特别说明

Using virtual instrument multi-parameter measurement

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[Abstract] The concept of virtual instruments and the advantages of virtual instrument with elaborate multi-parameter measurement of the child design process.

[Key words] virtual instruments; multi-parameter measurement.

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1. Introduction

Instrumentation for a long time in scientific experiments occupy a very important role, is also the instrument of our physical education, physics experiment to carry out an important foundation. The development of computer technology and applications to the instrument in the field has brought profound changes, in particular the emergence of virtual machines and applications can be said to be a revolution in the field of equipment, but for a long time, whether they are in our physical education activities, Still dominated by traditional instruments, computers and measuring instruments are basically still in the isolated state, which will greatly affect our understanding of-the-art equipment and hands, so learning some basic knowledge of the virtual instrument is quite necessary.

The virtual instrument panel has a virtual personal computer equipment. It is common personal computer-based simulation software function and control of hardware components. Operators through friendly graphical interface and graphical programming language to control the operation of equipment, complete testing by the volume of the collection, analysis, judge, show that the data generated and stored. Virtual machines have the following characteristics.

1） Virtual instruments to make full use of computer hardware and software resources to break through the traditional instruments in data processing, storage and expression, and other restrictions, have made traditional instruments unparalleled.

2） Software is the core of the virtual instrument. In general computer platform to configure the appropriate modular hardware, the next great deal of work is the preparation of the software.

3）Virtual instrument structure flexible, easy to upgrade, virtual instrument hardware structure is relatively fixed, and the software does have a great deal of flexibility to upgrade the operating system or software, virtual machines can be updated replacement.

Virtual machines for its outstanding merits, have shown strong vitality, and the emergence of widely used test equipment will have a very profound impact.

2 .the composition and apparatus operating principle

With the completion of a number of parameters of the equipment has been tested in the field of measuring a real problem with traditional instruments often very difficult to achieve. The most common is by increasing the types

of equipment to multi-parameter measurements, but this only increased the cost of measurement, but also reduces the reliability.

The use of virtual instrument design, can easily achieve a number of parameters of measurement, the instruments to test the temperature, force, pressure, displacement, mechanical vibration parameters 5, a total of 6-channel, the channel testing with the exchange, At the same time can be measured one or more of the parameters. We use temperature, force, pressure, displacement, vibration sensor signal conditioning devices with the completion of the acquisition and signal amplification; the use of data acquisition cards to complete A / D conversion by the computer to complete the final data analysis, to deal with. Hardware equipment is mainly responsible for signal conditioning and analog-to-digital conversion, through the bus and PC computers to exchange data. Users to use the mouse or keyboard directly in the virtual panel on the operation can be easily completed the parameters of the test, analysis, printing and other functions.

3. the instrument hardware design

Virtual hardware equipment, including computer hardware and equipment hardware consists of two parts, of which only equipment needed is the hardware design. The

The hardware equipment from the main sensors, signal the same token, data acquisition cards and four computer parts. To cover a larger range and meet certain measurement accuracy, the choice of different parameters measuring range of more than sensors. For example, force measurement in the range of 0-1KN, precision measuring 0.3% (FS), should be measured by the upper limit of the four sensors 1KN.3KN.5KN.10KN assistance to cover their range. NI signal conditioning devices selected companies ("Nationnal Instruments", National Instruments, is a virtual production equipment components well-known company) produced a SCX1-1122 multiplexer, SCX1 a 1122 maximum 16-channel, Strain gauge conditioning, thermistor, RTD, thermocouple voltage signal and communication, process control switch the type of signal conditioning.

In accordance with the use of the computer is a laptop or desktop, choose different data acquisition board. In order to facilitate the portability of this equipment is used in portable computers. NI data acquisition card is a Ai Corporation DAQCard a 16XE a 50 for 16-bit A / D converter sampling rate for single-200K, multi-channel at 20K. The measurement accuracy of this instrument to 0.3 percent. 16 of the A / D fully meet this requirement; 20K sampling rate by conservative method can also be reached 5kHZ bandwidth, in line with the general body vibration parameters of the dynamic testing requirements of the rest of the temperature, force, pressure and displacement are Static parameters of the equipment not too high frequency bandwidth

4.software design

Virtual instrument software is the core of the software design quality has a direct impact on the performance of virtual machines. We will of the entire software design for the open structure of the users according to their actual requirements for software modification or addition. The main instrument of this software from data acquisition card driver module, the virtual panel modules, each module measuring parameters, calibration and error correction module composed of four parts.

Virtual panel user interface that is user devices to exchange information with the bridge. The instrument panel layout of the reasonable and easy to operate, highly interactive, user every step of the operation can be prompt and immediate response, and provide on-line help.

DAQ driver into the preparation of dynamic-link library (DLL) form and to provide source documents. Have the ability to develop the company's customers do not understand the acquisition card interface circuit and principles

of the instrument can be modified or expanded features.

Measuring the parameters of modular software structure, is a reasonable division of the measurement modules, and enhance the use of common parts of the general, and to provide the parameters of the complex graphics and tables output.

Calibration and error correction module, not only on the sensor can be calibrated to amend the source of error, but also the use of the average, and so on the relevant calculation of inhibition and to reduce interference and improve the measurement accuracy and increase the reliability of measurement.

The apparatus of the software used NI's Lab Windons software development platform for the preparation of the procedures in running under the Windons98.

5. Conclusion

Using virtual instrument multi-parameter measurements simplifying the hardware can greatly reduce the cost of equipment and increase the reliability of the test. Virtual machines on the traditional instruments of the concept of a major breakthrough in its flexible structure, the operation simple and intuitive, easy to upgrade and many other advantages, has become a complex apparatus and instrument of choice for multi-functional design. With the computer in China to further universal, virtual instrument is bound to be more widely used, it is bound to make physical education a greater contribution.

虚拟仪器实现多参数测量

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［摘要］介绍虚拟仪器的概念和优点，详细阐述用虚拟仪器实现多参数测童的设计过程。

［关键词］虚拟仪器；多参数测量；

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一、引言

仪器仪表长期以来在实验科学中占据着十分重要的地位，仪器仪表也是我们进行物理教学,开展物理实验的一个重要基础。计算机技术的发展和应用，给仪器仪表领域带来了深刻的变化，特别是虚拟仪器的产生和应用，可以说是仪器领域的一次革命，但长期以来，不论是在我们的物理教学活动中，还是传统仪器占主导地位，计算机与测量仪器基本上还处于互不相关的状态，这必将大大影响我们对于先进仪器的了解和掌握，因此学习一些虚拟仪器的基本知识是颇必要的。

虚拟仪器是指具有虚拟面板的个人计算机仪器。它由通用个人计算机，模拟化功能硬件和控制软件组成。操作人员通过友好的图形界面及图形化编程语言控制仪器的运行，完成对被测试量的采集、分析、判断、显示、存储及数据生成。虚拟仪器具有以下几个特点。

1.虚拟仪器充分利用计算机的软硬件资源，突破了传统仪器在数据处理、表达和存储等方面的限制，取得了传统仪器无可比拟的效果。

2.软件是虚拟仪器的核心。在通用计算机平台上配置合适的模块化硬件设备后，接下来

的大量工作便是软件的编制。

3.虚拟仪器结构灵活，容易实现升级、虚拟仪器的硬件结构是相对固定的，而软件却具有很大的灵活性，对软件或操作系统升级后，虚拟仪器就可以更新、换代。

虚拟仪器以其突出的优点，显示了强大的生命力，它的出现和广泛使用，将对测试仪器产生极为深刻的影响。

二、仪器构成和工作原理

用一台仪器完成多个参数的测量一直是测试领域的一个实际问题，用传统仪器往往很难实现。最常见的是靠增加仪器的种类来实现多参数的测量，但这不仅增加了测量费用，而且还降低了可靠性。

采用虚拟仪器的设计方法，可以方便地实现对多个参数的测量，本仪器可以测试温度、力值、压力、位移、机械振动5个参数，共6个通道，各通道测试功能具有交换性，可同时测量一种或多种参数。我们采用温度、力值、压力、位移、振动传感器配以信号调理器完成对信号的采集和放大;使用数据采集卡完成A/D转换最后由计算机完成数据的分析、处理。仪器硬件主要负责信号调理和模数转换，通过PC总线与计算机进行数据交换。用户利用鼠标或键盘直接在虚拟面板上进行操作，即可轻松完成各种参数的测试、分析、打印等功能。

三、仪器硬件设计

虚拟仪器硬件包括计算机硬件和仪器硬件两部分，其中只有仪器硬件是需要设计的。本仪器的硬件主要由传感器、信号同理器、数据采集卡和计算机四部分组成。为覆盖较大测量范围并满足一定的测量精度，各参数选用不同测量范围的多只传感器。例如力值测量范围为0-1KN，测量精度0.3%(F.S)，则需用测量上限分别为1KN.3KN.5KN.10KN的四只传感器来援盖其测量范围。信号调理器选用NI公司(“Nationnal Instruments ”、美国国家仪器公司，是一家生产虚拟仪器组件的著名公司)生产的SCX1一1122型多路复用器，SCX1一1122最大可达到16通道，可调理应变片、热敏电阻、RTD、热电偶和交流电压信号，程序控制切换调理信号类型。

按照使用的计算机是台式机还是便携机，可选择不同的数据采集板。为便于携带，本仪器采用的是便携式计算机。数据采集卡是NI公司的DAQCard一Ai一16XE一50，为16位A/D转换器采样速率单通道方式为200K，多通道时为20K。本仪器的测量精度为0.3%。16位的A/D完全可满足这一要求;20K的采样速率按保守的算法也可达到5kHZ的带宽，符合一般机构振动参数的动态测试要求，其余的温度、力值、压力、位移都是静态参数，对仪器的频率带宽没有太高的要求。

四、软件设计

软件是虚拟仪器的核心，软件的设计质量，直接影响虚拟仪器的性能。我们将整个软件设计为开放式结构用户可根据自己的实际使用要求，对软件进行修改或增补。本仪器的软件主要由数据采集卡驱动模块、虚拟面板模块、各参数测量模块、校准及误差修正模块四部分组成。

虚拟面板即用户界面，是用户与仪器交流信息的桥梁。本仪器的面板布局合理，易于操作，具有高度的人机交互性，用户的每一步操作都能得到提示和即时响应，并提供在线助。

数据采集卡驱动程序编写成动态链接库(DLL)形式，并提供源程序文件。有开发能力的

用户，不需了解采集卡的电路结构和接口原理，便能对仪器功能进行修改或扩展。

各参数测量软件采用模块化结构，既合理划分各测量模块，又增强采用公用部分的通用性，并提供复杂参数的图形和表格输出功能。

校准及误差修正模块，不仅可对传感器进行校准，对误差源进行修正，而且还采用平均、相关等计算方法抑制和降低干扰，提高测量精度和增加测量的可靠性。

本仪器的软件采用NI公司的Lab Windons软件开发平台进行编制，程序运行在Windons98下。

五、结束语

用虚拟仪器实现多参数的测量能够简化硬件，极大地降低仪器的成本，增加测试的可靠性。虚拟仪器对传统仪器概念的重大突破，它以结构灵活、操作直观简单、容易升级等众多优点，已成为复杂仪器和多功能仪器的首选设计方式。随着计算机在我国的进一步普及，虚拟仪器必将得到越来越广泛的应用，也必将对物理教学作出更大的贡献。

Virtual Digital Oscilloscope Design and Implementation

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[Abstract] The combination of a virtual digital oscilloscope design and development, introduced the basic components of virtual machines, and focuses on the graphical programming language based on LabVIEW virtual instrument programming methods and technology.

[Key words] Virtual instruments; digital oscilloscope; LabVIEW;

With the development of computer technology and traditional instruments to the computerized direction. Virtual instrument is the new 90's concept. Virtual instrument technology with the development of automatic test marks the twenty-first century and electronic measuring instruments in the field of technological development an important direction. The so-called virtual instruments, that is, in general-purpose computer platform definition and design of testing apparatus, the computer user, as is the use of a specially designed electronic device.

Traditional desktop machines by the equipment manufacturers to design and good function of the definition of an enclosed structure, it has a fixed input / output interface and equipment operation panels, each instrument to achieve a particular type of measurement functions, and to determine the way to the users. Equipment from the general design model of view, is nothing more than an instrument of data collection, analysis, processing, human-computer interaction and display parts and other components of the overall function modules. Therefore, we can imagine that, if necessary, the data acquisition hardware and general computer support, software design through the realization of the full functionality of equipment, which is the core of virtual instrument design. Compared with traditional instruments, virtual instruments in addition to performance, ease of use, users can customize and so has many advantages, in engineering applications and socio-economic benefits are also an outstanding advantage. On the one hand, China's high-end desktop machines such as digital oscilloscope, spectrum analyzer, logic analyzer and others rely mainly on imports, these machines processing complex, requiring high levels of manufacturing, production breakthroughs have difficulty using virtual instrument technology can only procurement of the necessary general data acquisition hardware to design their own equipment system; on the

other hand, the user can be some of the advanced digital signal processing algorithms used in the design of virtual instrument to provide the traditional desktop machines do not have the function, but also can be configured by software the realization of multi-functional integrated instrument design. Therefore, it can be said of virtual instrument measuring instruments on behalf of the future direction of design development.

Virtual instrument technology is developing rapidly in foreign countries, the United States National Instruments (NI company) to represent a group of vendors are already available in the market based on virtual instrument technology commercialization instruments designed products. Digital Oscilloscope in scientific research and engineering design of a widely used general-purpose equipment. The following combination of a virtual digital oscilloscope design and development of virtual instrument details the basic composition and based on the LabVIEW graphical programming language of the virtual instrument programming methods and technology.

1 Virtual Oscilloscope structure and composition of

The virtual digital oscilloscope PCI bus by a multi-function data acquisition card and the corresponding software. They are installed on a PC running the Windows95/98/NT machine (recommended configuration in PENTIUM Ⅱ / 233 and above), which constitute a powerful digital oscilloscope can be stored.

1.1 Data Acquisition Card

PCI bus transfer rate of high-data throughput large future data acquisition board design mainstream. The design uses the PCI-1200 data acquisition card is a better value for money products, support DMA mode and dual-buffer mode, ensuring the uninterrupted real-time signal acquisition and storage. It supports a unipolar and bipolar analog signal input, signal input in the range of -5 ~ +5 V and 0 ~ 10V. Provide 16 single-ended / 8 differential analog input channels, 2 independent DA output channels, 24-line TTL digital I / O, 3 16-bit timer counters, such as multiple functions. These features allow us not only can use the card design virtual oscilloscope, but also can design a virtual function generator or virtual counter, to achieve a multi-purpose card. Of course, limited to funding conditions, we chose the PCI-1200 card sampling rate can only be reached 100kS / s, the actual Oscilloscopes, this much can not meet the signal bandwidth requirements. Currently on the market sampling rate up to 200MS / s of PCI data acquisition card has been a mature product, the technical realization of high-bandwidth virtual oscilloscope problem does not exist. When the actual measurement input signal through the BNC connector from the input data acquisition card to enter the collection.

1.2 Instrument Function

The virtual digital oscilloscope design reference to HP's desktop dual-channel digital storage oscilloscope HP54603B functions, and instrumental analysis and processing functions have expanded. Instrument main features include: dual-channel signal input, trigger control, access control, time-base control, waveform display, parameter automatic measurement, spectrum analysis, waveform, such as storage and playback. The virtual digital oscilloscope also provides network interface, allowing the adoption of TCP / IP protocol network sharing or remote control apparatus. Table 1 is the virtual digital oscilloscope with HP54603B function table.

In addition to financial reasons make the selected sampling rate data acquisition card HP54603B below, this virtual oscilloscope display, measurement, analysis, storage and external connections so as not less than even higher than HP54603B

2 Software Design and Implementation

2.1 Software Development Environment

Virtual Digital Oscilloscope software design using advanced graphical programming language LabVIEW 5.1 for Windows98/NT. The main features of LabVIEW programming is divided into a number of virtual instruments basic function modules (equivalent to hardware design of integrated circuits), the representative pin module input / output interface. Programmers through interactive means, the use of graphical block diagram design method to complete the virtual instrument measurement and analysis of the logic and functional design.

LabVIEW program design process and design equipment people very close to the thinking process, the program block diagram on the realization of the program code function, to avoid a general idea of program design from the diagram to the process by cutting red tape. Another advantage of LabVIEW programming is the software interface design and functional design to an independent open, modify interactive interface to the entire process without debugging, which is designed as instruments of such a complicated operation panel in terms of man-machine interface is very convenient. LabVIEW also provides a function for users to expand functionality, the use of LabVIEW in the Code Interface Node (CIN), can call using the traditional C programming language to write code; the use of LabVIEW in the Call Library Function can call the standard dynamic link library (. DLL). In short, LabVIEW as a graphical programming language environment for the development of virtual instrument provides a fast, convenient and powerful software tools.

2.2 The main function modules

Generally speaking, virtual oscilloscope software control by the completion of signal acquisition, processing and display. System software in general, including data acquisition, waveform display, parameter measurement, spectrum analysis and waveform storage and playback, such as the five modules.

2.2.1 Data Acquisition Module

Data acquisition module to complete the major data acquisition control, including trigger control, channel selection control, time-base control. Of which:

• trigger control, including the trigger mode, trigger slope, trigger level control;

• Select the main control channel or dual-channel single-channel measurement;

• Time-based control of the main control acquisition card scanning rate, each channel scanning frequency (sampling number).

2.2.2 Waveform Display Module

Software provides three types of waveform display modes:

• AB A & B mode: by displaying channel selection button and Cong, can show a channel or two-channel input signal waveform;

• XY mode: When the two channels are in a gated state, use this mode to display Lissajous (Lissajous) graphics, phase or frequency measurement;

• A + B AB model: When the two channels are in a gated state, use this mode to display two-channel signal algebraic sum, after the subtraction of the waveform.

2.2.3 Parameter Measurement Module

Parameter measurement module HP54603B the parameters of the main analog measurement functions, including Vrms, such as the completion of 12 voltage and frequency parameters, cycle time parameter 7 measurement and

display its results.

2.2.4 Spectrum Analyzer Module

Spectrum analysis module fast FFT algorithm, the completion of the frequency domain signal analysis. The spectrum analyzer can be controlled include:

• Windows choice, provided the nine kinds of spectral analysis window;

• Log / Linear choice, provided the coordinates of two kinds of display mode;

• Display Unit choice, provided the eight kinds of units.

2.2.5 data storage and playback module

Krupp magnetic button controls for data storage Liao Krupp button control from the data file to read data. Main panel provides two file name input box, the former a signal waveform data file name input box, after a sampling period for the file name input box, these two documents from the write function and load sharing functions. From the floppy or hard disk to read the data with real-time acquisition of data, can automatically and display waveform parameter measurement and retained in the display window (display mode can be set to any of the three models a), may also need to set up in accordance with spectral analysis.

2.3 The main control structure

2.3.1 Measurement and Control Structure

Through logical button "measuring" control whether or not to conduct measurement; through the logic key "channel" control channel selection.

2.3.2 automatically adjust the scan rate of control structure

By the logic of key group "Automatic", "manual" to control the scan rate is automatically adjusted or manually adjust the scan rate.

2.3.3 display, memory display control structure

Logical drive from a dual function keys "normal / memory" control, the default for the normal show. In a normal state, can only show that A, B two-channel input signal waveform 2; in memory state, the maximum memory display A, B two-channel input signal 17 waveform (A memory channel can display 16 Group signal data, B-channel memory can only show 1 signal data). In practice, memory display the main signal used to measure jitter or a comparative analysis of two or more of the signal waveform.

This article describes a virtual digital oscilloscope desktop not only has the general function of digital storage oscilloscope, and give full play to a powerful computer and software design flexibility, the main technical characteristics of the performance in the following:

(1) the use of LabVIEW graphical programming language and object-oriented programming techniques, software development, high efficiency, good operability and maintainability;

(2) digital storage oscilloscope for an increase of frequency domain analysis functions;

(3) make full use of the computer storage and peripherals connected to the ability to measure results and waveforms can be directly or through printouts network sharing;

(4) hardware with the open, to allow the adoption of upgrading hardware to improve its performance;

(5) hardware in the same conditions, may amend or add software modules to form a new device features.

Virtual instrument design has become a test and instrument technology as an important direction of development. With high-speed A / D chip and further integrated circuit, could be envisaged in the near future, a virtual instrument software installed on a standard PC into a multifunctional measuring instrument station, fundamentally changing the current development of special equipment and production, has broad application prospects and huge potential economic benefits.

虚拟数字示波器的设计与实现

杨乐平 吕英军

[摘 要] 结合一个虚拟数字示波器的设计开发，介绍了虚拟仪器的基本组成，并重点介绍了基于图形化编程语言 LabVIEW 的虚拟仪器编程方法与实现技术。

[关键词] 虚拟仪器;数字示波器;LabVIEW;

随着计算机技术的发展，传统仪器开始向计算机化的方向发展。虚拟仪器是９０年代提出的新概念。虚拟仪器技术的提出与发展，标志着二十一世纪自动测试与电子测量仪器领域技术发展的一个重要方向。所谓虚拟仪器，就是在通用的计算机平台上定义和设计仪器的测试功能，使用者操作这台计算机，就象是在使用一台专门设计的电子仪器。

传统台式仪器是由仪器厂家设计并定义好功能的一个封闭结构，它有固定的输入／输出接口和仪器操作面板，每种仪器实现一类特定的测量功能，并以确定的方式提供给用户。从一般的仪器设计模型看，一种仪器无非是由数据采集、分析处理、人机交互和显示等几部分功能模块组成的整体。因此，我们可以设想在必要的数据采集硬件和通用计算机支持下，通过软件设计实现仪器的全部功能，这就是虚拟仪器设计的核心。与传统仪器相比，虚拟仪器除了在性能、易用性、用户可定制性等方面具有更多优点外，在工程应用和社会经济效益方面也具有突出优势。一方面，目前我国高档台式仪器如数字示波器、频谱分析仪、逻辑分析仪等还主要依赖进口，这些仪器加工工艺复杂、对制造水平要求高，生产突破有困难，采用虚拟仪器技术可以通过只采购必要的通用数据采集硬件来设计自己的仪器系统；另一方面，用户可以将一些先进的数字信号处理算法应用于虚拟仪器设计，提供传统台式仪器不具备的功能，而且完全可以通过软件配置实现多功能集成的仪器设计。因此，可以说虚拟仪器代表了未来测量仪器设计发展的方向。

虚拟仪器技术目前在国外发展很快，以美国国家仪器公司（NI 公司）为代表的一批厂商已经在市场上推出了基于虚拟仪器技术而设计的商品化仪器产品。数字示波器是在科学研究和工程设计中广泛应用的一种通用仪器。下面结合一个虚拟数字示波器的设计开发具体介绍虚拟仪器的基本组成和基于图形化编程语言 LabVIEW 的虚拟仪器编程方法与实现技术。

1 虚拟示波器的结构与组成

本虚拟数字示波器主要由一块 PCI 总线的多功能数据采集卡和相应的软件组成。将它们安装在一台运行 Windows95/98/NT 的 PC 机上（建议配置在 PENTIUMⅡ／233 以上），即构成一个功能强大的可存储数字示波器。

1.1 数据采集卡

PCI 总线传输速率高　数据吞吐量大　是今后数据采集板卡设计的主流。本设计采用的 PCI－1200 数据采集卡是一块性价比较好的产品，支持 DMA 方式和双缓冲区模式，保证了实时信号不间断采集与存储。它支持单极和双极性模拟信号输入，信号输入范围分别为－5～＋5V 和 0～10V。提供 16 路单端 / 8 路差动模拟输入通道、2 路独立的 DA 输出通道、24 线的 TTL 型数字 I / O、3 个 16 位的定时计数器等多种功能。这些功能使得我们不仅可以用该卡设计虚拟示波器，也可以设计虚拟函数发生器或虚拟计数器，做到一卡多用。当然，限于经费条件，我们选择的 PCI－1200 卡的采样速率只能达到 100kS / s，对实际示波器而言，这远不能满足信号带宽的要求。目前市场上采样速率达 200MS / s 的 PCI 数据采集卡已有成熟产品，技术上实现高带宽的虚拟示波器不存在问题。实际测量时输入信号通过 BNC 接头从输入端子进入数据采集卡进行采集。

1.2 仪器功能

本虚拟数字示波器设计参考了 HP 公司的双通道台式数字存储示波器 HP54603B 的功能，并在仪器分析和处理功能上有所扩展。仪器主要功能包括：双通道信号输入、触发控制、通道控制、时基控制、波形显示、参数自动测量、频谱分析、波形存储和回放等。本虚拟数字示波器还提供网络接口，允许通过 TCP / IP 协议实现网络仪器共享或远程控制。表 1 是本虚拟数字示波器与 HP54603B 的功能对照表。

除了由于经费原因使得所选数据采集卡采样速率低于 HP54603B 外，本虚拟示波器在显示、测量、分析、存储和外部连接等方面的功能都不低于甚至高于 HP54603B

2　软件的设计与实现

2.1 软件开发环境

虚拟数字示波器软件设计采用了先进的图形化编程语言工具 LabVIEW 5.1 for Windows98 / NT。LabVIEW 编程的主要特点就是将虚拟仪器分解为若干基本的功能模块（相当于硬件设计中的集成电路），模块的引脚代表输入 / 输出接口。编程者可以通过交互式手段，采用图形化框图设计的方法，完成虚拟仪器的逻辑和测量分析功能设计。

LabVIEW 程序设计过程与人们设计仪器的思维过程十分相近，程序框图就实现了程序代码功能，避免了一般程序设计从框图构思到程序表示的繁琐。LabVIEW 编程的另一个优点是将软件的界面设计与功能设计独立开来，修改人机交互界面无需对整个程序进行调试，这对设计像仪器操作面板这样复杂的人机界面而言是十分方便的。LabVIEW 还为用户提供了函数扩展功能，利用 LabVIEW 中的 Code Interface Node（CIN），可以调用用 C 等传统编程语言写的程序代码；利用 LabVIEW 中的 Call Library Function 可以调用标准动态链接库（.DLL）。总之，LabVIEW 作为图形化编程语言环境，为虚拟仪器开发提供了一种快捷、方便和功能强大的软件工具。

2.2 主要功能模块

概括地讲，虚拟示波器主要由软件控制完成信号的采集、处理和显示。系统软件总体上包括数据采集、波形显示、参数测量、频谱分析及波形存储和回放等五大模块.

2.2.1 数据采集模块

数据采集模块主要完成数据采集的控制，包括触发控制、通道选择控制、时基控制等。其中：

·触发控制包括触发模式、触发斜坡、触发电平控制；

·通道选择主要控制单通道或双通道测量；

·时基控制主要控制采集卡扫描率、每一通道扫描次数（取样数）。

2.2.2 波形显示模块

软件提供了三种波形显示模式：

·A B A&B 模式：通过显示通道选择按键撞驹和撞聪，可以任意显示某一通道或两通道输入信号的波形；

·X Y 模式：当两通道都处于选通状态时，使用此模式来显示李沙育（Lissajous）图形、测量相位差或频率；

·A＋B A－B 模式：当两通道都处于选通状态时，使用此模式来显示两通道信号代数相加、相减后的波形。

2.2.3 参数测量模块

参数测量模块主要模拟 HP54603B 的参数测量功能，完成包括 Vrms 等 12 个电压参数和频率、周期等 7 个时间参数的测量并显示其测量结果。

2.2.4 频谱分析模块

频谱分析模块采用快速 FFT 算法，完成频域信号分析。可实现的频谱分析控制包括：

·Windows 选择，提供了 9 种频谱分析窗口；

·Log / Linear 选择，提供了 2 种坐标显示模式；

·Display Unit 选择，提供了 8 种单位。

2.2.5 数据存储和回放模块

按键擐磁虜控制是否进行数据存储　按键撄僚虜控制是否从数据文件中读取数据。主面板提供了两个文件名输入框，前一个为信号波形数据文件名输入框，后一个为采样周期文件名输入框，这两个文件由写盘功能和读盘功能共用。从软盘或硬盘上读取的数据同实时采集的数据一样，能够进行自动参数测量以及显示波形并保留在显示窗口（显示模式可以设置为三种模式中的任意一种），还可以根据需要设置进行频谱分析。

2.3 主要控制结构

2.3.1 测量控制结构

通过逻辑按键“测量”控制是否进行测量；通过逻辑按键“通道”控制通道选择。

2.3.2 自动调整扫描率控制结构

由逻辑按键组“自动”、“手动”来控制是自动调整扫描率还是手动调整扫描率。

2.3.3 正常显示、记忆显示控制结构

由双功能逻辑驱动键“正常/记忆”控制，缺省为正常显示。处于正常状态时，最多只能显示 A、B 两通道输入的 2 个信号的波形；处于记忆状态时，最多可以记忆显示 A、B 两通

道输入的 17 个信号的波形（A 通道可记忆显示 16 组信号数据，B 通道只能记忆显示 1 组信号数据）。在实际应用中，记忆显示功能主要用于测量信号的抖动情况或比较分析两个以上的信号波形。

本文介绍的虚拟数字示波器不仅具有一般台式数字存储示波器的功能，而且充分发挥了微机强大的功能和软件设计的灵活性，主要技术特点表现在：

（1）采用图形化编程语言 LabVIEW 和面向对象编程技术，软件开发效率高，可操作性和可维护性好；

（2）为数字存储示波器增加了频域分析功能；

（3）充分利用了计算机的存储与外设连接的能力，测量结果和波形可直接打印输出或通过网络共享；

（4）硬件具有开放性，允许通过升级硬件来提高其性能；

（5）在相同硬件条件下，可以通过修改或增加软件模块，形成新的仪器功能。

虚拟仪器设计已经成为测试与仪器技术发展的一个重要方向。随着高速 A / D 芯片和电路的进一步集成化，可以设想在不远的将来，一台安装有虚拟仪器软件的标准微机成为一个多功能的测量仪器站，从根本上改变目前专用仪器的研制和生产方式，具有广阔的应用前景和巨大的潜在经济效益。