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Design of the Monitoring System of Chemical Industry Production Based on Internet of Things

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The objective of the thesis is to study and discuss the design plan of the monitoring system of chemical industry production. The thesis introduces the key technology involved in the monitoring system of chemical industry production, and makes improvement through combining with the technical proposal of Internet of Things, and divides main function modules. The thesis builds the system with the commanding and monitoring functions, and makes improvement based on the practical work of chemical industry production.The chemical industry production under the functional module of Internet of Things can continuously guarantee the completeness of functions, which also provides technical support for the production in the future.

1. Introduction

The modernized chemical enterprises pay more and more attention to the safety of people and equipment, in addition to some precautionary measures for production technology, the monitoring system gradually becomes a powerful assistant management plan, the new technology emerged with the rapid development of information also changes traditional chemical industry production mode. The construction of chemical industry park is the product that the country coordinates and optimizes industrial resource and plans industry structure reasonably, and meanwhile, the industrial pollution is also the major factor and the source of environmental influence. Especially in chemical industry production, due to the special nature of the industry, it is very easy to have safety accidents during production process. Particularly, plenty of the dangerous chemicals are piled up in chemical enterprises, which exists a certain risk. Therefore, the thesis designs the monitoring system based on the technology of Internet of Things, which eliminates safety accidents that may appear in its infancy according to data mining and analysis, and provides professional and standardized technical support for safe production. And during the research process of the monitoring system, it needs not only to consider the design of system functions, but also to combine with practical conditions to analyze various factors of the costs and prevent the occurrence of major accidents. The monitoring system after completion will be an integrated remote-network information management platform that is convenient for upgrade, extension and management, can realize the overall control of the production process and meet the technical requirements of the modernized chemical enterprises for production.

2. Literature review

The concept of the Internet of things was first proposed by Professor KevinAsh-ton of the Massachusetts Institute of Technology (MIT) in the United States in 1991. Then, the Massachusetts Institute of Technology in the United States established "Auto-ID" and proposed that "all things can be interconnected through the network", and the basic meaning of the Internet of things was clarified: that is, through the radio frequency identification (RFID), infrared sensor, global positioning system, laser scanner, gas sensor and so on information sensing equipment, to connect any items with the Internet for information exchange and communication, so as to realize intelligent identification, positioning, tracking, monitoring and management. However, with the development of science and technology, such as the development of sensor technology, information processing technology, network communication technology and computer technology, and the continuous integration of various information technologies, Liu and others believed that the meaning of the

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Internet of things has changed greatly. According to the definition of the Internet of things school enterprise alliance on the Internet of things in China, at present, the combination of almost all technology with computer and Internet technology can realize the mutual communication between objects and can be incorporated into the category of the Internet of things (Liu et al., 2014). The development of the Internet of things is in the beginning stage, but it is becoming more and more important in the world. It is called the third wave of the world information industry after the computer and the Internet. Many countries in the world have made a lot of research and application in the Internet of things. The Auto-ID center of the United States is the leader of the research on the technology of the Internet of things. The main purpose of the laboratory done by Skowron is to reduce the cost of RFID tags and readers; and to design and establish a global infrastructure to effectively implement the Electronic Product Code (EPC) network (Skowron et al., 2016).

The Internet of things is widely used in many fields, such as intelligent transportation, environmental protection, agricultural environment monitoring, public safety, industrial monitoring, safe home, medical care, and so on. Zhang and others of Nanjing University of Aeronautics & Astronautics set up a monitoring platform based on the Internet of things for the noise monitoring at the airport (Zhang et al., 2014). The scholars of the Huazhong University of Science and Technology designed the remote monitoring system for the monitoring of the elevator status (Li et al., 2015). The researcher Zou of the Wuhan University of Technology built the remote monitoring system based on the Internet of things in the tunnel (Zou, 2016). The remote monitoring system can monitor vehicle speed, wind speed, vehicle information and so on. The Research Institute of Zhejiang University did a research on the intelligent production of agriculture. Fang and so on designed a hydroponic flower intelligent production system based on the Internet of things, which played an active role in production (Fang et al., 2016). For the safety production of coal mine, in the age of Internet of things, the personnel, machinery, equipment and infrastructure in the complex environment of the coal mine can be implemented in a more real-time and effective cooperative management and control through the Internet of things. Miao and Huo found that the mine Internet of things is to realize the visualization, digitalization and intelligence of the whole coal mine, digitize the comprehensive information of the production process, safety management and mine construction, and realize the comprehensive perception and dynamic cooperative control of the mine safety production process (Miao and Huo, 2015). Some scholars, Zhang and others thought that the important theory and key technology of the coal mine IOT system were the basis of remote control, emergency rescue and safety monitoring under the complex environment of coal mine. It was one of the important contents of the research of digital mine and underground unmanned mining (Zhang et al., 2015). In order to adapt to the widespread perception and mass information processing of the network of transmission and transformation equipment, Hu Zhiyuan proposed a communication network structure and implementation scheme suitable for the online monitoring and equipment asset management system of the power transmission and transformation equipment. The proposed flat mesh network structure supports the scattered and distributed processing of the collection points of the field information. In the network structure, the function entity of the aggregation layer is added to realize the effective control and management of the communication equipment and communication flow of the Internet of things. And the cable and wireless dual channel heterogeneous networking technology is used in the implementation scheme of the network to enhance the fault tolerance of the system. In order to improve the production efficiency of farmland grain crops, Zhang Jie and other scholars designed and constructed a remote monitoring system of agricultural environment based on the Internet of things, and briefly introduced the overall structure of the system and the design of the software and hardware. The system uses sensors to collect environmental information such as high temperature and humidity, solar radiation, rainfall and soil temperature and humidity. The data are processed and analyzed through the data service center, and the remote monitoring of agricultural environmental information is completed with the GPRS network. The experiment proves that the system can realize the remote monitoring function of farmland environment and production site, and is conducive to improving the level of agricultural fine management. The application of Internet of things in chemical enterprises requires the establishment of a comprehensive information management platform for enterprise production. The data collected automatically by sensors, RFID tags, cameras, and other sensing devices are transmitted to the platform through the network. The mechanical operation, gas, dust and other environmental parameters in each workshop, the daily consumption of material and material, the rectification of the hidden trouble in the field, the transportation of the products, and all kinds of daily tables are displayed on the monitor screen dynamically and in real time. At the same time, through mobile communication network, different data information is pushed to the handheld terminal of the relevant personnel. In addition, the use of Internet of things technology can also realize the functions of automatic statistics of raw material consumption, energy consumption self-energy detection, production equipment status detection and fault call, personnel identification and attendance management, so as to make the production process of chemical enterprises truly automatic and intelligent. In short, the monitoring application of the Internet of things has been around people, and has changed people's habits without knowing it.

To sum up, the applications of these applications in various fields have improved the automation level and management efficiency of operation management to a certain extent. However, there are limited functions of these systems, and the research on monitoring systems related to chemical enterprises is not much. Therefore, based on the above research situation, in view of the problem, this paper introduces a kind of chemical production monitoring and warning and emergency response system based on the Internet of things technology. In the chemical enterprise, a series of functions Internet of things system, such as equipment state monitoring, data interconnection and intercommunication and automatic analysis, accident rapid warning and emergency intelligent decision making are set up in chemical enterprises. The new system uses the technology of Internet of things to improve the automation management level of the enterprise, thus making the whole chemical enterprise become a comprehensive network management system which integrates security, production, monitoring and early warning. The application of Internet of things technology makes enterprise production safety higher, and enterprise management is more time-saving, labor-saving and intelligent.

3. Methods

3.1 Technical proposal

In Internet of Things, different equipment and intelligent objects are included in the extendable Internet and becomes addressable and well-determined. During the process the innovation of information and communication technology and economic development, one of key points has been remarkably transferred to the technology related to Internet of Things, which is widely considered as one of the most important infrastructures and one of the promotion and commitment strategies in the future. Its main purpose is to realize the interaction and integration of physical world and network space. The basic framework is as shown in Figure 1 as follows:

Table 1: Data conversation

Steps	Phase	Data type
1	The data source	Original data
2	Data collection and registration	Unstructured data
3	The data processing	Structured data
4	The data analysis	Processed data
5	Data transfer	Visual data
6	Consumers	Information

Such a framework shall support the whole life cycle of data of Internet of Things, and explore the function that is able to realize large-scale data storage or preservation, aggregation and output in a long time. It is important that these infrastructures must ensure the security of data (completeness, confidentiality, availability and accountability system) and the protection of data ownership. And meanwhile, the big data processing needs powerful computing capability; there shall be executable data set strategies for event handling or in compliance with other demands on the trusted system.

3.2 System design plan

The plan must follow the regional safety monitoring and emergency integration management idea and be close to practical application demand of small and medium-size chemical industry parks, in order to realize the information service platform integrated with the enterprise environment monitoring and early warning and the emergency commanding management, comprehensively utilize modern and mainstream technology of Internet of Things, establish the environmental monitoring system for chemical industry parks, and then strengthen the dynamic supervising and managing capability of chemical industry parks, avoid the deficiencies of traditional manpower prevention and the delayed warning condition caused thereby, and improve the early warning and emergency rescue response efficiency for the accidents in the chemical industry parks. The specific flow process is as shown in Figure 1.

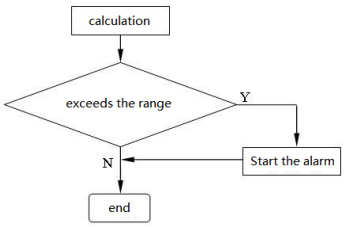

Figure 1: Flow process of alarm system

The environmental monitoring system designed and established in the system strengthens the regulation in advance and follow-up tracking management functions of the safety, health and environment protection of the enterprises, and combines the safety, environment and health management together, and makes the safety and environmental protection work of enterprises more standardized and scientific, carries out the daily activities, including classification, supervision for source of danger and safety inspection, and timely masters and implements the targeted guidance. This system is designed to conform to laws and regulations and supervision requirements on health, safety and environment, and to provide follow-up guarantee for the general policy and the implementation of specific objectives of enterprises, and also uses network storage array to save the production data and historical data. As the network storage is adopted with the mode of disk array, its security and reliability are higher than the storage method of common server, reduced the influence caused by hardware fault. When the master server of real-time database or the server of relational database breaks down, the configuration information and historical data will not be lost. The logical structure is as shown in Figure 2 as follows:

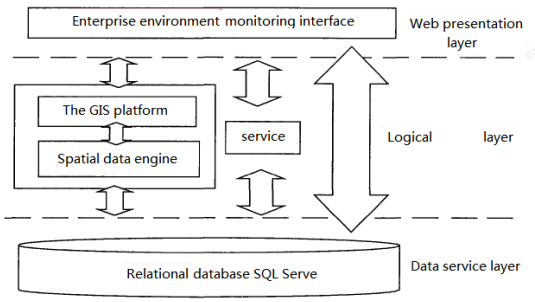

Figure 2: The logical structure of the data integration layer

The main function of the transmission layer is to realize data communication between the sensing layer and the application layer. The data transmission layer of the monitoring and emergency system of the chemical industrial park is composed of wired and wireless networks. By making full use of the advantages of wired and wireless transmission, the two are combined to carry out reliable transmission of environmental monitoring data collected by various sensors and monitor terminals. In order to ensure the stability, reliability and flexibility of the communication and transmission network in the large-scale monitoring and monitoring system of the chemical industrial park at the present stage, it is suitable to adopt the strategy of wired transmission and supplemented by wireless transmission. With the development of wireless communication technology, the wireless communication technology is expected to be used in the chemical industry park to replace the partial transmission task of the wired communication relying on the fieldbus and the optical fiber network. The wired main communication network composed of fieldbus and optical fiber can realize long distance data transmission from field monitoring to remote monitoring. Due to the large number of nodes, mobility and extensibility of outdoor wireless sensor monitoring system, the wireless sensor network is chosen to realize data transmission. The system has two subsystems: the integrated environmental database management subsystem and the emergency command subsystem. The environment integrated database management subsystem includes hazard management, hidden trouble management, accident and incident management. The database design of the system includes two types of databases: geospatial database and safety production information database. They are shown in Figure 3 and Figure 4 respectively.

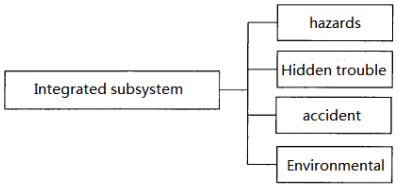

Figure 3: Environmental integrated management subsystem

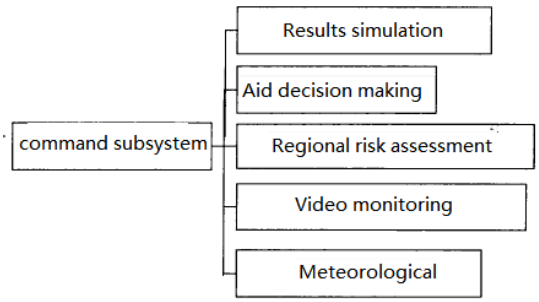

Figure 4: Emergency command subsystem

4. Results and discussion

The database of emergency system is mainly composed of the spatial database, the safety production management database and the emergency rescue resource information database. In the design of the database of the safety production business management, the Oracle relational database is used to access the data in the basic attribute database of the hazard source, including the real-time monitoring data of environmental risk sources, risk sources and hazard sources, basic information of plant areas, and basic information of risk materials in each plant area. Management information database includes user rights data, user basic information data and other information. The specific architecture is shown in Figure 5.

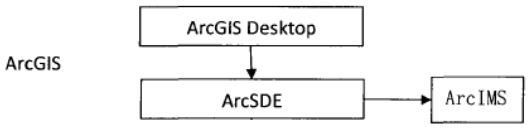

Figure 5: Space and data warehouse system technology frame

On the basis of economic economy, it is necessary to build the infrastructure according to the existing resources, purchase and deploy missing parts to reduce cost and repeat waste. In the investigation, it is found that the enterprise has built DCS (decentralized control system) system, part of the video monitoring system and the whole-plant-covered network system. However, it lacks the dangerous chemicals SIS system (Safety interlocking System), the various sensors and air pollution factor detector for monitoring the environment. Due to the great impact of the lack of part of the facilities on the realization of the functions of the environmental monitoring emergency system, it is recommended to purchase the relevant components and deploy and implement the specific environment to be detected in order to get the real-time data and the surrounding environment of the risk source, and transmit the monitoring data to the enterprise HSE server so as to realize the real-time monitoring and early warning of risk sources.

Real-time data transmission must ensure the security of transmission information. In this system, data transmission is considered to carry out on the basis of the original network system. Under the premise of security, the virtual private network (VPN) is used to establish a trusted security data connection in the network between the various parts of the factory. Through the network security technology such as VPN tunnel technology architecture and encryption technology, it must ensure that data transmission is not stolen.

Even if the content of data packet transmission cannot be read after interception, it must ensure the security of data transmission. A large number of video data transmissions will take up a lot of network transmission resources, and the message subscription mode is used, so video transmission and video display will be carried out when there is a demand.

With the idea of modularization and structured design, the architecture of ASP.NET is used to structure the whole system. The system adopts the hierarchical structure, and transmits and processes data according to UI presentation layer > BLL layer > DAL layer > MODEL layer. The data access layer (DAL) is used to operate the database. In order to reduce the workload, we can use OracleHelper to add, delete, revise and review the database. In this way, UI presentation layer is only responsible for ASP page representation and it is not used to operate the database. The system code is layered according to the process of request processing, so that the division of labor can be clear and the modification will be very easy. Furthermore, it can improve the use of code and reduce the coupling.

For the security of the whole system, the login interface is designed. When entering the system, the operator needs to verify the identity information and enter user name and password to verify it. In order to ensure the security of the system, the login password is set up, and user permissions are designed. The access to different pages by different roles implements the setting of different functional permissions. The system main page includes: The system's functional menu, hidden information, and related accident information are displayed and processed to support a variety of data types, take advantage of the existing things in the environment, supports NoSQL and other new forms of accessing data to overcome low latency, provide cheap storage, and carry out cloud deployment and integration.

5. Conclusions

Safety and environmental protection are very important work contents for chemical production enterprises, so it is necessary to establish and perfect scientific responsibility system for production safety and environmental protection responsibility. In this paper, a comprehensive monitoring and management system is built for the whole process of chemical production, and it aims to improve the security supervision ability, predict the safety accidents and realize full coverage of the functions. The overall supervision system based on the environmental comprehensive management system and the emergency command system is constructed, including the hidden danger processing, the risk source discrimination, the auxiliary decision-making module, etc. Moreover, the wireless sensor network is designed to extend the service cycle in combination with the actual environment of the enterprise. In the data design, in addition to designing the traditional relational database, the spatial database is designed in order to make the environmental monitoring emergency information in the chemical park can be displayed on the electronic map intuitively. In addition, there are early warning plans for emergencies in the emergency system, and this provides an important theoretical basis for decision-making. With China's further emphasis on chemical production, the system will continue to be perfected and optimized, and its overall function will be further improved.

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