## The Description and Analysis of Remote Network Virtual Laboratory

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#### Abstract

The fast development and improvement of remote network education provides a higher demand for the large construction of education resource, and experiments teaching are the most important method of practice teaching. In this paper, it talks about the model, the key technology and the solution method of the remote distributed virtual laboratory. Meantime, it proves that this project can't only provide a software environment for remote network virtual experiments, but also can improve the condition of experiment and provide a learning, practice and innovation technology platform.

*Keywords: Remote Education; Practice Teaching; Distributed Virtual Laboratory; Developed Flow; LABVIEW* 

### **1. Introduction**

Virtual laboratory is proposed by William Wulf of Virginia University in United States (1989). It is used to describe a virtual laboratory environment of computer network. It devotes to construct a scientific research integration environment with comprehensive different tools and electronic and network technology. In this environment, scientists can effectively engage in scientific research activities using all kinds of resources (data, information, equipment, human) of geography. Wulf calls the virtual laboratory as "no wall research center".

The so-called network virtual laboratory is a system that takes the computer network as the core and connects virtual instrument with the network to realize the data collection, analysis, and remotes operation. And according to the basic requirements of the experimental teaching, virtual experiment sets up virtual experimental environment and makes a real-time simulation with experiment model by all sorts of virtual experimental instruments and establishes a new type teaching experiment. Some basic experiment, automatic control principle and digital signal processing, *etc.*, can use the method of virtual experiment. The application and development of virtual experiment are supplement and complete to the traditional teaching mode of experiment.

Because all the activities are holding in the distributed network environment, virtual laboratory is a distributed computer system essentially. This paper mainly expounds the remote distributed virtual laboratory model and the key technology.

## 2. LabVIEW Development Environment Introduction

LabVIEW is launched by the national instruments (NI) in 1986 based on a graphics programming language (G language) development environment. It has very powerful functions, including data collection, signal processing, input/output control, signal generation and transmission, image acquisition and processing, *etc.*, it also provides rich function library and procedure. LabVIEW is used in Windows, Macintosh, Unix, etc and many operating system platforms It also has the third party providing practical software, such as Application Builder for executable file. SQL Tookit is used to connect LabVIEW program with local or remote database. LabVIEW also has a strong network function, communicating with TCP/IP or UDP, establishing Web Server and G Web Server and running program belongs to different remote platforms.

LabVIEW program called "virtual instrument program" (hereinafter referred to as VI), includes three parts: the front panel, block diagram, icon/connection port. LabVIEW uses button, switch, wave familiar graphics directly programming, interface image is intuitive and the program execution sequence is square flow chart. So LabVIEW is rapid and widely used. We use it to formulate the remote network virtual laboratory.

## 3. Structure of Virtual Laboratory

The commonly-used system structures of current information management system (MIS) are two-layer client/server (C/S) structure, the browser/server (B/S) structure and distribute multi-layer structure, *etc.* Generally, traditional two-layer C/S structure is composed of several clients and one server. The clients take charge of interaction with users, while the server is responsible for the data management, but there are limits such as poor scalability, inconvenience to manage a large number of clients, *etc.* B/S structure solved heterogeneity of clients and cross-platform in C/S structure to access all kinds of resources in computers on cross-platform and their network, but it has limits on interface dynamics, interaction and information instantaneity and functional completeness, and it requires high performance of server. Focusing on these problems, the remote virtual experiment system adopts distribute technique to logically separate user interface from application. The information system is divided into three parts, representation, application and data, placed in the same or different hardware platform, as shown in Figure 1 and Figure 2 below.

## 4. Key Point in Remote Virtual Experiment System

#### 4.1 Experiment data sharing technique

Experiment-data-sharing-based collaborative experimental environment is aimed at making several members in the same team design and operate on one experiment and therefore the experiment collaboration is achieved. In collaborative experiment modules, experiment data and concurrency control need to be supported, which means that collaboration between different experimenters completes the same experiment function and provides a collaborative environment.

The primary question of building a collaborative environment is to make every member aware if a client operates the experiment. Building software collaborative environment based on Java can adopt duplicate model. Every participant carries on the same application program. Input received by one user is distributed to all the other users, using mechanisms of truncating and distributing users' events, which captures events of all users and then distribute them to all members in the team by developing an



Figure 2. Three layer structure technology integration



Figure 2. The structure of network virtual laboratory

add-on which extends all GUI components of java, awl to a Process Event method. Because in real virtual experiment collaboration, only the design part needs to be known by all the members and there is no need that every input/output event are filtered, members acquire experiment operations by message-Pub/Sub model. The Pub/Sub model is a one-to-many model, *i.e.*, a message producer gives out a message to a theme, and many message consumers who subscribe to this theme will receive the message. Data sharing model is shown as Figure 3. International Journal of Multimedia and Ubiquitous Engineering Vol.9, No.1 (2014)



Figure 3. Virtual laboratory data sharing model

#### 4.2 Measure and control platform based on embedded technique

The measure and control platform which utilizes embedded techniques to construct remote virtual experiment lab, detached from DAQ board hardware environment, with better controllability and function-extension time, this measure and control system can effectively integrate lab hardware resource distributed in various location at the same. Therefore, it provides users with better utilization space. The embedded measure and control system structure is shown in Figure 4.

The connection between the measure and control platform and local physical equipment meanly adopt RS-232, USB and GPIB, *etc.* Meanwhile, the platform can put physical equipment and internet interface distributed in the network together by TCP/IP protocol, thus constructing a distributed measure-and-control system to enhance resource-utilizing-and-sharing, meanwhile helpful for collaboration between researchers and students.



Figure 4. Embedded measurement and control system software platform

#### 4.3 The implementation of Virtual Lab server

The server of Virtual Lab is the main part of remote virtual lab, composed by application server, database server and Web server. The implementation of the server mainly adopts Lab VIEW, a kind of graphic programming language by NI. The server structure of virtual lab is shown in Figure 5 and 6.



Figure 5. The structure of virtual Lab Server



Figure 6. The model of user authentication security

## 5. Network Virtual Laboratory Design and Implementation

#### 5.1 Network virtual laboratory system design and realization

Network virtual experiment system needs not only the virtual experimental operation, but also a series of auxiliary function module support. These function modules become a bridge between virtual platform and the subjects, and form a network virtual laboratory system. It helps students to finish the task and help management complete the task of administrator.

At present, the virtual laboratory platform can provide students with user register, login, user material modification, password retrieved, booking experiment, network virtual experiment, the experimental results preservation, fill in online experiment report, test report scores query, *etc*.

#### 5.2 The simulation experiments design and implementation

In the simulation part, based on the function of LabVIEW built-in web published, we design the web pages through the HTML, and use the function Microsoft IIS 6.0 released, generate www web of embedded experimental platform in the server directly, the user simply uses a web browser into our site, then do experiments through the Internet. Its principle is shown in Figure 7.

LabVIEW built-in Remote Panel Connection Manager is used to monitor and schedule the users. NI Web Server according to the far end of the experimental data of the operator, analysis, calculation and display, rendering the experimental curves, and complete report, *etc.* 

![](_page_5_Figure_2.jpeg)

Figure 7. Simulation experiments principle diagram

#### 5.3 Remote control experiment design and implementation

In the remote control part, we use the Application Server & API structure.

Application Server & API structure use LabVIEW programming, with its module built-in TCP/IP for the foundation, construct a Application Server Application Server and a API user terminals. The TCP/IP module complete network connection, data communication and fault tolerance processing .Application Server is used for sample and transmit experimental data, user management, record the users. And the API user terminals provide the operator GUI interface, realize the data access, analyze operation and display the storage. Its principle is shown in Figure 8.

![](_page_5_Figure_7.jpeg)

# Figure 8. Remote control part Application Server & API structure principle diagram

It can complete all kinds of virtual experiment under the network environment, using computer software to simulate concrete experimental environment, experimental object and experimental process to realize the function of the experimental teaching system.

## 6. Conclusion

This paper uses the development mode with the B/S is priority and the C/S mode is auxiliary. And at the same time, it develops a lot of remote experiment projects, provides students with a learning, practice and innovation platform.

Practice shows that, remote distributed virtual laboratory can not only save input in the experimental education, it can also improve the institutions of the existing teaching system, improve the teaching level of colleges and the teaching quality, promote students' learning autonomy, cultivate and improve students' practical and creative ability. It will make the modernization construction of university experiment teaching step on to a new stage.

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