A Virtual Laboratory Platform and Simulation Software Based on Web

Weicheng XIE, Xia YANG

School of Electrical and information Engineering
XIHUA University
Chengdu, China
scxweicheng@yahoo.com.cn

Fugan LI

School of Software
Electronic Science and Technology University
Chengdu, China
yangxia-0618@163.com

Abstract—**This paper presents a virtual laboratory platform based on the B/S structure framework in distributed network, and the virtual laboratory platform includes the software and hardware resources. The virtual laboratory allows network terminal to access through the network. The two parts of the virtual laboratory are laboratory device interface platform and software platform. The design method of the virtual laboratory device interface platform is provided in the paper, and the paper has done the development of the software platform for virtual simulation experiment. The software platform of the virtual simulation experiment is developed with ASP.NET and C# programming language. In this platform, students can take experiment simulation process, preview experiment content, and put in the experiment report, online FAQs and so on.*****

Keywords—**Virtual Laboratory, Simulation Experiment, B/S Structure, ASP.NET**

I. INTRODUCTION

In recent years, with the rapid development of the Virtual Instrument theory and Network technology, it is possible to build a virtual laboratory via web. Virtual Laboratory is a visual three-dimensional environment in the network, each of the visual 3D objects represents an experimental object. Users can take a virtual experiment by click and drag. The foundation of the realization is the integration of multimedia computer technology, network technology and instrument technology [1]. This paper takes the program-controlled equipment as an example, introduces the methods of designing a virtual experimental platform, simulating the experiment.

II. DESIGN ON THE ARCHITECTURE OF A VIRTUAL LABORATORY PLATFORM

Generic Virtual Laboratory platform includes two parts, one is the experimental device Interface platform, and the other part is a virtual laboratory software platform, its overall structure is shown as Figure 1, mainly includes the following components:

- Physical device (sensors, instruments, etc.) for the measurement of external data.

- Laboratory device interface platform is constructed by embedded technology for achieving instrument control and data acquisition.

- Virtual laboratory software platform provides virtual experiment simulation, Web applications, experiment project application and data management service's servers.

- Remote users can visit the Virtual Lab site via a Web browser (IE).

III. DESIGNING ON THE VIRTUAL EXPERIMENT DEVICE INTERFACE PLATFORM

GPIB, RS232 and USB interface are commonly used to connect local device, TCP/IP will be able to connect remote devices [2]. The short-range wireless network technology makes experimental apparatus rich, and it has a huge development space in instrument area, such as infrared, Bluetooth and ZigBee. Now there are many foreign and domestic manufacturers provide products and development modules.

A. Virtual Lab Device Interface Platform Structure

For the generic program-controlled laboratory equipment, embedded technology can be used to build virtual laboratory interface platform [3]. This interface based on embedded technology platform has good controllability and functional extensibility, and the system can integrate the laboratory hardware resources which distributed in different locations more effectively, so as to provide greater application space to users.

The connection between interface platform and local physics equipment mainly uses RS232, USB, and GPIB. At the same time, the hardware interface platform can integrate the physical equipment with network interface which distributes in the network together via TCP / IP or wireless communication to form a distributed measure & control system to enhance the comprehensive use of resources and sharing.

B. Device Interface Module Design

The embedded laboratory equipment interface platform and application programs adopt the modular design method, it

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includes device interface module and network services module. The Device Interface Module is used to achieve the communications with the external physical equipment. First, there is a simple preprocessing of the input signal, acquisition, and digital filtering. Then the interface software transmits processed data to th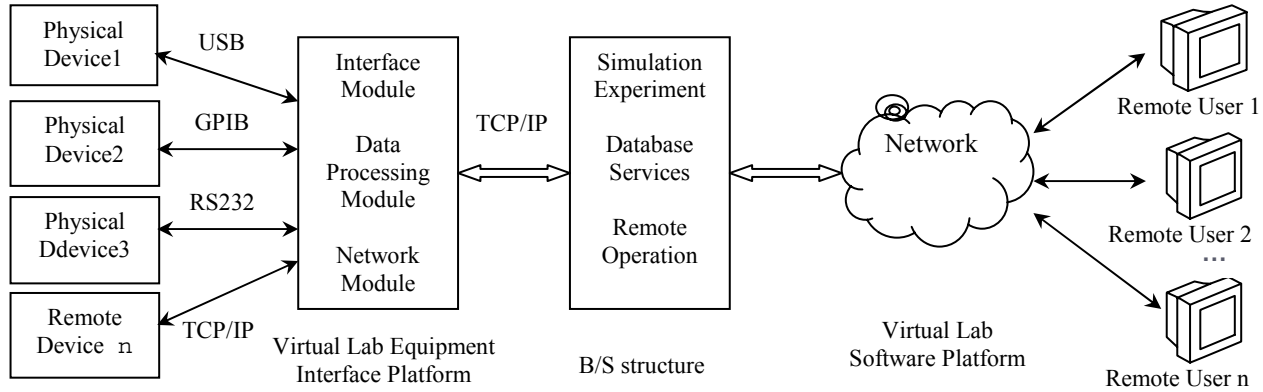e data buffer. Network service modules uses the TCP/IP protocol to implement the communication between virtual laboratory servers by Socket programming, which includes output the data from the data buffer to the virtual laboratory servers, as well as read the control commands which inputs by virtual experiment servers in network.


Figure 1.   The architecture of the virtual laboratory

IV.   VIRTUAL EXPERIMENT SOFTWARE PLATFORM DESIGN

B/S structure, namely Browser/Server (browser/server) structure, is the improvement or a change of the C/S structure. In such a structure, user interface is achieved by WWW browser entirely, part of affair logic is achieved in the front, but the main affair logic is achieved in the server, it forms a 3-tier structure, that is, the structure is formed by browser, the web server and data server. Client is a standard web browser, server is a standard web server which responses the request of the browser by collaborating with application server. Browser uses the hypertext transfer protocol (HTTP) message mechanism, and visits the server via a Web browser and issues request, and the server will transmit the response back to the client after a corresponding deal with the results. This three-tier structure is independent between the layers, and the change of any layer will not affect the function of other layers.

A.   Virtual Lab Software Platform Structure Design

In the B/S mode, the client users only need to install the browser, the other work will be completed in the server-side. The Data Acquisition System is still completed in the host, users can use a Web browser to connect with it, also they can see the same front panel with the host-side in the local, and can gain full control. Other users can monitor the entire operation process by login at the same website. In order to reduce conflicts, and for ensuring that customers can carry out the experiments in operating time, in a period of time, there can be only one user access the control of the physics experiment platform. In the B/S three-tier model, the client sent a Web request to the Web server via HTTP, Web server can coordinate and handle multiple requests from the clients automatically, application-layer application server is responsible for handling business logic and database access, application servers define and achieve the interactive with the databases, as well as the application of logic in the system, the B/S mode of the three-tier logic structure is shown as Figure 2.
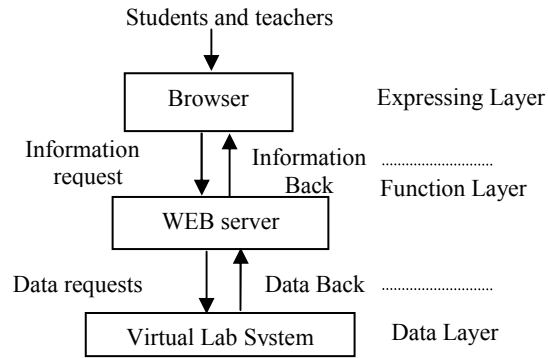
Figure 2.   Browser / Server three-tier structure

B.   Virtual Lab Software Platform Design

Virtual Lab needs the integration of the hardware and software, and eventually realizes the whole function of true experiment. In the basis of the hardware platform, software platform is an important part. And the difficulties and focus of the software designing is the design of virtual laboratory database and the use of multimedia technology. Due to advancement of software technological, more and more software become more and more powerful, so as to reduce the burden on the technical staff.

Virtual laboratory software platform is the basis of the whole virtual laboratory, which is based on B/S structure, and provides network support. Virtual Laboratory has three roles: The Super Administrator, experimental instructor and students. They have different powers. Experimental Super Administrator authenticate and login on the laboratory management background to release experiment news, notification, experimental arrangements, add experimental courses and curriculum management password, he has the highest authority. Experimental instructor can release courseware, and multimedia information (video, flash, etc.). Students are the ultimate beneficiaries, he almost has no authority, but all the

services are provided for them. The designation of the virtual laboratory software platform structure is shown as Figure 3.
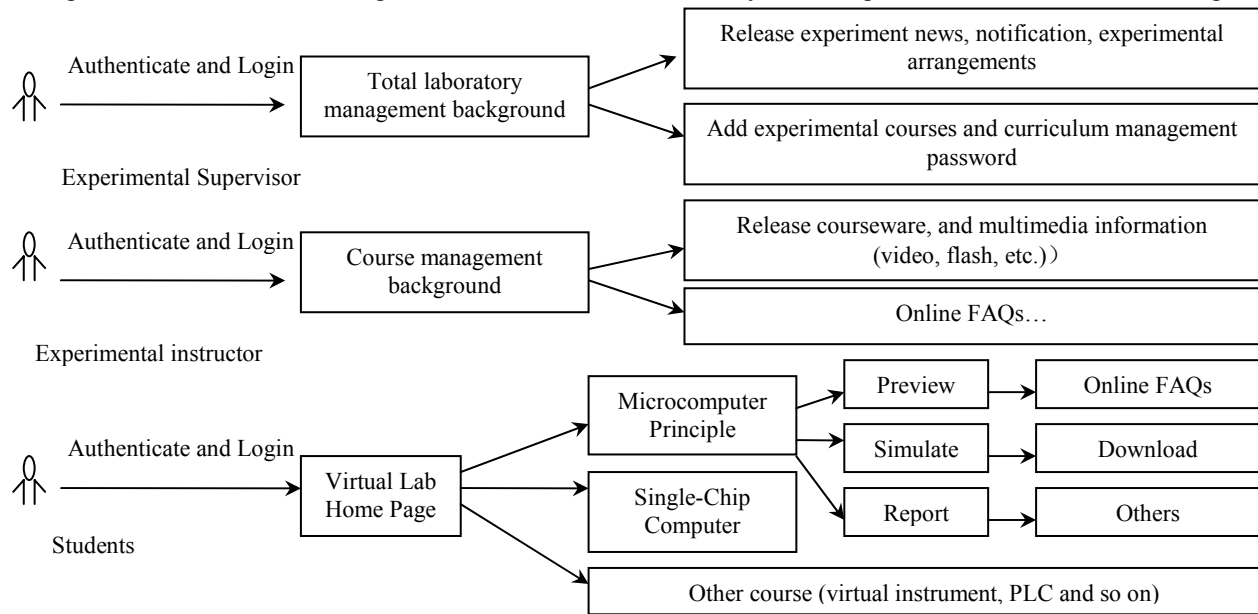

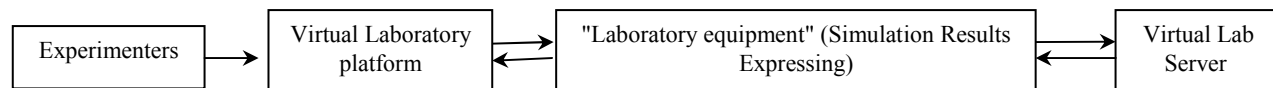Figure 3.   Virtual laboratory system software structure

Figure 4.   Virtual laboratory request and response operations

C. Virtual Simulation Experiment Processing

Remote virtual laboratory system is a heterogeneous problem-solved environment supported by virtual reality technology, which allows learners to do experiment on an same experimental project at different locations, a virtual equipment can be used the sharing software to simulate in a virtual laboratory at the same time, also users can realize simulate experiment by controlling remote virtual sharing device, which inevitably demands it can be realized easily on the WEB.

As the basis of remote virtual experimental platform, B/S module core server can realize the simulation of the experimental environment by using virtual reality technology, receive the operation request from the clients, adjust the apparatus states according different experimental request, simulate the experimental phenomenon, output the corresponding experimental data, and do unified control on the whole system. Learners do experiments on the client, experimental data in the process and results data will be stored in the database server under the core server unified control. They can also do response to the simulation experiment "simulation phenomenon", the processing is shown as Figure 4.

D. The Method of Virtual Simulation Experiment

Virtual experimental system mainly includes virtual scene and virtual experiments.

1)   Virtual Scene: Virtual Scene: Virtual scene is not only including virtual experiment environment, but also including demonstration experiment and the simulation devices, and so on, we can use the vidicon to record the real scene of the experiment phenomenon, but the documents is too big, and is unsuitable for real-time transmission online, we can use 3DS MAX for geometric modeling, use export order to output. The .max documents is converted to small transmission capacity .wrl files, avoiding the transmission of huge video frame online, only sending the model described scenes, animation frames generated on the local, in this way the network bandwidth will not affect the virtual scene display [4].

2)   Virtual Experiments: The experimenters take part in the experiment personally, they play a dominant role in the experiment processing, therefore, simulation experiment Processing will be complicated, mainly related to two issues:

At the first, the demonstration of the experiment phenomenon, that is, how to transfer the corresponding events in the specific time of the incident, how to trigger simulation scene, how to achieve the simulation scene. That is a problem about how to realize the video.

At the second, the realization of virtual instrument operation, such as the movement of virtual instruments, or placement. We can use the virtual reality modeling language VRML to complete the interpolation of animation, view video, frame video in the virtual experiments, as well as the interaction between virtual instruments, so that experimenters can feel himself operating at the presence scene [5]. This paper presents a use of text, pictures and other forms of the virtual simulation method, it includes two processes.

Process 1: An important step after uploading the prep material of the experimental for the instructor is to set the subject, content and related parameters of the simulation experiment. Laboratory instructor enter the curriculum management background courses by using the course code and management password, click the add simulation experiments to do simulation experimental settings. Experiment instructor does simulation experiment set is shown as Figure 5.
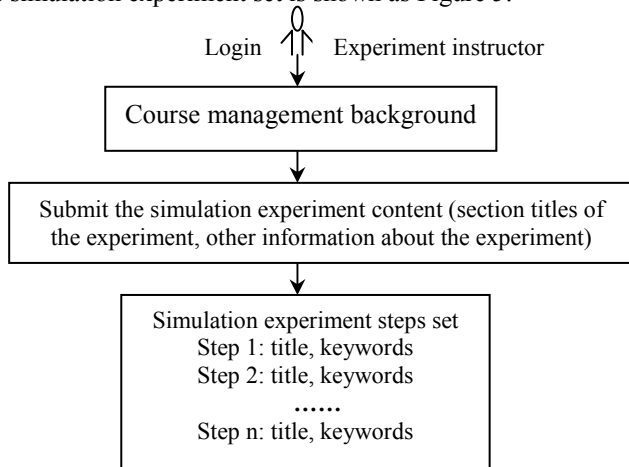

Figure 5. Experimental instructor sets simulation experiment.

How to judge that students' experimental operation or procedure is correct? The method of the simulation experimental is as follows:

First of all, curriculum management teachers add keywords to each experimental operation step, as long as the students' recording words in a text box contains all of the words, the virtual experiment system will judge his text or procedure is correct automatically, or it is wrong, as is shown as Figure 6.
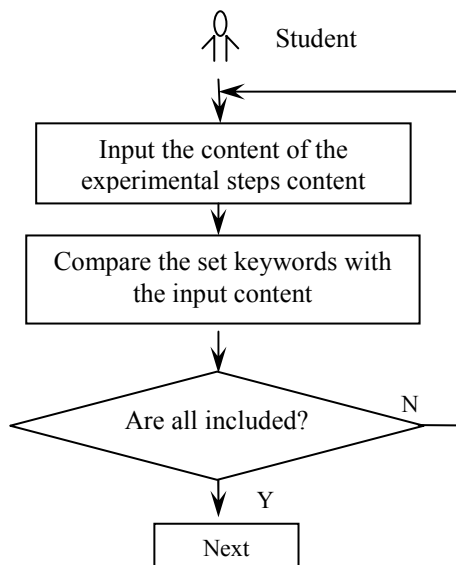

Figure 6. Judgement of the simulation content

The second process: the students do simulation experiment, it is shown as Figure 7.

Experimental course administrators set topic in the background, the students log in laboratory simulation page, select the subject to do simulation experiments.

Students choose a simulation experiment, first to complete step1. If the content of the experimental operation inputted in the text box is right, the system will move on to the next page. If the input is wrong, and system require for re-entry, only by entering the correct content can enter step two, and so on, until the completion of steps N. After the completion of the final steps we will see the results of the experimental courses. These experimental results including the Flash or video multimedia files, after reading and recording can students complete the simulation experiment finally.
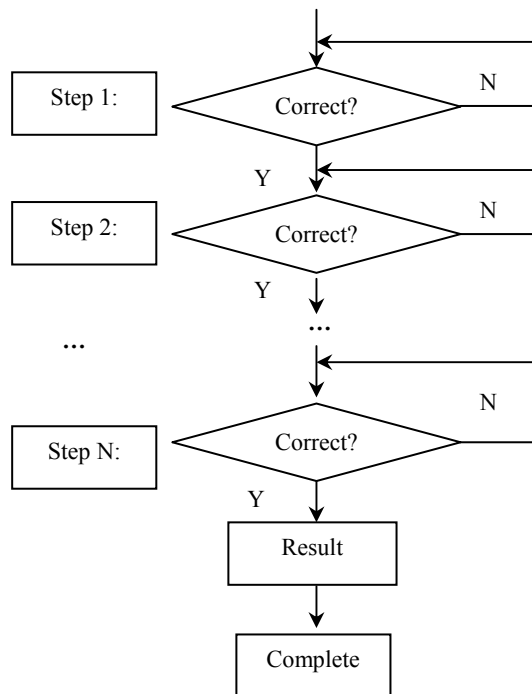

Figure 7. Students do simulation experiment

V. CONCLUSION

This paper presents construction methods of a virtual laboratory platform, including laboratory equipment interface and virtual laboratory software platform, and using ASP.NET development platform and C # language, to achieve the virtual simulation process, users can simulate experiment process, preview experiment content, put in experiment reports and online FAQs via Web.

REFERENCES

[1] L. S. He, "Reconfigurable virtual instrument system", Journal of China Machine, vol 41, No 2, pp14-17, 2005.

[2] X. H. Zhao, "Data Acquisition and Processing System for Press and Temperature Signal Based on B/S Mode", Journal of Harbin University of Science and Technology, vol 10, No 2, pp. 31-36, 2005.

[3] J. J. Zhang, W. X. Huang, C. C. Yan, "Design of virtual laboratory platform, Modern Journal of Electronics Technique", No 11, pp. 40-41, 2004.

[4] Z. G. Liu, "The thirds kinds built methods of Web Virtual Lab and Contrast", Journal of Computers and Applied Chemistry, No 1, pp. 91-93, 2003.

[5] H. Y. Che, S. Q. Yu, "Construction on the basis of the fictitious Laboratory of WEB", Journal of Beijing normal university, No 12, pp. 14-17, 2002.

[6] G. Z. Chui, X. Chen, "Design and Implementation of Network Virtual Lab Based on WWW", Journal of Peking University, No 6, pp. 43-46, 2004.

[7] S. Ni, "Based on Internet of Virtual Operating System Laboratory of Environment and Scheduling", Journal of Central South University, vol 32, No 8, pp. 72-75, 2001.

[8] H. Liu, J. F. Wang, D. M. Liu, "The Design of Virtual Experiment Platform Based on Web", Journal of HUAZHONG University of Science and Technology, vol 29, No 8, pp. 18-20, 2001.

[9] S. L. Wang, Q. Y. Wu, "Developing the Study and Application on Virtual Experimental System", Computer Engineering and Science, vol 22, No 2, pp. 33-35, 2000.