Practice of Medical Electronics Teaching Method
Based on Virtual Simulation

Jun-An ZHANG¹,a, Yong-Qiang CHEN¹,b and Tian-Xia ZHANG²,*

¹School of Medical Instrumentation, Shanghai University of Health & Medical Science, China
²Shanghai Reiyi Culture Communication Co. Ltd., China

a zhangja@sumhs.edu.cn, b chenyq@sumhs.edu.cn, *zhilong2018@126.com

Keywords: Virtual simulation; Medical electronics; EWB; Multisim.

Abstract. Virtual simulation software EWB, such as Multisim 13.0, was introduced into the teaching work. In the case of limited class hours, inexperienced students experience a large number of examples, phenomena and results in a short period of time, achieving the purpose of theoretical verification. Through simulation teaching, students have better understood the basic concepts, mastered the basic principles and methods of analyzing problems, cultivated the ability to analyze and solve problems, and improved students' interest in medical electronics courses.

Introduction

Since 2008, the Electronic Technology Teaching and Research Group of the Electronic and Electrical Training Center of Shanghai Medical Instrumentation College has started the virtual technology simulation teaching of electronic technology. To this day, it has accumulated important research results. In 2015, three universities in Shanghai merged into the Shanghai University of Health & Medical Science. The predecessor of the School of Medical Instrumentation is the Shanghai Medical Instrumentation College.

Using the Internet platform, through the intelligent terminal, personal computer and EDA platform, the system functions and performance indicators are set by virtual simulation, so that the simulation results can be realized according to the expected results, and further research experiments are further explored. The experiment is low cost, fast, flexible, and has no environmental limitations.

In addition, the project was later built to consider adding a manual or automatic control hardware system debug unit based on the virtual simulation, and comprehensive system control of each unit through hardware and software joint debugging and troubleshooting.

In the case of strong school support and funding conditions, post-construction will also consider accrediting CLAD (certified LabVIEW Assistant Developer) certification. National Instruments National Instruments LabVIEW Assistant Development Engineer Certification CLAD is NI's worldwide certification for LabVIEW's use and programming capabilities and is the cornerstone of all application techniques for the LabVIEW software platform [1]. Especially for recent graduates, CLAD is one of the important skill chips for employment, employment and the evaluation criteria of employers. According to relevant research, the relevant units are developing rapidly, the demand for talents is strong, and the LabVIEW gap is increasing year by year. In particular, the employers in East China generally recognize CLAD, and CLAD has gradually become “available and can be used”. The industry standard; at this level, LabVIEW or CLAD certification has different positive meanings even for students with different starting points [2].

Basis of Experimental

In September 2014, our training center and NI Company signed a school-enterprise cooperation agreement. Under the joint efforts of the school and the company, a joint virtual simulation laboratory experiment was established. The device includes 10 sets of NI ELVIS teaching experiment virtual instrument kit based on LabVIEW and DAQ system, detachable prototype board and integrated
instrument functions such as power supply, oscilloscope, multimeter and other instruments. This equipment is currently used primarily for teaching research in teachers, as well as biomedical engineering, clinical engineering students participating in electronic design competitions and technological innovation competitions. This equipment can also be further used to complete the experimental project of electronic technology combination.

The local area network of the virtual simulation software Multisim 13.0 is installed, including a server with teacher management software and 50 computer terminals. Students can carry out virtual simulation design through the LAN network terminal, and realize real-time interactive communication with the teacher. This equipment is currently serving the teaching work of our students, completing virtual simulation experiments of electronic technology courses such as circuits, analog electronics and digital electronics. The section headings are in boldface capital and lowercase letters. Second level headings are typed as part of the succeeding paragraph, like the subsection heading of this paragraph [3].

**Supporting Support**

Establish an Internet with sufficient bandwidth and sufficient concurrent response support to provide the necessary Internet addresses and virtual machines of the necessary capacity.

**Upgrade Existing Hardware Facilities**

At present, the virtual simulation experiment site is arranged in the information center school public computer room, which is shared with other public courses of the school. The server facilities are low in configuration and can only be adapted to the use of students in the local area network. If the service scope is socially extended, it is necessary to establish a special experiment center for school virtual simulation.

**Purchase Genuine Special Simulation System**

The simulation platform software currently used is a free/trial version, and extensive social services will infringe the copyright of related companies. In addition, considering the system expansion and upgrade and the later opening of the FPGA teaching project, virtual simulation software such as MATLAB and OrCAD were purchased.

**Experimental Teaching Method**

Take virtual simulation experiment teaching as an example. Use Multisim for simulation experiments. The experimental process is very close to the actual operation, and the experiment has a strong sense of reality. The system provides near-real electronic components, working environment and analog instruments, making students feel like experimenting in a real environment; the choice of various components is wide, the parameters are easy to modify, not as many as the actual number of operations. Solder components to damage the device and printed circuit board. Make circuit debugging quick and easy. It can be applied to circuit principles, simulating most circuits in electronics and digital electronics. It can be used not only to verify the characteristics and principles of individual circuits, but also for multi-level combinations Circuit.

In addition, Multisim provides us with a good multimedia operation platform that enables students to provide experiments, demonstrations and circuit analysis at any time during the teaching process. Intuitive image display helps to develop students' ability to observe and analyze problems, helps to focus on teaching and is difficult to explain, and stimulates students' interest in learning. Teachers can analyze the characteristics of various circuits in a multimedia classroom and explain the effects of various parameter changes on the road. Students can combine the learning content and perform debugging analysis close to the actual circuit, which is conducive to deepening the understanding of book theory. This is a good way of the theory department.

Inquiry-based teaching can fully mobilize students' learning enthusiasm, tap students' learning potential, and enable students to passively accept active exploration, fully embodying teacher-led and student subjects. In the past, due to the lack of real-time interaction between teachers and students,
one-way teaching for teachers and passive learning for students, Multisim has established a good interactive platform for teachers and students. Because, first of all, in the electronic technology classroom teaching situation created by Multisim, electronic components, instrumentation and analog analysis methods are also provided for teachers and students, so that students feel the feeling in the real environment of electronic circuits. Students are virtual. Internal observation of the environment is no longer a bystander, but an inquirer of circuit knowledge. Second, Multisim's circuit parameter settings, electronic analysis and simulation, data graphics processing, and result output are simple. You can complete the operation and complete the teacher-student interaction with just a few mouse clicks. Therefore, in the classroom, teachers and students can complete a comprehensive communication in a simple and convenient way, and students' questions and novel ideas can be verified and tried in time. It truly creates an open, efficient “what you want” communication platform for teachers and students [4].

Inquiring teaching generally follows the three steps of “problem situation - establishing mode - solving problem”. For example, in the teaching of a single-tube common-emitter amplifier circuit, the first step is to create a problem. The amplitude is 10mV, the sinusoidal signal with a frequency of 1KHz is amplified 50 times, and the load resistance is 2KΩ. In the second step, the student calls the existing knowledge (triode amplification characteristics, external conditions of the triode amplification state, triode input, output characteristics), in the Multisim environment, calls virtual components and virtual and instrumentation, builds the circuit model, and finally Under the teacher's questions, inspiration and guidance, the circuit continuously analyzes, tests, adjusts, and the amplifier circuit is completed, solving the problem. In this way, in a large number of brain exercises, students learn new knowledge (the basic structure of the common amplifier circuit, static working point, cutoff distortion, saturation distortion, frequency response characteristics, etc.

In short, EDA technology provides a high-quality platform for inquiry-based teaching and will also provide quality assurance for students' learning [5].

Experimental Methods and Steps

The steps for performing virtual simulation experiments on LAN, campus students, and users are as follows:
1. Start the computer and log in to the system;
2. Click the simulation software icon to enter the simulation platform;
3. Click “New” simulation project to enter the schematic editing interface.
4. Select the component library. Place components, signal sources, power supplies, and reference grounds;
5. Electrical connection, circuit troubleshooting;
6. Edit the simulation parameter setting file;
7. Run Pspice simulation, add analysis expressions, and display circuit simulation graphics;
8. The cursor measures various circuit characteristic indicators. If the requirements are not met, the schematic is corrected.
9. Run correctly, save the result, save as file name;
10. Submit the assignment and wait for the teacher to accept and feedback the information.
11. Write an experiment report, data analysis and processing.
12. Submit the lab report and wait for the teacher to give feedback.

The steps for performing virtual simulation experiments on Internet network users and clients are as follows:
1. Log in to the system for the first time, register, fill in relevant personal information, and set the user name (student number) and password.
2. Click “Login”, enter the student number and password, and enter the simulation experiment platform.
3. Select the experimental module, or select the unfinished experimental project to enter the system;
4. If necessary, click "Experimental Instance", "Help Information";
5. According to the experimental requirements, select devices, virtual instruments, and connect circuits;
6. The circuit is checked for errors and deleted and modified as needed;
7. Edit the simulation parameter setting file;
8. Run Pspice simulation, add analysis expressions, and display circuit simulation graphics;
9. The cursor measures various circuit characteristic indicators. If the requirements are not met, the schematic is corrected.
10. Run correctly, save the result, save as a file name;
11. Submit the assignment.

Technical Architecture and Major R&D Technologies

As shown in Fig. 1, on the basis of the existing virtual simulation experiment teaching center, a teaching resource database such as a simulation experiment teaching library, an experiment database, a user information database, and a management and control platform for facilitating the internet user link experiment center are added [6].

The client includes a personal computer with a terminal authentication system and iOS and Android terminals with plug-ins installed.

![System Architecture Diagram](image)

Figure 1. System Architecture Diagram.

Network Condition Requirements

It is recommended that the system deployed by the cloud server has at least 10M bandwidth. A system based on a LAN server deployment has at least 50M bandwidth.

It is recommended to support 50 students/terminals to concurrently access and request online. If a single experiment is occupied, the prompt will be queued online and wait for the previous experiment to finish, and then enter the next appointment queue.

Program Features

The virtual simulation experiment teaching is based on the student-centered experimental teaching concept, the accurate application of experimental teaching content, innovative and diverse teaching methods, advanced and reliable experimental research and development technology, stable and safe open operation mode, and continuous improvement of experimental evaluation. system.

According to the teaching experience of the teaching team for many years, the virtual simulation experiment teaching method and the hardware experiment teaching method have the following obvious advantages:

In the case of extremely limited class hours, students with no circuit work experience will fully understand the theory and concepts of the course in a short period of time through the most experimental examples, phenomena and results analysis.
The virtual simulation experiment teaching project further promotes the deep integration of modern information technology and experimental teaching projects, expands the breadth and depth of experimental teaching content, prolongs the time and space of experimental teaching, and improves the quality and level of experimental teaching.

Summary

Modular Teaching

The "project-driven" teaching mode breaks the traditional teaching theory of post-theory and post-experimental teaching. It is an innovative teaching method. It leads to theoretical knowledge through specific examples, allowing students to learn from perceptual cognition to rational cognition. Easy to master and apply knowledge.

The Theoretical Classroom Enters the Laboratory

Advocating practical courses should adhere to the teaching method of taking the equipment to the podium or moving the theoretical classroom into the laboratory, so that students can learn the theory in the experimental phenomenon and let the students truly understand the application. Skills and abilities.

The Student’s Hands-on Development

Compared with the previous EDA experiments based on software experiments, the virtual simulation experiment teaching mode encourages students to complete the design of the whole project, from PCB design, component soldering to software programming, debugging, downloading. By the completion of the final electronic product, the students will realize it automatically, which fully reflects the teaching requirements of applied talent training.

In short, the electronic technology virtual simulation experiment teaching activities have been widely praised by students, the students' learning initiative and autonomy have been greatly improved, and the teaching process has also realized information management.

Acknowledgement

This research was financially supported by the Demonstration Virtual Simulation Experiment Teaching Project from Shanghai University of Health & Medical Science.

References

[1] Li Ling, Zhou Bo, Zhao Dong-mei, Guo Wei, Research on Virtual Laboratory Construction of Electrical and Electronic Circuits Based on Multisim. Electronics World. 2018(13), pp. 33-34.


