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"Engineering Drawing" Ignites Intelligence: Research on the Cross-border Education Integration Strategy under the Co-drive of "Engineering Drawing" and "Intelligent Control"

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Abstract: This paper focuses on the challenges in the integration of engineering drawing and intelligent control education. By addressing issues such as the disjointed curriculum systems, the separation between research and practice in unmanned surface vehicle control, and the lack of systematic interdisciplinary education, it proposes effective strategies for cross-border education integration. Through case studies and surveys, the paper validates the effectiveness of the proposed strategies in enhancing students' comprehensive abilities.

1. Introduction

In the modern engineering education landscape, the convergence of different disciplines is crucial for nurturing well-rounded professionals. Engineering drawing and intelligent control are two fundamental yet currently disjointed fields[1]. The integration of these areas can significantly enhance students' understanding of complex engineering systems, but several challenges impede this process.

2. Literature Review

Previous research has recognized the importance of integrating engineering drawing and intelligent control. Some studies have proposed theoretical models for curriculum integration, emphasizing the need to break down the silos between different courses[2]. However, these models often lack practical implementation details. Regarding unmanned surface vehicle (USV) control, research has mainly concentrated on either algorithm development or physical prototype construction, with limited attention to the seamless transition from theory to real-world application. In terms of interdisciplinary education, there is a growing body of literature highlighting the significance of integrating academic and ideological education, yet few studies have provided a systematic framework for implementation.

3. Current Teaching Practices and Challenges

3.1 Fragmented Curriculum Systems

Engineering drawing courses typically focus on geometric representation and drafting standards, while intelligent control courses delve into control theory and algorithm design. This separation makes it difficult for students to transfer knowledge between the two. For example, students may master 3D modeling in engineering drawing but fail to relate it to the motion control of mechanical systems in intelligent control.

3.2 Disconnection between Research and Practice in USV Control

Research on USV control often stays in the laboratory, with algorithms being developed without sufficient consideration for real-world constraints. As a result, when it comes to actual ship-based debugging, many issues arise, and students lack the practical skills to address them.

3.3 Lack of Systematic Interdisciplinary Education

In current interdisciplinary education, academic and ideological education are often conducted separately. Academic guidance is mainly centered around professional knowledge, and ideological education is added as an independent part, lacking integration with the curriculum content.

4. Proposed Strategies for Optimization

4.1 Integrated Curriculum Design

We develop an integrated curriculum module that combines engineering drawing and intelligent control. For instance, in the design of a robotic arm, students will first create engineering drawings and then design control algorithms for its movement, thereby enhancing cross-disciplinary knowledge transfer.

4.2 Practice-Oriented USV Control Training

An experimental platform is built that enables students to go from digital model design (using engineering drawing) to real-ship testing of control algorithms. A multi-stage verification mechanism is implemented, including simulation, semi-physical testing, and real-ship trials.

4.3 Systematic Interdisciplinary Education Framework

We propose a "Three-step and Four-aspect" framework. The three-step process involves basic knowledge learning, interdisciplinary knowledge integration, and practical application. The four-aspect ideological education includes patriotism, scientific spirit, teamwork, and environmental awareness, which are integrated into relevant courses.

Figure 1 is the framework diagram of strategies for optimization proposed in this paper.

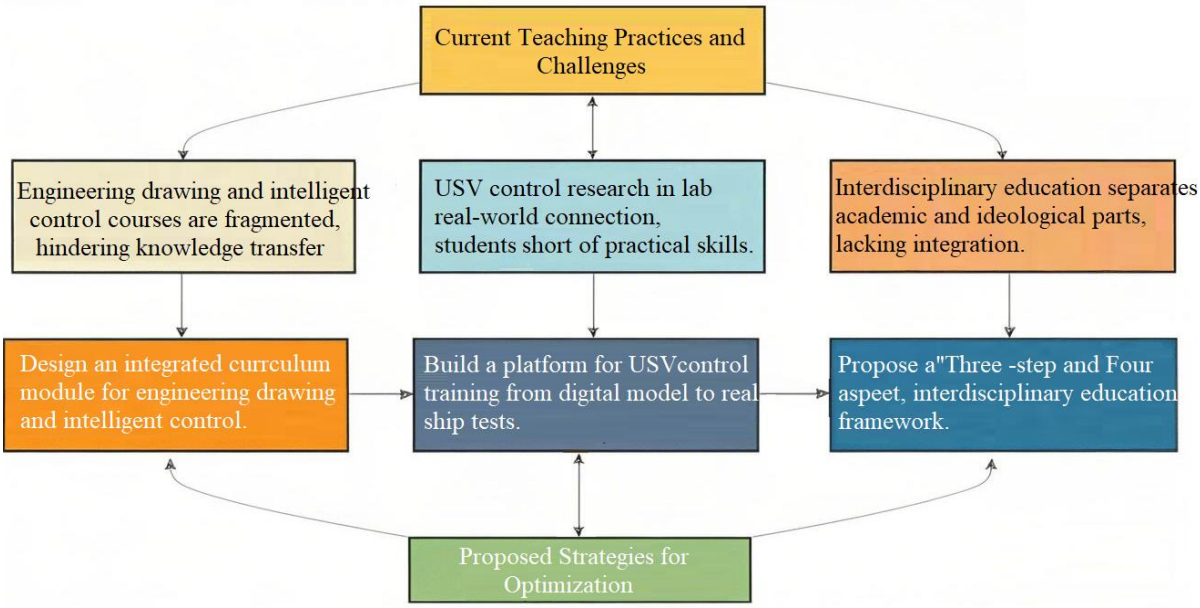

Figure 1 Schematic diagram of Proposed Strategies for Optimization

5. Case Study and Survey Analysis

A total of 120 sophomore students were selected and evenly divided into an experimental group and a control group. The students in both groups had similar academic backgrounds and prior knowledge in engineering drawing and intelligent control.

For the experimental group, the integrated curriculum was implemented. Students first learned engineering drawing skills to create 2D and 3D models. They were then guided to analyze the mechanical structure and motion requirements from the drawing, and finally designed control algorithms using Python programming language. Students used CAD software to design the hull structure, and then 3D-printed the hull. They installed sensors and control components on the printed hull and conducted a series of tests, from simulation in a virtual environment to real-ship trials on a nearby lake.

In contrast, the control group followed the traditional teaching approach. Engineering drawing courses focused solely on drafting standards and geometric drawing, while intelligent control courses concentrated on theoretical knowledge and algorithm design in the classroom.

A comprehensive survey was designed to collect students' feedback. The survey included questions about their understanding of cross-disciplinary knowledge, their ability to apply knowledge in practical situations, and their perception of the integration of academic and ideological education. Additionally, practical operation tests and written exams were conducted to objectively evaluate students' learning outcomes.

6. Results and Discussion

The results of the practical operation tests showed that students in the experimental group had a significant advantage. 85% of the students in the experimental group could successfully make the robotic arm complete complex movements according to the design requirements, while only 50% of the students in the control group achieved this. This indicated that the integrated curriculum effectively enhanced students' ability to transfer knowledge between engineering drawing and intelligent control.

Regarding USV control, students in the experimental group were much more proficient in real-ship debugging. During the real-ship trials, the experimental group spent an average of 30 minutes less than the control group in solving problems such as sensor failures and control instability. This demonstrated that the practice-oriented USV control training platform was effective in improving students' practical skills.

In the survey, 90% of the students in the experimental group reported that they could better understand the ideological concepts integrated in the courses, such as the importance of environmental protection when designing USVs for ocean exploration. In contrast, only 60% of the students in the control group had a similar understanding. This result indicated that the "Three-step and Four-aspect" interdisciplinary education framework successfully integrated academic and ideological education.

7. Conclusion

This study has proposed and validated effective strategies for integrating engineering drawing and intelligent control education. By addressing the challenges of fragmented curriculum systems, the disconnection between research and practice, and the lack of systematic interdisciplinary education, these strategies can enhance students' comprehensive abilities. Future research could focus on further refining these strategies and expanding their application to other engineering disciplines.

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