Design of Universal Measurement and Control System for Thermal Power System Test Bench Based on PXI Bus Technology

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Abstract: In order to meet the requirements of various kinds of thermal power system bench test and verification, a universal measurement and control system based on virtual instrument technology is designed. The hardware platform of the system is set up based on PXI bus technology, and the software development platform is based on interactive C language development platform of LabwindowsCVI. The proposed design combined modularized instruments with signal conditioning system, and can be shared by multiple test benches with the use of a multiple special adapters, which can save the development cost and shorten the development period of test bench.

1. Introduction

With the rapid development of science and technology, the test workload of various thermal power systems is getting larger and larger, and the test content is getting more and more complex. The traditional manual test technology is now unable to meet the requirements, and automatic test system (ATS for short) has become a powerful guarantee for the development of industrial automation. ATS usually refers to the system that can automatically measure, process, store, transmit and diagnose the equipment being tested, and display or output the test results in an appropriate way[1]. At present, the test system based on virtual instrument technology and modular instrument integration has become the mainstream direction of ATS due to its features of hardware function being software-based, man-machine interface virtualization, flexible and diversified test functions etc..

The platform test of power system has the features of high test cost and high risk, especially in the hot run test, therefore, people tend to set up as many collection points as possible in each test to monitor or perform data analysis after test, and that leads to rising cost of the test. The measurement and control system(measurement and control system, MCS for short) cost often accounts for more than half of the cost of the whole test bench, and it is independently developed only for one test bed. After the completion of the test, the traditional measurement and control equipment is often idle, which causing a huge waste.

In view of the fact that different MCS have some of the same components, such as data acquisition, storage, processing, transmission and other functional modules, and the real difference is only some pre-processing front-end and peripheral interface, it is necessary to design an universal measurement and control platform(universal measurement and control platform, UMCP for short) as well as universal operating console used for multiple test benches, which can not only save the test cost, but also shorten the test system development cycle, besides, the rapid development of computer technology and the standardization of instrument interface provide the conditions for the construction of universal test platform. In the long run, it is an inevitable trend for automatic test system to develop from a special type to a general type. Therefore, based on the analysis of the common requirements of many kinds of thermal power test benches, this paper presents a design scheme of universal MCS for thermal power test bench.

2. Virtual Instrument and PXI Bus Technology

Virtual instrument technology is an integrated concept of software and hardware in essence. It is a combination of testing technology and computer technology. Virtual instrument is a MCS composed of computer hardware resources and software for digital analysis and processing, process communication and graphical interface. It transforms the way of instrument manufacturers define instrument functions into the way of users define instrument functions. The user defines and designs the test functions of the instrument according to the requirements on the general computer platform, and when the user operate the computer he will feel that he were operating a test instrument designed by himself[2].

The development of test and measurement is marked by the development of test bus. PXI bus is a modular instrument platform specially tailored for industrial data acquisition and automation applications with a high-end timing and trigger bus built in, which is an extension of the PCI bus in the instrument field. The advantages of virtual instrument based on PXI bus are mainly reflected in the following aspects[3-5]:

(1) It effectively introduces the desktop PC technology into the test and measurement environment, expands the instrument characteristics which did not exist in the desktop PC;

(2) It is compatibility with computers, while providing more stringent standards, brings compatibility between multiple vendors and convenient system integration;

(3) It defines a standard software framework that requires compatible products to provide corresponding driver software to simplify system integration;

(4) It is modular, easy to reconfigure, and easier to move than other devices;

(5) It can provide better protection against impact, vibration and high temperature, and has strong resistance to harsh environment;

(6) It is low cost with good upgradability;

(7) It can be seen from the above that the development of MCS based on PXI bus technology can meet the test requirements of thermal power system.

3. Design of System Hardware Platform

PXI instrument and equipment based on PXI bus has the characteristics of high reliability, multiple expandable modules and synchronous bus on the back plate, which can meet the requirements of the thermal power system bench test in this paper. As shown in figure 1, a test system usually consists of two parts, including MCS and test bench body.

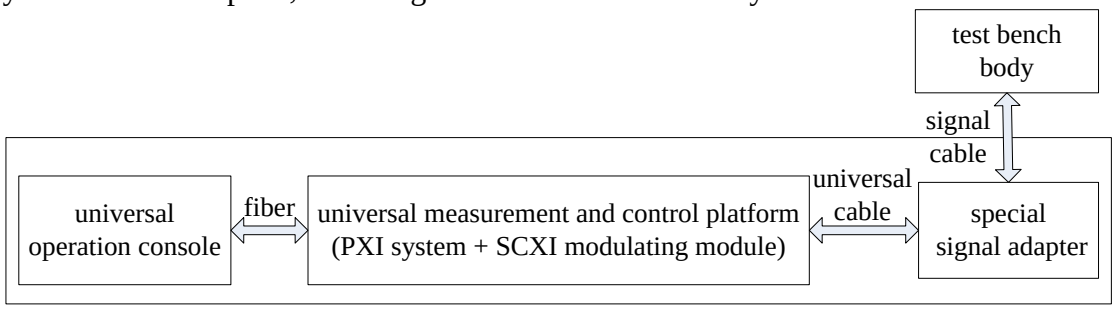

Fig.1 Block diagram of universal thermal power measurement and control system

The universal MCS designed in this paper is shown in the dotted line frame in figure 1. It is composed of three parts: universal operation console (universal operation console, UOC for short), UMCP and special adapter. Among them, the UMPC and UOC are common for all test benches, and the special adapter is special for each test bench.

3.1 Universal operation console

The hardware of the UOC takes the industrial personal computer IPC610 as the core equipment, and the performance requirements for IPC610 is common configuration. A PCI8366 communication

card is inserted into IPC610, and it communicates with the PXI1042 (a built-in PXI8366) system on the UMCP through optical fiber. The software of the UOC is installed in IPC610, which is a special measurement and control software developed according to the experimental requirements of each test bed with LabwindowsCVI as the development environment. The UOC receives data from the UMCP on one hand and issues operation instructions to the test bench body through UMCP on the other hand.

3.2 Universal measurement and control platform

The UMCP integrates PXI bus module and SCXI conditioning module. In this design, PXI bus module includes multi-function card PXI6251, switch card PXI8366, RS485 serial communication module PXI8432, RS232 serial communication module PXI8431, and external zero slot controller (PXI8366+PCI8366). SCXI conditioning module includes analog input card SCXI1125, analog output card SCXI1124 and communication module SCXI1349. The UMCP receives the upper command signal to realize the collection and control signal output of various parameters of the power system test, including the signal collection of pressure, flow, temperature, speed and torque, as well as the control of solenoid valve, regulating valve, motor and dynamometer.

3.3 Special adapter

The special adaptor is designed according to the measurement and control parameter requirement of the test bench and the interface type of the common cable used, it mainly completes the function of signal transfer, conditioning and adaption between the test bench body and the UMCP.

4. Design of System Software

The purpose of MCS is to monitor the system operation status by analyzing the collected data. The measurement and control software enables the computer and the data acquisition hardware to form a complete data acquisition, analysis and display system.

Based on the analysis of the testing requirements of various kinds of thermal power test bench, this paper divides the measurement and control system software into two parts, including data acquisition software and data playback analysis software, as shown in figure 2. The data acquisition software mainly completes hardware self-check, system initialization, data acquisition, real-time display and data storage and other functions. The data playback software mainly plays back the data of each channel according to the time period, displays the dynamic change process of the data of each channel, and edits and completes the generation of the test report.

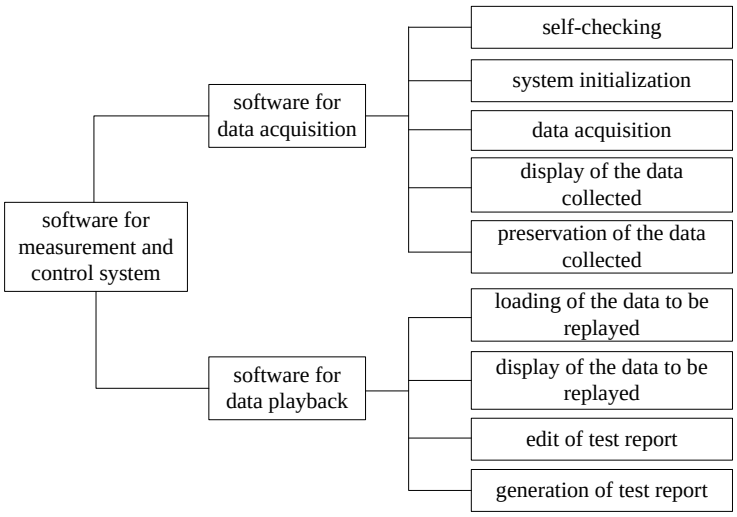

Fig.2 Software design for measurement and control system

LabWindows/CVI is an interactive C language development platform from National Instruments, which combines powerful and flexible C language platform with professional measurement and

control tools for data collection, analysis and display. Based on its integrated development environment, interactive programming methods, function panels and rich library functions, it provides an ideal software development environment for developers and designers familiar with C language to write application software such as detection system, automatic test environment, data acquisition system and process monitoring system. Figure 3 presents the main interface of data acquisition program based on LabWindows/CVI. The main function module in the panel includes “power “module, which perform self-check function and system initialization, data display module, variable pump control module and data preservation module etc..

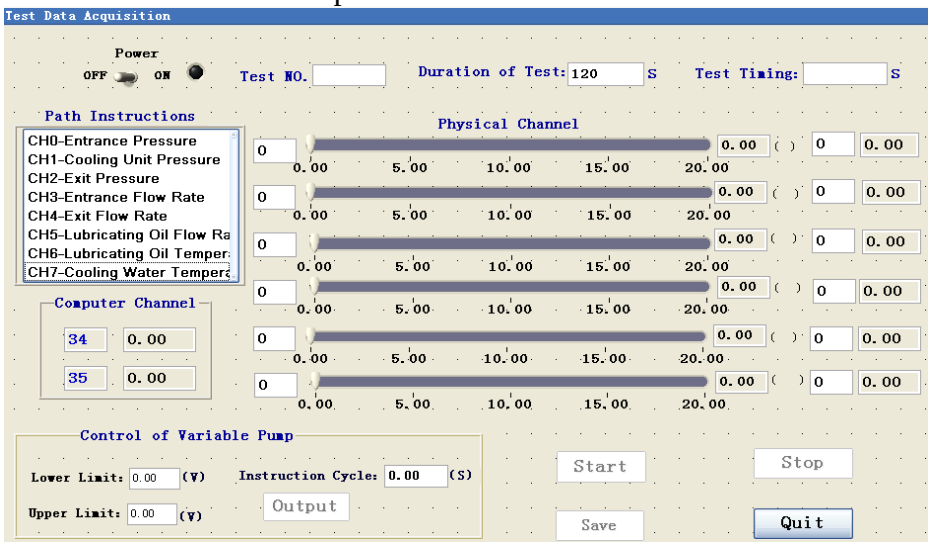

Fig.3 Main interface of data acquisition program

5. Conclusions

At present, the technical advantages of virtual instrument based on PXI bus have brought about an earth-shaking reform to the measurement and automation industry, and become the mainstream technology of ATS in the field of industrial automation. By analyzing the test requirements of various thermal power system test bench, this paper presents a software and hardware design scheme of a universal measurement and control platform based on PXI bus technology, SCXI signal conditioning technology. The proposed scheme is applicable to various thermal power systems, and can reduce the test cost and shorten development period.

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