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Design of Environmental Monitoring System Based on Virtual Instrument

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Abstract: With the development of world economy, the rapid expansion of industry, government and entrepreneurs are spent on equipment invest more and more, the huge cost, greatly limits the enterprise's capital. Easy and virtual instrument technology with its development, the development of low cost, short development cycle and other obvious advantages, gradually emerging in the field of industrial measurement and control. The system includes hardware and software parts. On the hardware side, using the data acquisition card PCI-6251, the monitoring system collect output signal from the temperature and humidity sensor AMT2001 and gas CDM4161 CO2 convert them into digital signals. On the software side, in order to achieve the function of real-time collection, handling, recording, and storing for temperature, humidity and concentration of CO2. This paper uses the front panel and block diagram programming by LabVTEW8.6 software. With the shared variable technology through the Internet, this paper achieves the sharing and publishing of data and complete remote monitoring system. Debugging and experiments to prove: the monitoring system can meet the requirements of environmental monitoring. With good scalability and practical advantages, the system proves a useful exploration of the practical application of virtual instrument technology.

Keywords: Environmental Monitoring, LabVIEW, Remote Monitoring, Virtual Instrument

I. INTRODUCTION

The development of domestic environmental monitoring technology is relatively slow, and many advanced monitoring equipment and monitoring tools are relatively backward. With the development of science and technology and the improvement of environmental awareness in China, great progress has been made in environmental monitoring technology, and the gap with developed countries is gradually narrowing[1][2]. After 30 years of development, China has initially formed an environmental monitoring technology system, which is dominated by physical measurement and supplemented by ecological monitoring and biological monitoring. The technical level of environmental monitoring in China is developing in the direction of internationalization and modernization. High and new technologies such as satellite data transmission, satellite remote sensing analysis, geographic information system, remote spectrum and so on have been used in the field of environmental monitoring. The State Environmental Protection Bureau of our country has studied the supervision information system for the management of monitoring information. The automatic on-line environmental monitoring system proposed by Wang Shaohua has combined Internet, wireless transmission, satellite communication, GSM network and other transmission modes, combined with PC and GIS technology, to establish an online monitoring network. Zhang Bin designed a set of environmental index detection expert system based on high precision data acquisition, combined with PSTN network data transmission and database management. The system realizes the data collection, display and remote data transmission of the environmental index, and collates and analyzes the environmental index, and finally puts forward the prediction by using the expert system[3].

At present, the domestic environmental monitoring system is far from the international standard. Due to the emergence of various emerging technologies, domestic enterprises are in the stage of technological innovation, the market demand for environmental monitoring is increasing day by day, and the requirements for environmental monitoring technology are getting higher and higher[4]. Environmental monitoring information technology is one of the general trends in the development of environmental monitoring. It is a new marginal application subject that integrates environmental, electronic science and information science[5]. It is the driving force for the development and development of environmental monitoring education and management, environmental monitoring system development and development. Environmental monitoring is developing towards the trend of science and technology, networking and informatization[6].

In recent years, the development of environmental monitoring system based on virtual instrument platform has become a hot spot in the field of environmental monitoring at home and abroad. Shuhaimi et al developed an environmental detection system for data acquisition, display and transmission of environmental parameters such as air pressure, temperature and humidity for remote telemetry stations by using virtual instrument development software LABVIEW,. Wang Lei et al studied and developed a gas detection system based on virtual instrument to realize the function of monitoring volatile gas. F.Torm et al completed a network water quality monitoring system with water temperature, pH, dissolved oxygen and other data using LABVIEW.

Li Xin et al realized the monitoring of air pollution index based on LABVIEW, and monitored CO, CO2, SO2 and temperature in real time. Xu Meng designed a system based on LABVIEW to monitor the gas composition in cockpit, which realized the real-time display of concentration waveform and concentration worth displaying in real time. According to the characteristics of oil fume detection, Shen Xiaohong and others developed a real-time monitoring system based on the design idea of virtual instrument system. It can be seen from the above that the use of virtual instrument technology in environmental monitoring at home and abroad has developed from one parameter to multiple parameter detection, from field detection to remote real-time monitoring.

II. DESIGN SCHEME OF VIRTUAL MONITORING INSTRUMENT

There are usually two ways to design a virtual monitoring instrument:

(1) Design of hardware and software resources based on upper computer

Developers are required to master the basic programming software, and have a certain design ability, fully understand the hardware, the corresponding software and hardware part of the program design.

(2) Design of virtual instrument development platform based on specialization

Only need to master the professional development software developed by the commercial software company, choose the supporting hardware equipment to design.

As visual development tools, VB, VC and DELPHI have rich API interface functions and strong practicability. They are a good platform for designing virtual instruments, but developers must be proficient in the corresponding programming language and have good programming skills, and the development time is long and the work efficiency is not high. The LabVIEW virtual instrument development platform provided by the National instrument Company of the United States is a graphical programming language, which provides a wealth of graphic control. Developers do not need to write a large number of programs to develop a variety of instrument systems quickly. In this paper, a remote environment detection system based on LabVIEW is designed by using the second scheme. The virtual monitoring instrument participates the computer in the test process, maximizes the use of the software and hardware resources of the computer, makes the hardware part of the traditional instrument software, improves the flexibility of the system, and reduces the investment cost to ensure the reliability of the system.

A. Design Scheme of Environmental Monitoring System

The structure diagram of the virtual instrument testing system based on LabVIEW development platform of PC-DAQ is shown in figure 3.1. The workflow of the test system is as follows:

First, the measured signal is changed into an electrical signal via a sensor.

Second, the output electrical signal is processed by a series of conditioning circuits and output in the form of standard voltage.

Thirdly, the collected voltage signal is converted into digital signal by A / D data acquisition card.

Fourth, the driver of the data acquisition card is connected to the upper computer by calling the driver of the data acquisition card.

Fifth, in LabVIEW, through the program front panel and program block diagram programming, write the instrument function algorithm and flow chart.

The system adopts the structure of "sensor + conditioning circuit + data acquisition card + computer".

B. Design process of environmental monitoring system

We need to design a virtual instrument testing system through the overall design scheme, system software, system hardware, system integration and debugging process of the test requirement analysis system.

① First of all, it is necessary to analyze the form, range and quantity of the measured parameters, the performance index and functional requirements of the system. The environmental monitoring system is to collect the four environmental parameters of temperature, humidity, CO2 concentration and natural gas concentration in real time, and to realize the environmental monitoring.

②According to the actual test requirements, the corresponding test methods are selected to determine the structure of the system. The environmental monitoring system designed in this paper is based on virtual instrument technology. The environmental parameter sensor and NI data acquisition card are composed of signal acquisition system. The data processing and display are realized by programming on LabVIEW virtual instrument development platform. Finally, the shared variable technology supported by LabVIEW is used to realize data sharing and data communication on computers at different locations and at different times to achieve the purpose of remote monitoring.

III. SOFTWARE DESIGN OF REMOTE ENVIRONMENTAL MONITORING SYSTEM

The software part of the remote environmental monitoring system is carried out on LabVIEW virtual instrument software. It controls the acquisition card to collect voltage signals of four sensor channels, generates trend curve after filtering, and realizes the monitoring of environmental parameters by using virtual instrument technology.

In this chapter, the key program design of the software part includes signal acquisition, digital filtering and trend curve generation.

The monitoring system software is composed of LabVIE8.6 evaluation version application development platform and Nl-DAQmx. With the help of PC, the data processing function is completed, and the functions of data acquisition, display and recording of environmental parameters such as temperature, humidity, carbon dioxide gas concentration and natural gas concentration are realized.

A. Core Design of Monitoring System

The main advantage of multi-thread is that it can make full use of the processing power of multi-processor computer, can make a program have multiple parallel execution ways, and improve the running rate of the program. The application of multithread technology can make multiple independent tasks run at the same time and greatly improve the efficiency of the program. In the traditional programming language, the writing of multithreaded programs is more troublesome. First of all, the text programming language sequential execution code, multi-thread code can not be intuitively reflected; secondly, in order to involve inter-thread communication and shared resource management and other issues, it is often necessary to add separate code in thread management. Because LabVIEW is a graphical programming method, which is convenient for multi-thread code development, users can intuitively see parallel code in the programming environment of data flow. LabVIEW encapsulates complex operations such as inter-thread communication and thread management, thus simplifying the process of writing multithread code.

LabVIEW is an automatic multithreading language, which automatically determines the number, allocation, management and switching of threads according to the program written by users. This system uses the method of multi-thread parallel technology to ensure that the system is in a high speed state. They are temporarily stored in memory in the form of FIFO. When the monitoring system is in a running state, each module runs in a multi-thread method. The data transmission between them is carried out by means of local variables.

B. Modular Design

The characteristics of L abVIEW modular design reduce the complexity of the program, increase the overall efficiency and design flexibility of the software, simplify the programming process and later maintenance, and simplify the construction of the system and the writing of the code. Based on the above characteristics, the designer can develop an application program with high reliability, complete function and humanized interface. The monitoring system can be divided into three modules to design, that is, environmental monitoring and measurement collection, real-time display of monitoring data and data reading.

IV. HARDWARE CIRCUIT DESIGN

As shown in Figure 1, the application circuit of a diode as a temperature sensor. In the circuit, the silicon diodes VD1 and VD2 are used as temperature sensors, and the temperature coefficient of the silicon diodes is 2 mV/ C. A and VT1 constitute a constant current source circuit, which provides constant current for VD1 and VD2. B is an amplifier, which amplifies the voltage changes of VD1 and VD2 corresponding to the temperature to the required level. If the A/D conversion is connected to the output of B, the analog-to-digital conversion of the signal can be realized, and then the digital signal can be connected to the virtual instrument by connecting the digital signal to the data acquisition card.

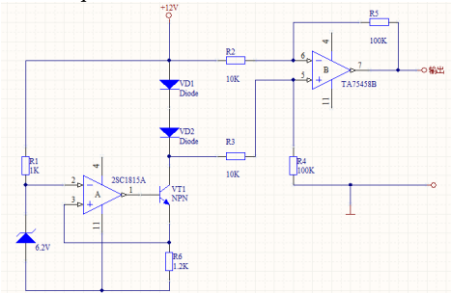

Fig. 1 Temperature sensor circuit

As shown in fig. 2, in the humidity sensitive area of the humidity sensor AMT2001 access circuit, the sensor is connected to the corresponding resistance and amplifier, the humidity signal monitored and collected is amplified, the voltage signal converted by the sensor is amplified, and when the voltage exceeds the limit value, the alarm in the circuit sends out an alarm warning that the humidity exceeds the limit.

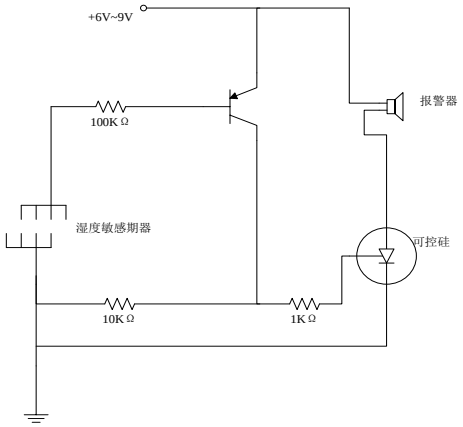

Fig. 2 Humidity sensor circuit

As shown in fig. 3, the carbon dioxide concentration sensor CDM4161 is added to the marking position, and the sensor outputs the corresponding carbon dioxide concentration at the output end of the IC4 of the amplifier after multiple resistance, inductance and step by step amplification. The output value can be connected to the A/D conversion to realize the analog-to-digital conversion of the signal, and then the digital signal can be connected to the data acquisition card to realize the over-time alarm reminder.

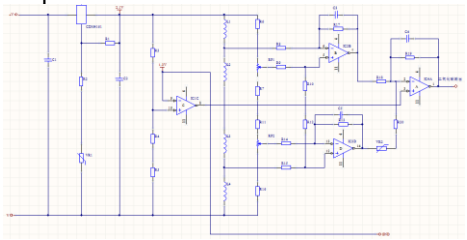

Fig. 3 The concentration of carbon dioxide sensor circuit

As shown in Fig. 4, the combustible gas sensor KGS-20 is connected to the gas sensor area, the corresponding resistance is connected to form the driving circuit of KGS-20, and then the IC is connected to form the natural gas concentration acquisition and monitoring circuit. The output voltage signal of IC can be amplified by the transistor to drive the alarm circuit to realize the alarm under the corresponding conditions.

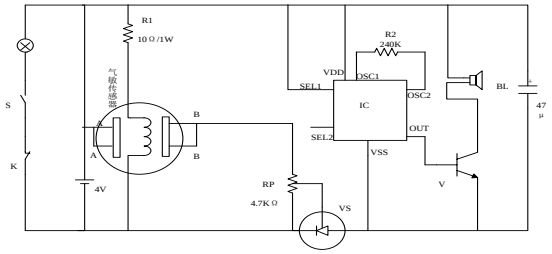

Fig. 4 Gas concentration sensor circuit

V. CONCLUSION

Firstly, this paper briefly introduces the core technologies and important sub-templates used in the environment, designs the software part of the system according to the requirements of the environmental monitoring system. Then, the monitoring of four environmental parameters, such as temperature, humidity, CO2 concentration and natural gas concentration, is realized by using LabVIEW software platform, and the functions of data acquisition, data processing and data display can be completed, and the data can be read. The technology of shared variables is used to realize the remote testing of environmental parameters. Then the overall hardware design process of virtual instrument monitoring system is introduced, and the hardware design of remote

environment detection system is studied emphatically. According to the requirement of actual monitoring, the hardware of environmental monitoring system is composed of silicon diode, humidity sensor AMT 2001, carbon dioxide concentration sensor CDM4161, combustible gas sensor KGS-20 and NI PCI-6251 data acquisition card.

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