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# Teaching Reform and Exploration of Robot Innovation Practice Assisted by Artificial Intelligence

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**Abstract:** Against the backdrop of the deep integration of artificial intelligence technology and education, robot innovation practice has become a core carrier for cultivating students' engineering thinking, innovative capabilities, and digital literacy. Aiming at the pain points in traditional robot teaching, such as the disconnection between theory and practice, insufficient personalized training, and a simplistic evaluation system, this paper proposes a teaching reform concept of "AI Empowerment Hierarchical Practice Collaborative Innovation". It constructs an integrated curriculum system of "Perception-Integration-Control", a progressive teaching path of "Learning-Practicing-Innovating", and a multi-dimensional dynamic evaluation mechanism. Through interdisciplinary curriculum restructuring, the construction of a virtual-real integrated practice platform, and the innovation of a human-machine collaborative teaching model, the transformation from knowledge imparting to ability training is achieved, providing a replicable practical paradigm for robot education reform in the context of emerging engineering education.

**Keywords:** Artificial Intelligence; Robotics Education; Teaching Reform; Innovative Practice; Engineering Literacy.

## 1. Introduction

With the wave of artificial intelligence set off by ChatGPT, the field of education is undergoing a profound transformation from "standardized indoctrination" to "personalized empowerment". As an important carrier for the implementation of AI technology, robots have evolved from simple teaching aids to "teaching partners", becoming a key tool to solve the problem of personalized teaching. Currently, robot teaching is confronted with three major predicaments:

The rigid curriculum system with insurmountable disciplinary barriers, making it difficult to cover the entire technical chain of robots including "sensing - perception - integration - control". [1-2]

The simplistic teaching model that emphasizes theory over practice, resulting in insufficient cultivation of students' practical abilities and innovative thinking.

The rigid evaluation method that overemphasizes knowledge assessment while neglecting process-oriented and innovative evaluation.

In this context, exploring the teaching reform path of robot innovation practice assisted by AI is of great practical significance for implementing the requirements of emerging engineering construction and cultivating interdisciplinary innovative talents.

## 2. Teaching Reform Concept and Framework of AI-Assisted Robot Innovation Practice

### 2.1. Core Teaching Reform Concepts

Adhere to the three principles of "AI Empowerment, Integrated Innovation, and Student-Centeredness": take artificial intelligence technology as the support to realize the dynamic update of teaching content and the precision of teaching process; take interdisciplinary integration as the path to break professional barriers and construct a full-technical-chain practice system; take student development as the core to meet the learning needs of students at different levels and stimulate their potential for independent innovation.

### 2.2. Overall Teaching Reform Framework

Construct a "Trinity" teaching reform framework: with the curriculum system as the core, build an integrated curriculum group of "Perception-Integration-Control"; with the teaching model as the path, design a progressive practice process of "Learning-Practicing-Innovating"; with the evaluation mechanism as the guarantee, establish a multi-dimensional dynamic evaluation system. These three elements support each other and work together to form a complete teaching reform closed-loop As shown in Figure 1

## 3. Implementation Path of Teaching Reform for AI-Assisted Robot Innovation Practice

### 3.1. Construction of an Integrated Curriculum System of "Perception-Integration-Control"

Guided by the entire technical chain of robots, break disciplinary boundaries, restructure interdisciplinary curriculum content, and form a three-level curriculum module of "Foundation - Integration - Innovation". Design differentiated teaching content for three academic stages to achieve hierarchical and progressive training:

1) Foundation Module: Cover core knowledge such as robotics principles, Python programming, and sensor technology. Utilize AI adaptive learning systems (e.g., iFlytek Smart Learning Network, Xuetang Online AI Teaching Assistant) to push personalized learning resources according to students' cognitive levels. For example, use the AI wrong-question notebook function to accurately identify students' weak points in knowledge such as "forward and inverse kinematics of robot motion" and "sensor data collection".

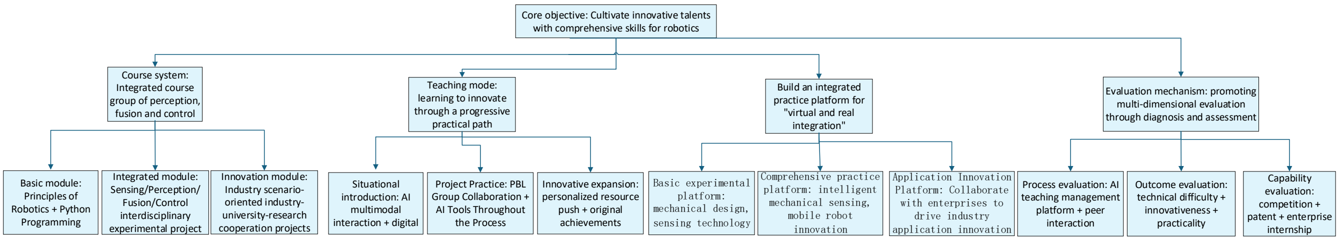


**Figure 1.** AI-Assisted Robot Innovation Practice Teaching Reform Framework

2) Integration Module: Focus on the four dimensions of "sensing" (mechanical sensing), "perception" (information processing), "integration" (collaborative integration), and "control" (decision-making and control), and set up comprehensive experimental projects such as sensor fusion application, machine vision recognition, and robot trajectory planning. Introduce open-source AI frameworks such as PaddlePaddle and OpenCV, and require students to complete projects including "vision-based robot part sorting" and "autonomous obstacle avoidance robot with multi-sensor fusion" to cultivate their technology integration capabilities.

3) Innovation Module: Combine real industry scenarios such as smart cities, intelligent logistics, and industrial quality inspection to design interdisciplinary innovation projects, such as "Design and Implementation of Intelligent Garbage Classification Robots" and "Path Optimization of Warehouse Robots Based on Deep Learning". Collaborate with enterprise mentors to formulate project indicators, requiring students to integrate cutting-edge AI technologies such as reinforcement learning and SLAM (Simultaneous Localization and Mapping) to solve practical problems.Meanwhile, establish a dynamic curriculum update mechanism. Introduce cutting-edge technologies in the field of AI and robotics every semester, such as large model-driven natural language interaction for robots and the application of digital twin technology in robot debugging, to ensure that the curriculum content keeps pace with industrial development. [3]

## 3.2. Building a Progressive Teaching Model of "Learning-Practicing-Innovating"

Based on AI technology, a teaching process of "Scenario Introduction - Project Implementation - Innovation Expansion" is constructed to realize the progression from knowledge absorption to capability output. Specific teaching cases and implementation data are provided for each stage:

1) Scenario Introduction Stage: An AI multi-modal interactive system is adopted to create real-world scenarios through virtual simulation, industry case videos, and other forms. For example, when explaining intelligent handling robots, a video of robot sorting in JD Logistics' "Asia No.1" warehouse is played, and the robot operation process is restored with the help of a digital twin platform; an AI voice assistant raises the question "How to solve the obstacle avoidance problem of robots in complex warehousing environments" to stimulate students' interest in exploration.

2) Project Implementation Stage: The Project-Based Learning (PBL) model is adopted. Students work in groups of 3-5 to complete the full process of "demand analysis - scheme design - hardware construction - programming and debugging - system testing". AI tools provide full-process assistance: computer vision technology is used to realize robot environmental perception, reinforcement learning algorithms are applied to optimize robot path planning, and the AI toolbox in MATLAB is utilized to diagnose parameter optimization problems during debugging. In the "autonomous navigation robot" project, students used AI debugging tools to reduce the path planning error from 15% to 3%, improving project completion efficiency by 40%.

3) Innovation Expansion Stage: Students are encouraged to expand the functions of basic projects, such as integrating face recognition technology into voice-controlled robots and adding defect detection functions to sorting robots. Teachers use an AI learning analytics system to accurately push extended resources and guide students to carry out original development. Students have completed 34 innovative expansion projects in total, among which 12 have applied for national utility model patents.

## 3.3. Constructing an Integrated Virtual-Real Practice Platform

Jointly build a progressive "Foundation-Integration-Application" practice platform with enterprises to achieve seamless integration of the technology chain and industrial chain. The hardware configuration and application scenarios of each platform are as follows:

1) Basic Experiment Platform: Renovate laboratories for mechanical design, sensor technology, etc., and equip them with open-source hardware such as Arduino, Raspberry Pi and STM32, as well as basic modules including ultrasonic sensors, infrared sensors and cameras. It supports core technology verification experiments and meets the basic practical needs of all students.

2) Comprehensive Practice Platform: Build platforms for intelligent mechanical sensing and mobile robot innovation. Students can conduct robot modeling and debugging through digital twin technology, reducing the loss cost and operational risks of physical robots. For example, in the "industrial robot welding simulation" project, students completed over 100 debugging sessions on the virtual platform before conducting physical operations, increasing the welding qualification rate from 70% to 95%.

3) Application Innovation Platform: Cooperate with enterprises such as Advantech and Hikvision to build an industry application innovation platform, introduce equipment such as industrial-grade six-axis robots and AGV handling robots, and import real industrial project cases. Students can participate in enterprise-commissioned projects such as "product surface defect detection based on machine vision", deploy AI algorithms to industrial robot systems, and realize the deep integration of industry, academia and research.[4]

## 3.4. Establishing a Multi-Dimensional Evaluation Mechanism of "Evaluation - Diagnosis - Promotion"

Break the simplistic evaluation model and construct a dynamic evaluation system of "Process + Outcome + Ability" with supporting specific evaluation indicators and implementation data:

1) Process-Oriented Evaluation (40%): Use AI to record data such as students' classroom participation, experimental operation standardization, and team collaboration contribution. Combine teacher comments and peer evaluations to fully reflect the learning process. For example, the platform generates a process-oriented evaluation report by analyzing the standardization of students' programming code, the number of debugging sessions, and problem-solving efficiency. In the pilot classes, this evaluation method improved students' experimental operation standardization by 50%.

2) Outcome-Oriented Evaluation (30%): Quantitatively score students' project works from three dimensions: technical difficulty, innovation, and practicality. Invite university teachers and enterprise experts to form a review panel to provide professional feedback. Set up a three-level scoring standard. For example, "technical difficulty" is divided into three levels: "basic algorithm application", "improved algorithm design", and "original algorithm research and development". In the 2025 provincial and national robot innovation competitions, the award-winning rate of pilot students reached 85%, far exceeding the 32% of non-pilot classes.

3) Ability-Oriented Evaluation (30%): Assess students' engineering thinking, innovative ability, and problem-solving ability through robot competitions, innovation project applications, and enterprise internship assessments. Incorporate the results of national and provincial competitions, patent applications, and enterprise internship appraisals into the evaluation system. During this period, students have won 33 national-level robot competition awards, 56 provincial and ministerial-level awards, applied for 18 invention patents, and 42 utility model patents. [5]

# 4. Practical Effects of Teaching Reform

This teaching reform program has been piloted for one semester among the 2022, 2023, and 2024 undergraduate students majoring in Robot Engineering at Suzhou Institute of Technology, achieving remarkable results:

Significant Improvement in Students' Abilities: The number of awards won by students in robot discipline competitions has increased significantly, with 33 national-level awards and 56 provincial and ministerial-level awards accumulated. Among them, Li Weiwei, a student from the 2022 cohort, won the runner-up in the China Robot Competition. 82% of students can independently complete robot project development, which is 35% higher than that of other majors.

Steady Improvement in Employment Quality: The employment rate of the Robot Engineering major has remained above 90%, and 68% of students have been employed in fields such as robotics and intelligent manufacturing. The satisfaction rate of employers with students' engineering practical abilities has reached 92%.

# 5. Conclusion

The teaching reform of AI-assisted robot innovation practice has effectively addressed the core pain points of traditional robot teaching through the restructuring of the "Perception-Integration-Control" curriculum system, the innovation of the "Learning-Practicing-Innovating" teaching model, the construction of a virtual-real integrated platform, and the reform of a multi-dimensional evaluation mechanism. Practice has proven that this teaching reform path, centered on AI empowerment and oriented towards ability cultivation, can achieve the transformation from sknowledge imparting to literacy training, providing strong support for cultivating interdisciplinary innovative talents to meet the needs of the intelligent era. In the future, it is necessary to continuously deepen the integration of AI and robot education, continuously optimize the teaching reform program, and promote the development of robot education towards higher quality and more distinctive characteristics.

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