Research Article

Remote controlled communication electronic circuit Experiment

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Abstract

This paper presents an amplitude modulation experiment for remote experiment in communication circuit. Based on combination with specific experimenting circuit and NI Elvis embedded control hardware as well as LabVIEW software package, the proposed solution enables the rapid and easy creation as well as handy operation of different interactive remote control experiments. A communication-circuit-based remote control laboratory for teaching purposes has been realized using the schema. Equipped with a set of virtual instruments, this remote laboratory enables the remote users to easily interact with a set of physical and control experiments through the Internet. In the friendly user interface, the remote user can change predefined system parameters and observe system response like waveform on oscilloscope, textual response on the panel or real-time surveillance video. On the basis of Amplitude Modulation and detection, the solution was proved to work out fine, the waveform of the AM and detection shown on the oscilloscope, interaction with remote server working properly, and status of the laboratory transmitted normally.

INTRODUCTION

The remote experimenting laboratories has become a wide spread reform and research throughout universities. Remote experiment has created a new era in teaching / learning environment. During experimental work, students become acquainted with real-world features and gain experience and knowledge, which can't be obtained by EDA simulations. But there has been a time and space limitation on classical hands-on laboratories. The problems with traditional classical laboratories can be avoided by using remote experiments and remote laboratories. Although remote experiments seem to be very useful and educational, much hard work is needed on making interactive functions. This paper proposes a remote experiment based on LabVIEW developing environment and NI Elvis platform, which is integrated with twelve common virtual instruments. The developing scheme enables us to rapidly construct a framework while improving the development efficiency of the virtual instrument, as well as flexibility, expansibility and scalability. Controlling remote equipment while monitor the real-time status, online communication and local simulation are three major aspects in implementing the experimenting communication circuit. AM circuit was made use of to show the way the remote experiment is carried out.

Experimenting communication circuit laboratory (ETCLab for Short) is constructed dependent on LabVIEW, NI Elvismx, Multisim and NI Elvis II hardware platform. In the laboratory system, LabVIEW serves as the user front for data visualization and parameter tuning as well as data acquisition, data processing, circuit simulation and remote circuit control on the end. This LabVIEW based remote experiment can enlighten students on communication theory and practical usage who are not familiar with the experiment. ETCLab invokes a new way of modern education and promotes learning experimenting knowledge in dormitory as well as at home.

This paper is organized as follows: Section II presents an overview of how the laboratory was constructed as well as the hardware board and operating procedures. Section III contains a detailed description of the design of the laboratory

and how the virtual instruments and other key components was designed and developed. Finally, conclusions and future work are stated in Section VI.

II. ETCLAB OVERVIEW

A.   ETCLab Block Scheme

Users can access remote experiments over the Internet using the browsers on their computers and execute various remote experiments. Figure 1 shows the block scheme of the remote experiment system. Sets of software in the server monitor experimental equipment, control experimental equipment, manage experimental process and provide essential parameters related to experiments.
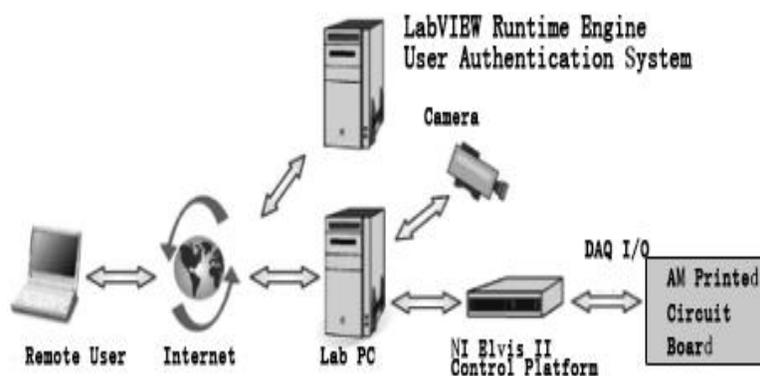
Figure 1. Block scheme of a remote experiment system

The server also has a database comprised of information for teachers and students. Several virtual instruments are put into use through a multi-functional panel to configure and see the status of a current circuit. Virtual instruments properties are changed in accordance with the user operation and external performance. With NI server, the platform can generate a LabVIEW-created html file that can be publicly accessed. Simply typing the corresponding URL, one can get a connection with the remote server and get started on the experiment. The platform runs on a PC as a server, responsible for the communication with Elvis—a data acquisition hardware platform from which the telecommunication circuit is started and the I/O signal is transferred as well as the remote client. The Amplitude Modulation is made as our sample experimenting circuit.

B. Amplitude Modulation On PCB

Amplitude Modulation has widespread applications in modern communication. We designed the circuit layout and build the circuit on a PCB. We connect our experimenting circuit on Elvis before hand, specify the input signal and join the output cable to the virtual instrument (For example, the oscilloscope).The circuit is connected to NI Elvis platform through six ports, two of which are signal input and the other one of which is signal output. The others are power supply, ground and DC offset, the last one of which is used to alter the modulation index. After connecting theses ports on NI Elvis, we can get the PCB board on power and configure signal input. The modulated signal should be presented on the virtual oscilloscope.

C. Operating Procedures

a. Server Preparation

There are a few first-phase preparations need to be done in getting the laboratory function properly. First of all, the Amplitude Modulation PCB should be well set up, the input and output ports joined with the ports of specified functions. These functions are programmable by LabVIEW code. Secondly, there are a few steps including preparation on local database, checking out network variables, and open the vi on the server.
Figure 2 shows a snapshot of the entrance vi that has been ready to serve but not remotely connected yet.
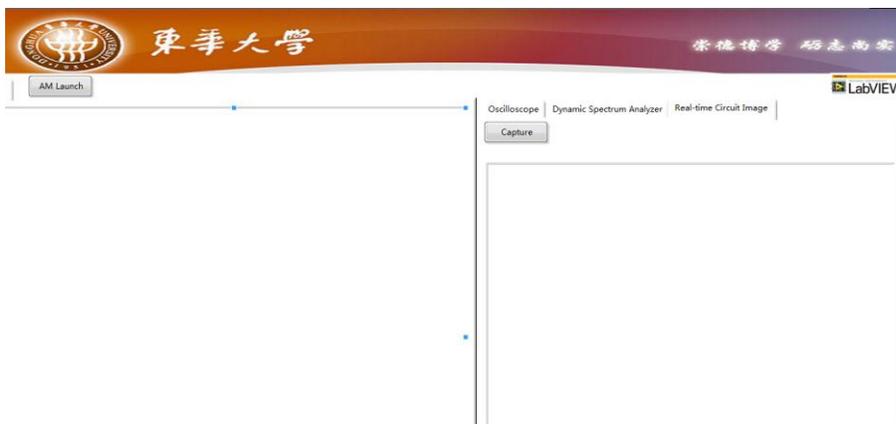
Figure 2. Snapshot after normally start up

b. Login and view the output

As long as the vi is published (HTML code are generated by LabVIEW), the corresponding URL should be public and visible to all the users on the net. Our laboratory server is connected to the Local Area Network, thus the web page should be visible to computers within the same local LAN. The page should be accessible and operated well on an IE-based Internet Web browser. After the IE browser makes a correct request and get a valid response, then it comes to user authentication. A message box pops up, waiting for the user to authenticate his identity. The authentication message box shows below in figure 3.

Figure 3. Authentication Message Box

If successfully authenticated and logged in, users can configure the virtual instruments and observe the results on the panel. Now it's time for experimenting. A typical AM experimenting result shows below in figure 4.
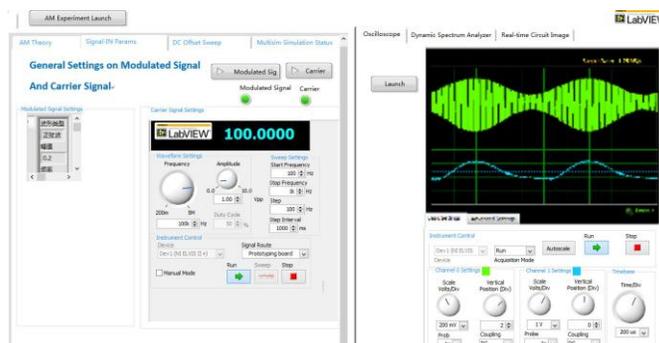

Figure 4. Configured input and oscilloscope output of a typical common Amplitude Modulation experiment

As the figure 4 shows, the panel can be divided into two parts, the left of which is responsible for signal input (the modulated source signal and carrier signal) and the right is integrated as a panel for experimenting result.

The configuration includes the common parameters of a signal, especially the amplitude and frequency of one signal. Here on the oscilloscope the channel 1, the green part, that's the modulated signal and the channel 2, the blue waveform below, it's the demodulated wave.

c. Typical features

Apart from setting the frequency and amplitude of the waveform, one of our features is to change the DC offset on amplitude modulation board, thus regulate the modulated degree. Figure 5 shows the configuration of the DC offset on one tab of the left panel. When the DC bias is increased from zero to about 12V, the degree of the modulation is changed, which can be reflected from the output waveform. As a result, the oscilloscope shows a waveform with different modulation index when DC offset changes.
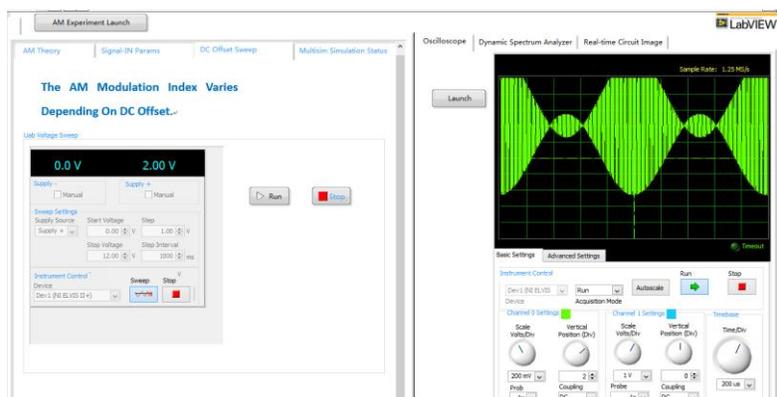

Figure 5. Configuration on DC bias to Degree of modulation

Besides, we have introduced multisim co-simulation as our means to strengthen the experimenting effect. The platform has successfully realized the integration with multisim code and LabVIEW block diagram. Simply by clicking on the simulation button, the simulation launches and the output is shown in Figure 6.
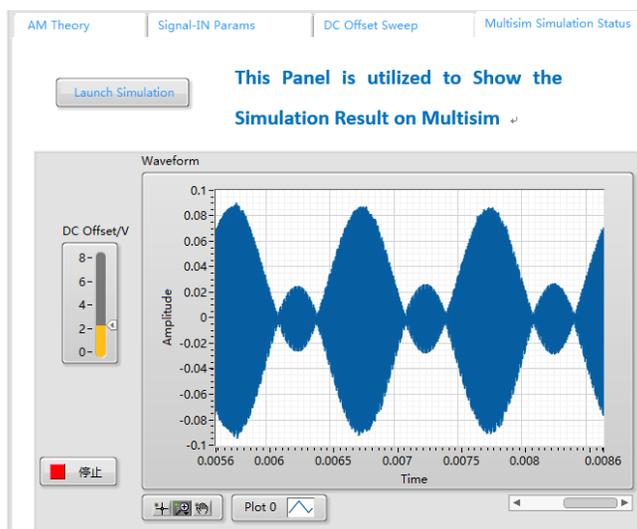

Figure 6. Simulation output on one tab of the left panel

d. Video monitoring services

The lab is equipped with a video camera to monitor the real-time circuit and represent on the panel. The video the camera captures can be accessed by a vi of the laboratory system, and be presented on the remote panel. The video surveillance in the right panel ensures that the real-time circuit image acquisition from the camera is continuously transmitted to the

front panel. So users can check if the circuit is running properly, as well as find out the circuit error. As is displayed below in Figure 7, the real-time image acquisition shows a snapshot of the video acquisition of the camera.
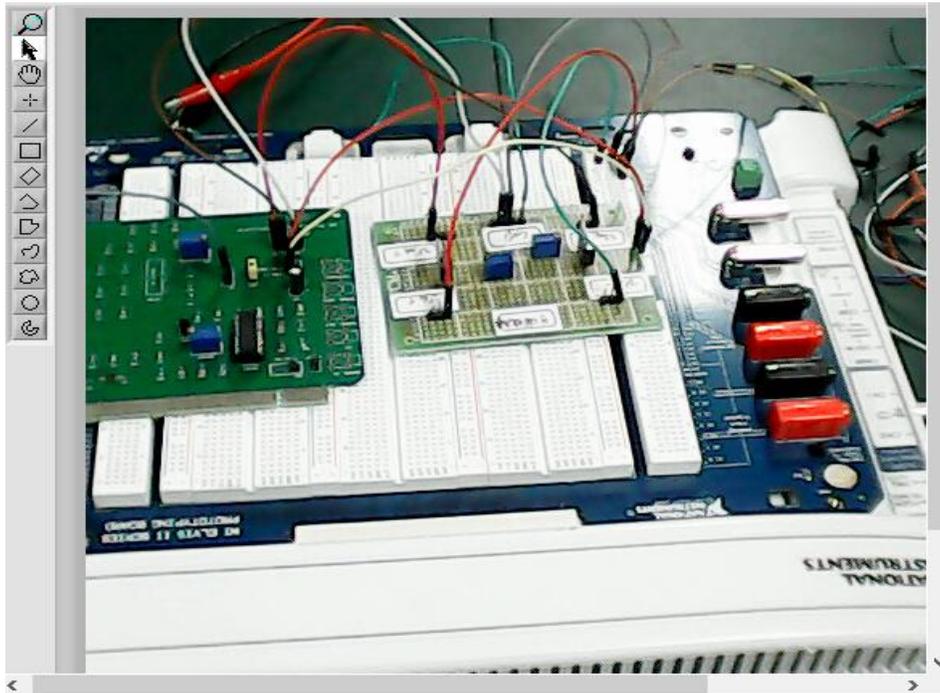

Figure 7. Video capture
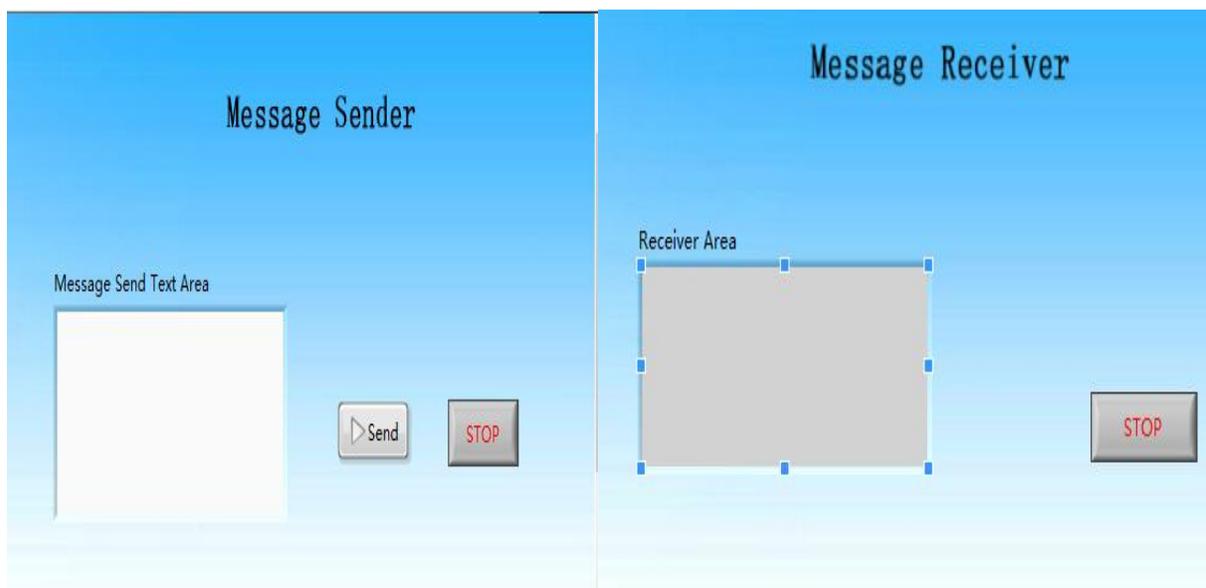
e. Broadcaster and receiver

Figure 8. Broadcaster and receiver

Figure 8 shows two panels of the message broadcaster and receiver. Administrator monitoring the local PC can send a message and inform remote users to do experiment correctly. The user operating the remote panel should receive the message from the local administrator. The administrator can send operating manual and administrative instructions to the user when necessary.

III. DESIGN OF REMOTE EXPERIMENT SYSTEM

A. Fundamental Requirements

The remote experiment system involves two kinds of users: student and system administrator. On a basis of traditional experimental process and an analysis of characteristics of remote experimenting, the user's fundamental requirements of the remote experiment system are listed in Table 1.

Table 1. Requirements of remote experimenting system

User	Fundamental Requirements
student	a. Log in
	b. Configuration of the basic signal input
	c. Configuration of the DC bias
	d. View Signal Output
	e. View Simulation Output
	f. Output waveform in oscilloscope and dynamic spectrum analyzer.
	e. View on-the-spot circuit
	f. Message receive
System manager	a. User management
	b. User session management
	c. Message Broadcast

B. Interaction Design of the laboratory

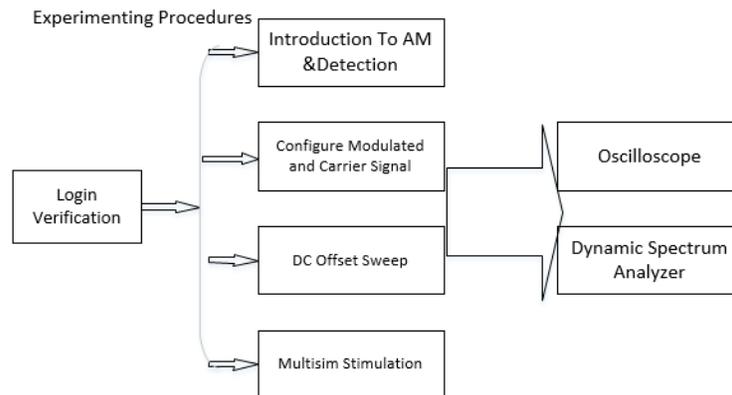Figure 9 below shows the typical experimenting procedures.

Figure 9. Major operating procedures

As is illustrated from the fig, student can remotely view the output in time domain or frequency domain as well as multisim simulation output according to corresponding selection. Figure 9 shows the proposed interactive relations and interactive methods in the design of learning and teaching process of the remote experiment system. During the construction of our virtual laboratory, there are several more virtual components we integrated, all of which are displayed below in Figure 10.
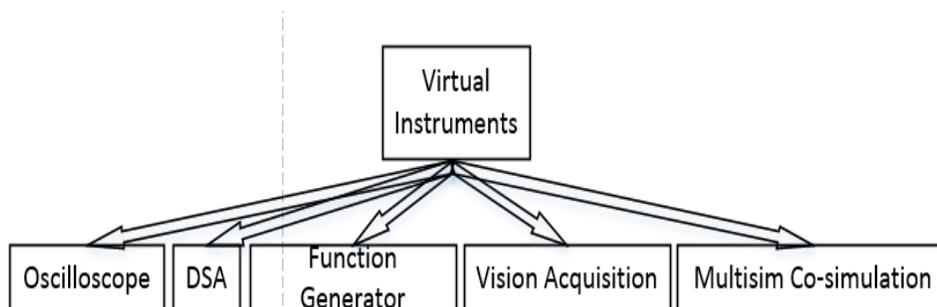

Figure 10. Virtual components

D. Programming Approaches

In the virtual experimenting laboratory, we integrated user operations, virtual instruments and AM circuit control through LabVIEW on NI Elvis II.

a. NI Elvis Virtual Instruments

Basic virtual instruments like oscilloscope, variable power supply and function generator are developed and modified on the basis of open source code from NI Elvismx, as attached file after installed NI Elvis ms driver. There are twelve virtual instruments for us to customize. These virtual instruments can be modified into meeting the requirements of the experimenting platform. The most challenging of which is how we can integrate those separate components into one VI. Luckily, with the help of sub-vi technique, we can design and test in separate vi, while running one major VI and access those components by the sub-vi technique. As a matter of fact, all these 12 virtual instruments are constructed on the basis of DAQ, as a unique technology, which is available only on NI devices. DAQs mask the details of our developments and help us put attention on major development.

b. Integration Techniques

The way of integrating every component is very simple. Here we apply a simple but very efficient technique, that's to invoke a sub-vi by clicking on a button, when a button is hit, and the panel of sub-vi will be embedded into the calling panel where the sub-vi and sub panel is related. The techniques we use are event-triggering and sub-vi embedded technique. The calling and called files are separated and independent, while the code of calling file holds the path of the called file. The sub-vi code structure is displayed below in figure 11
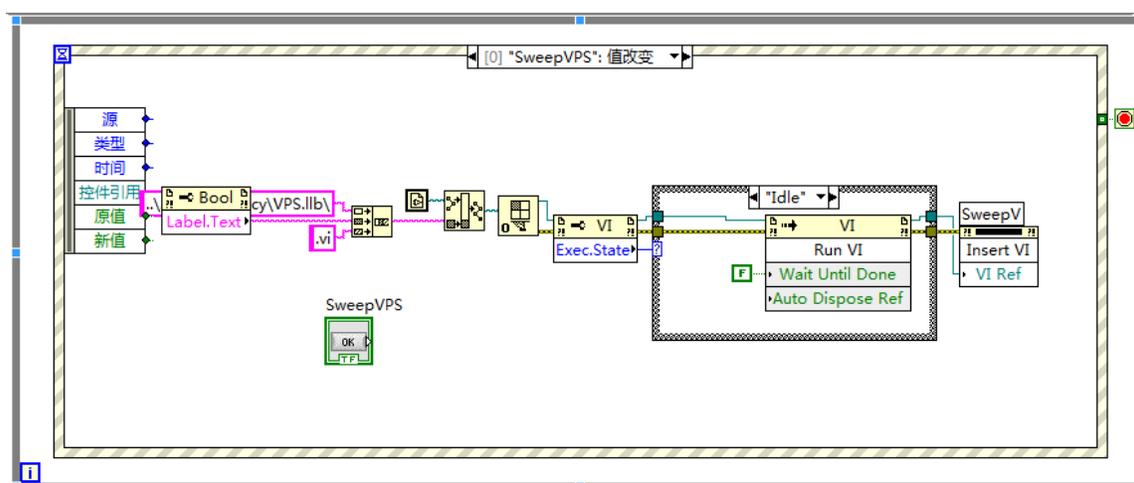

Figure 11. Event triggered VI block diagram

c. Internet access

The web server of the LabVIEW enables us to publish a locally operated VI onto the Internet. Every computer, as long as it's connected to the Internet, can access the published VI and control the remote panel just like it's a local VI. Since the IP of every machine on local area network at school is unique, it's easy to make communications through LAN with the IP. The technique is the same on the Internet as long as the server is assigned with a public IP address.

d. User Authentication with LabSQL

The user authentication problem is approached with LabSQL technique. Before the main entrance there is a LabSQL query that should be executed and get the success result. Based on an additional LabVIEW component toolkit, LabSQL offers an easy way to read the data from a database. By the way, the database we use is Microsoft Access. It's user friendly and convenient. Figure 12 shows the query code as a vi block diagram.
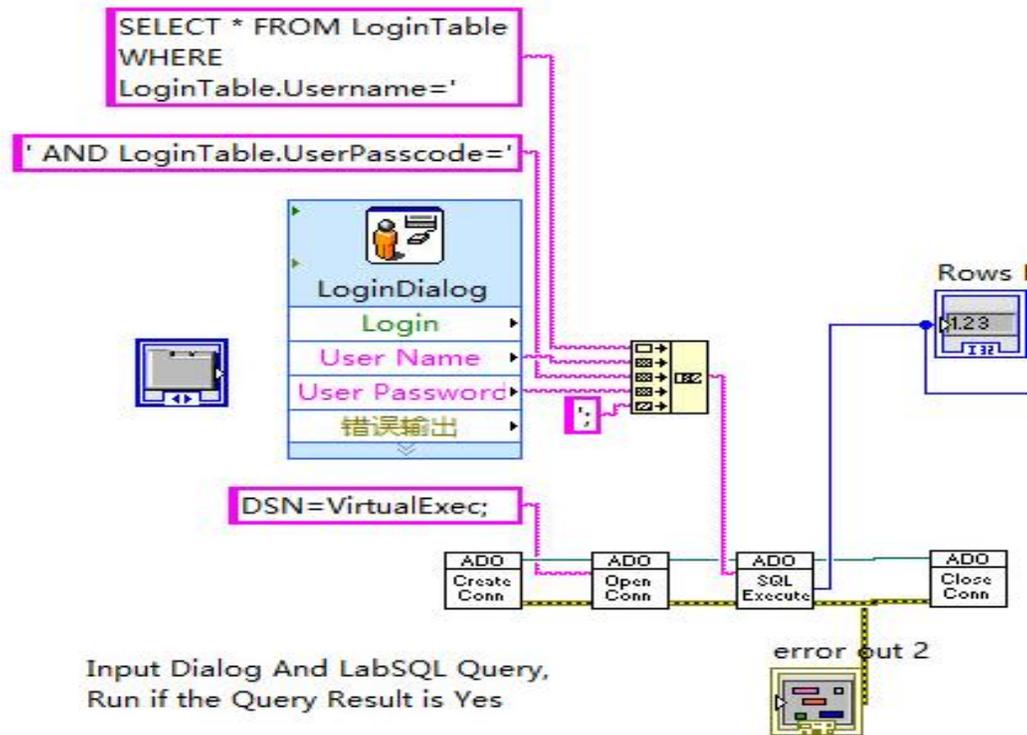
Figure 12. LabSQL Query Code

e. Multisim simulation

Multisim is widely used in academia and industry for circuits education, electronic schematic design and SPICE simulation. As a powerful tool in simulation, it offers a way that enables us to define the input and output of the circuit and package it into a LabVIEW VI block. We can utilize Multisim to make comparison with real modulated waveform from the front panel and waveform output from co-simulation. After we define the I/O fins of the AM circuit in Multisim, the co-simulation ready,a simulation block can load and start the multisim file. The co-simulation block shows below in figure 13.
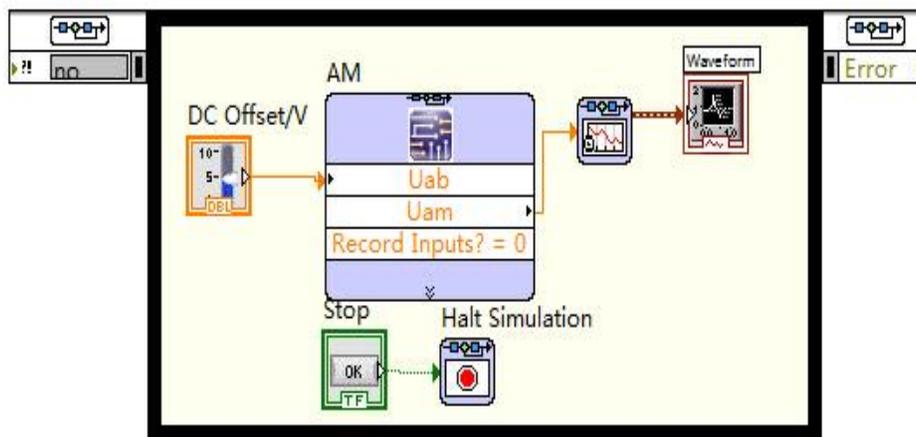

Figure 13. Amplitude Modulation co-simulation component

f. DAQ Signal Output

Apart 12 major virtual instruments, we need some vi to realize a custom function. With the help of DAQ, all programmable ports, analog or digital signal, input or output can be configured   to be working on our purpose. And the DAQ can be configured with the help of DAQ assistant, a simple wizard that helps to generate block diagram.

g. Message Communication

Message Communication is a separate component to make communications between the administrator and the user, with the goal to avoid wrong experimenting steps or configurations. On the basis of the LabVIEW data socket technique, one can send a message to each other. The only thing needed to be done before is to configure the talking line in data socket manager and open the data socket server.

h. Camera Vision Capture

LabVIEW provides an easy way to capture camera vision, as long as the camera can be recognized from LabVIEW. With an additional developing packet NI VAS, a VI with vision caption can be easily created. The vision acquisition assistant is also a wizard helps to customize our need and generate into a specific vision code. The back panel code looks just like figure 12.
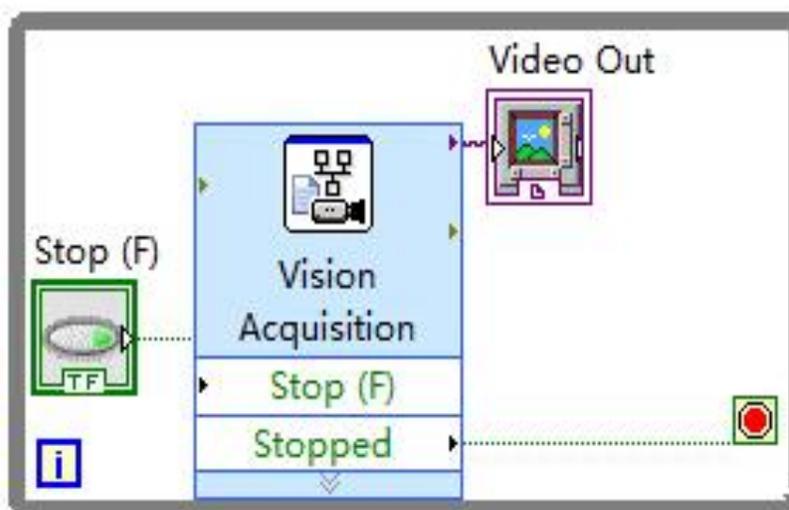

Figure 12. Vision Control Block Diagram

As a whole, LabVIEW offers a great bunch of tools to develop a software based on LabVIEW. It provides a common interface among NI devices, which proves easy to get started. It's handy to use DAQ to fulfill some of the function we need.

DISCUSSION

In this paper, the solution for a rapid remote experiment development process and a communication circuit-based remote control laboratory has been presented. The presented solution is based on an architecture that can be easily adapted to different remote control experiments. However, in virtual experiment there are many problems need further research, such as multi-user at one time or vivid interaction with remote devices. In contrast to some existing remote experiment solutions, this solution requires a free "LabVIEW run time engine" program on the client computer in order to perform experiments. The presented remote laboratory is currently being utilized in communication educational undergraduate courses. Available remote experiments are used throughout the course homework assignments, in which students are required to solve an actual control problem using techniques that were learned in class and verify their designs on the actual system through the Internet. Discussions with students indicate that the use of the remote control laboratory has improved their understanding of the course material. Although only one experiment is described in this paper, the remote laboratory paradigm can easily be applied to a wide range of experiments. Currently, a variety of different remote control experiments are under development. These experiments will offer an interactive teaching and demonstration facility to students over different applications in the field of communication circuits.

CONCLUSION

The design of our lab has solved the problem of distant experimenting. With this technique, one can develop a remote

controlled lab in a short time. The advantage of the remote experiment lies in the fact that put together "thinking", "doing" and "haptic-visual" processes'. However, there's a lot more work to do, such as the simulation performance, multi-user access as well as user experiences. This is going to be a long way to go. The remote experiment will benefit each student and encourage the increase of knowledge.

Acknowledgment

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