Exploration of Engineering Practical Course System and Teaching Mode: Based on 1500PLC Three-Axis Palletizing Simulation Application Design

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Abstract: Practical teaching is of vital importance in engineering education. However, traditional practical teaching methods are restricted by factors such as venue, equipment, funds, and safety. As a result, the actual implementation rate of practical courses is low, and the teaching content is limited, making it difficult to meet the needs of industrial development. Virtual simulation practical teaching integrates advanced educational concepts with modern information technology, and features high-fidelity simulation and interactivity, becoming a new teaching model. It effectively solves problems in traditional practical teaching, such as expensive equipment, high maintenance costs, and insufficient practical time for students. It improves students' practical skills and observation ability, and reduces the error rate. Through the virtual simulation platform, practical teaching activities such as process simulation, safety inspection, and program development can be carried out. Taking the "Simulation Application Design of a Three-Axis Palletizer Based on 1500PLC" as an example, this paper designs a practical teaching model that combines online teaching, offline teaching, and the virtual simulation platform, achieving diversified teaching. As a teaching medium, virtual reality technology effectively makes up for the deficiencies of traditional teaching and improves the teaching achievements and quality.

Keywords: Practical Teaching; Simulation Application; Curriculum System; Teaching Mode; Virtual Teaching

1. Introduction

Practical teaching is an important part of the curriculum system for engineering majors, which aims to cultivate students' ability to apply the theoretical knowledge and skills they have mastered in practical operations. Traditional practical teaching in engineering majors is restricted by practical conditions such as practical venues, practical equipment, investment in teaching funds, and potential safety hazards. This leads to limitations in practical content, making it unable to adapt to the rapidly changing industrial development and being unfavorable for cultivating innovative and application-oriented talents [1,2].

The design of practical schemes in the traditional practical teaching mode for engineering majors is rather simple, and the teaching methods and instruments are outdated. Students still passively receive knowledge, making it difficult for them to keep up with the development of cutting-edge technologies and unable to meet the needs of the country for the development of educational informatization and intelligence in the new era [3].

Virtual simulation practical teaching integrates advanced educational concepts with modern information technology. It has become increasingly mature at present and is widely applied in the practical teaching of colleges and universities, evolving into a brand-new teaching mode featuring high-fidelity simulation, interactivity, immersion, ideation, and intelligence [4,5].

2. Engineering Practice Teaching Disadvantages

As a specialized field that spans multiple domains, engineering majors possess strong practical application characteristics and have high requirements for students' practical skills. However, the existing traditional practical methods still face numerous challenges. Due to

the lack of necessary facilities and resources, students can only rely on watching demonstration videos to make up for some of the practical operation content. There are various types of large-scale instruments in the practical equipment, which are expensive and cannot all be purchased in full. Moreover, even for the practical activities that can be carried out under certain conditions, due to the high maintenance costs of the instruments, students can only perform some simple practical operations and cannot practice repeatedly to achieve a proficient level.

In addition, to ensure that students' understanding meets the requirements, teachers usually spend a certain proportion of educational resources introducing how the equipment and technology operate correctly before the actual operation. This undoubtedly further reduces the total amount of study time and energy that can be allocated to each student for practical activities. Therefore, it is often the case that due to the overly tight curriculum arrangement, students find it difficult to fully master the implementation process of the entire project within the study time of one class period. To solve this problem, teachers often choose to omit the content of a certain link or let students quickly obtain the results, etc., in order to save valuable time for other tasks. However, doing so may bring about another potential problem. That is, if a key procedure is missing, it will affect the effective progress of subsequent work and reduce the impact of the practical achievements.

3. Virtual Simulation Practice Teaching Features and Advantages

3.1 Reducing Risk Factors

Adopting virtual simulation practical teaching can not only enable students to study in a safe environment, effectively avoiding potential dangers and physical injuries that may be caused by operational errors, but also significantly reduce educational costs. It allows students to conduct preparatory exercises through simulated practices, reducing the expenses for purchasing physical equipment and maintaining it. More importantly, students' learning is not restricted by time and space. They can carry out learning activities at any time and place without having to worry about venue conditions or material supply issues.

3.2 In-depth Learning Experience

The simulated environment created by AR technology has greatly stimulated students' enthusiasm and interest in participation [6]. On the virtual practice platform, students can actively explore the minute details and deeply understand their roles in actual operations. This process not only exercises students' observation ability, deepens their understanding of detail handling and problem-solving strategies, but also effectively reduces the error rate in actual operations. The educational approach of the panoramic virtual model enables students to systematically sort out the steps and processes of practical operations in an entertaining exploration activity, strengthening their understanding of the information and significance of each step, enabling them to form a deep memory of the control process, laying a solid foundation for future practical applications, and enhancing the effectiveness of practical teaching [7].

3.3 In the Practical Teaching of Engineering Majors, Virtual Simulation can be Widely Applied to the Following Practical Learning:

① Process Simulation Practice. By simulating the entire production and processing chain, students can have hands-on experience in a virtual scenario, thus deepening their understanding and control ability of the production process.

② Safety Detection Practice. Simulating the actual operation situation, focusing on the safety inspection of the control program, and enhancing the awareness and response ability to system safety.

③ Program Development Practice. Based on diverse virtual production process environments, students can develop and debug programs, cultivating their ability to solve complex engineering problems.

④ Repeated Practice Training. Students can repeat the operation countless times. This not only exercises students' practical skills but also improves their ability to deal with the uncertainties in industrial control [8].

4. Virtual Reality-based Immersive Hands-on Teaching Design

Taking the "Simulation Application Design of a Three - Axis Palletizer Based on 1500PLC" as an example, this paper designs a practical teaching model that combines online teaching, offline teaching and the virtual simulation platform based on the Xuexitong platform and the Factory IO virtual simulation platform.

4.1 Preparation before Class

Before the class, the teacher releases the practical content of the "Simulation Application Design of a Three - Axis Palletizer Based on 1500PLC" on the Chaoxing Learning Platform. This content includes the Factory IO simulation platform, process control videos, equipment materials, practical steps, etc. According to the designed practical steps, students enter the Factory IO simulation platform to lay out the project of the three - axis palletizer. They complete the simulation configuration of the palletizer project through immersive operation. By discussing in groups and dealing with the actual problems encountered in the virtual simulation practice, students continue to improve their own practical designs. The Factory IO simulation platform is shown in Figure 1.

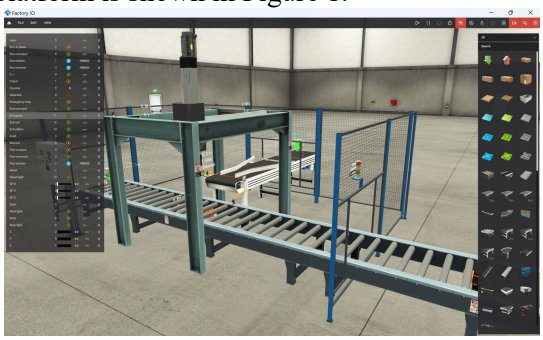

Figure 1. Factory IO Simulation Platform

4.2 Implementation during Class

First of all, the teacher demonstrates the basic usage and matters needing attention, and shows the students how to use the more complex mechanical equipment, enabling the students to understand the structure of these devices, their operation mechanisms, and the working processes of the core components. Then, with the help of 3D models, the teacher decomposes and explains various devices, expounds their principles, and provides an intuitive visual effect in terms of material flow, so that students can comprehensively understand all the components of the palletizing system, laying a foundation for the students' subsequent programming exercises. Finally, the students enter the programming practice mode. After independently writing the TIA Portal control program, the students connect it to the Factory IO virtual simulation software for program debugging practice. Only by completing each step according to the process can the next operation be carried out. The teacher conducts appropriate observation, supervision, and guidance during the practical process. By completing the entire control process, students can not only deepen their understanding of theoretical knowledge but also master the programming of 1500PLC and the palletizing control process well. The simulation application design of the three-axis palletizer based on 1500PLC is shown in Figure 2.

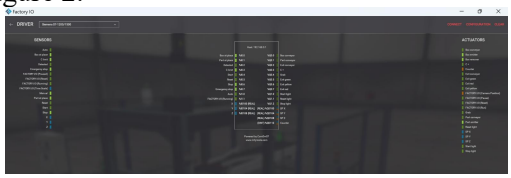

Figure 2. Based on the simulation connection of 1500PLC

4.3 Post - Class Feedback and Evaluation

The evaluation mainly consists of three steps: pre - class, in - class, and post - class evaluations. The pre - class, in - class, and post - class scores account for 30%, 50%, and 20% of the total score respectively. Before class, the feasibility and integrity of the practical simulation design plans submitted by student groups are evaluated. During class, the students' simulation result scores are recorded in numerical form, and the collation and analysis of the score data are completed through the Xuexitong platform. After class, the entire practical process is reviewed and summarized through the tests released on the Xuexitong platform. Finally, a practical summary report is submitted in the form of a group. The teacher comprehensively evaluates the test scores on the Xuexitong platform and the practical summary reports submitted by the groups.

5. Wrap-up

Virtual reality technology has evolved from a concept to practical application. As a teaching medium, it effectively compensates for the deficiencies of traditional teaching. Its features such as immersion, interactivity, and

imaginability have established a new relationship structure among teachers, students, and the platform, transforming the educational form and teaching process [9- 10]. The simulated practical education system constructed with the help of virtual reality technology has effectively enhanced students' practical engineering skills. With its gradual development and optimization, the models of equipment and instruments will gradually expand, the types of processes will become more diverse, and the models will become more elaborate, with their settings better adapted to actual needs. It provides students with an immersive virtual operation experience, addressing the issues of students' lack of practical experience and short practical time, and giving students the opportunity to access more practical cases and try them out personally. This can not only stimulate students' enthusiasm for learning, strengthen their ability to apply professional knowledge, cultivate professional thinking, and broaden the scope and depth of practice, but also break through the time and space limitations of traditional practice, improving the teaching achievements and quality.

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