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Laboratory construction and teaching application of surveying and mapping engineering in university based on virtual reality technology

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Abstract: The widespread application of virtual reality technology in the field of surveying and mapping engineering has garnered attention for the construction and educational applications in university laboratories. Against this backdrop, this paper explores the importance and potential value of using virtual reality technology for the construction and educational applications of surveying and mapping engineering university laboratories. By analyzing existing research and practical experiences, a systematic laboratory construction plan is proposed with the aim of promoting students' profound understanding of surveying and mapping engineering and cultivating practical operational skills.

1. Introduction

With the rapid development of virtual reality technology, the field of surveying and mapping engineering is continuously experiencing new opportunities and challenges. To better adapt to the requirements of modern surveying and mapping engineering, there is a need for continuous innovation and improvement in the construction and educational applications of university laboratories. This paper aims to explore how to utilize virtual reality technology to enhance the construction level of surveying and mapping engineering university laboratories, optimize teaching methods, improve teaching tools, and enhance the quality of talent cultivation to better meet the development needs of surveying and mapping engineering.

2. Overview of the Application of Virtual Reality Technology in Surveying and Mapping Engineering

2.1. Basic Principles and Characteristics of Virtual Reality Technology

Virtual Reality (VR) technology is a computer-generated simulation environment that immerses users in a fictional three-dimensional space. Its basic principles include perception technology, interaction technology, and simulation technology. Perception technology transmits sensory

information such as vision and hearing through devices like head-mounted displays and controllers. Interaction technology enables real-time interaction with elements in the virtual environment. Simulation technology creates realistic virtual scenes through powerful computer graphics processing capabilities. The key characteristics of virtual reality technology are its high level of immersion, real-time interactivity, and highly simulated representation of real scenes.

2.2. Current Applications of Virtual Reality Technology in Surveying and Mapping Engineering

Virtual reality technology has been widely applied in surveying and mapping engineering, presenting unprecedented development opportunities for the discipline. Firstly, by utilizing virtual reality technology, surveying and mapping engineers can simulate the modeling of geographical environments, enhancing the realism and accuracy of map production. Secondly, the application of virtual reality technology in measurement, navigation, and geographic information systems improves the efficiency and precision of surveying data collection. Additionally, virtual reality technology is extensively used in fields such as geological exploration and urban planning, promoting the multidisciplinary integration of surveying and mapping engineering.

2.3. Advantages and Challenges of Virtual Reality Technology in Teaching

In terms of teaching applications, virtual reality technology brings significant advantages to the field of surveying and mapping engineering. Firstly, students can experience real surveying scenarios through virtual reality technology, enhancing the interest and depth of learning. Secondly, the establishment of virtual laboratories allows students to perform multiple practical operations in a safe and cost-effective environment, deepening their understanding of surveying principles and techniques. However, challenges in teaching with virtual reality technology include high equipment costs and rapid technological advancements, necessitating continuous improvement by universities to overcome these obstacles and ensure the sustainable enhancement of teaching effectiveness.[1]

3. Analysis of the Needs for University Laboratory Construction

3.1. Current Status of Existing University Surveying and Mapping Engineering Laboratories

Currently, there is a certain gap in the equipment and technological levels of university surveying and mapping engineering laboratories in China. Some laboratories have aging equipment that cannot meet the demands of modern surveying technology, while others, although updated in hardware, lack up-to-date software support. Moreover, the costs of equipment maintenance and updates are continually rising, impacting the efficiency of practical usage. This imbalance results in differences in students' practical experiences and affects their in-depth understanding and passion for surveying engineering. Therefore, a comprehensive evaluation of the current state of laboratories is crucial, with a clear focus on improvement.

3.2. Application Requirements of Virtual Reality Technology in Laboratory Construction

The application of virtual reality technology in laboratory construction provides an effective approach to elevate the level of experimental teaching. Firstly, virtual reality technology allows laboratories to present more realistic and diverse surveying scenarios, enabling students to engage in various practical operations in a virtual environment. This immersive experience contributes to enhancing students' practical skills and operational proficiency. Additionally, in situations where real

experiments cannot be conducted due to objective limitations, timely support can be provided through virtual reality technology to ensure the normal progression of experimental teaching.

Secondly, virtual laboratories offer students the opportunity to repeatedly practice in a simulated environment, deepening their understanding of surveying principles and improving practical proficiency. Students can conduct experiments multiple times in a virtual environment, gaining a more in-depth grasp of key concepts and technical aspects of surveying engineering. Furthermore, the application of virtual reality technology can compensate for the lack of laboratory equipment, providing a broader range of surveying content to meet diverse disciplinary needs. Even with limited laboratory equipment, students can still access rich surveying content in a virtual environment, expanding their knowledge and cultivating comprehensive application abilities.[2]

In summary, the application of virtual reality technology in laboratory construction is a comprehensive requirement, effectively promoting the improvement of surveying and mapping engineering experimental teaching by providing immersive experiences, practical opportunities, and a broader range of disciplinary content.

3.3. Student Expectations and Feedback on Laboratory Construction

Students have clear expectations and feedback regarding laboratory construction. They expect laboratories to provide advanced surveying equipment and technological support to better prepare them for future career challenges. Additionally, students strongly desire laboratories to incorporate virtual reality technology, offering more innovative and engaging practical experiences. Student feedback also emphasizes the importance of integrating practical operations with theoretical knowledge in laboratory construction, enabling them to apply learned knowledge to real-world work and enhance practical skills. These expectations and feedback provide a strong basis for laboratory construction, emphasizing the core goal of meeting student needs.

4. Construction Scheme of University Laboratory Based on Virtual Reality Technology

4.1. Selection and Configuration of Virtual Reality Laboratory Hardware

The successful application of virtual reality technology relies on advanced and well-configured hardware. In the construction of a virtual reality laboratory, head-mounted displays are crucial devices. To provide a clear and highly immersive virtual experience, it is essential to choose head-mounted displays with high resolution and fast response. This ensures that students can accurately perceive geographical information in the virtual surveying environment, leading to a better understanding of the core principles of surveying engineering. Another indispensable hardware tool is controllers and motion-sensing devices. These devices enable students to interact more naturally with the virtual environment, simulating gestures and actions involved in actual surveying operations. Through controllers and motion-sensing devices, students can perform realistic measurements and operations in virtual scenes, enhancing the realism of experiments and the depth of learning. In terms of hardware configuration, efficient computers and graphics cards are critical to ensuring the smooth operation of the virtual reality system. Virtual reality applications demand high computing performance and graphic processing capabilities. Therefore, selecting hardware devices with outstanding performance is necessary to ensure that students can enjoy a high-quality visual and interactive experience in the virtual laboratory. Additionally, the internal network of the laboratory needs optimization to support high-speed data transfer and online interaction of virtual reality devices. Considering the laboratory's scale, usage requirements, and application scenarios, the selection and configuration of hardware devices should be a carefully planned process. Only by ensuring that the hardware is advanced, stable, and fully meets the needs of the virtual laboratory can high-quality virtual learning experiences be

provided to students, promoting continuous breakthroughs in teaching and research in the field of surveying engineering.

4.2. Selection and Development of Virtual Reality Laboratory Software Platforms

Choosing an applicable virtual reality software platform is a crucial aspect of constructing an efficient laboratory. Currently, virtual reality software platforms like Unity and Unreal Engine are widely used globally, providing developers with powerful tools and resources to support complex virtual environment construction and rich interactive functionalities. When selecting a virtual reality software platform, usability is a primary consideration. The platform should have an intuitive interface design, facilitating quick adoption by teachers and students. [3]

Simultaneously, the software platform should provide adaptable development tools for users with different technical levels to ensure the participation of a broader range of educators in the development and updates of the virtual laboratory. Flexibility is another key factor in the selection of a software platform. Virtual laboratories need flexible customization and adjustments based on different surveying engineering course designs and teaching requirements. Choosing a software platform with high flexibility enables better fulfillment of diverse experimental scene requirements, providing a richer learning experience.

In terms of software platform development, it should align with the characteristics of surveying engineering. Designing virtual experimental scenes that simulate surveying operations allows students to conduct realistic surveying operations in a virtual environment. An essential part of the software platform is the real-time feedback mechanism, providing instant assessment and guidance to help students better understand and master the technical points of surveying engineering. The interface design of the virtual laboratory should be intuitive and user-friendly, enabling students to easily get started. Introducing artificial intelligence technology can enhance the interactivity and intelligence of the virtual environment, offering students a more realistic learning experience.

In summary, the selection and development of a virtual reality software platform need to fully consider teaching goals, user experience, and compatibility with hardware devices. Only through careful selection and development can a powerful and flexible virtual laboratory platform be constructed, providing more efficient and innovative tools for teaching in the field of surveying engineering.

4.3. Laboratory Scene Design and Simulation

Laboratory scene design is a crucial step in the construction of a virtual laboratory. In the field of surveying engineering, scene design should closely align with practical operational needs, aiming to simulate real surveying scenes to provide students with diverse and realistic operational experiences.

Firstly, urban planning scenes can be designed, allowing students to participate in the entire process of urban planning in a virtual environment. From terrain measurement to data analysis, students can engage in urban planning projects in a virtual setting, enhancing their practical application abilities in surveying technology.

Additionally, terrain measurement scenes are also an important design direction. Through virtual reality technology, students can simulate measurement operations in different terrains, improving their adaptability in real-world work. One of the advantages of virtual laboratories is scene flexibility, allowing for real-time adjustments and updates based on teaching needs. This provides greater freedom for teaching, enabling teachers to flexibly design and improve laboratory scenes based on disciplines, professional development, and student feedback, ensuring alignment with the latest practices in surveying engineering. [4]

Simultaneously, scene design should not only consider realism and authenticity but also focus on

alignment with actual work scenarios. By connecting with real work scenarios, students can gain a more authentic professional experience in virtual experiments, better understanding the application background of surveying engineering, and enhancing their practical operational skills in real-world work. Overall, laboratory scene design and simulation are critical aspects of virtual laboratory construction, directly influencing student learning outcomes and the cultivation of practical operational abilities. Through clever design and continuous updates, a more diverse and innovative virtual experimental experience can be provided to students, propelling the teaching in the field of surveying engineering towards modernization.

4.4. Virtualization of Laboratory Teaching Content and Integration with Practical Operations

The virtualization of laboratory teaching content is the core of virtual laboratory construction. By digitizing traditional experimental content and integrating it into the virtual environment, students can perform practical operations in virtual scenes, which holds significant importance in the field of surveying engineering. Through virtualization, various stages of surveying processes, including measurement, data processing, and map creation, can be simulated. To achieve the integration of virtual and practical, the design of teaching content should focus on combining virtual experiments with actual operations.

Firstly, students can use virtual laboratories for pre-experiment practice, allowing them to become familiar with surveying operation steps and tool usage in a virtual environment. Subsequently, actual field operations can be conducted in the physical laboratory, applying the knowledge learned in the virtual environment to real scenarios.

Finally, virtual laboratories can be used for simulating and verifying experimental results, reinforcing students' theoretical knowledge and practical operational skills. This blended teaching model helps enhance students' practical operational abilities, enabling them to better adapt to future surveying engineering practices. The virtualization of content in virtual laboratories can be customized based on different courses and experimental requirements, ensuring that students can simulate practical operations in a safe and controlled environment.

By considering the compatibility of hardware devices, software platforms, scene design, and the virtualization of teaching content, the university's construction scheme for surveying engineering laboratories will provide students with more advanced, diverse, and in-depth learning experiences. This blended teaching approach not only expands students' practical operational space but also enhances the innovation and practicality of surveying engineering teaching.

5. Teaching Application and Effect Evaluation

5.1. Virtual Reality-Based Surveying Engineering Course Design

The design of surveying engineering courses based on virtual reality technology aims to fully leverage the advantages of virtual laboratories, providing a more in-depth, vivid, and practical learning experience. This design should align with the core knowledge system of surveying engineering, integrating virtual environments into the curriculum, including but not limited to key aspects such as map creation, measurement techniques, and data processing. [5]

Firstly, through virtual laboratories, students can participate in practical operations within simulated scenarios, such as conducting measurements, data processing, and map creation tasks in a virtual city. This not only enhances students' understanding of surveying principles but also enables them to proficiently apply relevant technologies in a virtual environment, laying a solid foundation for future practical work. Course design should also emphasize fostering students' problem-solving abilities and teamwork spirit. By setting complex scenarios and problems in virtual experiments,

students' ability to think critically and solve problems proactively can be stimulated.

Simultaneously, virtual laboratories can provide a collaborative environment, simulating real working scenarios and helping students cultivate excellent teamwork skills. The key is to ensure that the design of virtual laboratories is not merely a simple replacement for traditional experiments. Course design should be more in line with the development of the discipline and the needs of industrial applications, enabling students to better adapt to the challenges of future careers through virtual experiments. The design should focus on the enjoyment of experiments, allowing students to fully experience the joy of surveying engineering in a virtual environment and igniting their strong interest in the field. Such course design will contribute to the cultivation of surveying engineering professionals with practical skills and innovative thinking.[6]

5.2. Evaluation of Student Engagement and Learning Effectiveness

The evaluation of student engagement and learning effectiveness is a crucial aspect in the construction of a virtual reality-based surveying engineering laboratory. Virtual laboratories provide comprehensive monitoring and assessment capabilities through technological means, allowing teachers to gain a more holistic understanding of students' performance during the learning process.

Firstly, virtual laboratories can record students' actual operations in the virtual environment, including key steps such as measurements, data processing, and map creation. This provides teachers with an intuitive source of data to analyze students' performance in experiments, understand the proficiency of their operational skills, and identify potential issues. This aids in personalized guidance and targeted development of students' practical operational skills.

Secondly, virtual laboratories can collect feedback information from students through real-time interactive mechanisms. Through forms such as surveys and discussion boards, teachers can gather students' experiences and suggestions regarding virtual experiments. This feedback helps teachers better understand the difficulties and uncertainties students encounter in virtual experiments, allowing adjustments to course design and experiment content to enhance students' learning effectiveness. Key assessment points should include students' engagement, practical operational proficiency, improvement in problem-solving abilities, and a profound understanding and mastery of surveying engineering knowledge. Students' engagement reflects their interest in virtual experiments and the extent of their active learning, while operational proficiency and problem-solving abilities directly relate to their future application capabilities in actual work.

By evaluating these aspects, a more comprehensive understanding of the practical impact of virtual experiments on student learning can be obtained, providing strong support for the continuous improvement of virtual laboratory construction.

5.3. Improvement and Optimization of Laboratory Construction and Teaching Applications

The improvement and optimization of laboratory construction and teaching applications is an ongoing dynamic process aimed at adapting to the development of new technologies and changes in disciplinary requirements, providing a higher-quality learning experience.

Firstly, regular updates to hardware and software equipment are crucial to maintaining the technological advancement of virtual laboratories. With the rapid development of virtual reality technology, new devices and tools continually emerge. Regularly updating hardware and software ensures that students always have access to the latest virtual learning experiences. This includes selecting higher-resolution and faster-responding head-mounted displays, optimizing internal laboratory networks, and integrating the latest virtual reality software platforms to meet the specific application requirements of surveying engineering.

Secondly, continuous optimization of virtual laboratory scene design and content settings based

on student feedback and actual operational situations is a key way to continuously improve teaching quality. Close cooperation between teachers and technical teams is critical. By analyzing student feedback, adjusting virtual laboratory design, and making it more in line with the practical needs of the discipline, real-time optimization measures include improving the realism and authenticity of scenes, enhancing interactivity, and increasing the diversity of experiments to stimulate students' interest in learning.

Lastly, establishing a sound evaluation system is the foundation for ensuring continuous improvement in the construction and teaching applications of virtual laboratories. Regular assessments can evaluate the teaching effectiveness of virtual laboratories through multiple aspects, including students' engagement, learning effectiveness, and actual operational proficiency. This continuous monitoring process can promptly identify issues and shortcomings, providing robust support for subsequent improvements.

Through continuous improvement and optimization, we need to ensure that the virtual laboratory remains at the forefront of education and better serves the learning of students. This process is an evolving cycle, ensuring that the construction and teaching applications of virtual laboratories continuously adapt to changes in the educational environment and industry demands, providing students with the best learning experience.

6. Conclusion

Through an in-depth study of the construction and teaching applications of university laboratories in surveying engineering based on virtual reality technology, we find that virtual reality technology has tremendous potential in enhancing students' practical operational abilities, stimulating learning interests, and meeting industry demands. The implementation of laboratory construction schemes not only enhances students' practical skills but also guides the future development of university surveying engineering laboratories. With the support of virtual reality technology, these laboratories will better serve the dual needs of education and industry.

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