A Virtual Laboratory for Electrical and Electronics Teaching

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Abstract: This paper describes a virtual laboratory for Electrical and Electronics teaching, which can offer students a way to learn the different aspects of instruments and circuits as actual laboratory. In our study, we express its significance, analyze the construction and foundation and bring forward a 3-lay Client/Server(C/S) model based on www, dynamic web page and web database. This virtual laboratory is based upon the use of LabVIEW. With this, we can acquire data accurately from instruments in time with reality, interaction. Furthermore, We add much literature to the virtual laboratory, which makes it possible for students to query resource at will during experimentation.

Keywords: virtual laboratory LabVIEW virtual instrument web

1 Introduction

The level of education in science and engineering greatly depends on the quality of teaching experiments. Experiments can consolidate students' understanding of basic theories, cultivate their abilities of practice, operation, analyse and resolving problems, as well as consciousness and potential of innovation thought. The virtual laboratory, in consequence of computer technique and network's development, becomes a new efficient mode attracting more and more attention in many universities in and abroad reformations. In virtual of computers and network, it constructs a laboratory that can realize functions as actual lab. The students can do experiments as usual.

The virtual laboratory is a realistic, real-time, interactive, flexible system. In this paper a virtual laboratory for teaching Electrotechnics is introduced, which bases on traditional laboratory and network. It can compensate the shortages of the traditional laboratory as fund and professors' shortage, share resource, let students and teachers communicate freely, and expanded easily.

2 System Architecture

The remote experiment is located in one of the laboratory where needs nobody to attend. Cause of the complex, the architecture of system is separated into three functional layers: Teaching Environment Layer, Network Interactive Layer, and Physical Layer. Above all is teaching application layer. The Network Interactive Layer is up the Physical Layer. In the following, the functions of each layer and their relationship will be introduced.

Teaching Environment Layer

Dynamic Web Pages, Wiring Connection and Virtual Laboratory Environment are provided on this layer.
Dynamic Web Pages are for learning Electrotechnics' theorems and experimental content, and are the gateway for the system to exchange the necessary information

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between the client machine and the server. The Web browser is a platform providing an environment to run the necessary program which is written by Flash and HTML where animation was used to raise the students' interest and make them learning easier. Once a login is successful, a WebCam is connected for the environment of the hardware rig to the Internet. It gives the student a feel of the actual setup. It is also to give a signal for any one in the remote lab that the machine is being used and no disconnection or movement are allowed.

Wiring Connection part provides students with the connection practice. After each connection, it can transfer the specify connection to the control panel of the Laboratory, and then realize.

Virtual Laboratory environment is based upon the use of a commercially available package called LabVIEW (laboratory Virtual Instrument Engineering Workbench) that was produced by National Instruments Corporation. It can acquire data accurately from instruments in time, which make the laboratory seems actual laboratory much more. In this environment, students can learn simulation through interact with instrument by push buttons, switches and others.

Network Interactive Layer

This layer is based on the structure of Client/Server. It provides interaction function for other two layers.

The Web Server on this layer works as Communication Server, and controller. Students could interact with each other by question, discussion; even consult teachers through Web browser. The functions like tracing students' action, log in also can be realized in this layer. In a word, the serves of this layer is the physical undertakers to realize the functions of Teaching Environment Layer.

Besides, there is a database made from Access on this layer, through which teachers can inquire students' information as sex, scores, major, logging in time, even the points unknown. This gives teachers great convenience to help students learn Electrotechnics quickly.

Physical Layer

This Layer includes of the data acquisition part and the network connection of Client and server.

In the connection, the Ethernet is wired to the LAN through the Campus Network. The LabVIEW provides several communication manners. Here, Common Gateway Interface (CGI) and TCP are used for the communications between the client and the Web server. The CGI is written for the program involved with the HTML on the web pages whereas the HTML is popular form of access for sending data across the Internet. TCP is popular used for its reliability.

In LabVIEW, there are five modules in common use, that is TCP Listen, TCP Open, TCP Read, TCP Write, and TCP Close.

When developed, the port of network is specified in initialization. Use TCP Listen establishes the waiting for incoming request from TCP. Adding TCP Write functions to send various data, which convenient for client receiving.

In this TCP communication, both client and server must communicate through a certain port specified previously to make sure the net works properly.

3 Data Acquisition

Data acquisition system includes sensors, convertors, signal adjust circuit, DAQ card, driver, hardware configuration management software, application software and computer. Use sensors measure various physical quantities, and then transform the signals into electric. The adjust signal facility regulates the signals to suit the DAQ card, which concludes amplify, isolate, filter, inspirit, linearize. Computer acquires the data from the DAQ card, controls the whole DAQ system, estimates when acquire data and from which channel analyzes and deals with the data, show the results into figures or tables by software. Figure 1shows the system architecture.

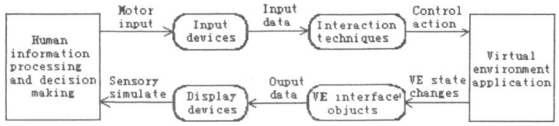

Figure 1 DAQ system architecture

A typical DAQ card can realize analog input, analog output, digital I/O, count/time and other functions by multiplexer (MUX), Amplifier, sample/hold circuit as well as AD converter (ADC). According to sample theorem, the DAQ system samples the analog signals, and then exports to computer. It decides the whole virtual laboratory's performance.

4 The User Interface

In order to give students an impression that they are actually operating on physically existing instruments, the user interface of a remote laboratory should be friendly. Figure 2 is the main page for the virtual lab.

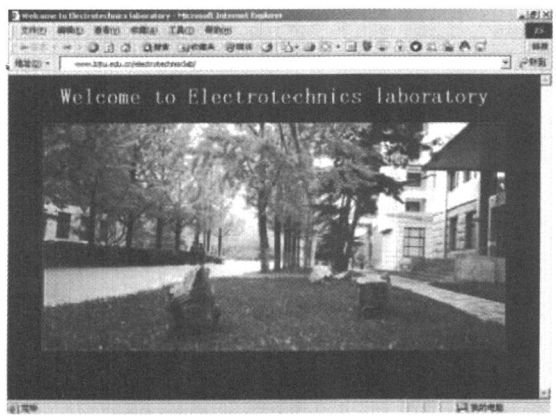

Figure 2 Main page for the virtual laboratory

After students' logon, authentication and selection experiments from menu, a request sheet of experiment will be seen. Students can learn about the content and follow the procedure. If there is something unknown, they also could inquire in network libraries. According to the experiments, they measure various data. They operate with computer as in usual laboratory. When finish, they submit the result. The database makes records of the procedure data and the students' information that could be looked at any time.

5 Conclusion

Virtual laboratory is a new trend of using computer-assisted technique for the teaching of experiments. It will lead to the development of virtual factories, wherein assembly can be performed remotely, using network-accessible time-shared facilities, from sites which otherwise would lack the necessary resources to accomplish such tasks. The benefits of these virtual laboratories and factories can be greatly enhanced by using hypermedia mechanisms.

In education, students can do experiment in this lab at any time, even night and weekend, with no limitation for location. It is especially convenient for those who have difficulty to attend laboratories. In virtue of this, it will be used widely and make great progress in remote education.

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