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Design of Measure and Control System Based on VC++ for Damper Test Bench

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ABSTRACT
The paper introduces the working principle of electro-hydraulic servo damper bench. Then using the PCI2306 - DA card as excitation signal output hardware, applying Visual c + + language in the Windows environment, a measure and control system test for damper test bench has been developed.

Keywords: *Test bench, Visual C++, excitation signal.*

1. INTRODUCTION

The shock absorber has great influence on ride comfort and safety of the automobile. Reasonable shock absorber performance testing equipment and test methods are very important for the study of shock absorber performance. The electro-hydraulic servo test bench of automobile shock absorber can provide various vibration waveforms for shock absorber test, and the performance of automobile shock absorber can be tested according to the test requirements.

In this paper, PCI2301-DA card is used as the output hardware of excitation signal, and Visual C++ 6.0 is used to prepare the signal generation program. The measurement and control system generates test signals, after amplifying and condition, then output the voltage signal, which makes the hydraulic cylinder piston of the test bench move in accordance with the required speed and direction.

2. THE WORKING PRINCIPLE OF THE TEST BENCH

The test bench is designed and developed by the research group. The power source of the test bench is the hydraulic power source of the SV-5 electro-hydraulic servo test bench system provided by the designated manufacturer, and the test signal output is realized by matching the high-speed servo valve. FIG.1 shows the working principle of the shock absorber test bench. During the performance test, the microcomputer issues the action instruction according to the test request, the PCI2306-DA card converts the digital signal to the analog signal, generates the electric signal in the input device, and amplifies and regulates the signal by the servo amplifier. The amplified electrical signal control hydraulic power components by the electro-hydraulic servo valve, hydraulic cylinder piston moving according to the required direction and speed, so as to drive the shock absorber movement. In order to realize the accurate control of the test bed, feedback sensors are added into the system. When the shock absorber bench testing, the output displacement signal of hydraulic cylinder is detected by the sensor at any time, after transformation, the electrical signal feedback at the input end, and the input signal and feedback signal error is approximately zero, shock absorber produces the expected movement.

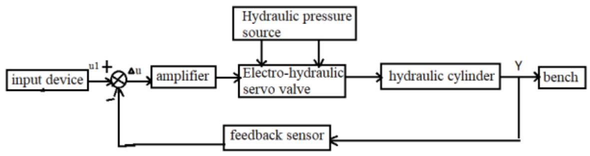

Figure 1 The working principle of the test bench

3. THE HARDWARE INTRODUCTION OF MEASUREMENT AND CONTROL SYSTEM

The hardware of the measurement and control system mainly includes PCI2301 — DA output card, electro-hydraulic servo controller and sensor.

PCI2301 is a PCI bus optoelectronic isolation 8-way, 12-bit universal D/A conversion template that provides 8-way voltage or current signal output.

The electro-hydraulic servo controller used in this system is CSEC-30 electro-hydraulic servo controller. The controller is compatible with CSV8 series electro-hydraulic servo valves. Its function is to receive the signal from the sensor, amplification processing, output current to control the servo valve movement.

According to the requirements of the test method and the work characteristics of the test bench, the NS-WL1 series tension pressure sensor and NS-WY03-150D displacement sensor are selected in this system, and SD14N18 acceleration sensor produced by Beidaihe Testing Technology Research Institute is selected.

4. THE SOFTWARE DESIGN OF CONTROL SIGNAL

This measurement and control system uses Visual C++ to generate the application program. It mainly completes the control of the test bench and outputs the excitation signal to coordinate the work of the test bench to achieve the control.

4.1 Signal generation

According to the requirement of shock absorber performance test, the system can generate sinusoidal wave, square wave, triangular wave, random signal and frequency sweep signal and other excitation waveform.

4.1.1 The basic signal

The basic signal can be generated directly by mathematical functions, and the program needs to contain the header file of math.h. The phase, amplitude and frequency of the generated signal can be set in the control panel, and then transmitted as a formal parameter to the corresponding function of the generated signal. We need to define a one-dimensional vector DABuffer to hold the resulting signal data.
The random signals generate callable rand functions. To produce a different random number, we need to call srand function before using rand. The srand and rand functions are included in the header file of stdlib.h. The random number directly generated by the function rand is from 0 to rand_max. Rand_max is a large number, so to generate the number from X to Y, we need to make the following call in the program:
DABuffer=rand()%(Y-X+1)+X

4.1.2 The frequency sweep signal

The test bench also needs to provide a frequency sweep signal when doing dynamic tests. Frequency sweep vibration mode is a process in which the test bench vibrates from low frequency to high frequency at a set frequency interval and then returns to low frequency from high frequency at the same frequency interval to complete a frequency sweep vibration.
The vibration signal issued by the excitation table can be regarded as sine wave x=Asin(2 π ft + Φ), f is the vibration frequency of the test bench. If the low frequency is set as f1, the high frequency is f2, and the number of reciprocating frequency allocation is n. From low frequency to high frequency, control frequency

$$f_{i1} = \frac{(f_2 - f_1)*2*(i-1)}{n} + f_1$$

i—The number of controls (1 to n/2)

fi1 ends up being f2, and ends up vibrating from low frequencies to high frequencies. The test bed controls the frequency from high frequency to low frequency

$$f_{i2} = f_2 - \frac{(f_2 - f_1)*2*(i-1)}{n}$$

i—The number of controls (1 to N /2)
When I is equal to n/2, and fi2 is equal to F1, the high frequency to low frequency oscillation ends. The frequency sweep vibration of the test bench runs according to this control algorithm.
In the vibration process, because the maximum vibration velocity of the test bench cannot exceed 2.0m/s, when the frequency is too high, the value of amplitude needs to be changed to control the vibration velocity.

4.2 Program implementation

The waveform data generated by the function is sent to the servo amplifier through the excitation system program call function and DA output card. After amplification, it is sent to the servo valve to control the operation of the hydraulic cylinder. This system uses the PCI2301 card driver provided by the manufacturer, and uses VISUAL C++ 6.0 to write the excitation signal generating program, and calls the following operation functions to the relevant hardware:

4.2.1 Create device objects

Before using a device, we use the CreateDevice function to create a device object handle hDevice, which gives you control over the device, and then pass the handle as a parameter to other functions.

4.2.2 Output the DA data

The program calls the WriteDeviceProDA function to output the generated waveform data.

4.2.3 Release equipment

A ReleaseDevice function must be executed to release the device after a device is created each time. Therefore, when data output is stopped, the system resources and device objects occupied by device objects must be released. When the CreateDevice function is called again, those hardware and software resources can be used again.

In this software, the Visual C++ multithreading technology is used to control a special part of the worker threads. In this way, the control of frequency, amplitude, data acquisition and excitation signal output can be carried out simultaneously in the worker thread, which makes full use of the efficiency of the computer CPU. In the program, a main thread is created firstly, and then three subthreads are created. The first subthread is used to control the output of the excitation signal, the second subthread is used to control the data collection, the third subthread is used to control the amplitude and frequency of the signal in the closed-loop control, and the main thread is used to control the operation of the entire program. In this software, there are three thread functions: DAstart() is the output function of excitation signal, DataRead() is the data acquisition control function, and BihuanControl() is the function that controls the amplitude and frequency change of the signal.

4.3 Use of programs

In order to reflect the principle of humanized design, the system provides a rich and friendly human-computer interaction interface.

In this control panel, the user can select the type of signal and set the frequency amplitude, phase and so on. Before starting the output signal, the channel must be selected. PCI2301 card has eight output channels ranging from 0 to 7. We can also set the amplitude, frequency and other parameters as needed. The type of excitation signal should be selected first. If the frequency sweep signal is selected, the scanning time and frequency interval should be set. Then the control mode of the test bed, namely displacement, velocity or acceleration, should be determined by the circular button in the control mode box. After the control mode is selected, the corresponding parameters should be set. When the parameters are set and the start output button is pressed, the test bench will output the desired excitation signal. Fig.2, Fig.3 and Fig.4 shows the output sinusoidal, random excitation and sweep signals respectively.

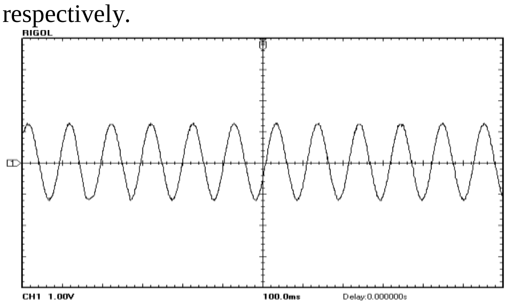

Figure 2 The output sinusoidal signal

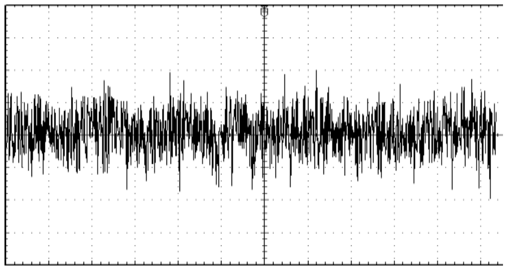

Figure 3 The output random signal

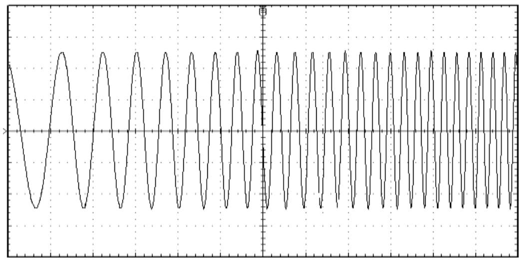

Figure 4 The output sweep signal

If you want to stop the vibration during the vibration of the bench, press the output stop button.

5. CONCLUSIONS

We designed and successfully realized the measurement and control system of the electro-hydraulic servo shock absorber test bench, which based on VC++ and PCI2301. The paper introduced the realization of the system hardware and software program. The experimental results show that the system can generate sinusoidal wave, square wave, triangular wave, random signal and frequency sweep signal required by dynamic test. The shock absorber tester can provide all kinds of signals for shock absorber test, It is of great significance to study the performance of shock absorbers.

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