efficiency needs, etc.

(c) Whether information is a factor or a product, the value of its productivity will gradually replace the dominant position of industrial productivity.

Information help our country realize the transition from the initial stage of IIoT to the advanced stage. Therefore, the in-depth development of information technology will become an important trend in IIoT.
Challenges

Many companies still face problems in adopting the industrial Internet of Things. They don’t know where to start and which automated processes will help improve efficiency[5].

**Security Vulnerabilities.** Internet of Things devices automatically communicate with each other. In the absence of a secure and properly encrypted network, the adoption of the Internet of Things may lead to new security challenges and vulnerabilities. Independent security elements will have to be introduced into the network to achieve adoption without a higher risk of hacker attacks or data leakage.

**Lack of Interconnection Standards.** Sensors, interface standards, communication protocols and management protocols need to be standardized. At present, many international organizations and standardization organizations related to IIoT have been established internationally, but their authority is insufficient.

**Communication Performance Requirements Become Higher.** With more and more devices accessing the IoT, the performance requirements of communication are also improved. At present, there are related technologies in the high-performance Internet of Things of large scale, such as high-performance Internet of Things. To some extent, large-scale Internet of Things is handled through standards such as NB-IoT.

**The Mode of Production Organization Is More Traditional.** Mass production cannot meet the needs of personalization and service, and the traditional mode of organization cannot adapt to the changes of complex industrial chain.

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