Research and Practice on the Innovative Talent Training System for Robotics Engineering under the New Engineering Education Framework

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Abstract: Against the backdrop of rapid development in emerging industries and the rise of the new economy, the Robotics Engineering major faces challenges such as scarce teaching resources and a single cultivation model, making it difficult to meet the demand for high-quality talents in the new engineering field. Addressing these issues, the Robotics Engineering program at Shenyang Aerospace University proposed an innovative talent cultivation system characterized by the "Dual Mentors, Three Lines, Four Dimensions, Five Guarantees, and Six Integrations" model. This system enhances students' innovative and practical abilities by introducing enterprise mentors, implementing a three-line parallel cultivation approach, developing a four-dimensional integrated curriculum, and employing six integrated teaching methods. Additionally, a quality assurance system based on the OBE (Outcome-Based Education) philosophy has been established to comprehensively improve the quality of professional education. This initiative strongly supports industrial technological upgrading and economic innovation, offering valuable practical experience and reference for talent cultivation in new engineering disciplines.

Keywords: New Engineering; Robotics Engineering; Talent Cultivation; Quality Assurance

1. Introduction

With the rapid development of technologies such as the Internet of Things, Big Data, and Artificial Intelligence, China's manufacturing industry is facing both challenges and opportunities brought by a new wave of technological revolution and industrial transformation. To meet the strategic demands of "Made in China 2025, " the Robotics Engineering major, as an integral part of the new engineering discipline, has become particularly critical. However, the current state of the discipline is hindered by its short establishment history, insufficient cultivation experience, and limited teaching resources, making existing educational models inadequate to fully address industry development needs. Therefore, exploring an innovative talent cultivation model tailored to regional industrial development within the framework of "New Engineering" is imperative [1-2].

Shenyang Aerospace University established its Robotics Engineering major in 2020 with the aim of cultivating high-quality talents capable of meeting the needs of national and regional economic and social development. This paper proposes an innovative talent cultivation system characterized by the "Dual Mentors, Three Lines, Four Dimensions, Five Guarantees, and Six Integrations" model. the goal is to integrate regional industrial characteristics and create an education model that combines theory with practice, thereby promoting the innovative application and industrialization of robotics technology and contributing to the healthy development of the robotics industry in China.

2. Problems in Cultivating Innovative Talents in Application-Oriented Undergraduate Universities

2.1 Single Talent Cultivation Model

Currently, innovation education often exists merely as a part of dual innovation courses or elective courses, with a single and fragmented approach. It has not been fully integrated into the overall talent cultivation framework. For

emerging engineering disciplines like Robotics Engineering [3], cultivating students' innovative capabilities, practical skills, and abilities to solve real-world engineering problems requires a comprehensive educational model. This involves embedding innovation throughout the teaching process to systematically enhance students' practical and innovative abilities [4].

2.2 Insufficient Engineering Practice Skills Among Teachers

Due to the interdisciplinary and practical nature of Robotics Engineering, teachers often devote more time to theoretical teaching, with limited opportunities for enterprise-based practical training. This limits their ability to guide students in developing innovative and practical skills. Therefore, it is essential to strengthen teachers' engineering practice capabilities to better support students in addressing complex engineering challenges.

2.3 Lack of In-Depth Industry-Academia Collaboration

The Robotics Engineering discipline emphasizes cultivating students' practical abilities to solve complex engineering problems. However, current collaboration between academia and industry lacks depth, with limited involvement of enterprises in the practical training aspects of talent cultivation. Consequently, students often lack the necessary skills and practical experience to address real-world challenges. Application-oriented undergraduate universities must actively explore and implement multidisciplinary, interdisciplinary, and comprehensive talent cultivation models to ensure a deep integration of academic content and enterprise-required skills.

2.4 Incomplete Quality Assurance System

The current quality assurance system for innovative talent cultivation models suffers from issues such as inadequate management frameworks and incomplete quality monitoring and evaluation mechanisms. These shortcomings hinder improvements in the quality of innovative talent training. Therefore, application-oriented undergraduate universities must establish robust quality assurance systems, improve teaching quality monitoring mechanisms, and enhance the effectiveness and outcomes of innovative talent cultivation in Robotics Engineering.

3. High-Level, Specialized, Application-Oriented Innovative Talent Cultivation System

Shenyang Aerospace University is committed to building a high-level, specialized, application- oriented innovative talent cultivation system for its Robotics Engineering program, as illustrated in Figure 1. Anchored in the reform and innovation strategy of "driving talent cultivation system transformation through innovation" outlined in the College of Artificial Intelligence's three-year action plan, this system features interdisciplinary integration, engineering practicality, and cutting-edge technologies. By introducing enterprise mentors and a three-line parallel cultivation model, it ensures a close integration of theory and practice. the system implements a four-dimensional integrated curriculum and a comprehensive, fused educational approach to develop versatile talents with innovative thinking and practical abilities, addressing the demands of emerging industries and future economic development. This framework emphasizes not only academic depth and professional skills but also the holistic development of students in engineering projects and industrial practices, laying a solid foundation for them to become leaders in their fields.

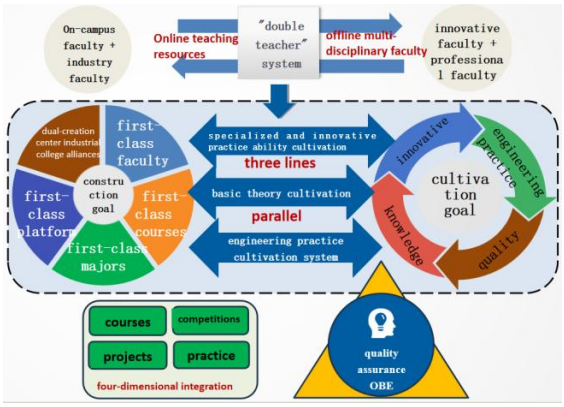

Figure 1. High-Level, Specialized, Application-Oriented Innovative Talent Cultivation System for the Robotics Engineering Program

To implement the reform and innovation strategy of "driving talent cultivation system transformation through innovation, " the Robotics Engineering program's high-level, specialized, application-oriented innovative talent cultivation system adopts a concrete

approach characterized by "Dual Mentors, Three Lines, Four Dimensions, Five Guarantees, and Six Integrations, " as illustrated in Figure 2.

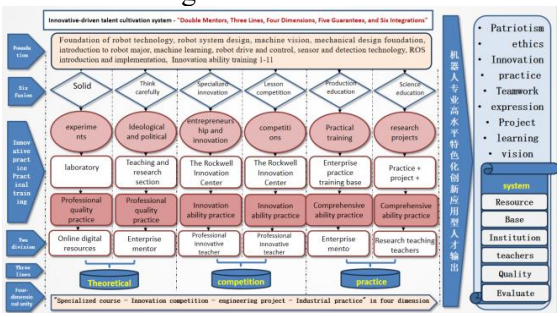

Figure 2. The "Dual Mentors, Three Lines, Four Dimensions, Five Guarantees, and Six Integrations" Innovative Talent Cultivation System

(1) Dual-Mentor System Development

By introducing enterprise mentors and establishing a mentor database, a "university faculty+enterprise mentors" dual-mentor system is formed. This approach strengthens the engineering practice capabilities of the teaching team, enhancing students' practical skills and innovative abilities.

(2) Three-Line Parallel Cultivation Approach

A three-line cultivation approach is proposed, encompassing the "theoretical line, innovation competition line, and industrial practice line. " Theoretical teaching solidifies foundational knowledge, innovation competitions inspire students' creative potential, and industrial practice enhances their ability to solve real-world engineering problems.

(3) Four-Dimensional Integrated Cultivation Model

A four-dimensional integrated model is established, combining "specialized courses, innovation competitions, engineering projects, and industrial practice. " This model tightly integrates professional courses with innovation education, encouraging students to participate in competitions, projects, and practical activities to comprehensively enhance their overall competencies.

(4) Five-Strategy Support System

The system ensures effective operation and sustainable development of the innovative practice talent cultivation framework through five strategies: infrastructure and facilities, faculty strength, curriculum content, evaluation feedback, and resource sharing.

(5) Six-Fusion Implementation

Six comprehensive integrations are achieved: "theory-practice integration, specialization-thinking integration, specialization-innovation integration, course-competition integration, industry-education integration, and science-education integration. " Innovation practice is embedded throughout every stage of the professional training process, spanning the entire teaching cycle.

4. Comprehensive Integration of the Innovative Practice Talent Cultivation System Across the Teaching Cycle

4.1 Application of the Three-Line Cultivation Model in the Curriculum System

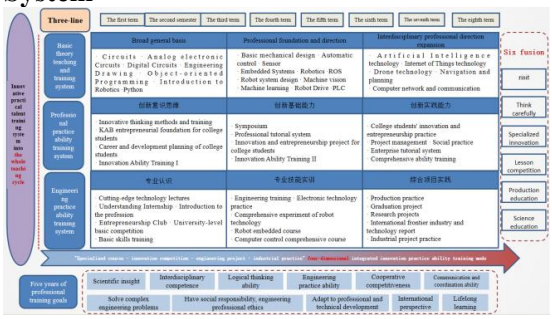

Figure 3. Integration of the Innovative Practice Talent Cultivation System into the Entire Teaching Cycle

The innovative practice talent cultivation system is seamlessly integrated into the entire teaching cycle, as shown in Figure 3. Through the concretization of the three-line cultivation model, the curriculum progresses in layers—from foundational theoretical teaching to specialized innovation practice training and then to engineering practice training—providing students with comprehensive development opportunities.

The curriculum design balances general education with professional depth [5], while interdisciplinary elective courses promote cross-disciplinary understanding and application capabilities. In terms of specialized innovation practice training, students improve their creative thinking and competition skills through systematically arranged innovation training courses. For engineering practice training, comprehensive experimental training and industrial project practices significantly enhance students' professional skills and practical capabilities, ensuring the full implementation and in-depth application of the innovative practice talent cultivation system [6].

4.2 Development of the Quality Assurance System for Innovative Practice Talent Cultivation

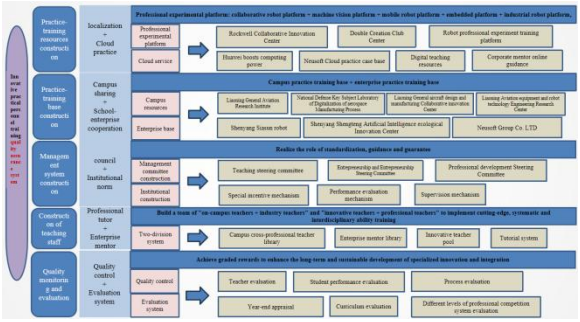

Figure 4. Quality Assurance System for Innovative Practice Talent Cultivation

Based on the Outcome-Based Education (OBE) philosophy, an innovative talent cultivation quality assurance system is proposed, as shown in Figure 4, to ensure the smooth implementation and sustainable development of the innovative practice talent cultivation system. This system includes the following components: Assurance of practical and training resources, Development of internship and training resources, Establishment of management systems, Strengthening of faculty team development, and Construction of a quality monitoring and evaluation system. These measures provide students with comprehensive learning support and practical resources, promoting the overall enhancement of their integrated competencies and innovative practice capabilities.

5. Conclusion

This paper explores the high-level, distinctive, application-oriented innovative talent cultivation system for the Robotics Engineering program at the School of Artificial Intelligence, Shenyang Aerospace University. This system effectively integrates interdisciplinary education, engineering practice, and industrial demand, providing a balanced platform that emphasizes both theoretical and practical education for cultivating engineering and technical talents with innovative thinking and high-quality multidisciplinary skills.

The introduction of enterprise mentors and the multi-line parallel cultivation model further enhance students' professional capabilities and practical skills, preparing them to address challenges from emerging industries and new economic developments in the future. However, with the continuous development of new technologies and evolving industrial demands, this system requires ongoing optimization and improvement to remain relevant and contribute significantly to the long-term advancement of intelligent manufacturing in China.

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References

[1] Li Ruifeng, Rong Weibin, Deng Xin. Research and Exploration of Robotics Engineering in the Context of Emerging Engineering Education [J]. China University Teaching, 2020(Z1):32-36.

[2] Ding Li, Ye Xia, Huang Ming, et al. Exploration of the Talent Cultivation Model for Robotics Engineering in Application-Oriented Universities [J]. Science & Technology Wind, 2021(31):16-18.

[3] Ma Haishu, Chen Haijun, Li Hui, et al. Exploration of the Innovation and Application-Oriented Talent Cultivation Model for Robotics Engineering [J]. Technological Innovation and Productivity, 2023, 44(11):34-36.

[4] Fan Liangzhi, Jiang Ke, Zhu Haiping, et al. Research on Robotic Knowledge System and Course Content in the Context of Emerging Engineering Education [J]. Research in Higher Engineering Education, 2021(2):32-38.

[5] Wang Shuai, Wu Chengdong, Jia Zixi, et al. Exploration of Innovative Talent Cultivation Model for Robotics Engineering in the Context of Emerging Engineering Education [J]. Education and Teaching Forum, 2020(14):52-54.

[6] Liu Jingjun, Shi Baoyu, Yang Changlong.

Exploration and Construction of a Course-Competition Integrated Teaching Model for Engineering Majors Based on OBE Philosophy [J]. Polymer Bulletin, 2021(12):93-99.

