

Multi-Channel Temperature Measurement System based on LabVIEW

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Abstract—With the rapid development of computer technology and instrument technology, virtual instrument and Labview language has great development. Labview based on G language is widely used in industrial and academic development of data acquisition system, instrument control software and analysis software.

The multi-channel temperature measuring system is based on Labview. At first, we introduce the virtual instrument on the basis of the Labview software. And then we detailed introduce the measurement temperature. For multi-channel temperature measuring system, the system can be divided into the hardware part and software part. In the hardware part, the system is focused on the design of the temperature acquisition module. In order to obtain the good temperature signal, the system will make the temperature of the measured physical quantity through the amplifier circuit for processing. Then through data acquisition card we convert analog signals to a computer to process the digital signal. And in respect of software part we mainly through the Labview software have preliminary processing temperature signal and the temperature signal is read. Through Labview software program, the temperature signal can be obtained by calling, transformation, acquisition, processing, and then displayed on the waveform graph.

The multi-channel temperature measuring system based on Labview has a short development time, the development of low cost, good reliability and good performance characteristics. And it can be widely used in the field of temperature measurement and processing. At the same time, the multi-channel temperature measurement system based on Labview can overcome the adverse effects of traditional temperature measuring system, so the design of temperature measuring system is more convenient.

Keywords—Virtual instrument; Labview; Temperature sensor; Data acquisition component

I. INTRODUCTION

With the rapid development of science and technology, more and more highly requirement of temperature are in all walks of life. At the same time, the temperature measurement is becoming more common. And it also has higher requirements on accuracy of temperature measurement. Besides the different temperature can produce different objects. In the oil industry, for example, different temperature will produce different gases. But the more serious situation is that there is no good control of accidents in the production of temperature. To avoid this situation, people control the change of temperature through various means. At the same time, in order to be simply and clearly observation of the changes of temperature, research staff designs all kinds

of temperature measuring instrument. However, most of the temperature control system use the traditional temperature measurement instrument at present. Most of the function are implemented by hardware or solidification software and complex operation. It also need the high demand for staff. In addition, the temperature measurement system maintenance needs to spend lots of manpower and material resources. This situation has gradually couldn't keep up with the pace of The Times, and satisfy the requirements of modern temperature control system. In order to solve these problems, the companys' reasearch staffs invest a lot of energy. With the rapid development of computer technology, National Instruments(NI) firstly push out the concept of virtual instrument, and make the industry of measurement and control instrument take place great changes. Virtual instrument make full use of the computer's powerful computing ability and break restrictions what the traditional instruments are in data processing, display, transmission, storage and so on. Virtual instrument can come true system control and display of measuring data by the picture form. It overcomes the traditional temperature measuring system's abuse which is in a variety of cross connection of hardware and software.

This design uses the multi-channel temperature sensors, signal processor and a virtual instrument measuring temperature control system. It's easy to operate. And upgradeing the software and hardware can be easily replaced. Due to the frequency of the temperature sensor's signal is too small and waveform are often not appropriate, and with all kinds of noise, so I need to make signal which is received through signal processor pre-processing such as amplification plastic, filtering. Processed signal will process and transmit through the data acquisition card and display through the Labview software in the form of image.

II. LABVIEW INTRODUCTION AND DESIGN STEPS OF THE SYSTEM

Labview is laboratory virtual instrument integration environment. It is a softwar which is the NI company designed specifically for the research and development of virtual instrument. Labview has low requirement for developers. As the industry standard graphical programming software, it not only can easily finish the connection with a variety of software and hardware, but also provide powerful data processing ability, all aspects of the conversion, data processing, storage, and display the results to the user. Because of Labview's low

threshold and complete functions, many users only need to understand the overall function of the software and to design the function of the virtual instrument, they can quickly design and development. Labview software via years research. It has more rich, powerful utility software package, and equipped with various kinds of libraries at the same time.

In this paper, the design as the below: Firstly, the quantities are measured through peripheral equipment acquisition such as temperature. At the same time, these quantities are done some rough treatment, such as physical quantities can be converted to electrical signals, and amplifying, filtering and other processing. Secondly, electrical signals which are bulk processing convert into the digital signals which computers can recognize through the data acquisition card and the digital signals would be imported the computer. Thirdly, the digital signals which are imported the computer are read by Labview software, and display, analysis, storage, etc.

III. THE SYSTEM HARDWARE CIRCUIT DESIGN

The signal collection section of Multi-channel temperature measuring system is temperature signal acquisition. It needs to be operated by temperature sensor. Due to the difference of type of temperature sensor and parameters, the collected temperature signal is different too. The signal frequency and the existence of noise need to be regulated through the signal conditioning device. Therefore it is divided into temperature

sensor and signal conditioning part in the hardware part of the system.

A. The design of the temperature sensor

In the external temperature measuring system module, the most important part is temperature sensor part. We can easily get to the temperature signal through the temperature sensor. Temperature sensor is a kind of combinations of various components and a device of temperature which changes into electrical signal device. Through the various physical properties of different thermal conductive material with the rule of temperature changes in the temperature, it can be converted into usable output signal. In this experiment, it mainly adopts two temperature sensors: heat resistance sensor, thermocouple sensor

- The heat resistance sensor employs thermal resistance of PT100 type. The principle makes use of change of resistance of material which follows variations in temperature and shows a certain linear relationship. The heat resistance sensor temperature test takes advantage of principle to the temperature test. Both ends of the thermal resistor are exerted a constant voltage, and calculate the temperature of the object to be tested by measuring the resistance tolerance. Temperature measurement range is mainly $-200 \sim 500^{\circ}\text{C}$. Thermal resistance sensors of temperature measuring circuit is shown in figure 1.

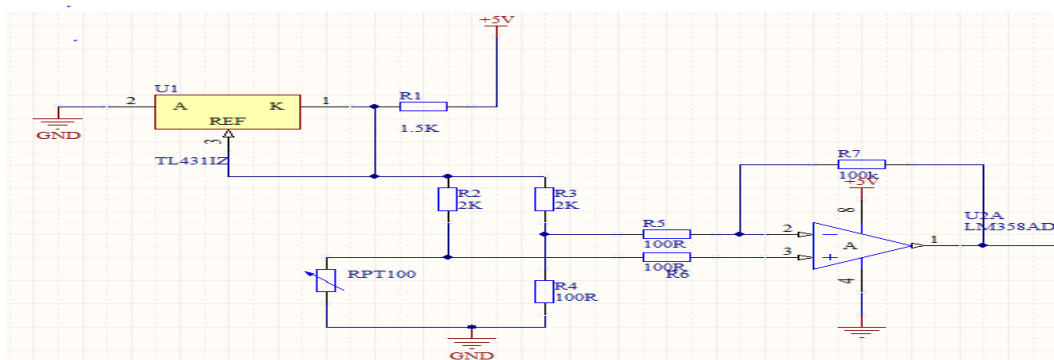


Fig.1. Thermal resistance sensor circuit

In thermal resistance sensor circuit, I provide 5V power supply voltage for circuit. Both ends of the thermal resistance of PT100 type get 2.5 V voltage through voltage regulator circuit which is composed of TL431, and then measure voltage of U_0 from 1 port through the amplifier whose model is LM358. Finally the PT100 resistance value will be calculated through the formula 1.

$$U_0 = \left[\frac{R_{PT100}}{R_2 + R_{PT100}} - \frac{R_4}{R_2 + R_4} \right] * 2500 \quad (1)$$

- Thermocouple sensor model is WRNT-01. Its temperature measure principle is that when there are two different conductors or semiconductor A and B to form a closed loop, and when temperature gradient is at both ends, it creates an electric current in the circuit. The thermocouple is composed of two different conductors or semiconductor form a closed loop, so it doesn't need to

give the external voltage. And as a result of the thermocouple electromotive force is too small, it needs to be enlarged its processing. We use LM324 chips to zoom voltage, capacitance C2 and C3 to play the role of a stable voltage. In the 7 port I measure voltage U_1 , I calculate the voltage at the ends of the thermocouple through the formula.

B. Signal conditioning circuit module

When the electrical signals are needed from the temperature sensor, it would be found that the electrical signals exist many problems, such as the signal frequency is too small, the waveform is not appropriate, there is a noise, and so on. So I need to use the signal conditioning circuit preprocess for signal amplification, such as plastic, filtering pretreatment. Signal conditioning circuit is mainly composed

of the power supply and various types of amplifier and the composition of the corresponding signal conversion circuit. It is mainly to do some preprocessing for the output temperature signal

C. MPS - 010501 data acquisition card

In this experiment,I collect the signal by MPS - 010501 data acquisition card. It is a multi-function data acquisition card based on USB bus, with 4 road differential analog signal acquisition, 1 analog signal output and 8 digital signal input/output.

In the MPS-010501 data acquisition card, green leds show self-checking system instructions. When the indicator is on, the system works normally. Red leds show collection status indication. When the indicator is on , it represents the acquisition card in the configuration state. Lights is out, it represents the acquisition card is in working condition.

IV. SOFTWARE PROGRAM DEBUGGING SESSION

When we take temperature test for the temperature sensor, The temperature measurement system is not measured the same temperature signal, and waveform oscilloscope's temperature signal will have corresponding change in virtual instrument. We can see different kinds of different waveform which is collected by different types of temperature sensors clearly and accurately and get the results which are imagined by program designed. The whole process of debugging design as the figure 2 shown.

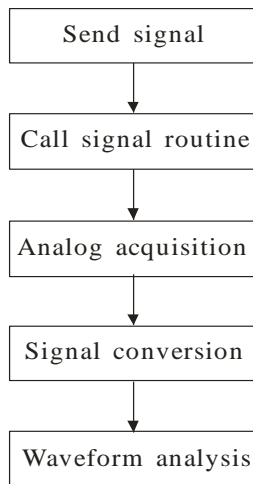


Fig.2. The whole process of debugging design

By Labview design multi-channel temperature measuring system and using the powerful software simulation of Labview, the temperature signal which is got by temperature sensor transfers to the Labview program and then signal waveform will get spectrum analysis and wavelet analysis after the analog acquisition, signal A/D conversion.

To call a function program module to send command function called as follows in figure 3.

In the process of program design, system need to input signals, so I call temperature sensors have received signal. As shown in figure 4.

After signal transferring into the program, the first step is that the getted signal simulat acquisition. Only the signal acquisition, can we better have a sufficient knowledge of the signal. After a full of understanding , I have a clear understanding of the following programming. Hold the whole design accurately and easily write at the back of the program. As shown in figure 5.

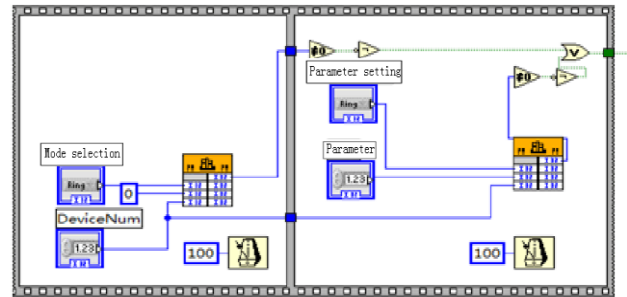


Fig.3. Send command function called program block diagram

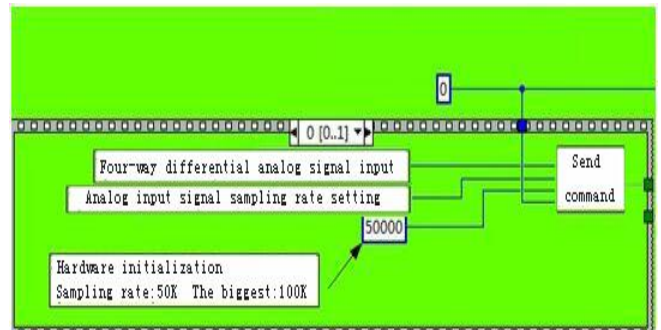


Fig.4. Program calls the function diagram

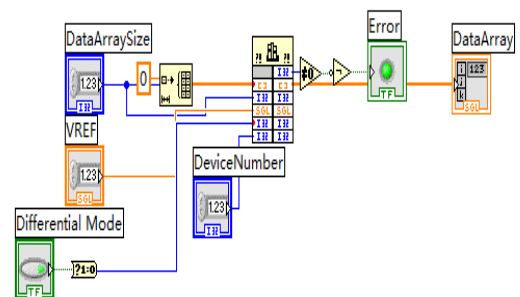


Fig.5. Analog signal acquisition module

V. THE RESULTS

Temperature measurement program of temperature sensor program is debugged, temperature measurement procedures without temperature signal march simulation signal samples and save. And let it compare with temperature measurement measurement procedures with the external temperature signal.(Fig.6~Fig.9)

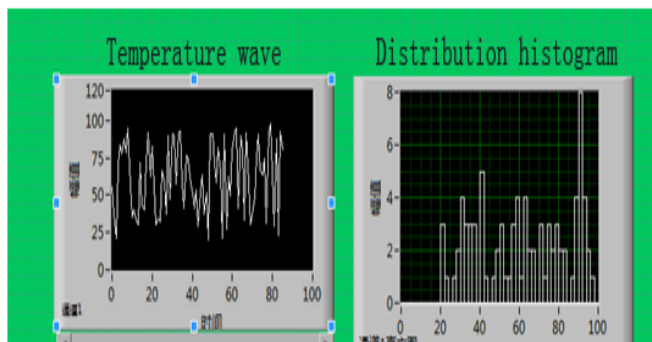


Fig.6. Thermal resistance temperature measurement program simulation signal

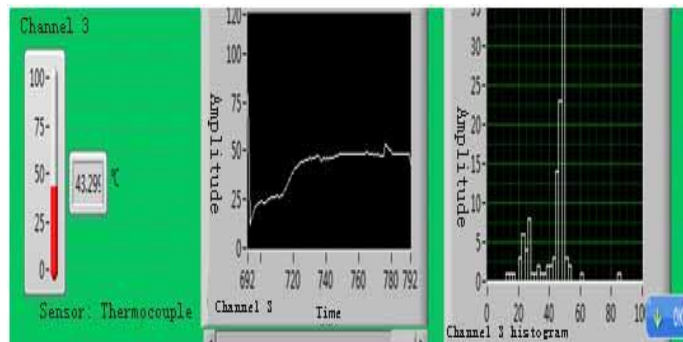


Fig.9. Thermocouple temperature measuring signal acquisition program

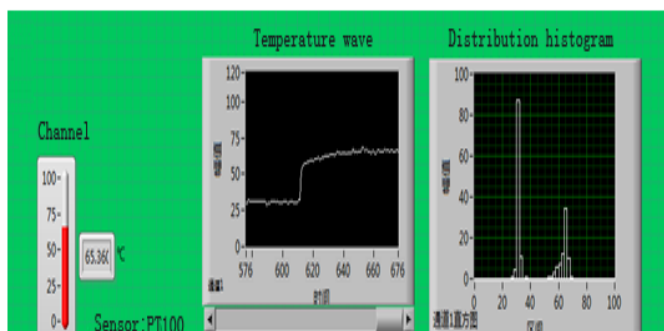


Fig.7. Thermal resistance temperature measurement signal acquisition program

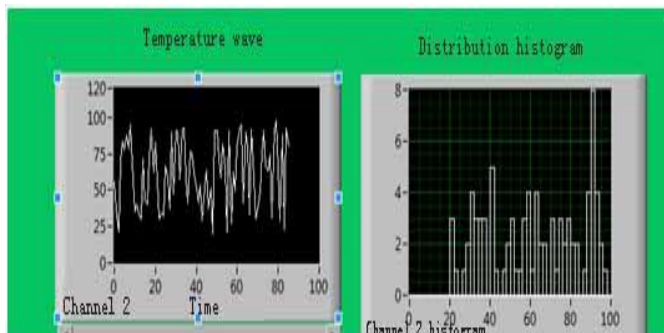


Fig.8. Thermocouple temperature measurement program simulation signal

The core part of the experiment is LabVIEW software programming module, the collected temperature signals will be identified through sata acquisition card, and the temperature signal is extracted. Then the signal is analyzed. Experimental process displays on the computer by writing the Labview program.

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