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Application of Virtual Simulation Technology in Electrical Control and PLC Technology Courses

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Abstract

Currently, the practical training teaching in engineering majors generally faces problems such as insufficient hardware resources, aging of practical training equipment, and outdated training technology that lags behind the technological development of enterprises. This is more evident in professional courses with strong practical operability. To improve the current situation in the practical teaching of electrical control and PLC technology courses, where there is no physical operation equipment as the controlled object, virtual simulation technology is introduced into the course teaching. MCGS configuration software is used to establish a simulation model of the production project, replacing the real controlled object to display the control effect. Adopting this teaching method not only compensates for the insufficient training conditions of electrical control and PLC technology courses, but also helps to connect the courses with the subsequent MCGS touch screen engineering project application courses, effectively improving the quality of teaching.

Keywords

Virtual Simulation Technology; Electrical Control and PLC Technology; Touch Screen Technology; Connection between Courses.

1. Introduction

In the era of rapid development of industrial automation, electrical control and programmable logic controller (PLC), as key technologies, are widely used in many fields such as industrial production, transportation, and intelligent buildings, and are one of the core technologies for achieving automation control. For students majoring in related fields, mastering electrical control and PLC technology is not only an essential skill for adapting to future career development, but also the foundation for promoting industry technological progress. The course of Electrical Control and PLC Technology, as a core course for majors such as Electrical Automation and Mechatronics, aims to cultivate students' ability to master the design, installation, commissioning, PLC programming and application of electrical control systems, so that they can quickly adapt to the needs of related job positions after graduation.

As a practical oriented course, the Electrical Control and PLC Technology course has high requirements for students' hands-on operation. However, due to the lag in equipment construction in the training room compared to industrial technology development, the training equipment is often outdated or even scarce. Especially in the PLC teaching part, due to equipment limitations, most practical projects in the classroom are carried out in the form of PLC programming operations without actual controlled objects[1]. Students cannot touch the real controlled object equipment and can only judge whether the written PLC control program works as expected through the output indicator lights

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on the PLC experimental platform. It is often difficult to imagine how the actually controlled object acts, and the expected teaching effect cannot be achieved.

To solve the above problems, this article introduces virtual simulation technology into the practical teaching of electrical control and PLC technology courses[3]. From the perspectives of the integration of virtual simulation technology and course content, as well as how virtual simulation technology can help connect this course with other courses, this article explores how to make up for the shortcomings in the current practical teaching of electrical control and PLC technology courses, in order to improve the teaching effectiveness of the course.

2. The Integration of Virtual Simulation Technology into the Curriculum

Generally speaking, the course content can be divided into two parts: electrical control and PLC technology. The electrical control part mainly refers to relay control. In this part of the study, students need to learn about the commonly used low-voltage electrical appliances, such as buttons, AC contactors, relays, etc., and understand the basic working principles of each component; Subsequently, learn basic electrical control circuits and principles, such as concepts related to self-locking and interlocking, as well as forward and reverse control of motors; Then analysis typical machine tool electrical control circuits and learn how to analyze or design them. The knowledge involved in the electrical control part is relatively specific, and its practical projects mainly focus on component recognition, relay control circuit wiring and construction. After students have a foundation in electrical control, the course moves on to the PLC technology section, which mainly explains the basic principles and programming methods of PLC, introduces application examples of PLC technology, and most of the practical training projects in this section come from actual production. In recent years, with the development of industrial technology, the application scope of PLC has gradually expanded, and the teaching focus of many schools has also shifted towards PLC technology. However, due to the lag in the construction of training rooms compared to industrial application development, most practical projects in the classroom do not have specific operating objects due to equipment limitations. Students could only judge whether the PLC control program they have written works as expected through the output indicator lights displayed on the PLC experimental platform.

For the problem of applying PLC technology in courses where there is no physical operating equipment as the controlled object, this article proposes using the MCGS configuration software platform to establish a simulation model and interact with the existing PLC experimental platform to simulate the operation effect of controlled objects in different production projects. The corresponding PLC electrical simulation system structure is shown in Fig. 1.

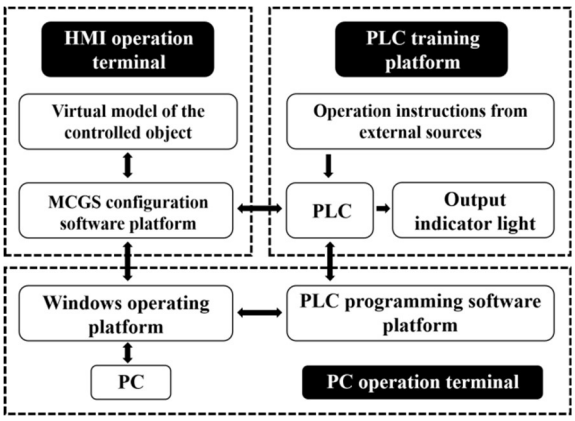

Fig. 1 Structure diagram of PLC electrical simulation system based on MCGS configuration software

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Build simulation models of corresponding production projects in advance in MCGS configuration software, such as multi-level conveyor belts, intersection traffic lights, simple robotic arms, multi-level elevators, automated production lines, etc. In practice, software can be used to create virtual controlled objects to replace real controlled equipment. After completing programming training in class, set up the communication connection between the PLC and the MCGS touch screen based on the assigned I/O points to complete the simulation. Students can see the running effect of the designed PLC control program on the MCGS touch screen.

Virtual simulation technology can simulate the operation status of actual hardware devices in a flexible development environment, making teaching not limited by hardware resources in the training room. Compared with traditional teaching methods, this strategy is more conducive than language expression to highlighting teaching priorities and breaking through teaching difficulties[4]. Using virtual simulation software to provide students with rich teaching resources, and combining with the computer and PLC training equipment equipped in the school's training room to jointly build a "virtual-real" teaching resource library. In addition to the fact that the computer in the training room can serve as a carrier for virtual simulation software, most students also have their own laptops, which can be equipped with simulation software for training outside of class, effectively promoting students' understanding and absorption of professional knowledge in the three stages of pre-class preview, in-class practice, and post-class review, and strengthening knowledge mastery.

At the same time, it should be noted that as a supplement to teaching methods, virtual simulation technology should be flexibly introduced into the classroom teaching process. Through reasonable design, it should be naturally inserted into various teaching links. At the same time, it is necessary to clarify that virtual simulation technology as a teaching tool serves teaching[8]. The principles of timely, appropriate, and moderate use should be maintained to ensure that the teaching center always focuses on the course content, avoiding the sense of disconnection and abruptness caused by simulation for the sake of simulation.

3. The Role of Virtual Simulation Technology in the Connection between Different Courses

The introduction of virtual simulation technology can not only make up for the shortcomings in the training conditions of electrical control and PLC technology courses, but also help to connect it with the application of MCGS touch screen engineering projects courses.

In practical industrial applications, PLC and touch screen usually work together. The PLC is responsible for the logical control and data processing of the controlled equipment, while the touch screen serves as a window for human-machine interaction, monitoring the operating status of the controlled object, and implementing parameter settings and operation instructions for the PLC. Effective integration of two courses in teaching can enable students to better understand and master complete industrial control systems, and improve their comprehensive practical abilities and employment competitiveness.

In the curriculum system of engineering majors, electrical control and PLC technology are often offered as prerequisite courses and taught in the earlier semester, while the application of MCGS touch screen engineering projects courses are generally taught in the later semester due to the technical complexity. In the previous section, we learned that MCGS configuration software can be used in the electrical control and PLC technology course to build a simulation model of the controlled object and to perceive the real control process through the dynamic changes of the virtual controlled object model during the simulation process. During the courses of Electrical Control and PLC Technology, although students did not delve into how the simulation models in the projects were established, they had already gained a preliminary understanding of them; In the subsequent MCGS touch screen engineering project application courses, how to establish the controlled object model of the practical project in the previous electrical control and PLC technology courses can be used as a practice task, and the simulation effect at that time can be reproduced. When students are designing

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touch screen interface configurations, they need to reconsider how to match the control logic of PLC and achieve real-time data interaction; When writing PLC programs, they can deepen their understanding of new knowledge while reviewing old knowledge, and explore how to reasonably set touch screen control parameters and response mechanisms according to the operational requirements of the control system. The cross application of this knowledge can help students establish a close connection between the knowledge of two courses and strengthen their mastery of the knowledge.

At the same time, the MCGS configuration model established by students in the subsequent MCGS touch screen engineering project application courses can also be used as a virtual controlled object for lower grade students in electrical control and PLC technology courses, as shown in Fig. 2. Through this connection, the two courses can promote each other's project resource updates and help optimize the construction of teaching resources.

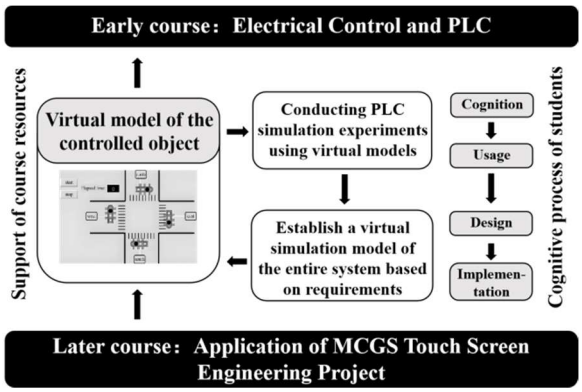

Fig. 2 The role of virtual simulation technology in the connection between different courses

4. Summary

This article focuses on the application of virtual simulation technology in electrical control and PLC technology courses. It explores the integration of virtual simulation technology and course content, as well as the role of virtual simulation technology in different course connections. The following conclusions are drawn:

(1) Introducing virtual simulation technology into the teaching of electrical control and PLC technology courses, employing the MCGS configuration software platform to establish a simulation model of the controlled object, and using it as a teaching resource to achieve teaching simulation of PLC control and application content in actual teaching, can effectively solve the problem of operating equipment without physical objects as the controlled objects in current practical teaching;

(2) The introduction of virtual simulation technology has effectively connected the content of electrical control and PLC technology, as well as the application of MCGS touch screen engineering projects. The models used by students for simulation experiments in the preceding courses are from the practical practice projects of senior students in subsequent courses, which helps students form a professional skill system cognition. Lower grade students can understand the basic concepts of subsequent courses in advance in the course, and consolidate and review old knowledge in subsequent courses.

The application of virtual simulation technology can effectively enhance students' learning initiative and significantly improve the teaching quality of the course "Electrical Control and PLC Technology". By introducing virtual simulation into the course, not only can the class of professional courses be expanded beyond the classroom and training room, but it also provides technical support for online open teaching. At the same time, in today's environment where flexible switching between online and offline teaching modes is needed, this teaching mode also has significant advantages.

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