

# Application of Virtual Instrument in Electronic Education

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## Abstract

Virtual instrumentation is defined as the combination of measurement and control hardware and application software with industry-standard computer technology to create user-defined instrumentation systems. Since the birth of virtual instrument (VI), it enters rapidly into the industrial production field, and Research and Development (RD) field. It can improve production quality, shorten development time, and increase production efficiency. So it is widely used in companies. In order to improve the ability of students' using new technology and equipment, and save daily funds, we try to use virtual instrument instead of traditional instruments for analysis and design circuits. The paper adopts the software-LabVIEW and many hardware modules of NI (National Instrument) to study of virtual instrument applied in electronic education of vocational college. The research result of this work can provide a theoretical and practical foundation for vocational education of virtual instrument in the future.

**Keywords:** virtual instrument, LabVIEW, electronic education, vocational college

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## 1. Introduction

National Instruments' LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming language that is commonly used throughout academia, industry, and government. Thus some familiarity with this vital tool is important for undergraduate electrical engineering (EE) students [1]. As the perfect combination of measurement and computer technology, virtual instrument is got fast development. In addition, it brings great influence to measurement technology and experimental equipment. Virtual instrument technology applies comprehensive computer technology, digital signal processing technology, standard Bus technology and software engineering method. It represents the development direction of measurement instrument and automatic testing system. Virtual instrument consists of three main parts: obtain and acquisition of signal, analysis and processing of data, expression and output of result. Moreover, analysis and processing of data is the most important part.

Now the students' training should meet the demand of companies and society, especially for higher vocational students [2]. Therefore, the application of instruments is very necessary. To the application of traditional instruments in electronic experiment, we need usually signal source (including DC regulated power supply, and sine, rectangular, triangular waveform generator), digital oscilloscope, digital multimeter, frequency meter, etc. Figure 1 shows the collocation of traditional instrument and equipment in electronic experiments.

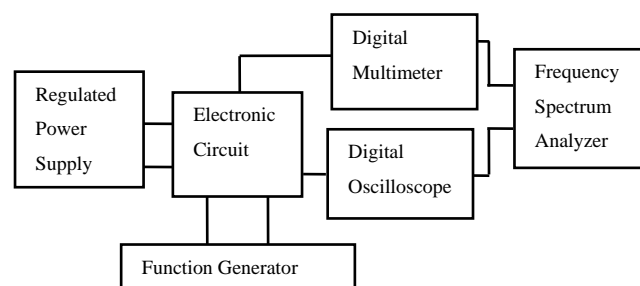


Figure 1. Collocation of Instrument and Equipment in Lab

In Figure 1 we can see, there are many instruments and equipments in traditional laboratory. They cost very much, but cannot well meet the requirement of experiments. For example, traditional instruments can only measure and display relevant data and parameters. However, they cannot compare and analyze the data and their curves of different time or different frequency. Virtual instrument technology can very well remedy the defects.

## 2. Construction of Virtual Instrument System

When virtual instrument is applied in electronic analysis, it need have three function modules: digital storage oscilloscope, signal generator, digital multimeter. In order to implement these functions, we need a PC (personal computer), some hardware and software modules. Compared with traditional instrument, virtual instrument has more functions, low cost, wide application range. Figure 2 shows a basic diagram of virtual instrument system.

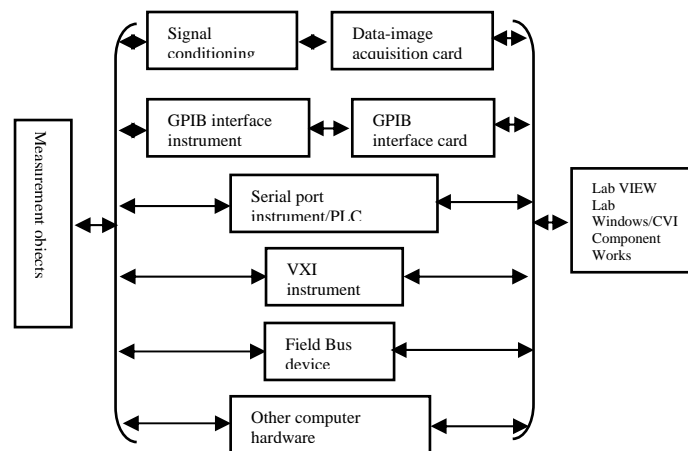


Figure 2. Diagram of Virtual Instrument System

## 3. Construction of Software Platform

The core thought of virtual instrument (VI) is that using computer software or virtualizes hardware equipments. This increases more functions and more flexibility of the system, reduces the cost of the system. Based on the importance of software in VI system, NI (National Instrument) proposes that the software is the instrument. Software programming of VI system is divided into two modus. One is programming by general program software, for example visual Basic, visual C++, Delphi, etc. The other is by professional graphical program software, for example VEE of HP, LabVIEW of NI, etc. In this work, we adopt LabVIEW to analyze electronic circuit. LabVIEW is a combination of direct front panel and flowchart programming, and an ideal tool of constructing VI.

All LabVIEW application programs include three parts: front panel, block diagram and icon/connector. Front panel is a graphical user interface. In another word, it is also a VI panel of NI, on what there are switches, buttons, control, and indicator. The front panel of VI is shown in Figure 3. For simplicity, we use the relation: **Current = Voltage/Resistance**, with the value of the resistance fixed at 24.2 ohms.

Block diagram provides graphic source code of VI. Man can program by block diagram to control and operate the input/output functions defined in front panel. Block diagram includes line terminal, functions and structure, etc. Figure 4 shows the block diagram of Figure 3.

In order to be able to combine the vocational education, we build a relative VI experimental system. By programming of computer software, the system can real-time, directly analyze and process the measured data, for example the implementation of digital filter, complete of cycle amplitude calculation. Then it outputs processing results with different forms. Therefore, the system has a strong ability of processing data.

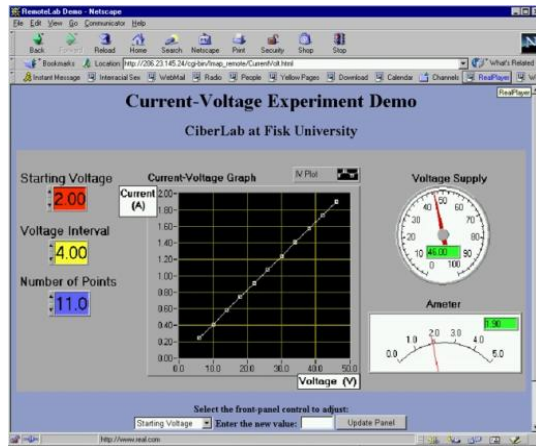


Figure 3. Front Panel of Virtual Instrument

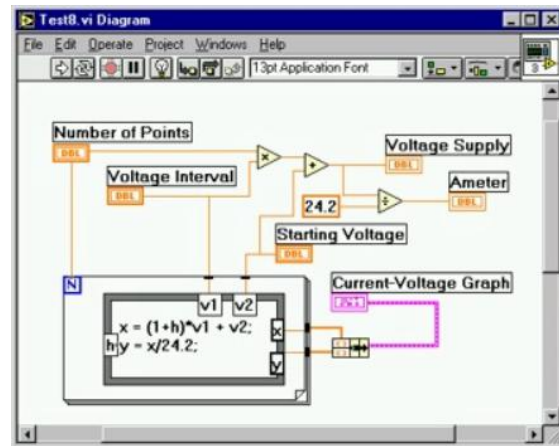


Figure 4. The Block Diagram of the Virtual Instrument Front Panel Shown in Figure 3

Conclusively, the system has the following abilities:

1. Changing the primitive form of signal to convenient for analysis and observation.
2. Selecting and extracting main and useful signals, filtering minor and useless signals.
3. Compressing data and finishing editor, improving the effectiveness of data.
4. Analyzing and calculating
5. Storing data for further analysis.

Figure 5 shows the diagram of VI experimental system.

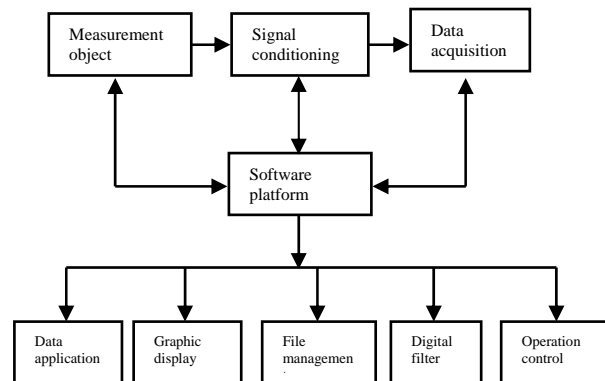


Figure 5. Block Diagram of VI Experimental System

During building the system, graphic modules of real-time data acquisition system adopt special G language of LabVIEW to compile program. Every graphic module implements a simple function, similar to a subprogram of C language program. The main program can call, combine and develop subprograms to realize some specific functions. Software has the following advantages: structuring, visualization, logicalization, modularization, etc. Additionally, it builds easily complex application programs, and has strong readability.

LabVIEW programming has usually the following steps.

1. According to demands of users, the layouts of panel and program flow are determined.
2. Front panel of VI is designed in edit windows of LabVIEW by tool and control formwork.
3. Block diagram is designed by tool and function formwork.
4. In edit window of front panel or block diagram, VI program can be implemented and debugged.

While analyzing electronic circuit, data acquisition module reads data from acquisition card. The data collected by experiment instrument can real-time display. In addition, according to different demands, program can call data processing module to analyze experiment data. At last, the experiment records are saved in data storage module. Meanwhile, graphic display module displays the graphic changes during data collection, data reading, data processing, and data storage.

RLC series circuit is shown in Figure 6. We demand collecting and displaying the time-domain curves of RLC series circuit under the action of square wave, and calculate the rise time  $t_r$ , the maximum overshoot  $\sigma_p$ , the rising slope, the attenuation coefficient  $\delta$ , etc.

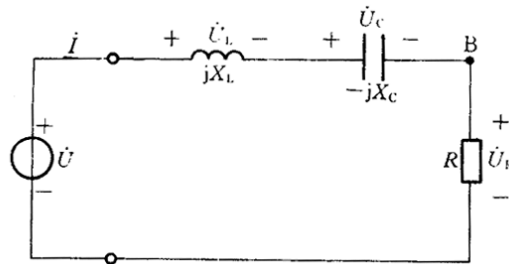


Figure 6. RLC Series Circuit

$$\text{Maximum overshoot } \sigma_p = 100 * \frac{\text{Local Maximum} - \text{Voltage High}}{\text{Voltage High}}$$

$$\text{Rising slope} = \frac{\text{Voltage High} - \text{Voltage Low}}{\text{rise time}}$$

The attenuation coefficient  $\delta$  of RLC series circuit can be calculated by adjacent peaks.

$$T_0 = t_1 - t_2; \delta = \frac{1}{T_0} \ln \frac{U_{m1}}{U_{m2}}$$

The Figure 7 shows the program diagram in time domain of RLC series circuit. The Figure 8 shows its analyzing interface of time-domain step response.

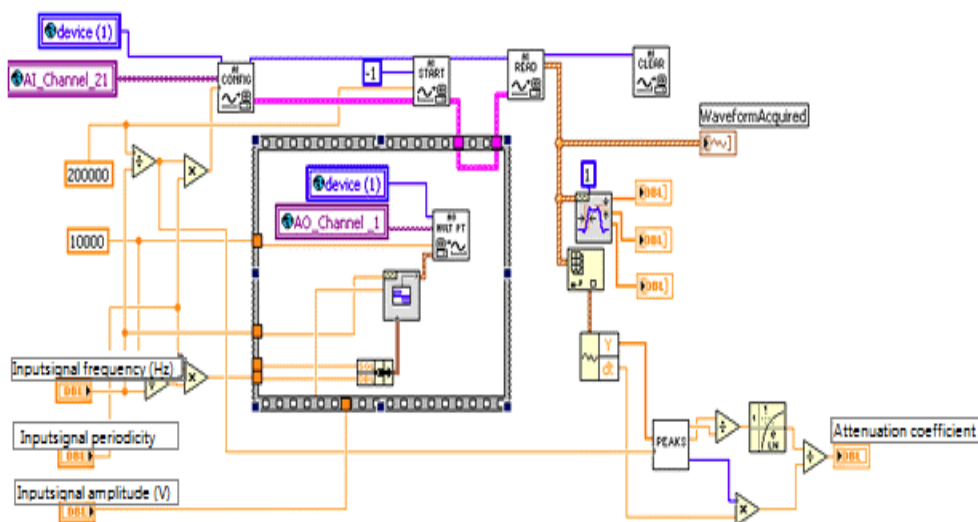


Figure 7. The Program Diagram in Time Domain of RLC Series Circuit

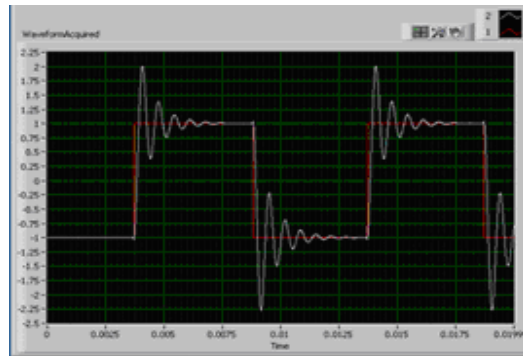


Figure 8. Analyzing Interface of Time-domain Step Response

Figure 10 shows the amplitude-frequency response of the second order, underdamping RLC series circuit, and measures the resonance curves of the second-order RLC series resonance circuit. Finally, according to the measured resonance curves, man can calculate the resonance frequency  $f_0$  and Q factor of RLC series circuit.

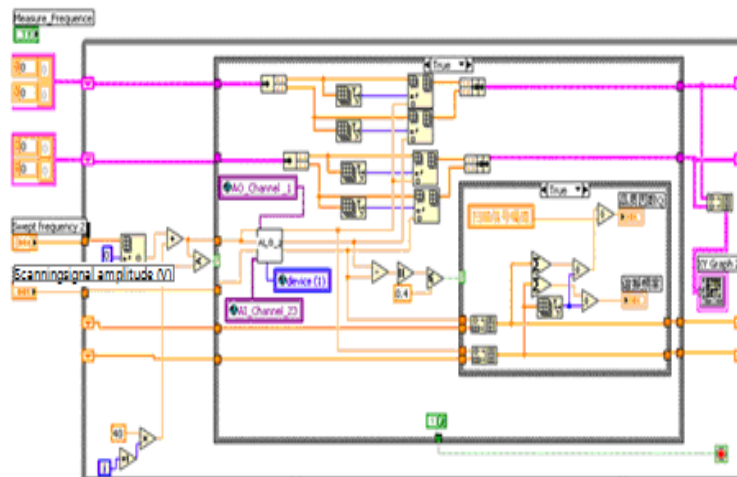


Figure 9. The Program Diagram in Frequency Domain of RLC Series Circuit

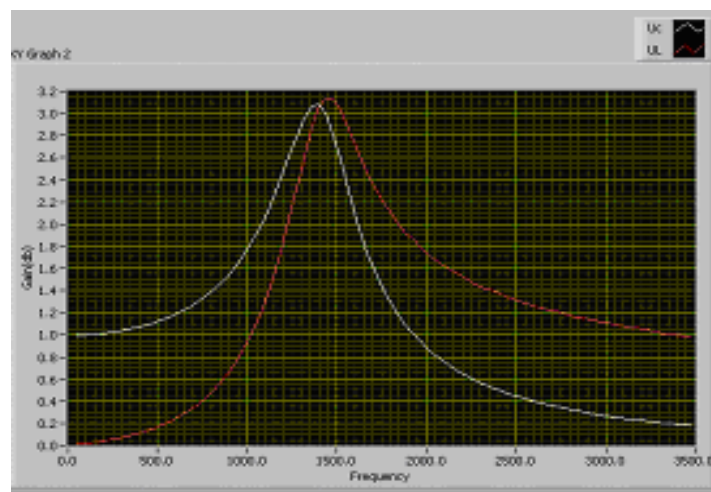


Figure 10. Analyzing Interface of Frequency-Domain Step Response

In a traditional electronic experiment, students must spend much time to adjust and familiarize themselves the equipments, make complex calculation, and draw the related curves. Now it is changed much faster and more convenient by LabVIEW. Because of decreasing the measure time, students can spend more time to analyze the circuit working parameters, and better understand the experiment theories.

## 5. Conclusion

Application VI technology brings a technical revolution in traditional electronic education. Virtual instrument experimental system reduces the experiment time of students, improves the students' interests in electronic study. Additionally, it decreases the daily education cost, provides a great convenience for a further data processing.

With the development of compute technology, the function of VI will be further extended. The software platform of LabVIEW provides many development tools of DBC, SQL, and Data Socket. Utilizing the tools can implement VI network system. In the system, users can obtain or observe data and processing results of remote server in own terminal. Therefore, students can access a VI laboratory and finish their experiment tasks in whichever on-line computer through internet. So it corresponds, that students have a never-close laboratory.

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