ISSN: 2637-6067 DOI: 10.6918/IJOSSER.201909_2(6).0027

Design of Optical Fiber Displacement Measurement System Based on Virtual Instrument

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Abstract

Based on the special virtual instrument development tool LabVIEW, the data acquisition card and stepping motor are used to develop the optical fiber displacement measurement system, the system hardware platform composition and software design method are explained, respectively, the design principle of optical fiber displacement measurement system based on virtual instrument is explained, the virtual instrument test system can realize gap setting and automatic adjustment, real-time display of gap value and voltage value, data collection cache and final image processing, and realize the automation of measurement.

Keywords

Optical fiber sensor; displacement; virtual instrument; LabVIEW; fiber displacement measurement system.

1. Principle of Optical Fiber Displacement Measurement

Optical fiber displacement measurement generally uses the light transmitting optical fiber, and light can be transmitted in the optical fiber, the optical fiber probe used in the experiment is shown in Fig.1, one optical fiber is used as a light source to emit optical signals, and the other is used as a receiving optical fiber and receive light intensity, the optical signal is reflected to the receiving optical fiber through the reflective surface we set, and then the receiving optical fiber transmits the optical signal to the CSY-998G sensor experiment instrument, other is a setting optical fiber displacement measuring module in the experimental instrument, the photoelectric conversion circuit included can convert the optical signal received by the receiving optical fiber into the voltage signal, since the distance between the optical fiber probe and the reflecting surface is different, light intensity the receiving optical fiber receive is different, and thus the voltage converted by the photoelectric conversion circuit is also different.

The virtual instrument measurement platform made by the virtual instrument software controls the rotation of the stepping motor and control the distance between the optical fiber probe and the reflective surface, and then the acquisition card collects the voltage signal, and then transmits it to the virtual instrument measurement platform to analyze and process the voltage signal, the corresponding proportional relationship between the gap value and the voltage, finally, the light intensity can be detected through their corresponding relationship, and then the change of the gap amount can be known.

When the optical fiber probe, light source, reflector, optoelectronic converter and amplifier are determined, the output voltage of the amplifier is a single-valued function of the distance between the reflector and the optical fiber probe. Reflective surfaces can also be attached to the reflective film to increase the reflection efficiency of light to make the results of the measurement system more accurate.

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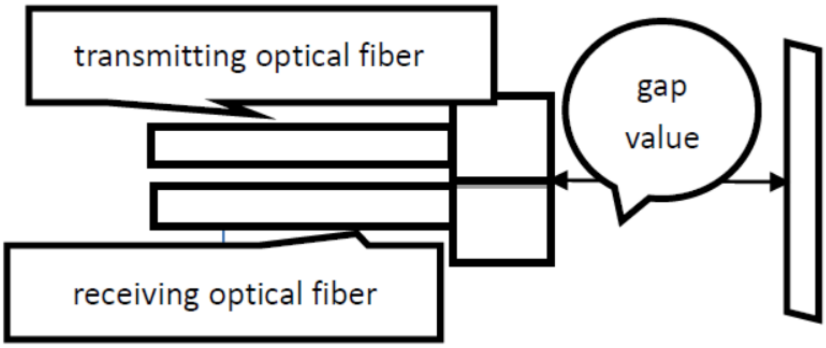

Fig 1. Optical fiber probe

2. Hardware Design of the Measurement System

The measurement system consists of optical fiber probe, reflective surface, CSY-998G sensor experiment instrument, spiral micrometer, aluminum alloy star flexible coupling, 42 stepping motor, stepping motor driver, voltage-stabilizing power, data acquisition card and virtual instrument platform, structure diagram as shown in Fig.2;

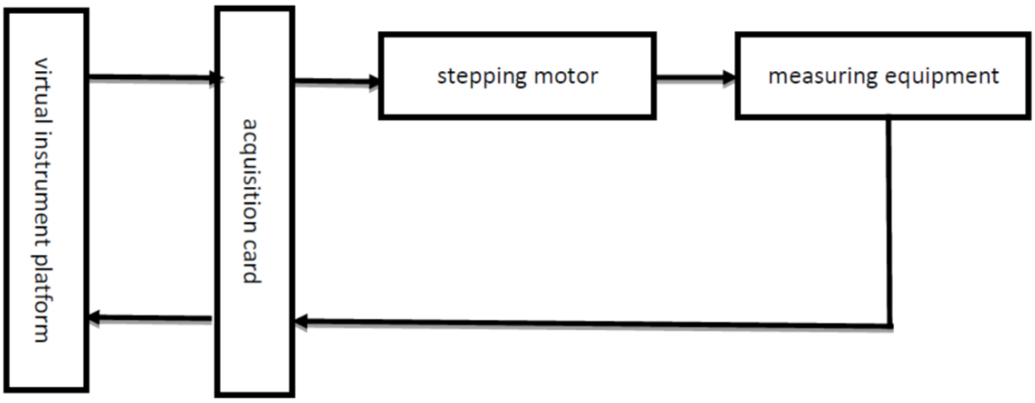

Fig 2. Structure diagram of the measurement system

The fiber optic probe, the CSY-998G sensor experiment instrument and the signal amplifier together form fiber sensor part. The NI myDAQ multi-function data acquisition card play a bridge role between PC and data transmission in the whole system, the integration level of the virtual test system depends largely on the resources and performance of the multi-function data acquisition card. The virtual instrument platform consists of the virtual instrument development tool LabVIEW, and a computer.

3. Software Design of the Measurement System

In a graphical programming environment, the test system uses a modular design idea. The main basic functions achieved are as shown in Fig.3:

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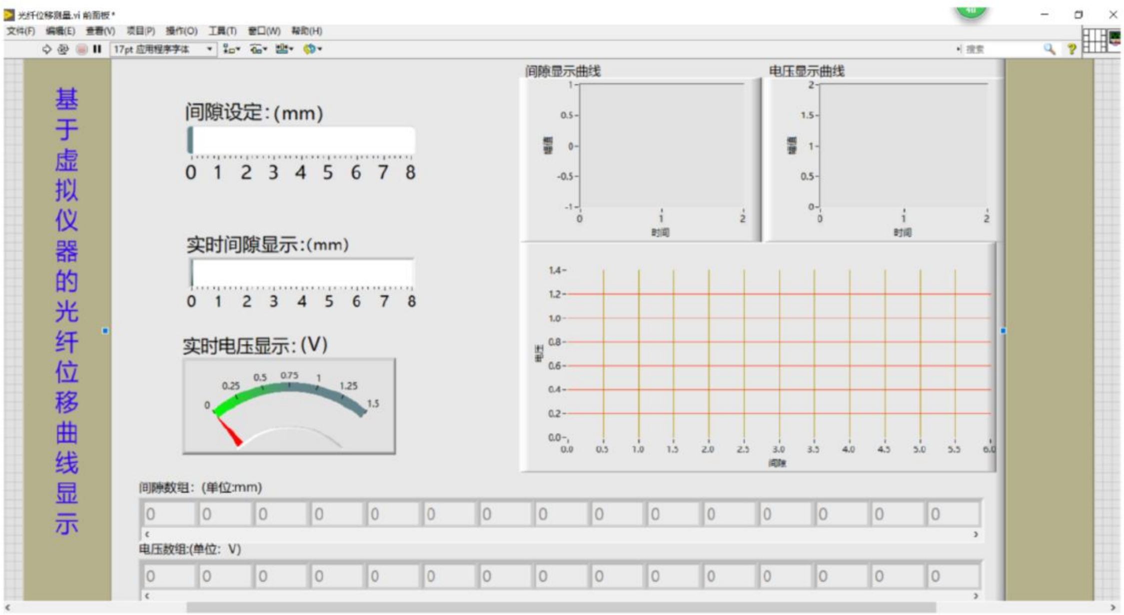

Fig 3. Block diagram of program front panel

(1) Realize the use of NI myDAQ acquisition card to control the stepping motor.

(2) Setting of sampling data interval and test data display in real-time.

(3) Image the collected data.

Fig.4 is a partial block diagram of the test software in the virtual instrument test platform, the gap setting module from left to right, the stepping motor drive module, the voltage data acquisition module, and the waveform generation module are in sequence.

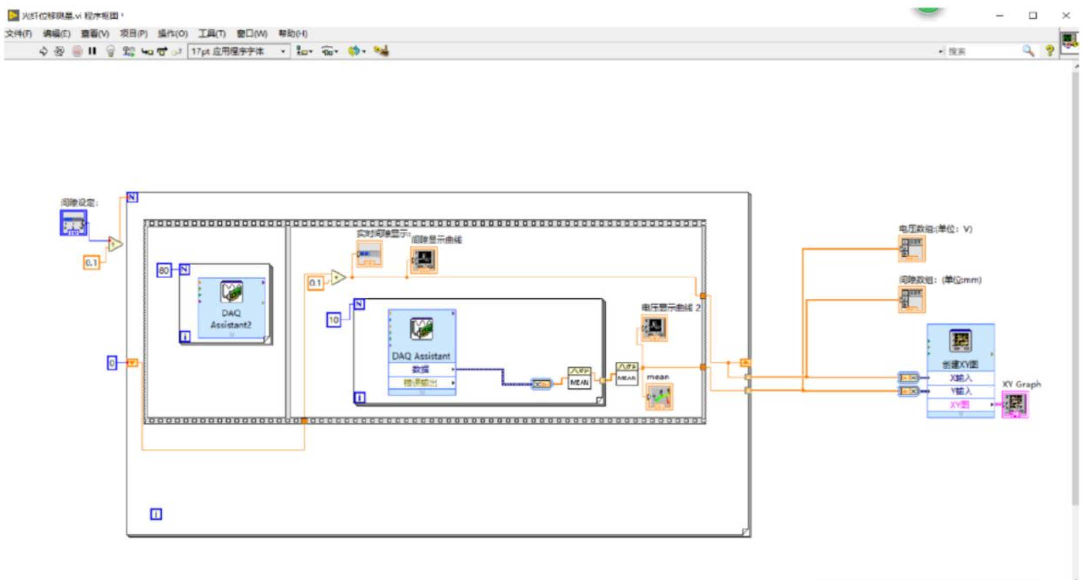

Fig 4. Block diagram of program code

When starting the program, and set the leftmost input gap to 6mm, since the set program is paused every 0.1mm, the gap setting is divided by 0.1 to get the outermost For cycle, which need run 60 times. The next module is the stepping motor drive module. By consulting the data and calculation, the stepping motor rotated for one cycle, the NI myDAQ acquisition card is required to input 400 pulses, while the spiral micrometer turns 0.5mm one cycle, therefore,

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every 0.1mm rotation requires NI myDAQ acquisition card to input 80 pulses, so set NI myDAQ acquisition card to input 80 pulses of stepping motor. The next module is the voltage data acquisition module, which connects the voltmeter on the CSY-998G sensor experimental instrument with the acquisition card to collect the voltage data, the data can be transferred out by DAQ assistant[18], In order to quality of the data, the data of every 0.1 seconds is averaged, and 0.1 is superimposed once from the shift register in the For cycle, then the data cached in the shift register and the voltage data processing module are generated one by one, finally, the output array is output to the waveform generation module, it is possible to obtain a waveform of the corresponding relation between the desired gap value and the voltage. In order to observe the change of gap value and voltage value in real time and check the exact data after testing, a waveform program for displaying real-time gap value and voltage value was added to the program, finally, a specific numerical output program for gap array and voltage array was added to the final waveform generation module.

According to the above basic functional requirements, the test data can be displayed on the test display interface in real time, and the basic settings before the test are completed, such as recording setting of the sampling interval of the data. The display of the current recorded data is switched between the test interface and the test result display interface through the window label in the toolbar. The flow chart of the data acquisition, display and recording of the test software is shown in Fig.4 and Fig.5. After the test is completed, it will automatically switch to the test result display interface.

When data acquisition starts, first, set the gap value in the gap setting of the front panel, and then click on the upper left corner to run, when only one run is needed, click on the running label, when needs to run continuously, click on the continuously running label next to the operation, when the program starts running, The two windows below the gap setting are real-time gap display and real-time voltage display, which correspond to the two waveform diagram above the right side, during the test, the actual distance between the optical fiber probe and the reflective surface and the actual voltage converted by the CSY-998G sensor experimenter are clearly displayed through these four windows, the waveform diagrams below the right side are the summary of all the experimental results, the relationship between the collected gap values and voltage values is displayed intuitively through the image, the bottom table is the summary of all the gap values and voltage values in the whole data acquisition and processing process.

4. Test and Result Analysis

The optical fiber probe is mounted on the platform probe holder in the actual test, and the probe is vertically aligned with the center of the reflector to be measured. First, zero adjustment is required to make the optical fiber probe just fit the reflective surface, the spiral micrometer with 0.02mm resolution is mounted on the other end of the bracket to drive the reflective lens to generate displacement, the experiment starts from the state of zero adjustment. Through various data acquisition and analysis before the experiment, in order to avoid the experimental time too long, the spiral micrometer collects the voltage data every 0.1mm, and sets the gap value of the test system to 6mm, the basis for setting the gap value of the voltage data acquisition and the total experimental gap value is: on the one hand, it can observe the law that the voltage value changes with the change of the gap value, on the other hand, it avoids the experiment collect too much useless data, resulting in wasting time and effort.

Fig.5 is an experimental image obtained after the acquisition is completed;

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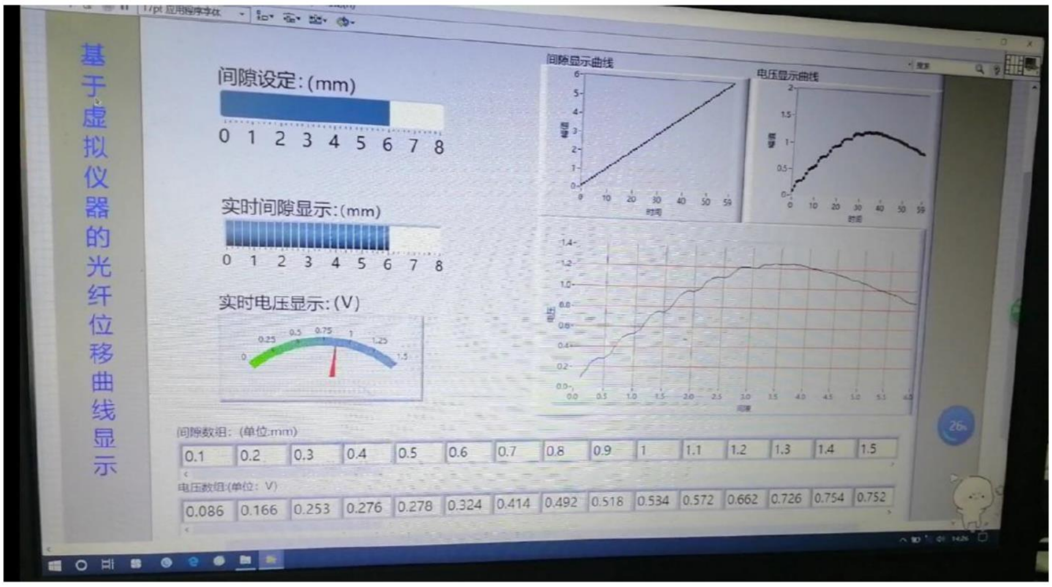

Fig 5. Measurement system interface

(1) It can be seen that the curve obtained by the experimental result is a curve that rises first and then falls, and the rising trend is much larger than the decreasing trend.

(2) At the beginning, as the gap value increases, the voltage value increases monotonically, when the gap value reaches 3.5mm, the voltage value reaches about 1.22V peak value, then as the gap value increases, the voltage value decreases monotonously.

(3) When the initial value of the gap value is 0 mm, the voltage is 0V.

It can be seen from the above experimental results that in the monotone decreasing process after the peak, if the gap continues to increase indefinitely, finally, the signal transmitted through the transmitting optical fiber will be very weak after being reflected back through the reflecting surface, which is similar to none and can be ignored.

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