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Research on Integration of Theory and Practice Teaching Mode of Power System Relay Protection Course

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***Abstract*—In this paper, remote steerable experimental teaching platform and general microcomputer relay protection experimental device are deeply studied, and their design principles and main functions are also clearly defined. This paper will apply "Internet plus education" technology into power system relay protection course in order to improve distance learning model. By taking advantage of Internet technology, teachers can operate experiment instruments remotely to perform experiments in teaching, and students can watch the experiment's real-time image which is returned by live broadcast. Moreover, the theoretical explanation and practical demonstration will be conducted simultaneously in teaching to enhance teaching effect.**

Keywords—power system; relay protection; experiment teaching; remote control; Internet

I. INTRODUCTION

In the teaching of power system relay protection course, traditional teaching mode has obvious drawbacks. Theoretical teaching and experimental teaching should complement each other: theoretical teaching serves experiments and lays foundation for it; in return, experiment result tests the achievement of theoretical teaching and makes up its deficiency [1]. At present, the power system relay protection course is limited by teaching instruments and experiment's class hour, leading to a separation of theory and practice. Using the remote steerable experimental teaching platform and general microcomputer relay protection experimental to teach device, there are three characteristics: the unity of time and space, the synchronization of cognitive process and the intersection of cognitive form will be achieved in teaching process, and knowledge and skill training system will be built, helping students to internalize knowledge.

II. THE DESIGN OF REMOTE STEERABLE EXPERIMENTAL TEACHING PLATFORM

As shown in "Fig. 1", the remote steerable experimental teaching platform (shaded) is based on distance education and Internet of Things technology, aiming to enable teachers to operate teaching instruments in laboratory remotely and perform an experiment relating to classroom teaching without any confining of space, such as real-time relay protection measurement and control test project [2]. Based on the Internet of Things technology, when the experimental teaching instrument starts, the camera starts at the same time and transmits experimental images. Students can observe experimental phenomenon or result in real time through images, and participate the experiment with teacher at the same time. Therefore, students can get experimental report in class [3], [4], [5]. This kind of Electromechanical integration remote control experimental teaching platform with the help of multimedia and Internet communication technology enhances the flexibility of experiment teaching, overcomes the limitations brought by laboratory sites and class hours, which can help to improve students' overall ability of practice and operation.

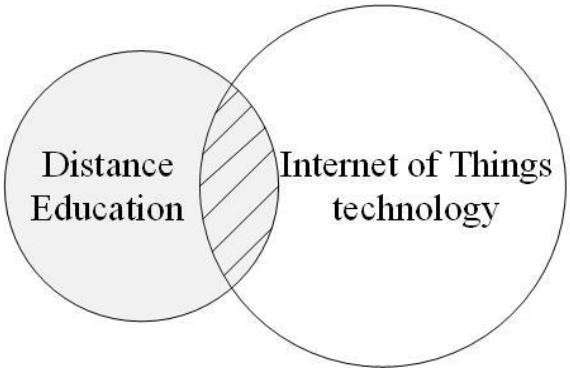

Fig. 1. The remote steerable experimental teaching platform.

A. Design Principles of Remote Steerable Experimental Teaching Platform

1) Advancement: The construction of remote steerable experimental teaching platform must ensure its timeliness. It adopts the most advanced remote control technology and video transmission technology in the world, who will maximize its service life under the relevant construction requirements of our state.

2) Reliability: The remote control experimental teaching platform must avoid problems such as controlling failure,

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video jam or disconnection during class. On the one hand, the construction of internal logic program and the design of software need to be as simple as possible; on the other hand, the design and development of hardware need to choose equipment or devices with low failure rate and easy maintenance, ensuring the platform can work continuously without interruption.

3) Security: The platform needs to rely on the network to achieve operation. Therefore, its security is the foundation of performing an effective experiment course. The platform system is highly encrypted to against network viruses and Trojans through a perfect authorization management mechanism.

4) Compatible expandability: To ensure that the remote control experimental teaching platform can keep pace with the times, and new concepts and new technologies emerging in teaching tasks can be added to the platform, it will use standardized conventional devices to build itself that will also bring convenience for adding new devices and upgrading old devices in the future.

5) Practicality: When we do efforts to guarantee all the functions of the platform, the increasing capital input of developing extra functions also should be comprehensively considered. A higher cost performance should be kept. The platform can perform basic network troubleshooting through remote operation even though lacking of professional maintenance personnel.

B. *The Main Functions of the Remote Control Experimental Teaching Platform*

1) Access control: Teachers obtain their access rights of the remote control experimental teaching platform through their personal account password.

2) Experimental integration: Teachers not only can perform all the integrated power system relay protection's experiments shown in the textbooks, but also can add experiments that are not covered in the textbook, but suitable for students to learn according to needs of class teaching.

3) Remote access: According to the overall arrangement of laboratory, teachers can get access to the complete experimental operation interface by logging into the platform remotely, then adjust the experimental parameters online, operate the relay protection experimental teaching instrument to perform an experiment, and obtain experiment's data finally.

4) Parallel access: Internet makes the remote operation of experimental teaching instrument available. Although the platform allows only one person to operate, multiple users are allowed to visit at the same time.

5) HD live broadcast: The webcam is connected to the experimental teaching instrument through Internet. According to the direction of the experimental teaching instrument, the camera angle can adjust by itself. The whole experimental operation process will be broadcasting at every direction smoothly.

III. General Microcomputer Relay Protection Experimental Teaching Device Auxiliary Teaching

A. *General Microcomputer Relay Protection Experiment Teaching Device*

By studying one kind of general microcomputer relay protection experiment teaching device, several different brands of microcomputer relay protection devices can be simulated on this device. It can expand students' operating width during experiment, and eliminate limitations caused by hardware. It also can solve the dilemma of hardware limitation in relay protection test and improve teaching effect of relay protection experiments. The device can perform typical relay protection experiments such as over current protection, low voltage protection, power direction protection and other experiments [6]. In class, according to the specific experiment teaching content, the hardware connections must be done in advance, such as connecting fault signal generator and the experiment teaching device in order to realize the access of fault signal and the output of action signal. According to the relevant signal delivered from fault signal generator, we can test the control logic of the typical microcomputer relay protection device.

B. *Design Principles of General Microcomputer Relay Protection Experimental Teaching Device*

According to the logic control requirements of the relay protection action, establishing a general microcomputer relay protection experimental teaching device so that all brands of relay protection devices can be mapped on this device.

The modular hardware of the general microcomputer relay protection experimental teaching device is compatible with real connectors of all brands of relay protection devices. And its modular software is compatible with virtual connectors of all brands of relay protection devices. As shown in "Fig. 2". The compatibility of modular hardware and real connectors, and the compatibility of modular software and virtual connectors give device the more practical meanings to real and virtual connectors. And the device can make a logical judgment according to people's needs.

The algorithm written of modular software in the general microcomputer relay protection experimental teaching device can use the software operation chain of each brand relay protection device to perform a logic control towards relay protection action. Through multiple combinations, it can create relay protection action conditions.

C. *The Function of General Microcomputer Relay Protection Experimental Teaching Device*

The research and development of general microcomputer relay protection experimental teaching device is based on embedded technology. The device is compatible with common power system relay protection methods. By constructing a modular hardware connection and use it as a

system, the hardware functional mapping of common power system relay protection devices is realized.

General microcomputer relay protection experimental teaching device has modular software with general protection algorithm and calculation method of basic electric quantity. They can be connected into a system by parallel or series connection, thus to achieve software's functional mapping of common power system relay protection devices.

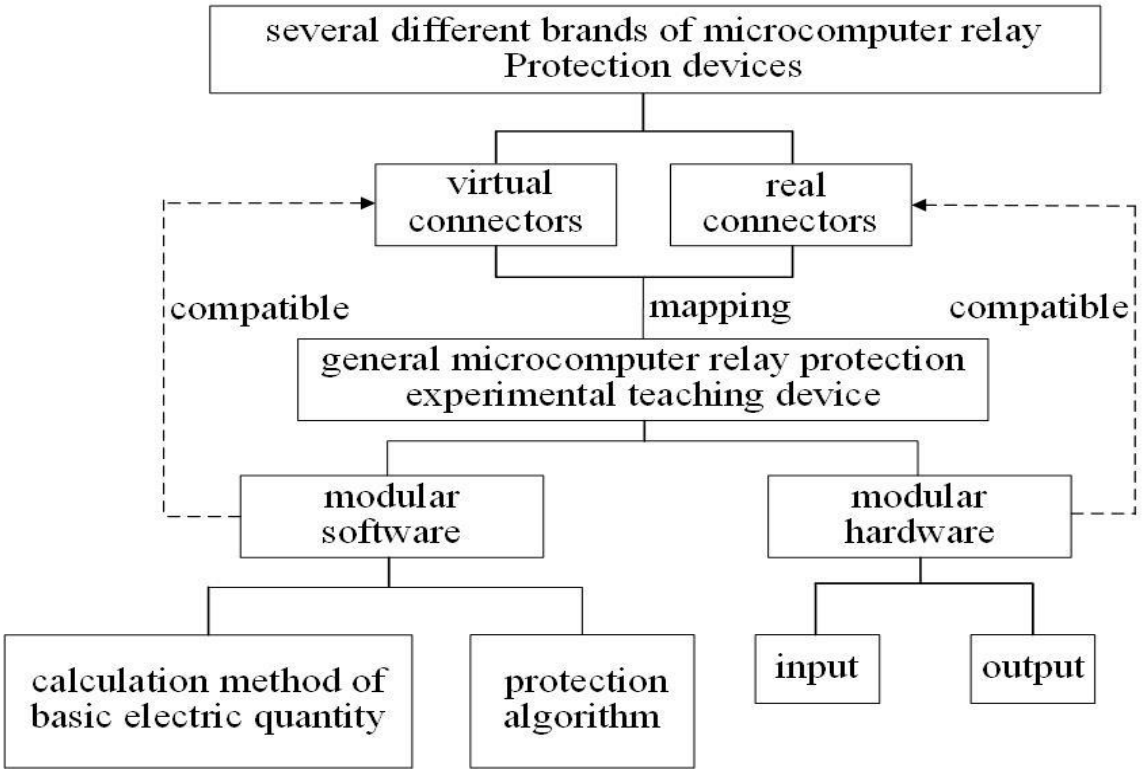

Fig. 2. Module diagram of general microcomputer relay protection experimental teaching device.

IV. Construction of Teaching Mode Combining Theory with Practice

In traditional teaching paradigm, classroom teaching advocates standardization, and the teaching method focuses on how to teach objective theory efficiently and mechanically. Moreover, teaching hours are arranged precisely and strictly, and the progress of course is also clearly defined. The remote steerable experimental teaching platform is built according to the concept of "Internet + education". It can achieve the connection between classroom and laboratory, theory and practice, virtual and reality, and further promote the spatial integration of learning and context. It provides help to teaching and learning, and accelerates the transformation of knowledge cognition and knowledge creation [7], [8]. The general microcomputer relay protection experimental teaching device can simulate the characteristics of different brands of microcomputer relay protection devices, assisting the remote steerable experimental teaching platform. By connecting the general microcomputer relay protection experimental teaching device with the remote control experimental teaching platform via Internet, the number of devices that need to be connected to the remote steerable experimental teaching platform is reduced, which makes the operation of the remote steerable experimental teaching platform more convenient. These will be beneficial to teacher's operation because he does not have to switch different connection ports due to different experiments [9], [10]. In addition, the live camera device does not have to change the shooting angle neither, saving debugging time. The waiting time of users in the parallel access queuing area is shortened. At this point, this paper completes the establishment of integration of theory and practice teaching mode.

V. Conclusion

This paper pays attention to the shortcomings of the power system relay protection course teaching, and then applies the concept of "Internet + education" to develop a remote steerable experimental teaching platform and a universal microcomputer relay protection experimental teaching device, finally builds a teaching mode combining theory and practice. This paper advocates that theory and practice should be closely combined in class teaching. When class teaching is activated, the teaching information should be guaranteed to be transmitted synchronously. And the theoretical content also can be verified in practice in class. All of these can strengthen students' understanding of knowledge, avoid deviations or misunderstandings on professional cognition, and optimize the teaching process of power system relay protection course.

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