Vitual Laboratory for Electronics Instrumentation Training via the Internet

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Abstract

Telematic and new programming technologies support the increasing demand of education and training leading to the delivery of computer based learining systems open to distance and continuing education. Using LabVIEW, we designed and implemented an interactive learning environment for practice on electronics measurement methodologies. The environment provides remote access to real and simulated instrumentation and guided experiments on basic circuits. The environment is applied to the education and training on electronics for engineers in the field of semiconductor industry.

1. Introduction

The exponential development and diffusion of information technologies of the last few years have produced a considerable amount of research and activity in the field of computer based education aimed at :

- The enhancement of effectiveness of the learning process
- Multimedia education material for high quality training programs
- The improvement of methods and techniques for the open distribution of training material and the interoperability of resources.

More recently, computer networks have became a driving force addressing client-server dynamics and network services. The traditional way to support learning and training activities and to produce, and distribute learning materials changed, and the concept of virtual classroom was introduced. Teachers make available didactical material on the network and guide the learning process using electronics communication tools. The virtual approch is suitable for distance learning, continuing education, and professional training and can encompass the entire learning process.

Our work extends the virtual approch beyond the distribution of didactical material to provide practice opportunities remotely. A virtual laboratory, to practice instruments and to conduct experiments addressed to the knowledge of measurement methods, play a significant role in the learning process of electronic measurement and test. The term "virtual laboratory" refers to a representation of the laboratory, that is distributed on the network and provides access to and control of the real laboratory instrumentation and experiences, via software simulation. Virtual instrumentation helps to meet the challenge in a timely and cost effective manner. Moreover virtual instrumentation systems dramatically reduce the time required to develop complex test programs and unify the separated worlds of test and measurement and industrial automation. The proposed approach provid the following advantages.

- Users can remotely operate laboratories
- Laboratory instruments are used by more than one person at a time
- User is able to design their own experiment
- High-cost instruments are shared by many researchers
- Incompleted use of resources is avoided both in academic and industrial sites
- Virtual laboratory become part of distance learning curricula, with all the related advantages
- Standardization of course/laboratories format can authoring and enlarge the availability of teaching/learning material.

2. Choice of the Software

The current perception among the engineering disciplines is that multimedia tools are appropriate only for the courses which offer very little indivisualized help for students, and therefore, they are not suitable for the engineering subjects which require technology-intensive hands-on experience. However, recent developments and applications specially the LabVIEW-based applications, have shown that many pure lecture-based engineering courses and conventional experiments can be updated and integrated with custom-written virtual instrumentation, and can be delivered computers. In addition to this, the courses and experiments can be delivered remotely without having multiple copies of the experimental setups. Fig. 1 illustrates the common features of a computer-assisted real time experimental module. Additional scientific visualizations and advanced analysis can also be added in the form of virtual instruments with minimal cost, which is limited or not possible in the conventional laboratory practice. Moreover, the virtual instrumentation approach is open to further improvements and developments, which may increase the student participation and enthusiasm while providing an ideal delivery environment. However, due to the diverse nature of the lectures and the laboratory courses in every institution, custom-built software and hardware development is required most of the time. In addition, due to the fast developments in technology, the choice of the software and hardware should be considered carefully along with the cost. The software package LabVIEW is chosen in most of the engineering problems because of its overall versatility as an engineering tool. It is a graphical programming language that allows engineers and scientists to develop their own virtual instrument, which is flexible, modular and economical. Futhermore, the software meets most of the software selection criteria, and it not only does the data manipulation, analysis, and control, but also has some multimedia authoring capabilities with the help of the add-on tools. The LabVIEW software allows for the creatingof application-specific templates to reduce the production time for the identical subjects. Many useful functions can be incorporated with the LabVIEW programs to perform very useful tasks in a laboratory virtual instrumentation system design.

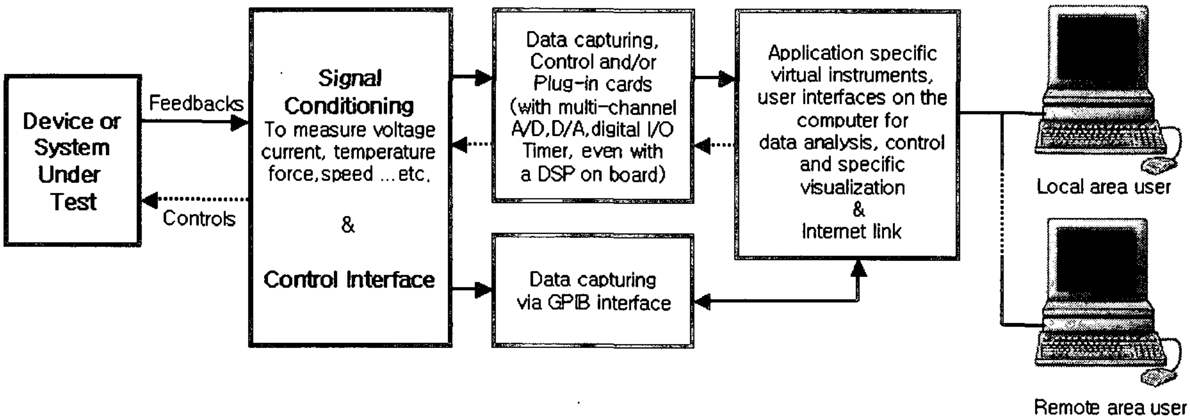

Fig. 1 The general diagram of a virtual laboratory system

3. Simulation for Analog and Digital Electronics

Fig. 2 illustrates a sample front panel of LabVIEW virtual instrument that mimics a two channel oscilloscope. As can be seen in Fig. 3, the modularity of LabVIEW programming allows the designer to simplify the programming structure by using sub-VI, which may require thousands of lines of codes in other programming software tools. One of the features of the LabVIEW programming is the hierarchical nature of Vis. Once a VI is created, it can be used as a sub-VI in the block diagram of a higher level VI. Fig. 4 illustrates a hierarchy of an application, which displays a graphical representation of the calling hierarchy for all Vis used in the application. The virtual laboratory regarding analog electronics cover op-Amp basics including AC and DC characteristics, filter, monostables, astables and log amp circuits. They are designed to demonstrate an electronic principle but can be used as a template for more complex real op-amp circuits. Fig. 5 illustrate the simulation of inverting op-amp. Click on the Run button to observe the circuit operation. One can change the resistance by click-and -dragging on the slide above each resistor or by enteringa new value in the digital display below each resistor. Digital electronics is one of the fundamental courses found in all electrical engineering and most science programs. The great variety of LabVIEW boolean and numeric controls/indicators, together with the wealth of programming structures and functions, make LabVIEW an excelent tool to visualize and demonstrate many of the fundamental concepts of digital electronics. Fig. 6 illustrates the operation of the Arithmetic and Logic Unit(ALU). The arithmetic and logic unit is a set of programmable two-input logic gates that operate on parallel bit data of width 4, 8, 16 or 32 bits. This lab focused on 8-bit

CPUs. The input resisters are called Register1 and Resister2, and for simplicity the results of an operation will be placed in a third register called output. The type of instruction (AND, OR, or XOR) is selected from the slide. We have developed several VIs to simulate digital electronics such as gates operation, encorders, decorders, binary addition, A/D and D/A converters.

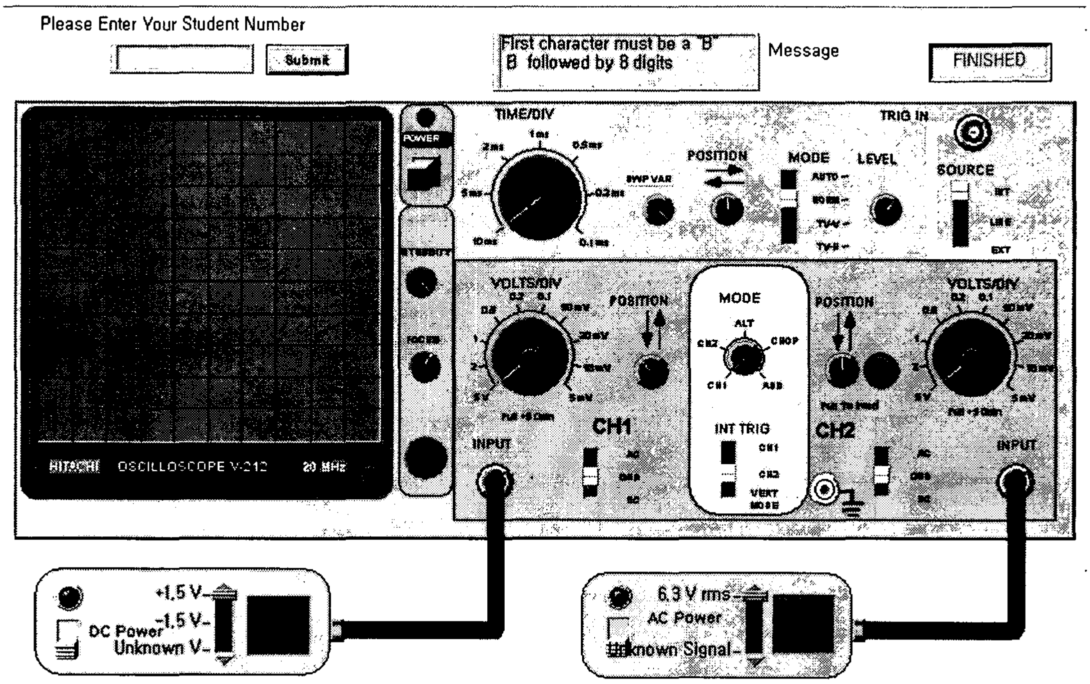

Fig. 2 Virtual instrument of an oscilloscope

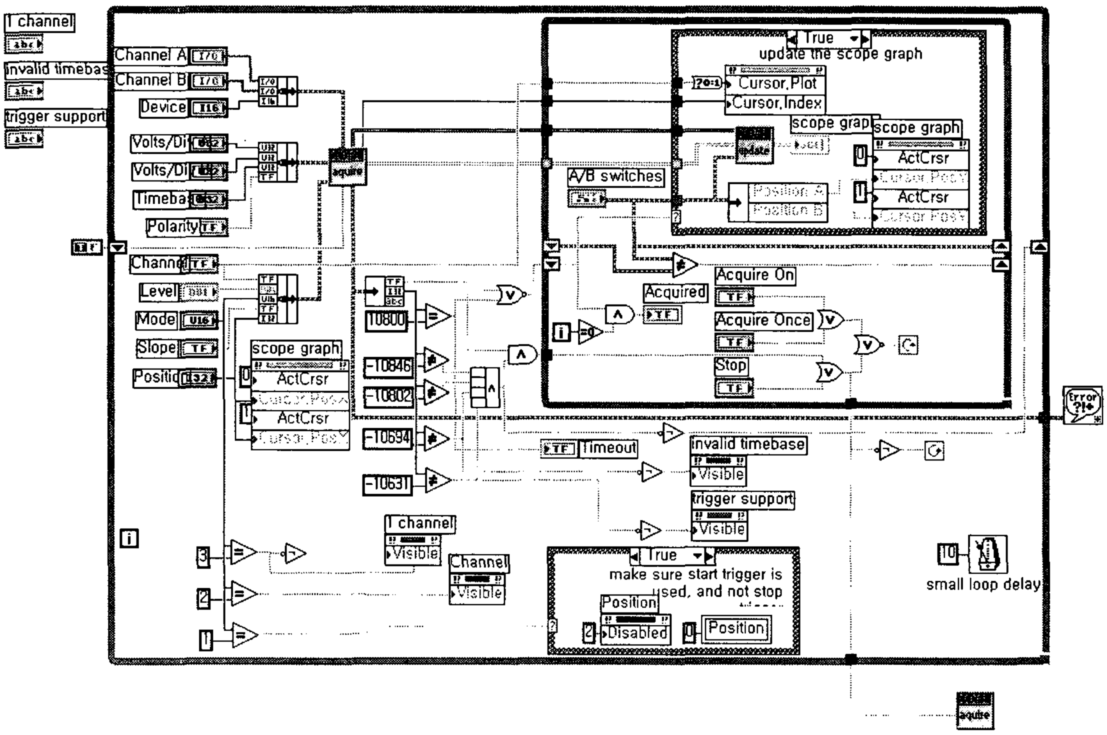

Fig. 3 A block diagram of two channel oscilloscope

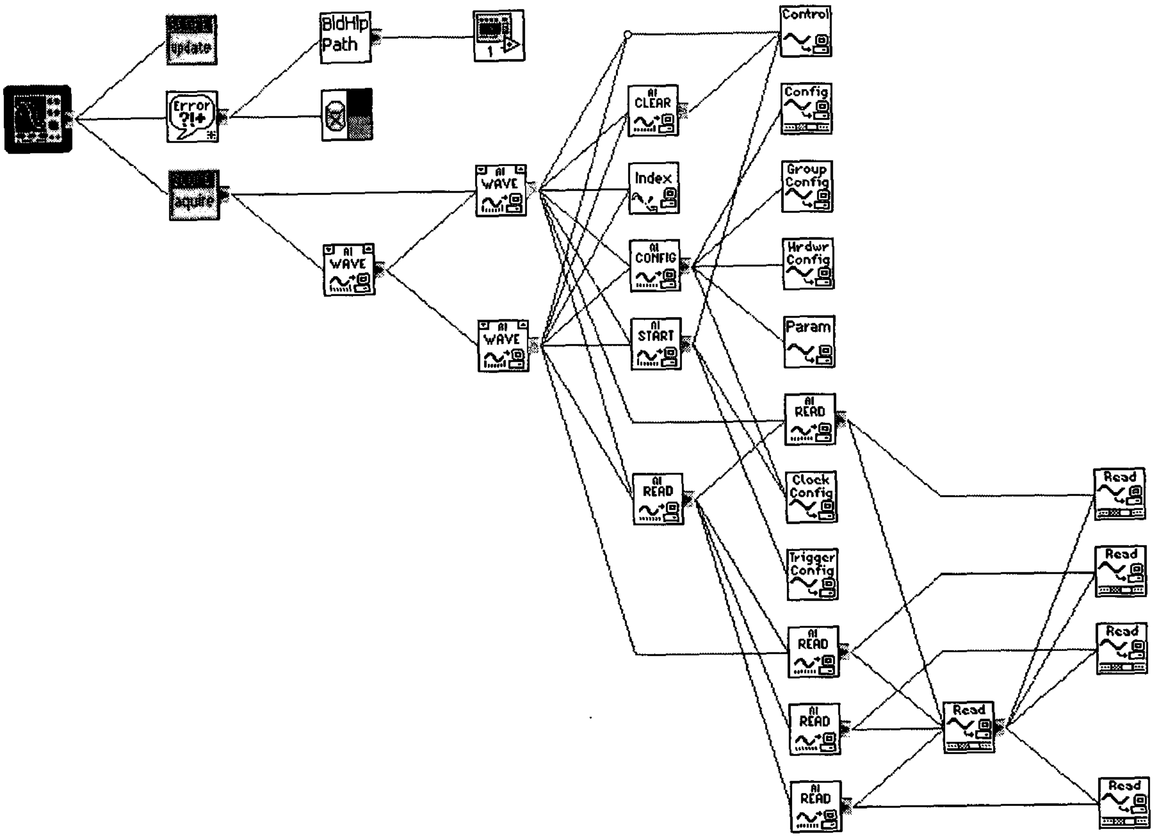

Fig. 4 A hierachy window of two channel oscilloscope (Fig. 3)

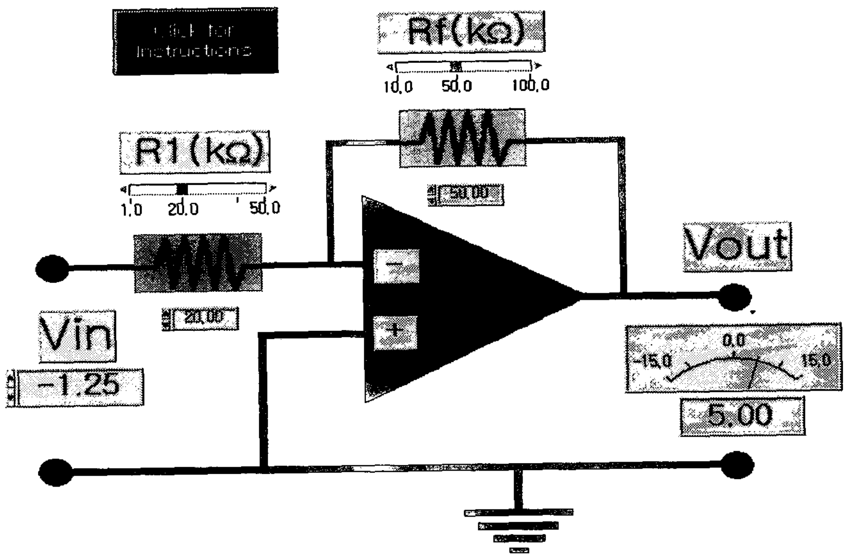

Fig. 5 Simulation of the inverting op-amp

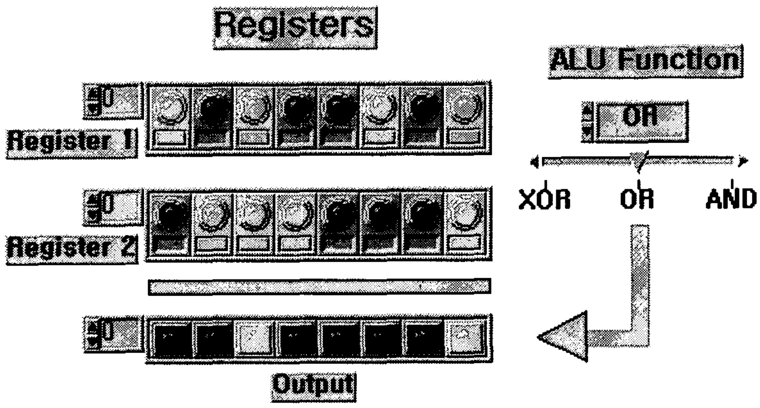

Fig. 6 LabVIEW simulation of an Arithmetic and Logic Unit(ALU)

4. Remote Panel Module

Distance learning and remote laboratories offer faculty and students an exciting new way to teach and learn important concepts. Remote laboratories eliminate the typical barriers found in a traditional laboratory setting because the web is avalable 24 hours a day, 7 days a week from anywhere in the world. Students can access a remote laboratory from home, the dormitory, or even outside via wireless internet. With remote laboratories, a professor can easily enhance the educational experience by integrating research demonstrations into a classroom lecture, and can also make the demonstration available to students and others at irregular times. In other example, a professor can demonstrate an electronic circuit in action and give students control of the experiment, all within the classroom environment. In fact, many top universities from around the world have recognized the benifits of remote laboratories for their teaching and research applications. At Dalhousie University, engineering and science students can log onto the Virtual Laser Laboratory 24 hours a day, seven days a week and conduct up to ten laser experiments. At Stanford University, students can log into a rempte optics laboratory to conduct an experiment to measure the physical properties of laser diode. Cyberlab provides not only monitoring and control features, but also a scheduler, refernce library and analysis tools. The experiment is the real world phenomenon being monitored, controlled, or manipulated. Typically, the variables important to the experiment are monitored with sensors and transferred to I/O hardware. The I/O hardware associated with a remote laboratory acts as interface between the experiment and the software. The I/O hardware reads imformation from the sensors into the software, and generates any outputs necessary for experiment stimulus. In all of the examples of past remote laboratory successes, intensive programming of ActiveX controls, Java Applets, or CGI scripting was required to bring the laboratories to a browser environment. Today thanks to the remote panels feature in LabVIEW, a few mouse clicks can turn computer into a fully functional remote laboratory server. With remote panels, we simply create the VI to accomplish our task. Once created, students can access the program from the internet at the click of a button. User no longer need to be concerned with actual Web implementation of the program because remote panels handles all the additional programming. The remote panels feature integrates all of the necessary technologies to provide a complete solution within the LabVIEW environment. Fig. 7 illustrates the data acquisition and analysis of sine wave monitored from the signal accessary via the internet.

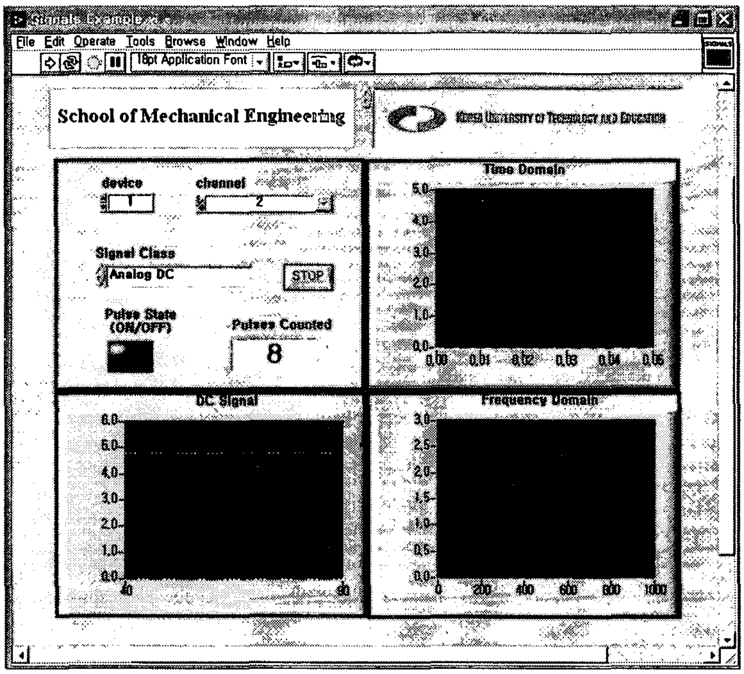

Fig. 7 Remote panel for data acquisition and analysis

5. Conclusion

Based on our experience with virtual instrument in analog and digital electronics, it is clear that such a simulators can be tailored to suit a variety of perfernces concerning contents emphasis, amount of LabVIEW programming to be included, and choice of example circuits for laboratory work. Virtual instruments developed by KUT takes advantage of the new features of LabVIEW 6.1, optimizing the distribution on the network of the instruments' interfaces and creating a successful virtual laboratory that is an asset to almost any electronics distant and continuous learning/training program for engineers in the field of semiconductor industry.

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