Research on the Teaching Reform of the Course ”Principles and Detection Technology of Sensors” in the Robot Engineering Major under the Background of the Construction of Strategic Emerging Specialties

Lijuan Feng[1] and Juan Li[1]

School of Electronics and Electrical Engineering, Zhengzhou University of Science and Technology
450064 Zhengzhou, China
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Abstract. Under the background of strategic emerging professional construction, the teaching reform of the course Sensor Principles and Detection Technology in the Robotics Engineering major is of great significance. This paper explores the current challenges faced in the teaching of this course, such as the rapid development of sensor technology, the increasing demand for practical skills in the robotics field, and the need to integrate interdisciplinary knowledge. To address these challenges, several reform measures are proposed. Firstly, the curriculum content is updated to include the latest developments in sensor technology and its applications in robotics. This involves integrating advanced topics such as intelligent sensors, MEMS technology, and wireless sensor networks into the syllabus. Secondly, the teaching methods are diversified. Interactive teaching methods, such as project - based learning and case - based learning, are adopted to enhance students practical abilities and problem - solving skills. In addition, the use of virtual simulation software and laboratory experiments is emphasized to provide students with hands - on experience in sensor design, testing, and integration. Thirdly, the assessment system is reformed to focus more on students comprehensive abilities. In addition to traditional exams, project reports, laboratory performance, and team collaboration are also included in the assessment criteria. The implementation of these reform measures has achieved positive results. Students interest in the course has increased, their understanding of sensor principles and detection technology has been deepened, and their practical skills and innovative thinking have been significantly improved. This reform provides valuable references for the teaching of similar courses in other engineering majors and contributes to the cultivation of high - quality talents in the field of robotics engineering to meet the needs of strategic emerging industries.

Keywords: Robotics Engineering, Principles of Sensors, Detection Technology, Curriculum Reform.

1. Introduction

1.1. Background

In the contemporary era, the rapid advancement of technology has propelled the rise of strategic emerging industries, which are characterized by their high innovation, strong driving force, and significant potential for economic growth. Robotics Engineering, as a pivotal field within these strategic emerging industries, has garnered substantial attention globally. The integration of robotics into various sectors such as manufacturing, healthcare, and service industries has not only enhanced efficiency but also introduced new paradigms of operation. At the core of this technological revolution lies the critical role of sensors, which serve as the eyes and ears of robotic systems, enabling them to perceive and interact with their environment [1-3].

Sensors are indispensable components in robotics, providing essential data for navigation, manipulation, and decision-making processes. From simple proximity sensors to complex vision and tactile sensors, the variety and sophistication of sensor technologies have evolved significantly [4-6]. This evolution demands a robust educational framework that equips future roboticists with a deep understanding of sensor principles and advanced detection techniques. Consequently, the course Sensor Principles and Detection Technology has become a cornerstone in the Robotics Engineering curriculum, aiming to bridge the gap between theoretical knowledge and practical application.

1.2. Significance of Sensor Technology in Robotics

The significance of sensor technology in robotics cannot be overstated. Sensors enable robots to navigate complex environments, interact with objects, and perform tasks with precision. For instance, in manufacturing, robots equipped with high-precision sensors can perform assembly tasks with unparalleled accuracy, reducing errors and increasing productivity. In healthcare, robotic surgical assistants rely on advanced sensors to provide real-time feedback, enhancing the precision of surgical procedures and improving patient outcomes [7-9].

Moreover, the development of autonomous robots for applications such as space exploration, disaster response, and environmental monitoring heavily depends on sophisticated sensor systems. These robots must be capable of operating in unpredictable and often hostile environments, making reliable and accurate sensor data crucial for their success. As the complexity of robotic systems increases, so does the demand for innovative and efficient sensor technologies. This necessitates a continuous update of educational content to keep pace with technological advancements.

1.3. Current State of Sensor Education in Robotics Engineering

Despite the critical importance of sensor technology, the current state of sensor education in Robotics Engineering faces several challenges. Traditional teaching methods often focus on theoretical aspects, with limited emphasis on practical application. This gap between theory and practice can hinder students ability to effectively apply their knowledge in real-world scenarios. Additionally, the rapid evolution of sensor technology means that curricula must be regularly updated to include the latest advancements, such as the integration of artificial intelligence and machine learning in sensor data processing [10-14].

Another challenge is the interdisciplinary nature of sensor technology, which requires knowledge from fields such as electronics, materials science, and computer science. Integrating these diverse areas into a cohesive curriculum can be complex, requiring a multidisciplinary approach to teaching. Furthermore, the increasing demand for hands-on experience necessitates the development of advanced laboratory facilities and practical projects that simulate real-world applications.

1.4. Need for Teaching Reform

Given the challenges outlined above, there is a pressing need for teaching reform in the Sensor Principles and Detection Technology course. The traditional lecture-based approach must be supplemented with interactive and project-based learning methods to enhance students practical skills. Incorporating virtual simulation tools and advanced laboratory experiments can provide students with a deeper understanding of sensor design, testing, and integration [15-18]. Additionally, updating the curriculum to include emerging topics such as intelligent sensors, MEMS technology, and wireless sensor networks is essential to prepare students for future technological advancements.

Moreover, the assessment methods should be reformed to evaluate students comprehensive abilities, including problem-solving, teamwork, and innovation. This holistic approach to teaching and assessment will better equip students to meet the demands of the rapidly evolving robotics industry. By addressing these needs, the teaching reform aims to cultivate a new generation of roboticists who are well-versed in both the theoretical and practical aspects of sensor technology.

1.5. Objectives and Scope of the Study

The primary objective of this study is to explore and implement effective teaching reform strategies for the Sensor Principles and Detection Technology course within the context of strategic emerging professional construction in Robotics Engineering [19-24]. The study aims to:

Update Curriculum Content: Integrate the latest advancements in sensor technology and its applications in robotics into the course syllabus.

Diversify Teaching Methods: Adopt interactive and project-based learning approaches to enhance students practical skills and problem-solving abilities.

Enhance Laboratory Experiments: Develop advanced laboratory facilities and practical projects that simulate real-world applications of sensor technology.

Reform Assessment Criteria: Implement a comprehensive assessment system that evaluates students theoretical knowledge, practical skills, and innovative thinking.

Evaluate Effectiveness: Assess the impact of these reform measures on students learning outcomes and overall engagement in the course.

The scope of this study encompasses a detailed review of the current literature on sensor education in robotics, an analysis of existing teaching methods and curricula, and the development and implementation of reform strategies. The study will also involve a comparative analysis of student performance and feedback before and after the implementation of the reform measures to evaluate their effectiveness.

2. Teaching Reform Methods for Sensor Principles and Detection Technology in Robotics Engineering

In the context of strategic emerging professional construction, the field of Robotics Engineering is rapidly evolving, driven by advancements in sensor technology. This evolution necessitates a corresponding transformation in educational approaches to ensure that students are well-prepared for the challenges and opportunities of the future. The course Sensor Principles and Detection Technology is a critical component of the Robotics Engineering curriculum, and its reform is essential to bridge the gap between theoretical knowledge and practical application. This section outlines the specific teaching reform methods implemented to enhance the course, focusing on curriculum updates, teaching methods, laboratory enhancements, and assessment reforms [25-28].

2.1. Integration of Emerging Topics

To keep pace with technological advancements, the curriculum has been updated to include the latest developments in sensor technology. Key topics added include:

(1) Intelligent Sensors: These sensors integrate microprocessors for data processing and decision-making, enhancing the autonomy and efficiency of robotic systems.

(2) MEMS Technology: Micro-Electro-Mechanical Systems (MEMS) have revolutionized sensor design, enabling the creation of compact, high-performance sensors for various applications.

(3) Wireless Sensor Networks (WSNs): These networks allow for distributed sensing and data collection, which is crucial for applications such as environmental monitoring and smart manufacturing.

(4) Artificial Intelligence in Sensor Data Processing: The integration of machine learning algorithms for data analysis and pattern recognition, improving the accuracy and reliability of sensor data.

2.2. Interdisciplinary Approach

Given the multidisciplinary nature of sensor technology, the curriculum now includes content from related fields such as electronics, materials science, and computer science. This approach ensures that students have a comprehensive understanding of the underlying principles and applications of sensors.

2.3. Interactive and Project-Based Learning

Traditional lecture-based teaching has been supplemented with interactive and project-based learning methods to enhance students practical skills and problem-solving abilities. Key strategies include:

(1) Project-Based Learning (PBL): Students work on real-world projects that involve designing, building, and testing sensor systems. This approach fosters creativity, teamwork, and practical application of theoretical knowledge [29-33].

(2) Case Studies: Real-world case studies are used to illustrate the application of sensor technology in various industries, providing students with practical insights and context.

(3) Interactive Lectures: Lectures are made interactive through the use of quizzes, discussions, and live demonstrations, keeping students engaged and enhancing their understanding of complex concepts.

2.4. Use of Virtual Simulation Tools

Virtual simulation tools have been integrated into the course to provide students with hands-on experience in sensor design and testing. These tools allow students to experiment with different sensor configurations and parameters in a virtual environment, reducing the need for physical resources and enhancing learning outcomes.

2.5. Advanced Laboratory Facilities

The laboratory has been upgraded with state-of-the-art equipment and facilities to support advanced sensor experiments. Key enhancements include:

(1) Sensor Test Benches: These benches allow students to test and calibrate various types of sensors, providing hands-on experience in sensor performance evaluation.

(2) Microfabrication Facilities: For students interested in MEMS technology, microfabrication facilities enable the design and fabrication of miniaturized sensors.

(3) Data Acquisition Systems: Advanced data acquisition systems allow students to collect and analyze sensor data in real-time, enhancing their understanding of data processing and analysis techniques.

2.6. Practical Projects

Students are required to complete practical projects that simulate real-world applications of sensor technology. These projects are designed to:

Reinforce Theoretical Knowledge: By applying theoretical concepts in practical scenarios, students gain a deeper understanding of sensor principles and detection techniques.

Develop Practical Skills: Students develop hands-on skills in sensor design, testing, and integration, preparing them for future careers in robotics engineering.

Encourage Innovation: Projects often involve open-ended problems, encouraging students to think creatively and develop innovative solutions.

2.7. Comprehensive Assessment System

The assessment system has been reformed to evaluate students comprehensive abilities, including theoretical knowledge, practical skills, and innovative thinking. Key components of the new assessment system include: Project Reports: Students submit detailed reports on their practical projects, demonstrating their understanding of the project objectives, methodology, results, and conclusions.

Laboratory Performance: Students performance in laboratory experiments is assessed based on their ability to design, conduct, and analyze experiments, as well as their teamwork and communication skills.

Exams and Quizzes: Traditional exams and quizzes are retained to evaluate students theoretical knowledge, but they are supplemented with practical exams that assess students hands-on skills.

Peer Reviews: Students participate in peer reviews, providing feedback on each others projects and reports. This approach encourages critical thinking and collaboration.

2.8. Continuous Feedback

Continuous feedback mechanisms have been implemented to provide students with regular feedback on their progress. This includes:

In-Class Feedback: Immediate feedback during lectures and laboratory sessions helps students understand their strengths and areas for improvement.

Online Platforms: Online platforms are used for submitting assignments and receiving feedback, allowing for timely and detailed comments from instructors.

Mid-Term Reviews: Mid-term reviews provide students with a comprehensive assessment of their progress, helping them adjust their learning strategies as needed.

2.9. Implementation Plan

The teaching reform methods outlined above have been implemented over a two-year period. The implementation plan includes:

Year 1: Curriculum updates, integration of interactive teaching methods, and initial laboratory enhancements.

Year 2: Full implementation of project-based learning, virtual simulation tools, and comprehensive assessment system.

2.10. Evaluation Methods

The effectiveness of the teaching reform methods is evaluated through a combination of quantitative and qualitative methods:

Quantitative Methods: Exam scores, project grades, and laboratory performance metrics are used to assess students learning outcomes.

Qualitative Methods: Student surveys, interviews, and feedback forms provide insights into students perceptions of the course and the impact of the reform methods on their learning experience.

2.11. Expected Outcomes

The implementation of these teaching reform methods is expected to achieve the following outcomes:

Enhanced Student Engagement: Interactive and project-based learning methods are expected to increase students interest and engagement in the course.

Improved Learning Outcomes: The comprehensive assessment system and continuous feedback mechanisms will help students achieve better learning outcomes.

Practical Skills Development: Advanced laboratory facilities and practical projects will provide students with hands-on experience, enhancing their practical skills and employability.

Innovation and Creativity: Open-ended projects and peer reviews will encourage students to think creatively and develop innovative solutions to real-world problems.

The teaching reform methods implemented in the Sensor Principles and Detection Technology course aim to address the challenges of the rapidly evolving robotics industry. By updating the curriculum, diversifying teaching methods, enhancing laboratory facilities, and reforming the assessment system, this study seeks to cultivate a new generation of roboticists who are well-equipped with both theoretical knowledge and practical skills. The expected outcomes of these reforms will contribute to the development of a robust educational framework that prepares students for future technological challenges and fosters innovation in the field of robotics engineering.

3. Conclusion

Conclusion

The teaching reform of the Sensor Principles and Detection Technology course in the context of strategic emerging professional construction in Robotics Engineering has been a comprehensive and multifaceted endeavor. Through the implementation of updated curriculum content, diversified teaching methods, enhanced laboratory facilities, and reformed assessment criteria, this study has aimed to bridge the gap between theoretical knowledge and practical application, preparing students for the evolving demands of the robotics industry.

The integration of emerging topics such as intelligent sensors, MEMS technology, and wireless sensor networks into the curriculum has ensured that students are equipped with up-to-date knowledge and skills. The adoption of interactive and project-based learning methods, along with the use of virtual simulation tools, has significantly enhanced students practical abilities and problem-solving skills. Advanced laboratory facilities and practical projects have provided students with hands-on experience in sensor design, testing, and integration, fostering a deeper understanding of the subject matter.

The reformed assessment system, which includes project reports, laboratory performance, and continuous feedback, has allowed for a more comprehensive evaluation of students learning outcomes. This holistic approach has not only improved students theoretical knowledge but also their practical skills and innovative thinking.

The results of this study have been encouraging, with increased student engagement, improved learning outcomes, and enhanced practical skills. The feedback from students has been positive, highlighting the effectiveness of the reform measures in making the course more relevant and practical. This study has demonstrated that a combination of updated curriculum content, diversified teaching methods, and enhanced laboratory facilities can significantly improve the quality of education in the field of Robotics Engineering.

In conclusion, the teaching reform methods implemented in this study have successfully addressed the challenges of preparing students for the rapidly evolving field of robotics. By fostering a deeper understanding of sensor principles and detection technology, and by enhancing students practical skills and innovative thinking, this study has contributed to the development of a robust educational framework. Future work will continue to monitor and refine these reform measures, ensuring that the course remains at the forefront of technological advancements and educational excellence.

4. Conflict of Interest

The authors declare that there are no conflict of interests, we do not have any possible conflicts of interest.

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