The DAQ system of internal combustion engine indicator diagram signal based on LabVIEW

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Abstract. With the development of internal combustion engine technology and the research of its performance, we need accurate data acquisition (DAQ) and analysis of internal combustion engine in order to obtain the technical specifications of the internal combustion engine and improve its performance. We have designed a DAQ system of internal combustion engine indicator diagram signal based on LabVIEW which mainly includes AVL engine simulator, preamplifier circuit, signal conditioning circuit, DAQ card and the system main program. This system has realized signal acquisition, display and storage. Compared with traditional instruments, the system is easy to update and upgrade and can be extended.

Keywords: LabVIEW, Signal conditioning, internal combustion engine DAQ.

1. The design of DAQ system

We have designed a DAQ system of internal combustion engine indicator diagram signal based on LabVIEW which mainly includes AVL engine simulator, preamplifier circuit; signal conditioning circuit, DAQ card and the system main program. The curve of internal combustion engine cylinder gas pressure (indicator diagram) is the important basis of its working process, power performance and fuel economy. Meanwhile, indicator diagram is also the foundation of fault diagnosis. This system mainly uses simulator to generate signal, and DAQ card, computer to collect, analysis and storage the signal. The working process is that signal is generated by simulator which is similar to the signal produced by engine sensors. Then, the signal is filtered and amplified by signal conditioning circuit and the signal is sent to the computer for being processed and stored through DAQ card. The overall system frame is shown in Fig. 1.

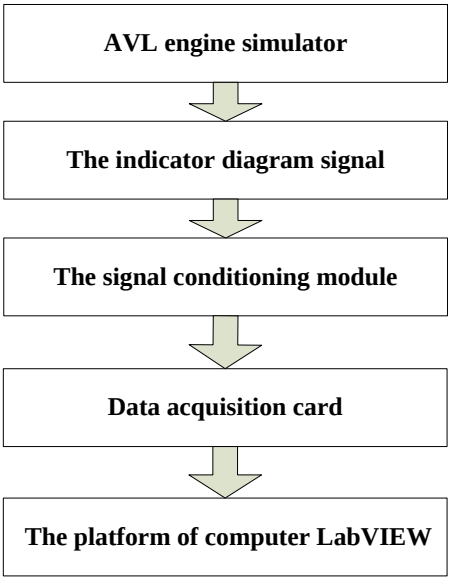

Fig. 1 The overall system frame of indicator diagram signal acquisition system

2. The design of system hardware

2.1. AVL engine simulator.

The structure of engine electronic control system is more and more complex. Because of uncertainty of the new system, if new ECU is tested on the engine directly, the engine is easy to be damaged and may produce safe trouble. Therefore, we need a simulator who can simulate the engine to test the new ECU for releasing the above problems and developing ECU will be more convenient in a shorter period. Engine simulator is able to simulate all kinds of engine sensor signals, and can produce accurate CDM and TRIG signal. In this paper we adopt the AVL engine simulator whose model is 6601•P02.

a) The choice of DAQ card.

This system adopts the PS PCI-3321 DAQ card which is a synchronous DAQ card based on PCI bus. Eight road 16 bit resolution synchronous analog input channels are provided by the card and the sampling rate of single channel can reach 500 KS/s. In addition, the card also provides eight road digital input/output ports, ten road multi-function digital input/output ports and two counters. Low pass filter is provided by the card to reduce the high noise and frequency aliasing, whose cut-off frequency is 200 kHz, so the card is suitable for high speed continuous and synchronous data acquisition.

b) Signal conditioning circuit

The synchronous pulse signal and trigger pulse signal from the simulator are spire pulse in the actual data collection system, so signal conditioning is required before the pulse enters DAQ card. The schematic diagram of synchronous pulse signal conditioning circuit is shown in Fig. 2 and the schematic diagram of trigger pulse signal conditioning circuit is shown in Fig. 3 DS8837 and SN74LS221 are used in the conditioning circuit as the main chips. The sampling precision of data is greatly improved due to the signal conditioning circuit.

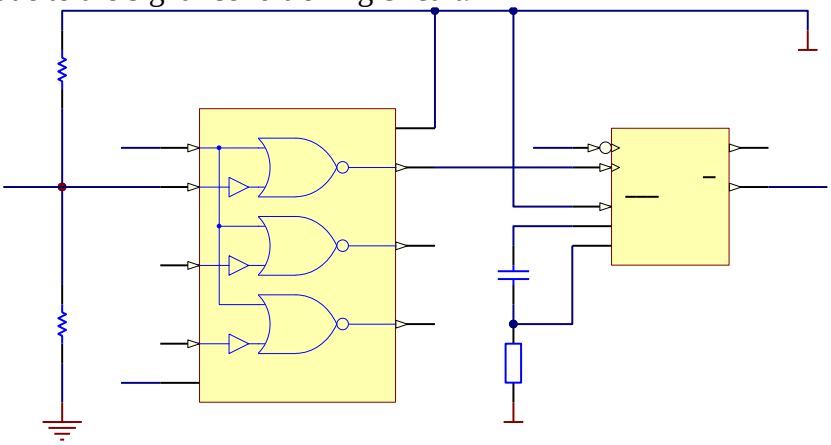

Fig. 2 The conditioning circuit of synchronous pulse signal

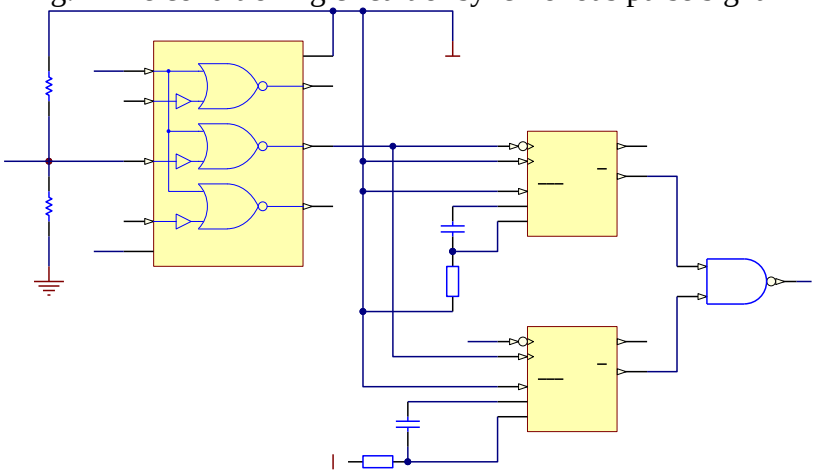

Fig. 3 The conditioning circuit of trigger pulse signal

3. The design of system program

The LabVIEW platform can quickly realize data acquisition, data analysis, data display and storage function, so it can improve efficiency and save time. Meanwhile, it can create a friendly human-computer interaction interface quickly. The Platform has front panel and block diagram. The front panel is composed of controller and indicator and used to control and display. The block diagram having library functions and the analysis subroutine, you need call icon which can realize the instrument operation, data processing and output display. Then, we send parameters into the icon and connect the icon to complete the programming. Our front panel is shown in Fig. 4 and the block diagram is shown in Fig. 5.

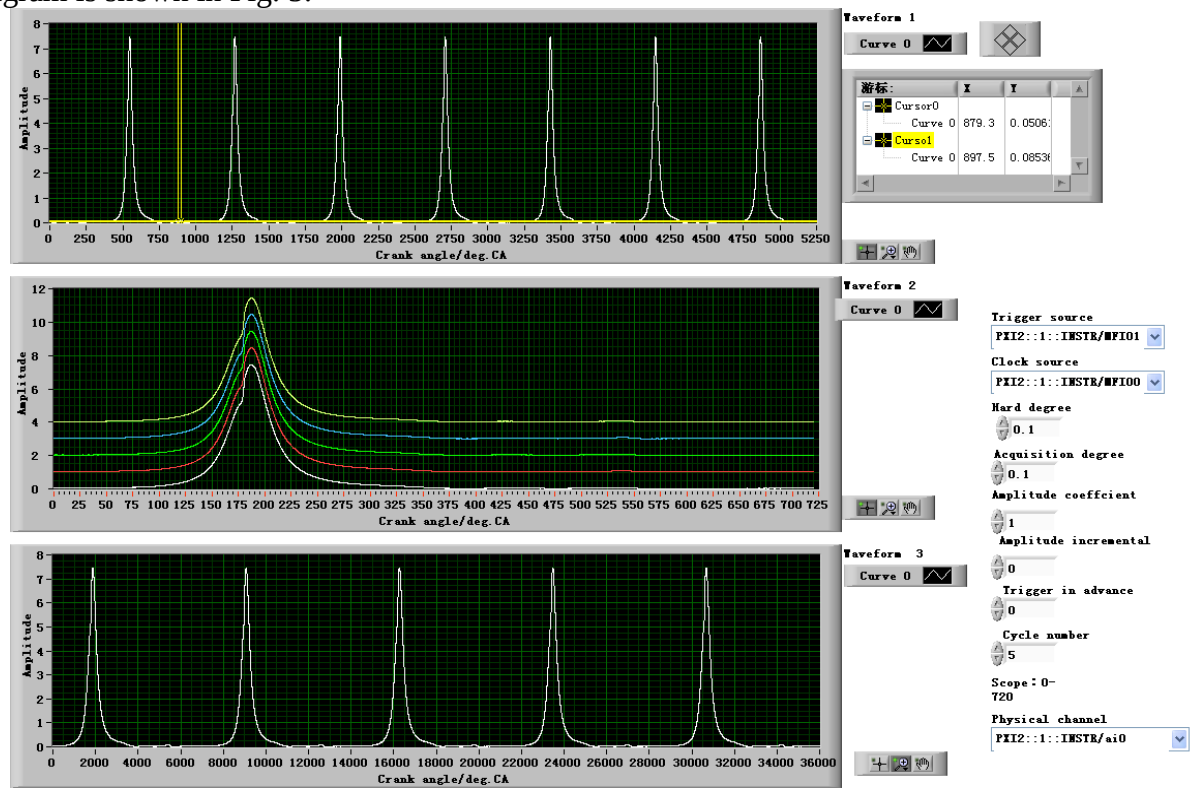

Fig. 4 The front panel

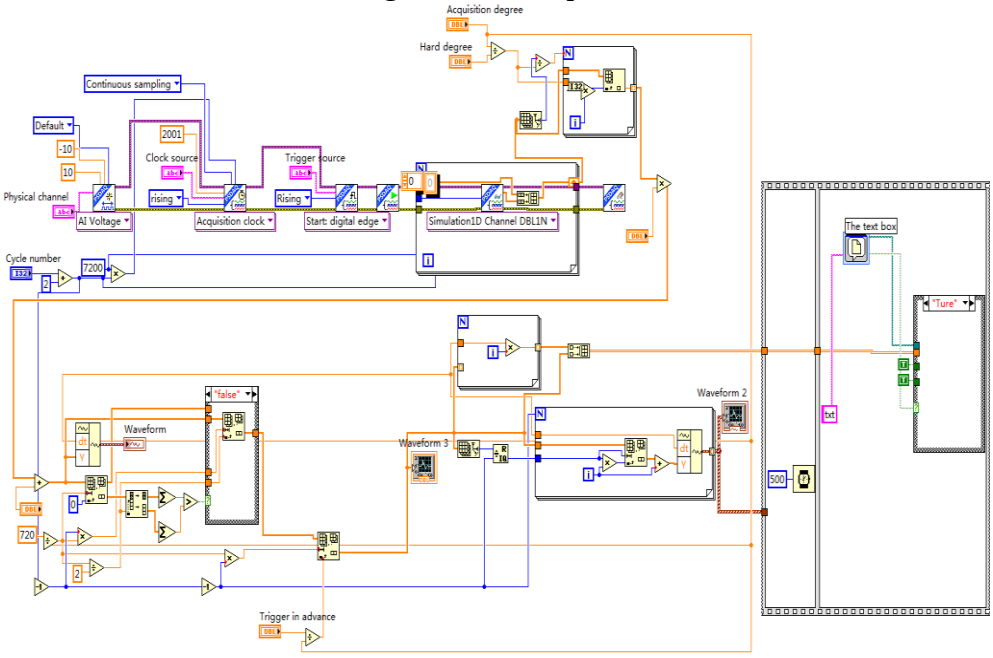

Fig. 5 The block diagram

In this paper, the front panel is composed of acquisition channel and control information, DAQ card parameter settings and the display of sensor output signal waveform and amplitude. DAQ card

parameter settings consist of trigger mode, trigger source selection, cycle number, channel selection, hardware and acquisition degree, tell the amplitude coefficient and incremental, trigger degree in advance. DAQ card parameter settings can meet the test requirements. First set DAQ card parameters and acquisition channel, and then start continuous sampling data. Finally, the continuous pulse signal is collected and processed, and then displayed on waveform figure in the front panel. The abscissa of waveform figure is the crankshaft angle. Waveform 1 and 3 show the indicator diagram and waveform 2 display the stack of indicator diagram. Meanwhile, the data is stored in specified file in order to use and look it later. In the subsequent experiment, we verify the DAQ system with an engine of GOLF which has been developed by our laboratory for proving that the DAQ system is correct and reliable.

4. Conclusion

In this paper, data acquisition system has been designed by LabVIEW which is a graphical design language, and completed the internal combustion engine indicator diagram signal acquisition, display and storage. Compared with traditional instruments, the system is stable and easy to update and upgrade because the system uses the technology of virtual instrument. It is a modern measuring method which has some practical value in the actual internal combustion engine tests.

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