

From Learning to Application: Integrating XIPU AI for Advanced IoT Skills Through Customized Control Systems Exercises

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1. Background

In the rapidly evolving world of Internet of Things (IoT), control technology remains a cornerstone of innovation. However, students often struggle to grasp its complex concepts. In the module IOT201TC IoT Control Technology, students encounter challenging topics such as Laplace transforms, transfer functions, and PID controllers. While these form the foundation for understanding control systems and their IoT applications, their complexity often prevents full comprehension. Traditional classroom instruction, limited by time, can only cover minimal examples, leaving students without sufficient practical experience for diverse problem scenarios and real-world applications, impacting overall mastery. Adding more examples and practical sessions to control technology teaching is crucial.

Traditional teaching often leaves knowledge gaps due to insufficient practical components. Outside class, students rely on textbooks or online resources, which is inefficient and frustrating without real-time feedback and targeted guidance. This theory-practice disconnect leaves many students feeling underprepared, unmotivated, and unable to apply knowledge practically. Limited practical opportunities, low engagement, and disconnection from real-world applications constitute the pain points forming the basis of the first teaching model, revealing traditional method limitations.

2. Solutions

This study designed two contrasting teaching models to explore more effective pathways:

Model 1: Traditional Learning Approach In the traditional model, students only complete limited control system exercises during class time. Due to time constraints, they typically practice only one or two problems per session—far from sufficient for mastering core engineering skills like Laplace transforms, transfer functions, and PID controllers. Outside class, students can deepen understanding through textbooks, online resources, or peer discussions. However, this self-directed learning often creates a

disconnect between theory and practice without instant feedback, leading to knowledge gaps and lack of confidence in solving real problems.

Model 2: Project-Based Learning with XIPU AI This innovative approach centers on project-based learning integrated with XIPU AI. Instead of passively solving predefined problems, students design unique, real-world-relevant control system problems, such as regulating office building noise levels or controlling humidity in agricultural environments, ensuring practical value and exploratory interest. XIPU AI guides students throughout—system modeling using Laplace transforms, establishing transfer functions, designing PID controllers—providing real-time feedback to optimize mathematical models and explore how different PID parameters affect system stability and performance.

AI Usage Guidelines:

- **Guidance & Exploration:** Encourage using XIPU AI to explore different solution approaches. Students should first attempt problems independently, then use AI to compare methods and results.
- **Validation & Error Correction:** Use AI to verify calculations and results, cross-checking manual derivations with AI-generated

conclusions to reinforce understanding through discrepancy analysis.

- **Restrictions:** Students cannot fully rely on AI-generated answers; they must demonstrate their own solution processes and understanding.

Process Documentation Standards: Students must thoroughly document their entire problem-solving journey, from initial attempts to obtaining and implementing XIPU AI feedback, recording insights, challenges encountered, strategies to overcome them, and explicitly stating how XIPU AI was used at each stage.

Reflection Requirements: Students should reflect on both content learned and process experienced, discussing how XIPU AI enhanced understanding and problem-solving capabilities, the benefits and limitations of AI as a learning tool, and personal growth.

Assessment Criteria: A comprehensive evaluation system assesses problem design clarity and originality, appropriate AI tool application, depth of analysis, documentation quality, and final solution accuracy, rather than just correctness of final answers.

3. Outcomes and Benefits

Research Results: A small-scale trial with 10 IoT and control systems students over 6 weeks evaluated XIPU AI-driven exercises.

Notable data showed:

- IoT skills improved by **35%** on average in post-tests, particularly in differential equations, system dynamics, and fault detection
- Students using XIPU AI completed tasks **25% faster** with significantly reduced error rates
- **85%** reported increased learning motivation through AI-driven exercises

Student Feedback: One student noted XIPU AI dynamically adapted to their ability level, maintaining an "appropriately challenged but not anxious" state, optimizing learning. Most reported increased confidence facing real IoT problems. Technically, XIPU AI reduced system latency by 40%.

Student A' s Detailed Feedback: Found the project challenging yet exciting, especially appreciating opportunities to independently design and solve control system problems with XIPU AI. Highly valued bridging theory-practice gaps, stimulating creativity, and deepening control system understanding. Practical learning maintained engagement, while

personalized XIPU AI feedback made learning flexible and efficient.

Suggested initial structured cases or step-by-step guidance to reduce entry difficulty and adding collaborative components (peer review, group discussions) for diverse perspectives.

Educational Value: This study demonstrates that XIPU AI integration in customized control systems significantly enhances IoT expertise.

AI-based personalized learning and real-time feedback improve technical capabilities and learning engagement, making IoT education more aligned with industry needs.

4. Replicability and Promotion Value

Transferability of Teaching Models: The contrast between two models clearly demonstrates traditional approach limitations and new method advantages. This shift from frustration to empowerment redefines IoT and control systems pedagogy and points to more efficient, promising directions for engineering education reform.

Project-Based Learning Promotion Value: Project-based methods are scalable and adaptable, balancing knowledge delivery and practical application. The model transfers to other engineering courses by having

students design real-world problems to promote active learning and creativity.

AI Tool Framework Applicability: XIPU AI usage guidelines (guidance & exploration, validation & error correction, cannot replace learning) apply to various technical courses. The concept of "AI as learning partner, not answer provider" has broad educational significance.

Small-Scale Validation Potential: Though limited to 10 students over 6 weeks, results have important implications for education, industry, and research. For educators, XIPU AI is ideal for designing IoT courses adapted to different student needs; for enterprises, it helps improve IoT system stability and reliability.

Cross-Disciplinary Prospects: The approach cultivates skills, confidence, and creativity essential for real-world complexity, achieving effective theory-practice integration. This capacity-building model transfers to other STEM disciplines.