Summary of Cyber-Physical System

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Abstract: With the development and application of big data processing, cloud computing and Mobile Internet, the industrial control and its manufacture are changing greatly. From the transformation of manufacturing to intelligent manufacturing, the continuous development of technology, the industrialization of the IOT technology also came into being. Whether it is the German idea of Industry 4.0, the American idea of reindustrialisation, or the Chinese idea of a new type of industrialisation, the idea of Made in China 2025, all of them have a common connection point with the present interconnection of all things, which can be understood as CPS, a fusion system of information physics, which is a multi-dimensional heterogeneous computing unit and an actual physical object. The complex new intelligent system, which is highly integrated and interactive under the network environment, has the characteristics of computation and data processing, mutual communication, cooperative control and self-adjusting feedback,etc. Networking, sensor networks, ARM embedded system are interconnected[1-5]. It integrates computation, communication and control into one. It also integrates sensor and network, communication system, computer network and other networks and technologies into a new complex system. This paper gives a brief overview of the system, then analyzes the research status at home and abroad. The structure and core technology of the system are discussed, the main characteristics and research direction are described, and the challenges in the future are also discussed.

Keywords: Information Physics Systems; Sensors; Operations; Internet of Things

1 Introduction

Cyber-physical System (CPS) is the integration of information and physical System. Embedded technology and computer network make the two cooperate and merge. In recent years, there are more and more seminars and reports on the topic of information physics fusion system, aiming at perfecting the CPS framework, looking forward to find possible problems, and promoting the application of CPS system in all walks of life. At present, CPS applications mainly focus on medical, automobile, Smart Grid, smart city and other fields, rely on a strong entity-physical interaction

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ability to ensure human health, facilitate human travel, overall planning and optimization of the allocation of power resources[6].

As shown in Fig1, Cyber Physical System (CPS) is a new generation of intelligent System which integrates computer technology, embedded technology, network technology, sensor technology, wireless communication technology and large-scale data processing technology. As the unity of computing process and physical process, it realizes the deep fusion or extension of new functions of human-computer interaction interface and physical process through feedback loop by using networked spaces to manipulate a physical entity remotely, reliably, in real time, securely, and collaboratively. CPS emphasizes the close integration of computing and physical processes. The core of CPS is the integration of 3C (Computing, Communication, Control) , which is based on perception. The organic integration of networked, controllable, trusted, and scalable physical equipment systems with computing, communications, and control capabilities to monitor or control physical entities in a secure, reliable, and effective manner, realization of the system real-time perception, dynamic control and Information Services [7].

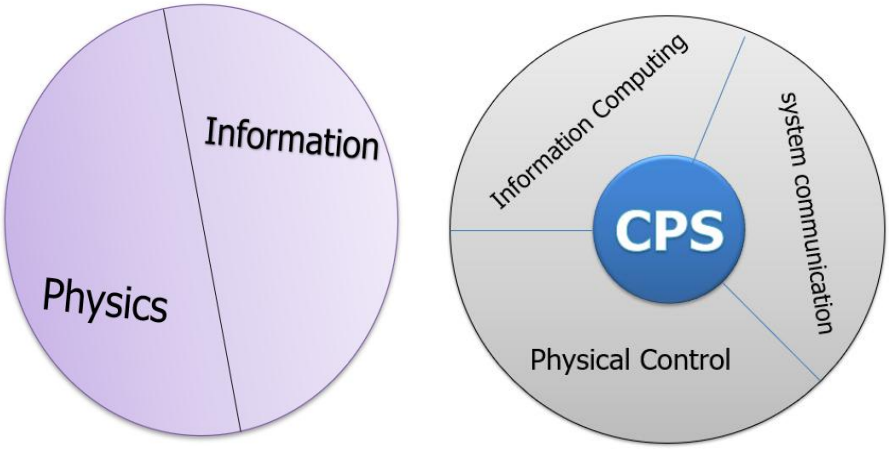

Fig.1 Cyber Physical System

The German "Industry 4.0" proposed a new type of industrial system called "intelligent factory", the CPS system in the first place. In the present research, the foreign research is mainly in the CPS security field, most focus on network data encryption, model validation or with the help of network security research methods, and some take into account the control security of physical systems. On the domestic front, Zhou Ji, Dean of the Chinese Academy of Engineering, referred to the concept of HCPS in his report thinking on China's smart manufacturing development strategy. It emphasized that the traditional manufacturing process will change from "man-physical system" to "man-information-physical system" under the strategy of intelligent manufacturing. CPS in the industrial field of innovative applications, the formation of industrial information physics system, in addition to the extensive study of industry, CPS has also been highly valued by the academic community[8].

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Literature[9] mentions that since 2006, when the US National Science Foundation listed CPS as a key research area, CPS has been one of the hot research areas in the academic and business circles, and many international symposia have been held around the world A number of well-known international journals have also published a special issue of CPS[9] .

The significance of cps lies in the networking of physical devices, which is connected to the Internet, allowing physical devices to have five functions: computing, communication, precise control, remote coordination and autonomy. CPS is essentially a network with control properties, but it is different from the existing control system, that is, put communication on the same level as computing and control, because CPS emphasizes the relationship between physical devices in distributed applications. Coordination is inseparable from the communication. The distance coordination capability, autonomy, and type and number of control objects of the internal devices of the network, especially the network scale, far exceed the existing industrial control network.

2 Structure and Core Technology

The information physics system is mainly divided into three parts, namely the sensing layer, the network layer and the control layer. As shown in Fig.2, the sensing layer is mainly composed of devices such as sensors, controllers and collectors. The sensors in the sensing layer acts as the end device in the information physical system. The main information collected in the environment is that the specific information sensing layer mainly acquires the information data of the environment through the sensor, and sends it to the server periodically. After receiving the data, the server performs corresponding processing, and then returning to the corresponding information of the physical end device, the physical end device must undergo corresponding changes after receiving the data. The data transmission layer is mainly a bridge connecting the information world and the physical world, mainly implementing data transmission, providing real-time for the system. The network service ensures the real-time reliability of the network packet, the application control layer mainly performs the corresponding analysis according to the cognitive result of the cognitive layer according to the data transmitted from the physical device, and returns the corresponding result to the client to present the visual interface.

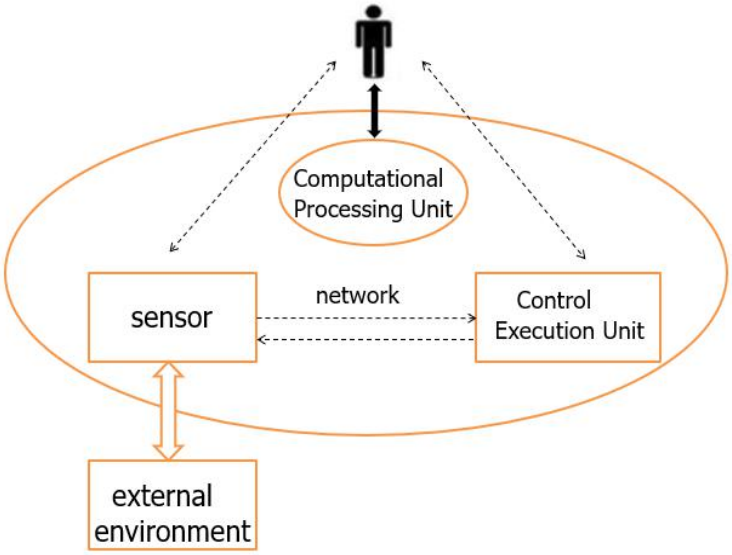

Fig.2 The information physics system

It is pointed out in reference [10] and Fig.3 that the four core technologies of CPS mainly include one hard, one soft, one net and one platform. Through the core technology reflects the running process of an agent including state perception, real-time analysis, autonomous decision-making, accurate implementation, learning promotion and cycle rise.

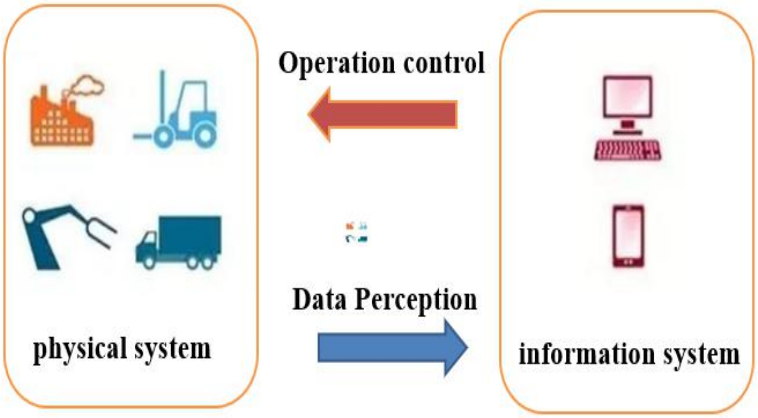

Fig.3 Core technologies of CPS

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Hard: refers to perception and automatic control. The state perception depends on the sensor, the precise execution depends on the automatic control;

Soft: refers to industrial software. Perform real-time analysis;

Network: refers to the sensor data and data sent to the controller through the industrial data bus for transmission;

Platform: refers to powerful cluster and a large amount of industrial software for intelligent analysis and Decision Making, namely Industrial Cloud Platform[10].

3 Main Features

Mass computing is a common feature of CPS access devices. As a result, access devices often have significant computing power. From a computational performance perspective, if some high end CPS applications are compared to a fat client / Server Architecture, then the Internet of things can be seen as a client server, since objects in the Internet of things do not have control and autonomy Communication also occurs mostly between goods and servers, so there is no synergy between goods. From this perspective, the Internet of things can be seen as a simple application of CPS, or CPS, to clarify the definition and concept of the Internet of things. In the Internet of things, it's mainly through communication between RFID and readers, and people don't get involved. Awareness is very important in CPS. It is well known that most of the changes of physical quantities in nature are continuous, or simulated, while the information space data is discrete

Dispersibility. Then the information flow from physical space to information space, must first through various types of sensors to all kinds of physical quantities into analog, and then through analog / digital converter into digital quantities, so as to be accepted by the information space. In this sense, the sensor network can also be seen as part of the CPS.

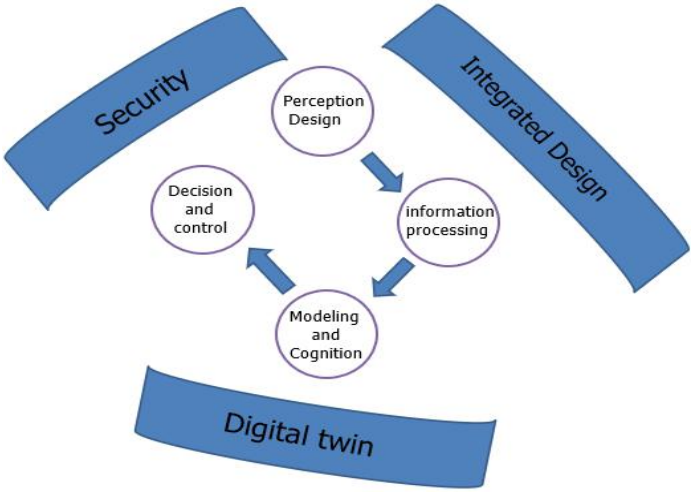

Fig.4 Main research directions of CPS

4 Future Challenges

CPS has two research directions: first, using CPS theory to solve the complexity of the existing information control system and improve the performance of the system; second, designing and building a new CPS [11] .The realization of its intelligentization can be divided into four stages, the first stage is the CPS's autonomous perception of the system environment information, the second stage is to process the obtained information appropriately after obtaining the perception information through the sensor network, for example, removing useless information and classifying information; the third stage is to model the CPS as a whole system on the basis of building a database; the fourth stage is through the whole model and database Achieve final decision-making and system control. According to the fig4 and progressive tasks of the above four stages, CPS technology research is divided into CPS perceived design technology, CPS information processing technology, CPS modeling and cognitive technology, CPS decision and control technology.

It is mentioned in document[11] that although a great deal of scientific research has been carried out on CPS technology in various countries around the world, it is basically in its infancy There are still many theoretical and technical problems to be solved, which need to be solved and further studied, mainly in the following aspects:

(1) real-time performance of the system:

The primary task is to design a new model to meet the real-time requirement. Because in these systems there are a lot of sensors, actuators and computing devices that need to exchange a lot of information. For example, because of the different location of sensor nodes, the CPS network topology will change greatly, and a great deal of information exchange needs to be carried out between systems to adapt to different applications.

(2) reliability and safety:

In general, the information interaction between systems must be affected by the uncertainty of the physical world. Different from the logical operation in the computing system, CPS has higher reliability and security.

(3) dynamical system in complex environments:

The biggest difference between a physical system and an information system is that the physical system changes in real time as the process changes, while the information system changes as logic changes. CPS integrates the characteristics of the two to build a corresponding dynamic model.

(4) feedback structure and its verifiability:

Dynamic changes will affect the performance of physical systems, especially the performance of wireless sensor networks. To solve this problem, many wireless network protocols must be designed to bridge the communication between the physical layer and the network layer of each node. The feedback mechanism has a uniform standard to restrict the information exchange between the boundary layer and the boundary point, and satisfies the traditional design and control scheme. Reflective structures provide specific reflective information that is important, including perceived data, performance parameters, and data availability.

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5 Conclusion

To sum up, CPS in the future has a very broad space for development. The traditional control mode of hardware plus software base unit has been gradually replaced by the system control mode of hardware plus software plus network, which is composed of CPS The later development will certainly to the system control way plus the Intelligent Cloud Platform Service Direction Development[12] . For the researchers, building a system between the information space and the physical space Cloud-based services such as state perception of basic units, scientific analysis of real-time data, scientific and effective decision-making, and a closed-loop intelligent control system with extreme precision and execution still need to be studied CPS will also play a role in the application of industrial control information processes and other aspects, facilitating the realization of Made in China 2025[13-15] .

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