Design and Implementation of Network Time-Frequency Test System*

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Abstract - As a key technology of the measurement of precise time-frequency signal, network test is one of the important directions of development of the test system. By means of putting the measurement equipment under remote control via Internet, the network test system provides anytime and anywhere monitoring and controlling of the measurement process. Moreover, the users can also set the measurement parameters and process the measurement results through the network test system so that the measurement interference affected by human activities can be reduced and the measurement accuracy can be improved. By doing so, this system provides widely hardware resources-sharing and system expansion, as well as enhancement of efficiency of instruments testing. This paper introduces the advantages of network test system at the beginning, then, it describes the basic components of system, operating principle and the implementation of this system in a very detail way. The results of the practical use indicate that the network test system has the advantages of flexible, stability and expansibility.

Index Terms – network test, time-frequency, remote control

1. Introduction

The technology of network has tremendously changed the way we work and the life we live. With the increasing applications of the Internet, it is an inevitable trend for virtual instrument to emerge. Network test system, which is based on virtual instrument, is a distributed computer system. In this system we have provided a platform for remote control and data processing based network, which means a large scale network data resource-sharing can be achieved conveniently. At present, the construction of virtual instrument-based network test system is a hot topic, but its focus will be different as the application purpose varies [1].

This paper describes the construction of a network time-frequency test system based on two aspects, which are the virtual instrument technology and the network technology. Network test system is mainly used in remote monitoring and controlling. Meanwhile it can accomplish the purpose of real-time monitoring and controlling of the measurement equipment through the Internet. Compared with the traditional communication method, the network test system has the advantages of wide-range utility. Generally speaking, the network test system can be realized by connecting the traditional measurement instruments with the Internet, which means the network test system can obtain the measurement information without concerning the constraints of time and space, Furthermore, some functions such as data processing, expression, delivery and storage which cannot be realized in the traditional instruments will be solved by the new system. At last, this test system not only improves the efficiency of monitoring and real-time performance, but also reduces the system cost and the workload of staff.

2. The Advantages of Networked Instrument

Compared with traditional instruments, network instruments have the following advantages:

Functions: combining the network instruments and the computer's powerful hardware resources would break through some restrictions of traditional instruments, such as data analysing and processing, expression, delivery and storage [2]. Network instruments allow the users to remote control and monitor the instruments which improve the ability of data analysis and process. At the same time, it has competitive real-time controlling and monitoring, as well as strong capabilities of online analysis. In addition, through the network the users can remotely monitor several testing processes at the same time, while different users can simultaneously monitor the same testing process.

Flexibility and interactivity: with the help of the professional computer software resources, some functions of the instruments can make successful transition from hardware to software. This kind of transition can not only save lots of hardware investment but also increase the flexibility of the system. By combining software technology and corresponding numerical algorithm, real-time data analysis and processing can be achieved in a variety of ways. Moreover, based on the graphical user interface (GUI) technology, a user-friendly and human-computer interaction can also be realized.

Network: on the basis of computer network technology and interface technology, the virtual instrument system can support a variety of communication interfaces, such as, general-purpose interface bus (GPIB), recommended standard (RS232) serial interface, and universal serial bus (USB) interface. Therefore, by using the virtual instrument technology, we can easily establish an automated test system which can achieve the network and automation of the measurement and control process.

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To sum up, the main difference between network instrument and traditional instrument is that the former one has a more powerful network function than the latter. Using the internet to test and control the object can take full advantage of existing resources and network. Meanwhile the resource can achieve the most effective and rational allocation. Therefore, instrument network is an inevitable trend of the future monitoring and controlling technology. However, in the process of realizing instrument network, the key technology of testing system focuses on software. This means that carrying out research on distributed network test system software architecture is of much significance for achieving a high-performance, fully functional network test system [3].

3. Designing and Implementing of System

A. Basic Structure of the System

Generally, a complete network test system is composed by the controller, test equipment, test software and interface bus. Use common computer as the controller, and put the design and development of test software under windows environment is able to realize automatization, simplification and visualization of test process [4].

Figure 1. The hardware components of system platform.

Fig.1 shows the hardware components of the network test system platform. It consists primarily of the following two parts:

1) The basic unit of the system: such as monitoring and control equipment, testing software and computer.

2) Communication network: the transmission medium which is used for connecting all of the units in the system.

The design of test platform of current system has already implemented two major types of hardware resources. They are the type of signal resource and the type of testing analysis. The type of signal source instruments contain Auxiliary Output Generator (AOG110), Low Noise Frequency Synthesizer (LNFS), High Resolution Offset Generator while the type of testing analysis instruments contain Spectrum Analyzer, Time Interval Counter, Frequency Stability Analyzer, Multichannel Measurement System and Phase Noise Test Set.

According to the various instruments of mentioned above, the communication interface of these instruments can also be divided into Net export form, Serial form and USB interface form, which almost cover all types of interfaces of test instruments. Therefore, based on different communication interface of the instruments of network test system, the component of their software will be different. In general, equipment with net export such as Multichannel Measurement System will only need one set of remote monitoring software while the equipment with serial interface or USB interface such as Time Interval Counter which can not be directly connected to the internet, its software will be composed of local monitoring software and remote monitoring software(local and remote). Combine all of their software can realize many functions of system, such as data acquiring and processing, resource sharing. Consequently, work coordinately to complete the monitoring and control tasks.

B. Operating Principle of the System

The system based on virtual instrument technology together with the C programming language is able to be established and realized. The main task to build a network test system is to achieve a real-time monitoring of the work status and remote controlling for network instruments. Fig.2 shows the overall structure of this network test system. Although different instruments are designed different monitoring software based on their interfaces, their operating principles are roughly the same.

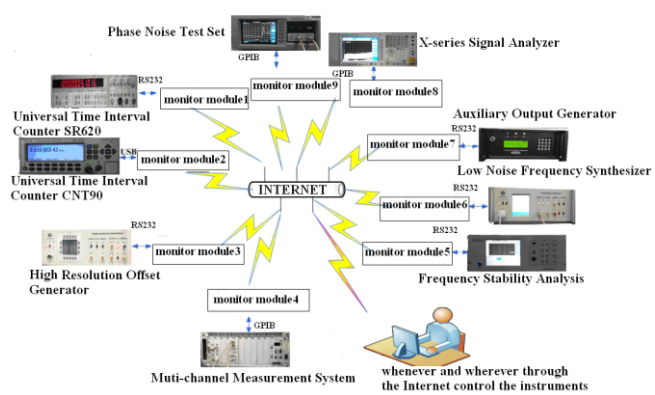

Figure 2. Overall structure of the system.

The operating principle of the network test system is monitoring and controlling the instruments based on software. In the main interface of the test system software there is a light in each of the instruments panel which indicates the mode of the instruments. When the light shows red that indicates the current system and the corresponding instrument are abnormally disconnected. If it is green, that means the

instrument is operating normally, while if the light is gray, that says there is no connection to the instrument. Then the users could click the 'connect' button on the main interface to send a connection request to supporting subsystem which corresponds to each instrument. When these subsystems receive the request, a message would be send to the test system, and the handshake protocol is established. After establishing a normal connection, a real-time remote monitoring for current operating status of each instrument can be realized. Meanwhile the users can also enter the corresponding subsystem by click on the 'open' button blow the corresponding instrument panel on the main interface of the test system, which allows the users to complete a further remote control of the instrument and several of operations such as data acquisition, analysis, display, and storage, data calculating and graphical display. Fig.3 shows the workflow of the system.

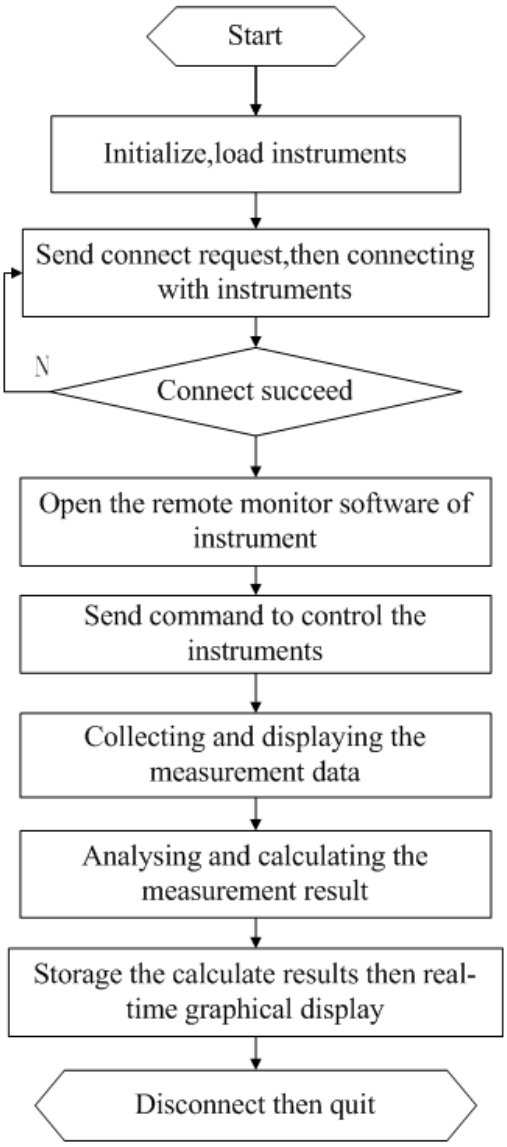

Figure 3. The workflow of the system.

C. *Realizing of the System*

The design and development of this system has covered all the functions of the original equipment. Besides, according to the requirements of the network test system, the ultimate system platform can complete some additional functions such as loading and unloading equipment, real-time remote control equipment by sending commands, real-time data display and graphical display, real-time data analysis and processing and acquisition of instrument status information and response to remote requests [5].Fig.4 shows the module block diagram of this system, which includes the management module, the remote monitoring module and the processing module.

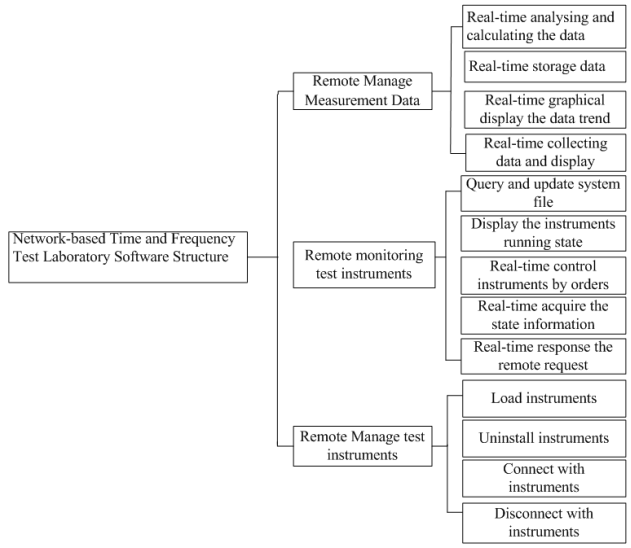

Figure 4. The module block diagram of this system

The management module of measuring instruments can fulfill the function of loading and unloading of the instrument, connecting and disconnecting between the system and instruments, which means that the users can install and uninstall monitoring software of instrument into the system at any time according to their needs. Besides, they can also establish or disconnect with the instruments at any time. Fig.5 shows the main interface of the system under instruments connected.

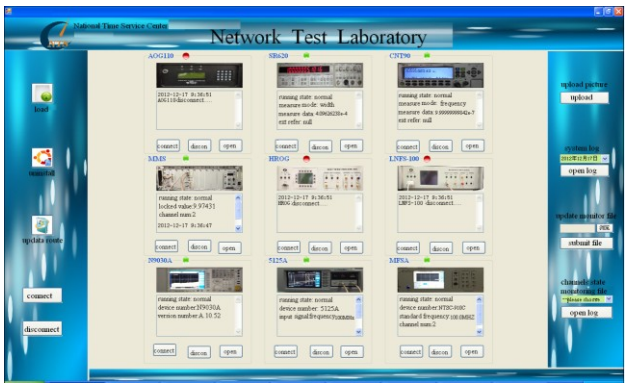

Figure 5. Main interface of the system

The monitor module of measuring instrument will circulate if the users have already successfully established the connection through the main interface of the system [6]. And then, trigger the 'open' button corresponding to the monitoring software of the instrument which needs to be controlled. In order to control the instruments and obtain the real-time status information, the users should send request that can be identified by certain instruments. By doing this, the users can also update and examine the system files as well as monitor the current operating status of each device.

The processing module of measuring instruments not only has the ability to collect and display the real-time data produced by the different instruments, but also can invoke the database to classify the data collected. Furthermore, according to the needs of users, the system can realize various data analysis and calculations, such as stability analysis and variation analysis. Besides the trend of the measure results and analysis can also be displayed in real-time.

4. Experiment and Results

From the above analysis, this paper will take the time interval counter in this system as an example to analyse and verify the practical effect of the optimal design. The communication between time interval counter and computer is accomplished through RS232 serial interface. After entering the main interface above as shown in Fig.5, users can click the 'link' button corresponding to the time interval counter, then click 'open' butter to enter the interface of time interval counter. Fig.6 shows the remote monitoring software interface of time interval counter. The users can perform such remote control operations of the software to

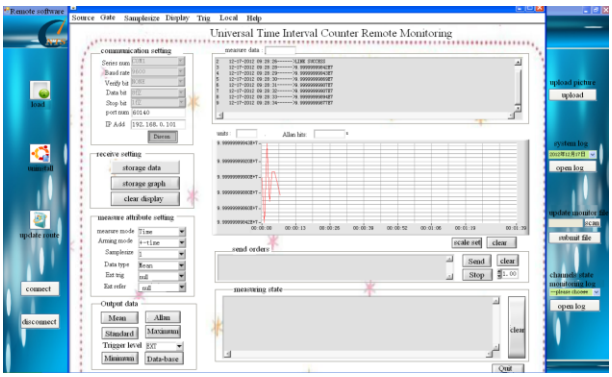

Figure 6. The remote monitoring software interface of time interval counter

achieve data acquisition, display on the graphic widget, real-time storage and display by using every widget on the software interface [7]. The system resources occupation of this software is less than 20% when it runs on a computer (Dual-core 3GHz CPU) [8]. Therefore, this software has the advantages of stability, high precision of measurement and control, good real-time property and strong anti-interference capability, which is in line with the expected design requirements and suitable for practical use.

5. Conclusions

Traditional measuring instruments can only be defined and produced by the manufacturer. Therefore, the drawback of traditional instruments is their low flexibility and expansibility [9]. Since they only can be used as a simple imitation of the manual testing steps. Hence, they are very inconvenient under some complex circumstances. While network test system is integrated the computer technology and network technology deeply. It requires not only the rational planning of virtual instrument to realize network, but also need to improve the various management functions of the system, such as the design of terminal software. This paper starts from the overall objectives and functions of the new system, then carrying out the specific design and implementation.

The construction of network test laboratory system not only breaks the limitations of the traditional measuring instruments, but also derives from the practical needs. The realization of the entire system is based on software programming, which has made fully use of the advantages of LabWindows/CVI, such as abundant class library resources, flexible interface arrangement and strong data processing capabilities. In addition, according to the needs of the future, users can add new instruments and devices to this system to expand its size and fulfill a variety of complex measurement task.

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