Research on the application of Wireless Sensor Networks for Intelligent Manufacturing Workshop

Shaotang Cai [1, a], Yinggao Yue [1, 2, b], Lian Xu[1, c], Shuoqi Ma [3, d], Li Cao [1, e]

[1]Artificial Intelligence Key Laboratory of Sichuan Province, Sichuan University of Science and Engineering Zigong, 643000, China

[2]Material Corrosion and Protection Key Laboratory of Sichuan province, Sichuan University of Science and Engineering Zigong, 643000, China

[3]School of Mechanical Engineering, Sichuan University of Science and Engineering, Zigong, 643000, China

[a]caishaotang1992@163.com, [b]yueyinggao2006@163.com, [c]xuliandeyoux@163.com, [d]819570631@qq.com, [e]Bryant413@163.com

Abstract

Internet of Things is an important achievement of the rapid development of modern information technology. It is an important bridge connecting the virtual network world with the real material world, and realizing the communication and connection between the human world and the material. With the rapid development of intelligent manufacturing, wireless sensor network technology has also been widely used in intelligent assembly shop, and the integration of wireless sensor network into intelligent assembly shop brings new opportunities and challenges for it. Because wireless sensor network (WSN) to have self-awareness, self-adaptation, self-analysis, self-decision, In the intelligent manufacturing workshop based on the wireless sensor network, the manager obtains the workshop information more comprehensively and concretely, and the real-time data can be fully guaranteed. This paper described basic meaning of the wireless sensor network and in detail introduced the main technical characteristics of the network; and the wireless sensor network in intelligent assembly shop in dynamic transportation, shop scheduling and workshop environment monitoring application make summary in detail. And the problems existing in the application of wireless sensor networks in the intelligent assembly shop are analyzed, and the application of the wireless sensor network in the intelligent assembly shop is prospected.

Keywords

Internet of Things; wireless sensor network; intelligent assembly workshop; dynamic transportation; intelligent manufacturing.

1. Introduction

A The wireless sensor network can perception, collection, calculation, transmission and analysis on the monitoring regional data by deploying various types of sensor nodes in the monitoring area[1].It is often known as an intelligent wireless sensor network because of its high complexity, autonomy and sophistication, it is widely used in various industries and complex environment, and for a long time as a hotspot and search emphasis in countries information field ,connect human society activities with the digital virtual world and the physical reality world[2-3].

The advanced intelligent assembly workshop needs timely and extensive feedback of information data in order to quickly respond to the assembly of various production lines and realize intelligent production and comprehensive management of the workshop。The traditional artificial acquisition of low efficiency, low resolution and low capacity has completely failed to meet the requirements of enterprise information engineering[4].The application of wireless sensor networks in the assembly workshop opened a new chapter to workshop information acquisition, features such as real-time

monitoring, autonomic computing, and wireless transmission simplify workload improve work efficiency, enabling workshop managers to receive accurate information in time。Managers adjust and make decision on workshop production management based on real-time data and expert system[5].

In the context of rapid development of Internet of Things, modern communication technology and computer network technology develop rapidly, and assembly shop and network are combined to form intelligent assembly workshop with higher automation degree[6].The organic combination of Internet of Things and assembly shop has caused many problems that need to be improved in traditional assembly shops have been greatly improved, such as how to improve the accuracy of the location of material distribution, how to optimize the scheduling of workshops in order to reduce costs, how to improve the assembly environment of the assembly shop and improve the quality of the environment. When measuring whether the industrial intelligence meets the requirements, the intelligent degree of the assembly shop is one of its important indicators. Therefore, the application of the Internet of Things is an inevitable trend in the development of the assembly industry[7-8].

2. General Overview of WSN

The wireless sensor network has developed rapidly for which integrates embedded technology, microelectronics, advanced sensor technology and modern communication technologies and so on[9]. Realizing real-time acquisition of required signals, self-processing of network systems, and wireless data transmission. Different from the traditional wired sensor network, the wireless network has the characteristics of low cost, easy department and high efficiency, which improves the robustness and fault tolerance of the network.

2.1 Characteristics of Wireless Sensor Networks

Wireless sensor networks belong to the development of sensor networks. Therefore, WSN also retains the most basic components of sensor networks: sensor node, gateway (convergent node), and managed node[10]. The basic architecture diagram of the wireless sensor network system is shown in Fig.1。The wireless communication system replaces the traditional wiring system, greatly improving the flexibility of the sensor layout, reducing the cost of equipment deployment and more convenient for the maintenance of the sensor. Selectively for different levels of monitoring of monitoring area, if need high strength on a particular area of monitoring is placed in the area is relatively more intensive sensor nodes, greatly strengthen the [11-13].At the same time, the existence of a large number of redundant nodes is to enhance the robustness of the system, even when some nodes environment, such as energy consumption failed, the whole network system can run normally and safeguard the basic work smoothly [14-15].

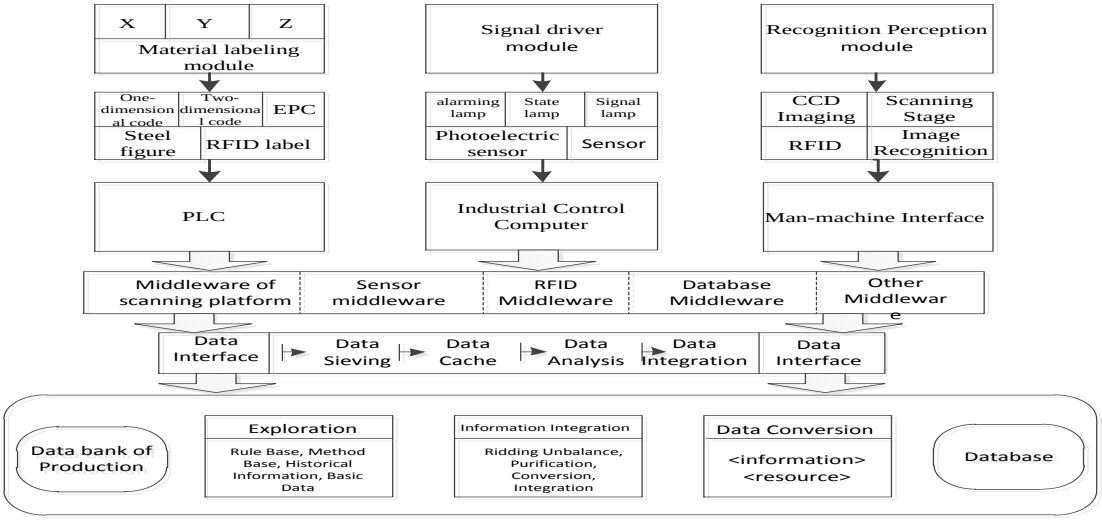

Fig1 Schematic diagram of the basic framework of WSN system

2.2 Overview of Wireless Sensor Networks.

The research of wireless sensor network technology is the key to understand the WSN, which mainly includes the research of its network protocol, node location, data fusion, topology control and wireless communication technology. Through the analysis and application of these technologies, the information layer is divided into the perception layer, the transport layer, the application layer。WSN network protocol currently uses improved MAC protocol, safety more routing protocol, Zigbee (Zifeng protocol) [16]. The application of these network protocol technologies improves the deficiencies caused by limitations such as sensor node's own energy consumption and computational storage capacity, and they are applicable to the dynamic changes of complex wireless network topologies and structures. Nodes positioning technology can be expressed as determining the location of the unknown node according to the location of the local known node, so that the sensing node can construct the related spatial relationship in the spatial structure [17]. As the core technology of WSN, nodes positioning technology determine the absolute position and the relative position of sensor node so that the real-time transmission of available information to find out the best optimal path to energy cost saving，It plays a key role in real-time tracking, assisting routing, network management and timing propagation [18]. In the process of information collection from perception layer to application layer in the wireless sensor network, data quantity and types increased with geometric series. So it is required that the WSN needs to establish a transmission mechanism, and the data fusion technology is developed to process redundant data and the network for energy saving. Implementing a good topology control on the network structure ensures the working efficiency of the network protocol meanwhile promotes the stability of data fusion and node location.

3. Application of WSN in Intelligent Assembly Shop

The intelligent assembly shop combined with the advanced technologies such as large data, artificial intelligence, wireless sensor technology, cloud processing and so on, and make the assembly shop have a qualitative leap of system management, workshop environment, production efficiency, etc. The realization of "made in China 2025" is closely related to the self-perception, self-analysis, independent optimization, self-judgment and autonomous execution ability of intelligent assembly shop system. The highly intelligent assembly shop undoubtedly reduces the manpower cost and comprehensively improves the production capacity and production quality of the manufacturing industry [19-20]. To establish a perceived physical layer, data transfer layer, intelligent service layer, application service layer of multilayer manufacturing data networking architecture is of the key to realize the physical connection, assembly workshop object perception, wireless transmission, intelligent processing and directly use terminal. A schematic diagram of the intelligent assembly workshop based on Internet of Things is shown in Fig. 2.

3.1 Application of Dynamic Material Distribution in the Workshop

The material distribution is the front end of production, and the material needs to be delivered to the designated location in the production process, For example, the automobile manufacturing industry needs to accurately transport parts to each assembly point. Chemical production needs to transfer the required materials to the designated container and so on. [21-22].In production, wireless sensor networks are built through sensing technology, wireless network communication, radio frequency identification, etc. and to build databases the system collects monitoring product information, completes real-time monitoring and control of products to solve shortages caused by material lags in the production process. Accumulation of excess material and other phenomena realize accurate positioning and real-time monitoring of materials in the production line. In the process of material distribution in the workshop, the wireless sensor network is composed of various sensor nodes and related actuators (such as transmission belt, driving, transport skip and discharge valve, etc.) in different positions of transmission line to form a wireless sensor network to monitor real-time monitoring of the material's location, time distribution, shape and other material transfer status information [23-24]. The network system transmits the collected data to the terminal and autonomously

controls the location, classification, etc. of the material space according to the characteristics of the network self-analysis and self-judgment [25].

In the actual material dynamic distribution, the distribution mode adopted by various types of materials is different, such as marking method, signal driver, perceptive mode and collected data and so on. As shown in Fig. 3, for the X type material, its identification is to scan and identify the electronic tag or two-dimension code on the material using a scanning platform, collect material static information, dynamic consumption information, and so on. According to the uploaded consumption data and storage situation, for X type material production materials carry out reasonable allocation and application. The material of Y with the use of steel code, RFID tags are identified, using scanning gun, CCD imaging methods such as batch acquisition, determine the type of Y material, the rate of qualified products, the overall number of line library number, material reaches the location [26].The material of Y scanning nameplate is located as a disposable consumable. All types of materials are equipped with signal driving module. Under the cooperation of sensors, signal lights, status, alarm lights and other equipment, it ensures that the storage state of the material is excellent, the assembly process is successful and the product recovery is simple.

Yang qing et al [27] .proposed the application of real-time perception to intelligent workshop material distribution through the combination of wireless sensor network technology and mechanical product assembly system, A multivariate data sensing model is established and the feasibility of wireless sensor is tested in a car assembly shop. Liang Changyong et al [28] considered the timeliness issues in manufacturing and used radio frequency identification tor put forward a modern assembly process that conforms to the just-in-time management mode. Song Likang [29] put forward at the technical level of division of the aircraft assembly process, material distribution links with the multi sensor equipment, realized in the transmission process of all kinds of manufacturing elements of materials (state, operation, monitoring and control), the integration of a variety of data, to realize manufacturing process monitoring and optimization services for the products,toestablish manufacturing the production standards of manufacturing information system.

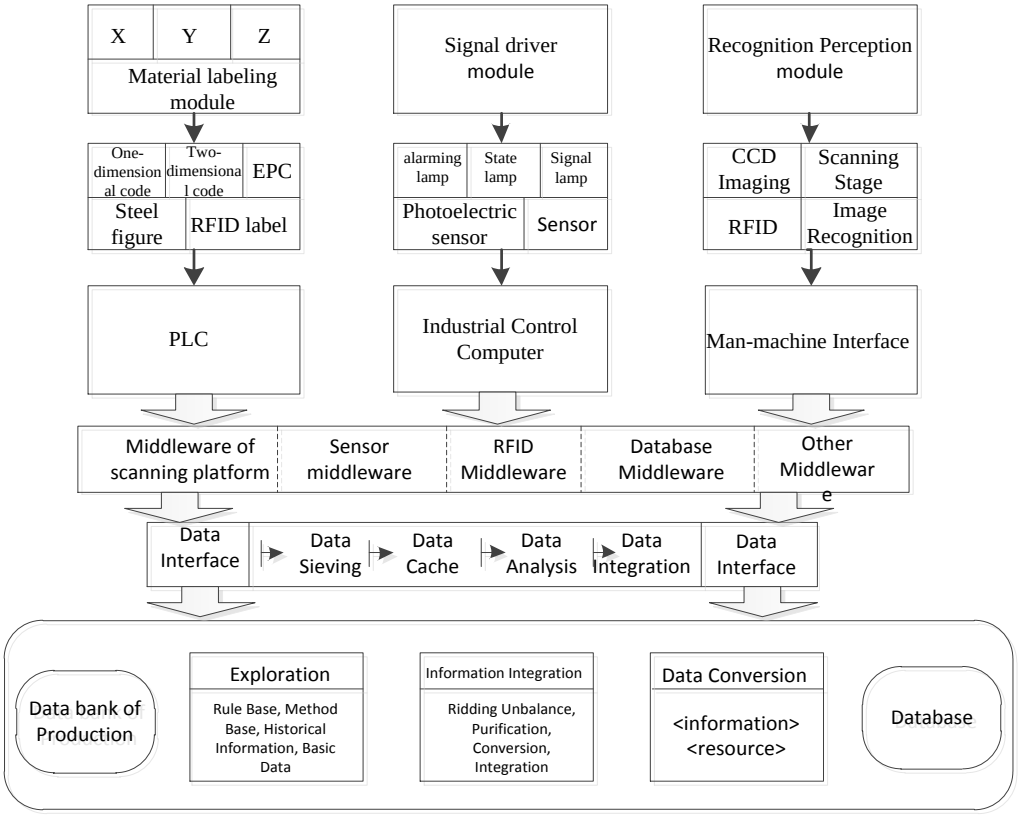

Fig. 2 A schematic diagram of an intelligent assembly workshop based on Internet of Things

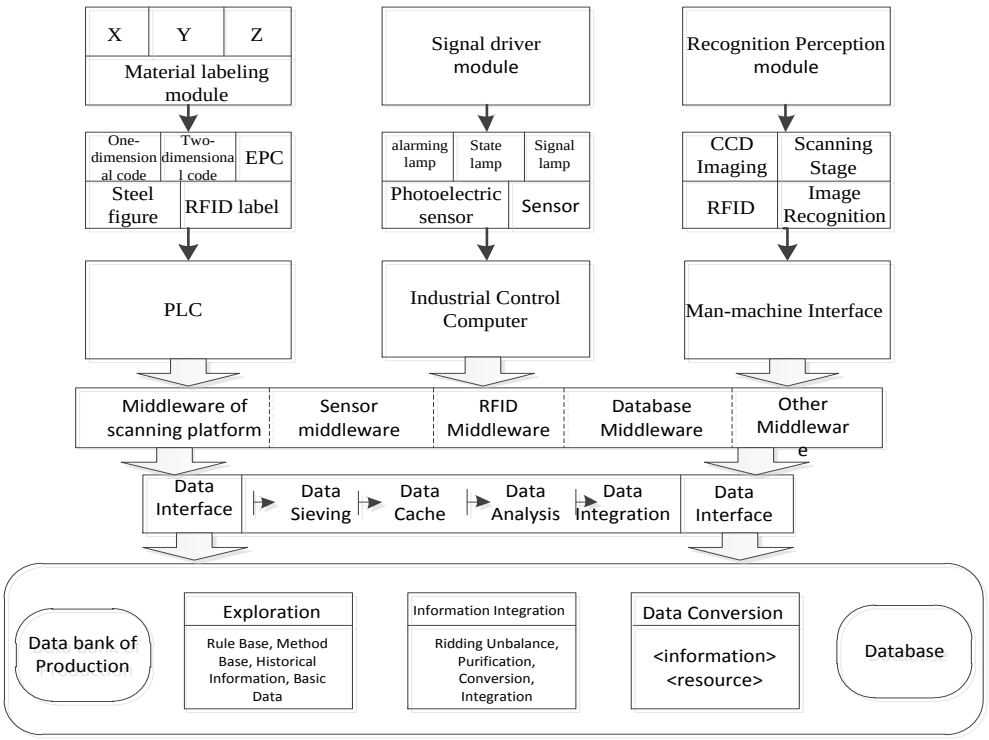

Fig.3 Material Deliver for Data Perception and Acquisition

3.2 Application for Shop Scheduling

Wireless sensor network technology has been widely applied to various intelligent assembly shop, compared to the real-time data acquisition difficulties in traditional manufacturing assembly shop, the sensor nodes collect data through WSN wireless network into a network of real-time dynamic assembly elements, the collection and management of the assembly data. Production process in the state cannot be timely feedback is one of the traditional assembly shop aspects of the problem, through the WSN technology to build the assembly process state feedback and to assess the state of implementation of intelligent assembly shop production status can be timely adjustment and visual information. In the assembly process of intelligent shop, there is a problem of data transmission and scheduling optimization in shop scheduling. Shop scheduling is not only limited to the scheduling of workshop staff, but also to the mobilization of mechanical assembly. Improving production efficiency is the most fundamental goal of intelligent manufacturing shop. The scheduling of intelligent shop includes scheduling of production factors such as staff, material logistics, manufacturing equipment, storehouse storage and so on. WSN is integrated into intelligent shop scheduling to realize the omnibearing monitoring of all production factors.

As shown in Fig. 4, the shop scheduling system based on wireless sensor networks is mainly mechanical equipment, product storage and staff for the workshop. The production schedule determines the mode of shop scheduling and shop scheduling with sensors and multimedia acquisition between all sorts of equipment and people, between people, equipment and equipment production collaboration data between data in order to reflect the production process of complex production collaboration. In practical production, each production link is closely linked, any link certain problems may affect the whole production line production, so they need to produce real-time monitoring a post status information, such as personnel, equipment and data, there is a problem play to the role of the emergency scheduling mechanism, control system optimization scheduling scheme, and control actuators to respond accordingly.

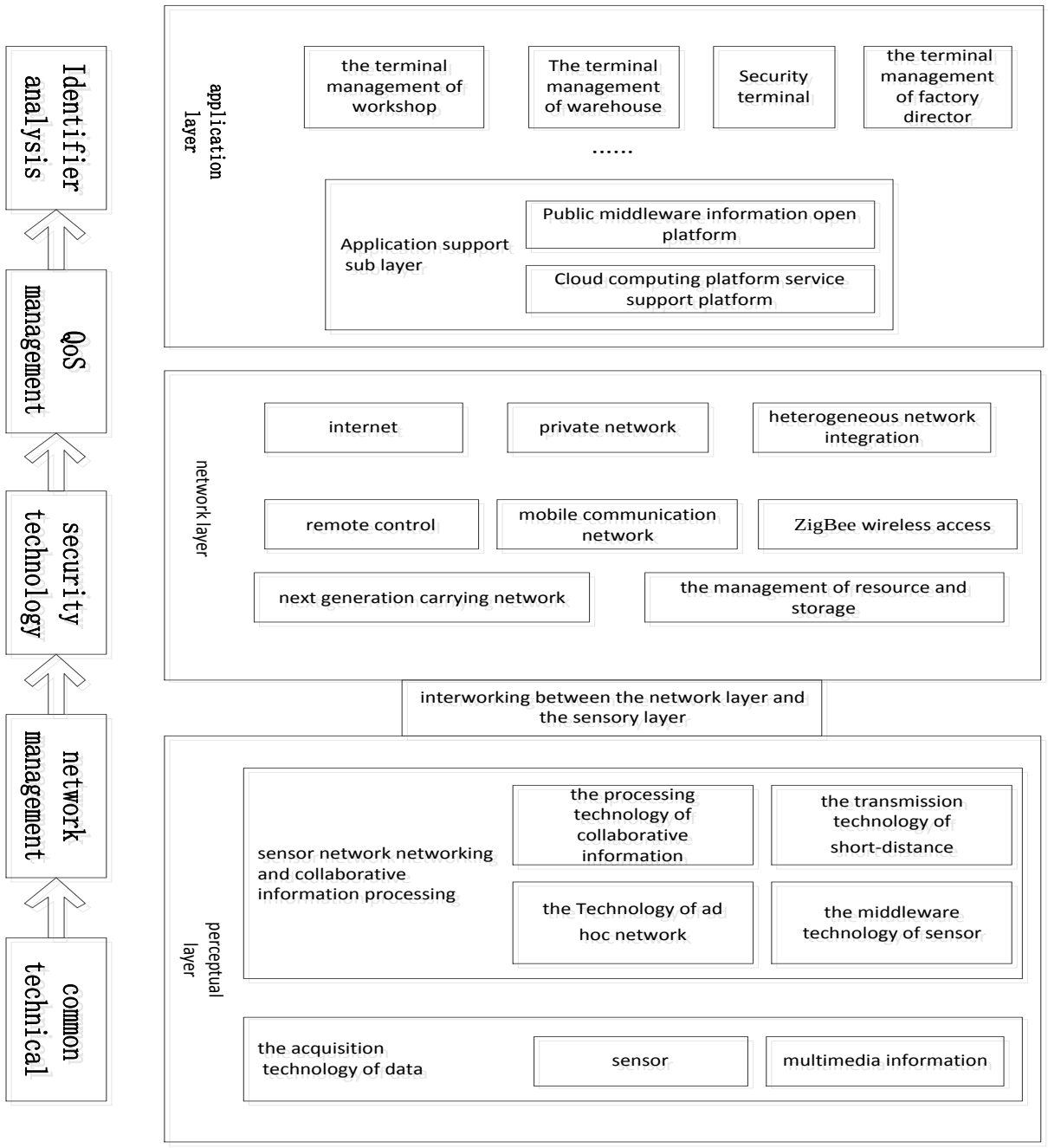

Fig. 4 Structure of Shop Scheduling Network

Han Jindong [30] combined with Zigbee and RFID to build intelligent shop scheduling sensor network system, using adaptive genetic algorithm to optimize data, to a large extent, to solve the problem of workshop personnel scheduling problems and reduce production efficiency. Zhang Kaiqi et al. [31] use the wireless transmission network technology to build intelligent sensing system. Combined with large data and cloud services, it solves the deviation from the job shop scheduling caused by the workshop uncertainty events, and ensured the normal production of the workshop and the timely delivery of the products. Xu Yuzhi et al. [32] for recognition to realize real-time data acquisition and processing parts, using radio frequency identification to build a wireless sensor network platform, the transmission of information data from the bottom of the workshop to the central information management system is realized.

3.3 Application of Environmental Monitoring in the Workshop

The production environment of the workshop relates to the safety of the production personnel, the health and safety of products and so on. How to effectively improve the workshop environment has

been the focus of attention. The introduction of workshop environment monitoring by wireless sensor network not only ensures the level of safety monitoring but also improves the process of workshop modernization. The characteristics of low energy consumption, wide range of node layout and low construction cost are all the basic conditions for wireless sensor networks, They are effective for data collecting in detection environment which is conducive to monitoring and early warning of workplace environment.

As shown in Fig. 5, the environmental monitoring of an intelligent assembly shop based on wireless sensor networks is divided into perception layer, network layer, and application layer。This type of system uses a comprehensive monitoring of the environment of the workshop, comprehensive analysis of collected data and adjustment of environmental quality through regulation and control methods. At the same time, these systems have established early warning mechanisms to prevent safety hazards and reduce the occurrence probability of production accidents. These systems can also be equipped with emergency response mechanisms to adjust the air flow and spatial gas exchange rates .such as fire and harmful gas leaks, etc.

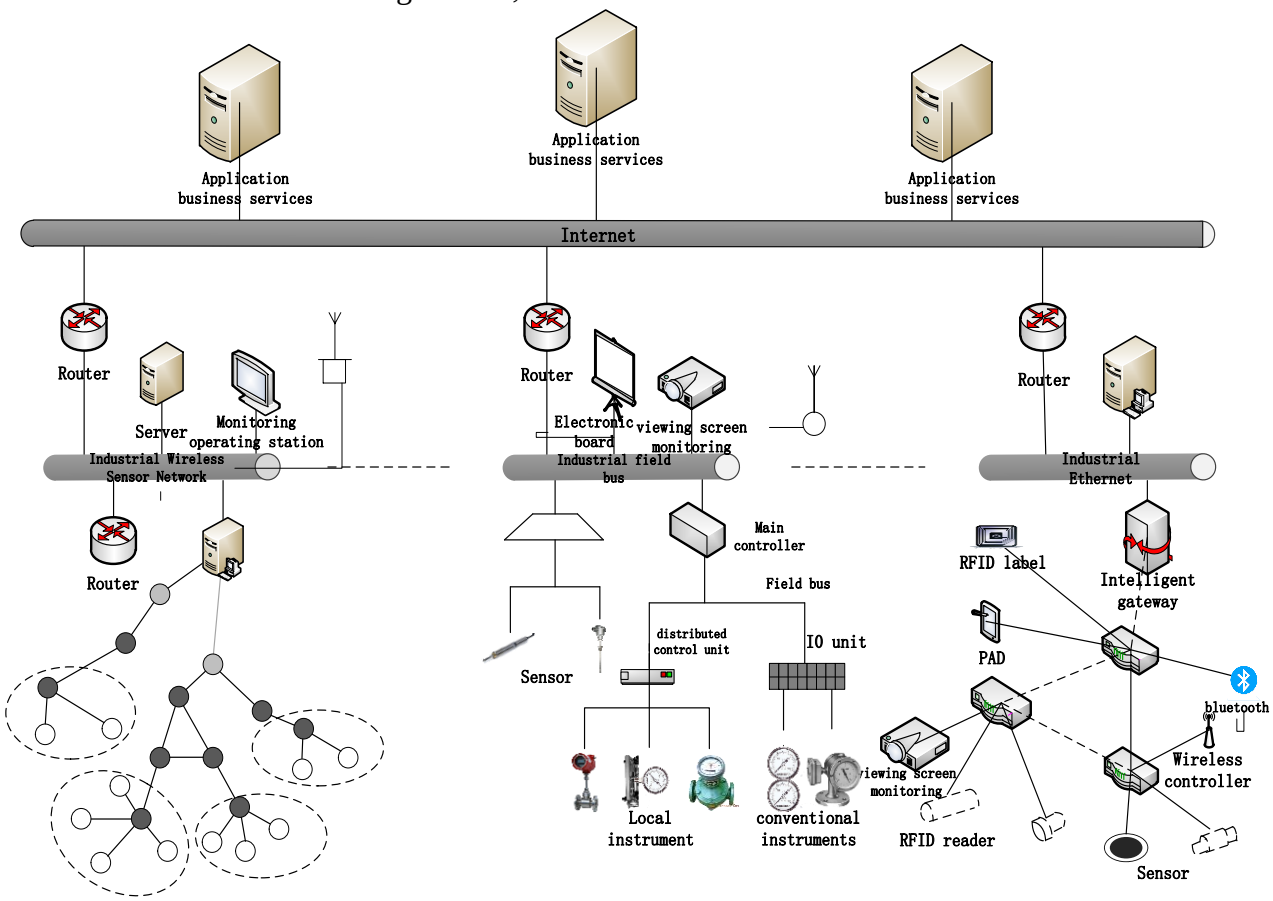

Fig.5 Multi Perception and Acquisition of Environmental Monitoring

Biao Meng [33] The literature proposed to apply the wireless sensor network to the smoke factory workshop to monitor the environmental indicators such as temperature, humidity and carbon dioxide concentration in the workshop. Zhanming Li et al.[34] used the ZigBee technology to construct a wireless monitoring network for the complex environmental monitoring of the petrochemical industry. The temperature, humidity, oxygen concentration, smoke concentration, carbon monoxide concentration, and methane concentration were tested in the workshop. Real-time monitoring system.

4. Problems existing in the current WSN for intelligent assembly shop

Although the wireless sensor network has been widely applied to intelligent assembly shop, its new technology and belong to the emerging science developed in recent years, there are still many urgent problems that need to be solved and many of the technology functions are still in the stage of research

and development. The main problem of wireless sensor network existing in intelligent workshop is the development of wireless sensor network itself. The main performances are as follows: First, some nodes in the network sometimes have failures that result in link failures and data transmission is fundamentally affected. Second, the network environment is open and unlimited, so network security is a very important issue. How to ensure the security and reliability of transmission data is still in the development stage. Third, the cost of deploying a single node is low, but when the wireless sensor network needs a large range of coverage, the number of sensor nodes required is huge and the problem of the entire system should also be considered. Fourth, because of the large numbers of nodes and their wide distribution, each node's energy source cannot be supplemented in time. Therefore, the lack of node energy may cause the link to fail and the network data collection is incomplete and inaccurate.

5. Conclusion

Wireless sensor network technology, which combines various high-tech technologies, is not only a new method for information acquisition and processing but also affects human production activities everywhere.At present, although the wireless sensor network is being used in the intelligent assembly shop, the scope of application is still too narrow。Wireless sensor networks in the production of intelligent assembly shop is a reflection of further intelligentization, modernization and automation of manufacturing production. Therefore, we should vigorously develop and research related technologies of wireless sensor networks to solve network node energy consumption, link failures, and node failures. And to ensure the reliability, robustness and stability of the network so as to better serve the tasks of the intelligent assembly shop.

Acknowledgements

National Natural Science Foundation of China (11705122), Artificial Intelligence Sichuan Key Laboratory Open Fund (2017RYJ01), Corrosion and Protection of Materials Sichuan Province Key Laboratory Open Fund (2017CL09), Talent introduction project of Sichuan University of Science and Engineering (2017RCL10)

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