

Exploration of Teaching Reform of Virtual Reality Technology in Agricultural Machinery Teaching Course

Changxi Liu^{1,2}, Jun Hu^{1,*}, Xin Liu¹, Yufei Li¹, Anni Zou¹, Qiang Li¹, Qingwei Liu¹

¹Heilongjiang Bayi Agricultural University, Daqing, Heilongjiang, China

²State Key Laboratory of Green Pesticides, Guizhou University, Guiyang, China

*Corresponding Author

Abstract: The specialized courses of agricultural mechanization and automation focus on the combination of theory and practice. And it needs the strong spatial imagination ability. For students of agricultural colleges and universities, it is difficult to understand the structure and working principle of agricultural machinery without farm practice and close contact with agricultural machinery. In this paper, virtual reality technology is introduced into the teaching of agricultural mechanization and automation. Taking the teaching contents of theoretical teaching and practical teaching as examples, this paper analyzes how to introduce virtual reality technology into the teaching process. Compared with traditional teaching methods, it is found that the application of virtual reality technology in agricultural machinery teaching increases students' interest in courses and helps students better understand the operation process of modern agriculture. In this way, the teaching cost is reduced, the teaching effect is improved, and the new engineering talents with innovative thinking are cultivated.

Keywords: Agricultural Machinery Teaching Course; Virtual Reality Technology; Teaching Effects

1. Introduction

Agricultural Mechanization and Automation is a national specialty major, which trains students to master the basic theories of biology, mechanical science, automation technology and management. The curriculum of this major emphasizes the combination of theory and practice, and involves the complex structure of agricultural machinery, which requires strong spatial imagination.

Taking Heilongjiang Bayi Agricultural

Reclamation University as an example, the core textbooks for agricultural machinery education include "Agricultural Machinery Science" by Zhang Wei and Hu Jun, "Agricultural Machinery Management" by Qiao Jinyou and Zhang Xinzhi, and "Tractor and Agricultural Vehicle Science" by Gao Lianxing. This article focuses on undergraduate students in the agricultural machinery program at the university. Teaching strategies should address two key characteristics: 1) While a small number of students come from reclamation zones, most lack comprehensive understanding of modern agricultural operations, making it particularly challenging for them to comprehend machinery structures and working principles; 2) Given students' age-specific learning patterns, prior knowledge gaps, and the need for rapid knowledge acquisition, integrating virtual reality technology as a modern educational tool can significantly enhance the quality and efficiency of knowledge delivery in agricultural machinery courses.

This educational reform initiative utilizes virtual reality (VR) technology as an auxiliary tool in agricultural machinery curriculum instruction. Virtual Reality (VR), first proposed by American scientist J. Lanier in 1989 (later chairman of VR specialist VPL Corporation), is also translated as "Lingjing" in Chinese. Internationally, similar concepts include virtual environments, artificial reality, and computer space [1]. Conventional VR implementation requires costly equipment like mainframe computers, helmet-mounted displays, data gloves, tunnel projectors, and sealed chambers—costs that most educational institutions cannot afford. Funding shortages have long constrained VR research and application in education, but with rapid technological advancements, VR technology is now demonstrating diverse development trends [2].

Regarding the application of virtual reality technology in agricultural machinery education: Lei Wen et al. [3] from Shandong Jianzhu University developed a VR-based simulation teaching system for the "Agricultural Machinery Science" course, using mouse and keyboard as human-machine interfaces. Meng Qingshan et al. [4] from Shandong Agricultural Machinery Research Institute utilized 3DVia Composer virtual interaction technology to create a comprehensive training system covering product knowledge, structural principles, disassembly and assembly training, and assessment in agricultural machinery vocational education. Building on this virtual training software, Cui Yuxin et al. [5] from Jilin University developed a complete virtual driving simulation platform for agricultural machinery, which has been implemented in the "Tractor and Automobile Driving Practice" practical course.

As virtual reality technology was pioneered as an educational aid abroad, its application in agricultural machinery training has been widely adopted in many developed countries. At the National Academy of Agricultural Engineering in South Korea, Yu-Yong Kim et al [6] developed a tractor simulator for safety training using a real tractor cab as a prototype. By leveraging VR technology to simulate virtual environments including roads, traffic signals, buildings, rice fields, and farmland, they created a system with four displays and two rotational degrees of freedom. Building on this, D. Ojados Gonzaleza and colleagues from Spain's Polytechnic University of Cartagena [7] developed a three-degree-of-freedom tractor driving simulation platform powered by three motors, complemented by VR headsets and projection equipment. Their research demonstrated the feasibility of using VR technology as an agricultural tractor training tool. The study revealed that 80% of participants expressed willingness to adopt safer driving practices after testing, 76% reported enhanced risk awareness post-activity, and 75% agreed tractor drivers should undergo occupational safety training.

Virtual reality technology holds significant potential for enhancing learning across multiple dimensions [8]. By synthesizing research findings from domestic and international scholars in virtual reality and its practical applications in education, this technology can be categorized into four types: desktop virtual

reality, immersive virtual reality, augmented reality-based virtual reality, and distributed virtual reality.

Desktop virtual reality, being relatively simple and cost-effective, demonstrates broad applicability in educational settings with substantial promotion value [9]. Augmented reality-based virtual reality integrates real-world environments with virtual elements, effectively reducing the costs associated with creating complex experimental environments while enabling intuitive interaction with virtual objects. This paper, based on the practical conditions at Heilongjiang Bayi Agricultural Reclamation University, primarily introduces desktop virtual reality and augmented reality-based virtual reality technologies as supplementary tools for agricultural machinery education courses.

2. Application of Virtual Reality Technology in Theoretical Teaching

2.1 Agricultural Mechanics

Traditional teaching of the "Agricultural Machinery Science" course primarily relies on textual descriptions, diagrammatic presentations, and agricultural machinery operation videos to impart theoretical knowledge. However, due to the complex structure of agricultural machinery, conventional teaching methods struggle to clearly demonstrate the interactions between components, as well as their relationships with soil and crops. This limitation creates significant challenges for agricultural machinery students in their subsequent specialized course studies.

Virtual reality technology creates immersive environments that provide students with realistic simulations. When combined with haptic feedback devices, it delivers a truly immersive experience. By constructing 3D models of mechanical components, students can examine equipment structures and operational states from multiple angles, serving as a valuable supplement to traditional teaching methods. For example, in a plow operation course, educators can use 3D Max software to model plow bodies and various soil types. These models are equipped with physics simulations, and augmented reality (AR) technology enables virtual plow movements and soil interactions to dynamically adapt to students' hand gestures. This interactive approach helps students better understand plow-soil interaction processes and identify specific areas where soil friction and

wear occur.

2.2 Mechanization Management of Agriculture

The course "Management of Agricultural Mechanization" requires students to acquire foundational knowledge in Management, Operations Research, Industrial Economics, and Systems Engineering. It aims to develop their ability to analyze and optimize agricultural machinery management, enabling efficient, safe, and cost-effective mechanized production for maximum efficiency. This underscores management's critical role in agricultural mechanization. However, most universities offering agricultural mechanization and automation programs—particularly engineering-focused institutions—tend to prioritize technical instruction over managerial education. As a result, students often memorize basic terms but struggle with applying knowledge in practical scenarios. To address this, the course adopts an "edutainment" approach: Beyond classroom learning, students engage in a "Sim Farm" simulation game to explore management strategies. They plan machinery schedules, manage field operations, and maximize profits throughout the entire crop cycle—from seed procurement to harvesting. Students can also share their simulated experiences in class, presenting their strategies through the game's virtual reality interface. Through the teaching plan of "learning through fun" and the means of desktop virtual reality technology, the learning interest of students is greatly stimulated, the management knowledge becomes vivid, students can constantly find and solve problems in exploration, the learning motivation of students is stimulated, and the teaching effect is improved.

3. Application of Virtual Reality Technology in Practice Courses

The agricultural machinery sector has witnessed growing demand for driving simulation technology since its inception. Building upon the research philosophy of automotive driving simulators, the School of Engineering at Heilongjiang Bayi Agricultural University has developed virtual agricultural machinery and environments through software modeling. By integrating hardware components like tractor steering wheels, pedals, and control levers with the software system, they created a

motion-sensing driving simulator as shown in Figure 1.



Figure 1. Simulation Platform for High-horsepower Tractor Driving

The high-horsepower tractor driving simulation platform independently developed by the Heilongjiang Bayi Agricultural University simulates agricultural machinery operations through steering wheels, pedals, and other control mechanisms. It replicates real-world scenarios like seed sowing, fertilization, pesticide spraying, and harvesting, including platform lifting and equipment attachment as shown in Figure 2. Unlike traditional campus road driving drills, this system immerses students in authentic field operation experiences. By widely adopting this platform in tractor driving training courses, instructors can conduct large-scale simultaneous teaching sessions while using software to monitor operational compliance. The VR-enhanced simulation platform reduces fuel consumption, minimizes environmental pollution, ensures safety and reliability, shortens training duration, and boosts instructional efficiency [10].



Figure 2. Effect of Cultivated Land

4. Conclusion

This paper explores the integration of virtual reality technology into agricultural machinery education as an innovative teaching reform. It highlights the advantages of VR as an educational tool, with many universities recognizing its potential and providing virtual

reality learning resources. However, given the high implementation costs of VR in higher education, it's crucial to evaluate instructors' demonstration effectiveness and students' comprehension capabilities before establishing VR media. For this educational reform initiative: Introducing VR in agricultural machinery instruction can visually demonstrate complex equipment structures, embed management concepts into students' minds, and create lasting impressions, serving as an effective teaching aid. The VR-based agricultural machinery education model demonstrates comprehensive advantages through its unique features, fostering innovative engineering talent development. In the current context of "Internet + Education" initiatives, VR-enhanced agricultural machinery teaching will gradually transition to online platforms through continuous refinement, evolving into a premium vocational education cloud resource system that lays the foundation for open online teaching platforms.

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