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Design and Implementation of Computer Data Acquisition System for Petrochemical Equipment based on the Reactor Multi-thread Model

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At present, the computer data acquisition system has been adopted in petrochemical industry. Based on the research theory of equipment data acquisition of petrochemical enterprises, and the Reactor multi-thread model, the computer data acquisition system of petrochemical equipment, which is composed of "FPGA", "ADC", "DDRII SDRAM" is designed. The Visual C++ software is used in Win7 system to simulate the petrochemical equipment system. The experimental results show that the newly designed computer data acquisition system for petrochemical equipment has good expansibility and system integration, and the system has a positive effect on improving the data collection of petrochemical equipment and enhancing the safety and stability of the whole petrochemical equipment operation. The monitoring range is enlarged and the speed of fault diagnosis and analysis is also improved. Therefore, the computer data acquisition system of petrochemical equipment based on Reactor multi-thread model can provide an operation template for more petrochemical equipment enterprises.

1. Introduction

1.1 literature review

The development and utilization of computer data acquisition system has promoted the reform and innovation of data collection system in the entire petrochemical industry (Yu, 2017; Zhao and Wu, 2017; Yu, 2018). In the field of petrochemical industry, the computer technology data acquisition system has been adopted in many aspects, such as product production, scientific research, and equipment information, in order to reduce the labor cost of the enterprise (Zhao et al., 2005). The core of the computer data acquisition system for petrochemical equipment is the number of petrochemical equipment.

Based on the Reactor multi-thread model, the main principle of the computer data acquisition is that all the parameters of the equipment include pressure, temperature, and speed changes are changed through the sensor. Based on these information, the data analysis results collected are then entered into the computer data acquisition system (Yu, 2014). The Reactor multi-thread model is to isolate the IO operation fromnon IO operation in the Handler, which is mainly divided into IO thread and worker thread.

The construction of Reactor multi-thread model is based on the reuse of non-blocking IO, IO and the Thread Pool so that the client's request will be connected directly to the thread pool to make the request sent by the client be received, thus ensuring the smooth running of the computer data acquisition system. The speed of data acquisition is more than 1000 points /s, therefore, the speed data acquisition is largely improved (Wu et al., 2014).

At the same time, the Reactor multi-thread model has a special NIO thread -Acceptor thread to listen to the server only, and accept the client's TCP connection request, and thus the computer data acquisition system can quickly analyze the real-time operation of the petrochemical equipment. It involves analyses of the equipment safety, the cause of the operation fault, solutions and the optimization of measurement and control. Therefore, it improves the safety and stability of petrochemical equipment operation (Pan, 2017).

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In a word, based on the Reactor model, the application of the computer data acquisition system in the petrochemical equipment improves the speed of the data acquisition system, the wide range of the system detection, the diversification of the measurement methods and the high efficiency of the data acquisition (Chen, 2014). Therefore, based on the Reactor model, the computer data acquisition system has broad application prospects in data acquisition of petrochemical equipment.

1.2 Purpose of the Study

With the rapid development of economic informationization, the petrochemical industry, as an important part of the national economy, has been widely concerned by the society. However, the development and application of the computer data acquisition system for petrochemical equipment lags behind, to a certain extent, hindering the development process of the petrochemical industry (Yang and Yang, 2013).

The process of petrochemical equipment production often has a lot of hidden dangers. It is one of the main factors to reduce the occurrence of petrochemical accidents by collecting, monitoring and analyzing the related data in real time. At present, the traditional data acquisition and information system adopted by petrochemical enterprises is imperfect in speed, efficiency and applicability.

On this basis, based on the Reactor model, how to collect the data parameters of petrochemical equipment by computer acquisition system, and to ensure the integrity and authenticity of information data, effectively improve the speed and efficiency of information data entry, extraction and analysis of chemical equipment are questions put forward in this paper. Based on these, the main purpose of this paper is to do research on the development and application computer data collection system.

2. Characteristics and Problems of the Data Acquisition of Petrochemical Enterprises

Computer data collection, also known as data collection, is widely used in the fields of medicine, energy, finance and other fields. Its measurement methods include non-contact and contact type, involving various components to ensure the accuracy of data acquisition (Wang et al.,2015).

At present, due to the high risk of petrochemical industry, many petrochemical enterprises adopt automation technology, fieldbus technology and distributed control system to realize the collection and storage of factory level production data, in order to reduce the risk of production (Pang, 2016). Therefore, the computer data acquisition system has begun to be applied in petrochemical enterprises.

In the production process, the external physical quantities such as pressure, temperature, humidity and water level of the production site are received and transformed into electrical signals through the computer data acquisition device, and the data are transferred to the data collector for processing, the flow chart of its data processing is shown in Figure 1. The data sampling method generally collects the same data information repeatedly every other sampling period (Liu and Chen, 2012). This new way can effectively guarantee the effectiveness of equipment data acquisition.

However, in the petrochemical enterprises, the automatic control system of each production site is in a state of independent operation (Peng et al., 2015). For some important production processes, functions including data collection, storage and sharing have not been realized (Li et al., 2014).

The whole production system lacks a unified management platform, and the production managers find it difficult to monitor the whole production process in real-time (Gao et al, 2015). In the production process, a lot of important data of oil chemical enterprises are not centralized stored or collected, which can not provide data analysis and support for management and decision-making (Gao et al., 2104). In addition, there is a lack of unified production management and scheduling in petrochemical enterprises (Luo et al., 2016).

The production managers can not understand the operation state of the whole production site comprehensively and timely (Wang, 2015). It is difficult to manage the production site as a whole, which bring many difficulties to the overall decision and management of the enterprise.

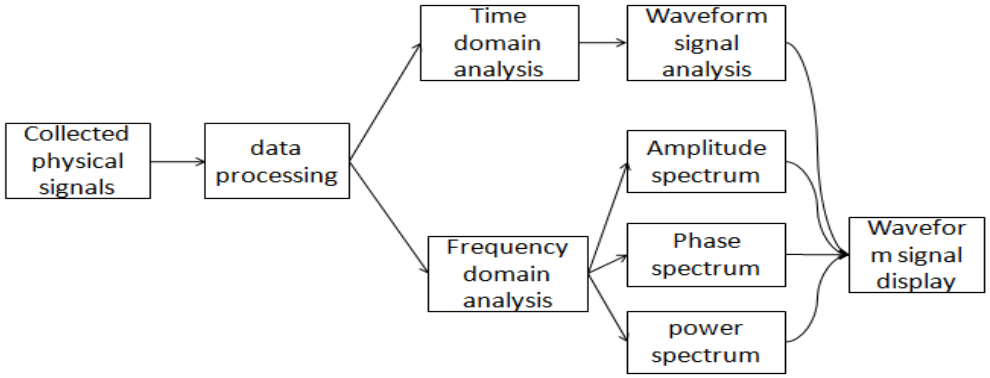

Figure 1: Flow chart of data processing

3. Design of Computer Data Acquisition System for Petrochemical Equipment based on Reactor Multi-thread model.

In the process of computer data acquisition in petrochemical equipment, a large number of process and non process information are needed, whether in production process, or in the process of simulation, optimizationor management. At the same time, in order to avoid half packet problem when NIO programming sends TCP/IP messages, we need to optimize the Reactor model. Under these conditions, the Reactor multi-thread model is used to design a computer data acquisition system for petrochemical equipment, which can improve the accuracy of data acquisition. In addition, it connects DCS with other petrochemical production equipment, and the detection system of the oil tank area, monitoring them as a while and uploading the collected data to the database, and thus completes the data collection process.

3.1 Design of data system for petrochemical equipment

According to the actual production needs of petrochemical enterprises, combined with the network access, the reality of production equipment, and the use of client users, the Reactor multi-thread model is used to design the petroleum chemical collection system. Among them, the computer data acquisition system of petrochemical equipment adopts the "FPGA+DDRII SDRAM+PCI9054" hardware architecture, and the system framework is shown in Figure 2.

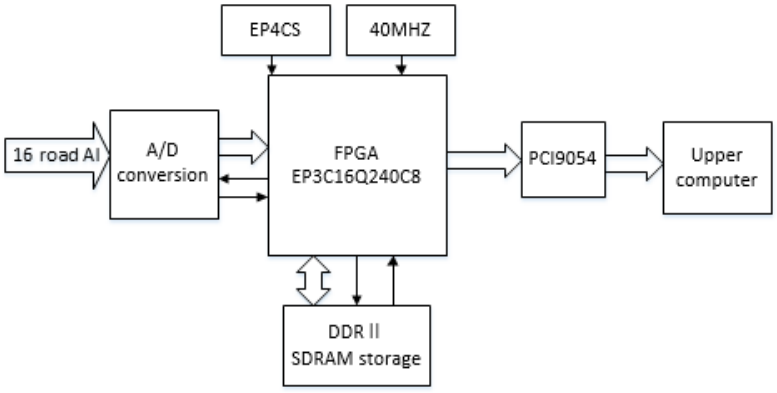

Figure 2: High speed data acquisition system

In Figure 2, the functional modules are divided into "FPGA", "ADC" and "DDRII SDRAM" modules. In order to achieve data acquisition and transmission, "FPGA" module is used to pass the data and the process is shown as follows:

1.16AI-Input analog signal-AD converter-FP-GA converter-DD3 SDRAM-FIFO-PC19054 Converter-PCI interface-upper computer

2. 16AI-Input dignal signal-FPGA interface-FP-DD2 SDRAM-FIFO-PC19054 interface-PCI interface-upper computer

In this process, the data acquisition system of petrochemical equipment is connected with the upper computer through the PCI bus. The upper computer transfers the data acquisition command to the FPGA module, initializes the module and resets the DDRII SDRAM, and further converts the 16 channel digital channel of the A/D. At the same time, the analog signals generated by the operation of petrochemical equipment are exported to the A/D converter through DG408 chip for digital conversion. The digital signals converted by petrochemical equipment are entered through Vin shorts and entered into the buffer FIFO so that the data run by the petrochemical equipment are connected to the I/O of the FPGA. At this point, the hardware data acquisition tool of petrochemical equipment converts the local bus to PCI bus and improves the data transferring rate to 325MB/S. By this way, the data collected by the hardware device of the petrochemical equipment can be transmitted to the PC port at high speed.

3.2 system simulation experiment

This experiment uses two servers of petrochemical database and relational database to connect the PC end of 5 petrochemical equipment, and provides 4 OPC interface systems, such as distribution, air separation, desalting water and boiler system, and designs the Modbus interface system such as air pressure, heat exchange station, circulating water system and so on. After setting up the petrochemical equipment, the software and hardware system of this design is connected well. The acquisition tool transfers the petrochemical equipment data to the physical layer through the PCI bus, and stores it in the DDRII SDRAM, and calculates the data of the collected petrochemical equipment. Finally, the Reactor multi-thread model is used to verify whether the data transmission framework can improve data transmission efficiency.

Through the above description, we design the overall operation process, as shown in Figure 3. In the data acquisition system of petrochemical equipment, it involves the static equipment of the tower equipment, heat exchanger, reactor, tank and all kinds of shell equipment, as well as the moving equipment of the conveying medium. In the flow chart, the petrochemical enterprises operate all kinds of equipment in combination with large data, and collect and analyze the activities data in the process of energy production. In this process, data acquisition equipment is needed to collect and collate the related data of the petrochemical industry, such as temperature, speed, pressure and so on, and send it to the data storage.

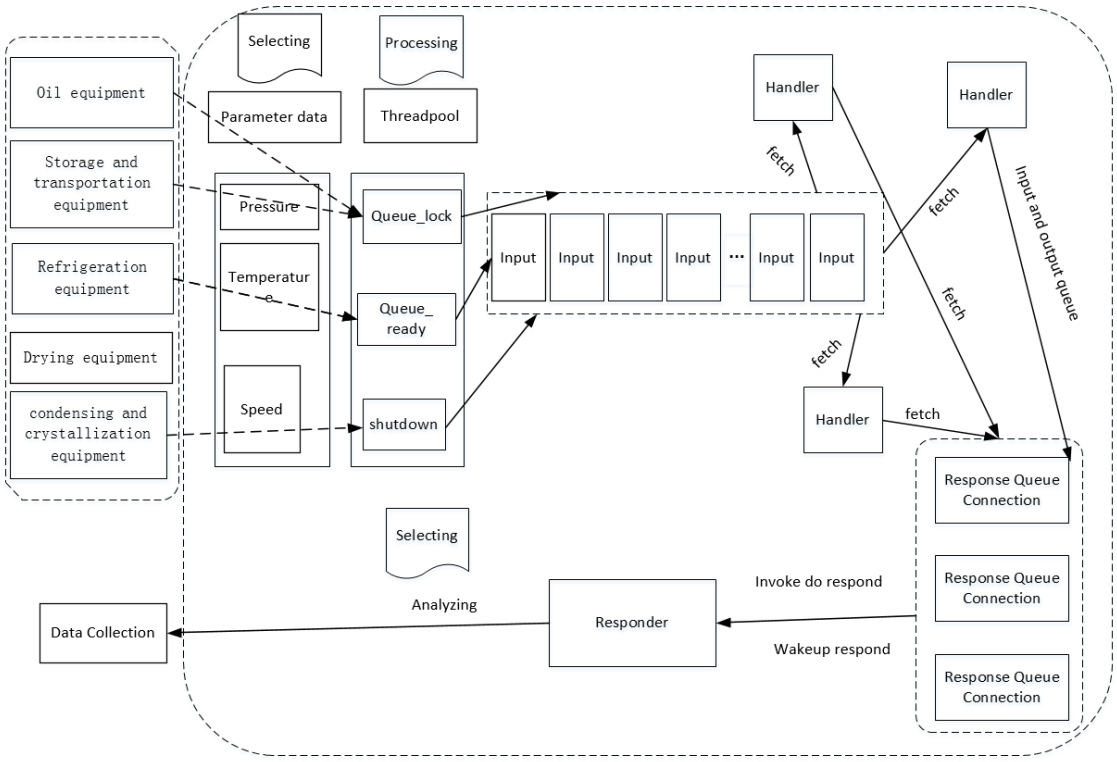

Figure 3: Operation Process of Computer Data Acquisition System for Petrochemical Equipment

At this time, data collected from petrochemical equipment are calculated. It is assumed that data nodes of petrochemical equipment can use loans to optimize data transmission rate, optimize dynamic bandwidth and

allocate resources rationally. By collecting multiple data sample values, the following formula is designed as follows.α is a ratio factor: $w_i \leftarrow \alpha w_i + (1-\alpha)w_i, 0 < \alpha < 1$. When the resource point receives the command of data acquisition from petrochemical equipment, the network delay RTT value will be set according to the algorithm. It is based on the Reactor multi-thread model to display data dynamic curves.
Similarly, by collecting multiple sample values, the RTTi formula is calculated as follows: β is a ratio factor,$RTT_i \leftarrow \beta RTT_i + (1-\beta)RTT_i, 0 < \beta < 1$. According to the optimal data node algorithm, the optimal data of petrochemical data downloading can be generated. Usually petrochemical enterprises will first download the necessary resources from the server. If the server lacks this data, it will download the resource from the optimal network node and select the strategy to make the download speed of the petrochemical data resource optimal. After integrating the petrochemical data, the data can be entered into a new system, and the results of the data can be tested to reflect the real industrial operation data of the petrochemical enterprises. At this point, we need to carry out simulation experiments on the system, and the details are as follows.

3.3 Analysis of Experimental Results

The experimental results show that when the data node is less than 5, the data transmission rate of the petrochemical equipment is small when the same data is downloaded by different transmission modes. With the increasing number of data nodes, the download rate is 756kb/s and the upload rate is 584kb/s. At the same time, the download speed of I/O blocking flow in C/S mode is reduced. Based on the Reactor multi-thread model, the transmission speed of petrochemical equipment data transmission system is higher than that of P2P. Therefore, under the Reactor multi -thread model, the new computer data acquisition system of petrochemical equipment has good expansibility and system integration, which provides an efficient system for the data collection of petrochemical enterprises, and can effectively improve the authenticity of chemical data.
At the same time, due to the increased monitoring range of new system petrochemical equipment, it can improve the speed of equipment fault diagnosis and analysis. This system design has effectively solved the data acquisition of petrochemical enterprises and realized the demand of information construction. Through the implementation of the clear range and accurate functional positioning of the data acquisition system, we can constantly improve the technology maturity of the current petrochemical enterprises, and further promote the economic benefits of petrochemical enterprises. The computer data acquisition system can take advantage of the function information technology, promote the integration of technology and information technology, and thus set standard for data inspection.

4. Conclusion

To sum up, Reactor multi-thread model can make full use of multi-core CPU, and improve the performance of I/O, which has strong application advantages in designing computer data acquisition system of petrochemical equipment. Under this model, the hardware architecture of "FPGA+DDRII SDRAM+PCI9054" of petrochemical industry is established through functional module segmentation method, and the software application system is set up on the basis of win7 system, so as to build the computer data acquisition system for petrochemical equipment. At the same time, the petrochemical equipment and the hardware and software of the system are built. The data transmission of petrochemical equipment is realized through the PCI bus acquisition tool, and the data is then stored in the DDRII SDRAM. Then, we simulate the new design system with the help of Reactor multi-thread model to verify whether the data transmission framework can improve the efficiency of data transmission. The final experiment data show that the Reactor multi-thread model is used to design the computer data acquisition system of petrochemical equipment. It can give full play to the advantages of its inheritance and extensibility, and can provide high quality data for the data collection of petrochemical enterprises. On the basis of providing more real petrochemical data, the system can enlarge the detection range of petrochemical equipment and improve the speed of equipment fault diagnosis. The advantages of this application can provide reference samples for more petrochemical enterprises or other fields.

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