Analysis of the Application Status and Development Trend of Visual Simulation System in Vehicle Professional Teaching

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Abstract: As visual simulation technology advances, its application across educational domains has become increasingly prevalent. In tandem with simulation training apparatuses, a myriad of visual simulation training systems have been established. This treatise provides a concise overview of the evolution and application spheres of visual simulation systems, surveys the current deployment of these systems within education, and elucidates upon the strengths and limitations, attributes, and application arenas of diverse visual simulation systems utilized in automotive professional instruction. Furthermore, it delineates the appropriate contexts for the varied types of visual simulation systems in the realm of automotive pedagogy. By integrating the emerging instructional and training imperatives in new energy vehicle education, an analysis is proffered on the future trajectory of visual simulation systems as they evolve to accommodate novel pedagogical necessities.

1. Introduction

With the advancement of science and technology, the educational sector has witnessed a significant increase in the techno-scientific aspect of its equipment. In the 1940s and 1950s, most teaching processes employed actual components for demonstration or operational teaching, which were inefficient and had limited scope. The evolution of visual simulation technology has broadened its application in education, offering students virtual experiences in various forms within a simulated environment, enabling interaction, operation, observation, and demonstration. Furthermore, practical learning through visual simulation systems significantly reduces costs, is unaffected by weather conditions, eliminates safety risks, and enhances the efficiency of learning and training. These benefits have led to the expanding role of visual simulation systems in education.

The method of practical training using visual simulation systems represents an innovative and digitally advanced educational approach with profound implications. It serves to bridge the gap between educational provision and societal needs, transform learners' cognitive processes, and even influence their perspectives on the world, time, space, and self.

Leveraging instruments, equipment, models, and virtual simulation technology, along with site and environmental layouts that mimic real-world procedures, environments, technical benchmarks, and action requirements, this approach encompasses scientific research, industrial design, simulation production, and assessment of teaching and training. Characterized by immersion, interaction, and imagination, the created learning environment provides a tangible sense of physicality, environmental authenticity, and behavioral realism. This allows learners to engage with solving genuine problems within quasi-realistic settings, fulfilling the experimental and practical teaching demands across diverse disciplines.

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2. The Scope of Application of Visual Simulation Systems in the Field of Education

2.1. Virtual Lab

Utilizing virtual reality to construct simulated labs has become a prevalent educational methodology. Owing to the issues of exorbitant equipment costs, protracted experimental durations, and perilous procedures, traditional methods are often ineffectively implemented. Nonetheless, the employment of visual simulation technology facilitates the creation of three-dimensional objects that mirror physical entities, such as virtual physics, chemistry, driving, photography laboratories, and studios. Within these virtual labs, students can manipulate virtual instruments to achieve effects analogous to reality, while educators can provide timely experimental guidance.

2.2. Virtual Library

The virtual library is constructed utilizing holographic photography, web3D technology, three-dimensional modeling, and database technology. The entire physical structure of the library, encompassing doors, windows, desks, lighting, corridors, bookshelves, retrieval machines, as well as an array of books, newspapers, CDs, tapes, etc., are all integrated into the computer using virtual reality technology to establish a virtual library. The books, newspapers, magazines, etc., within the virtual library are all electronic materials that have been scanned and digitally stored through high-definition scanners, allowing users to simply manipulate the mouse to freely peruse all the digital resources in the virtual library.

2.3. Virtual Gymnasium

The virtual gymnasium employs visual simulation technology in conjunction with material science, construction science, and virtual reality technology among other integrated technologies to develop a virtual gymnasium. Users, merely by donning visual helmets or glasses, are enabled to learn or practice their preferred sports. Students can engage in the sensation of playing by utilizing sensor-equipped rackets and wearing helmets or glasses. Subsequently, one can replay the recorded video of the interaction to analyze and summarize their own techniques, thereby enabling the summarization of skills, correction of erroneous actions, and standardization of skills and techniques.

2.4. Virtual Hands-on Teaching

Virtual practical teaching entails the application of visual simulation technology within the classroom setting. This pedagogical approach utilizes simulated displays to elucidate content that may be challenging for students to grasp, conducting virtual operational teaching to manipulate and exhibit outcomes, and utilizing imagery to construct a three-dimensional space. Such methodology facilitates students' comprehension of scientific principles through corresponding experiential activities, thereby enhancing their grasp of key knowledge points and fostering a heightened awareness of learning. It enables students to transition from perceptual to rational cognition, leading to a more profound understanding of knowledge, familiarity with the operational process and related precautions, ultimately facilitating an effortless internalization of knowledge.

3. Characteristics and Applications of Various Types of Visual Simulation Devices

3.1. Vehicle Professional Teaching Characteristics and Simulation Needs

In the realm of vehicular professional pedagogy, the practical educational trajectory for students chiefly encompasses structural apprehension, maintenance aptitude acquisition, and driving proficiency development, all intimately linked with actual vehicular engagement. This necessitates that pupils attain mastery through extensive hands-on drills, advancing gradually towards expertise. Nevertheless, owing to the fact that authentic vehicular practice demands substantial labor inputs, suitable environmental contexts, exorbitant utilization costs, and inherent safety risks, it results in elevated operational teaching expenses coupled with inefficiency. The advent of visual simulation technology has instigated a paradigm shift in these educational exigencies by fabricating a verisimilar vehicular operational milieu for learners. It leverages visual simulation technology to depict vehicle components, kinematic representations, and extraneous environmental alterations in a virtualized manner, thereby satiating the practical pedagogical requirements within the domain of vehicle specialization.

3.2. Screen Explicit Visual Simulation Simulator

Utilizing mainstream LED or LCD screens as display apparatuses, the explicit visual simulation simulator is positioned to facilitate student observation of the displayed information. Despite the inherent limitations of a small maximum size, inflexible flat display mode, and relatively fixed display position, the system boasts cost-effectiveness, simplicity of structure, and minimal hardware requirements. The construction of such a simulator system can be expedited. Depicted in Figure 1 is the on-screen vehicle simulation driving training system.

Figure 1 Screen explicit visual simulation simulator.

Crawler vehicle driving operation simulators frequently employ common screen explicit visual simulation simulators, wherein the display screen is mounted external to the driver's observational portal. Trainees view the displayed information through the driving pane, and synchronously, the screen renders virtual scenes in real-time contingent upon the trainee's maneuvers, enabling them to correlate driving actions with vehicle responses and hone driving prowess. The limited dimensions of the display and the constricted area it can encompass make such screen-explicit visual simulation simulators more apt for vehicles necessitating a narrow field of view during operator (or other occupant) interaction.

3.3. Helmet-mounted Visual Simulation Simulator

The helmet-mounted visual simulation simulator primarily harnesses VR (Virtual Reality) or MR (Mixed Reality) technologies, utilizing the display helmet as the primary output device. The in-built display within the helmet renders a virtual screen, capitalizing on the occlusive nature of the helmet's field of view to create an immersive, darkened environment that accentuates imagery and enhances the user's sense of presence. Additionally, these systems can adapt the visuals based on the wearer's ocular movements, providing robust substitutional and three-dimensional experiences —marking their salient features. Nevertheless, such simulation setups command a premium in acquisition costs and impose elevated demands on both software and hardware ecosystems. Complementary display and simulation software necessitate procurement, with concomitant challenges in software development. Furthermore, integrating and fine-tuning the complete apparatus is complex, coupled with high consumable usage expenses during operation. Protracted usage may induce vertigo in some users. Illustrated in Figure 2 is a vehicle virtual maintenance training system employing a helmet-mounted simulator.

Figure 2 Helmet-mounted visual simulation simulator.

The helmet-mounted visual simulation simulator's powerful sense of substitution, immersion, and three-dimensionality endow it with the capability to generate an intense immersive experience for users. With a nearly boundless viewing area, it proves particularly suitable for educational scenarios demanding extensive observation or active movement, such as advanced vehicle driving simulations and vehicle maintenance simulations.[3].

3.4. Glasses-style Visual Simulation Simulator

The glasses-type visual simulation simulator principally employs AR technology (Augmented Reality), utilizing spectacle frames as the medium. By integrating a minuscule display within the eyewear, it overlays the screen's content upon the real-world view, enabling users to perceive both the tangible objects and the information displayed. This method amplifies the accessible data. Its strengths include a lightweight design, the ability to observe actual objects without inducing vertigo, a commendable superimposition effect, and reduced costs. Nevertheless, the glasses-type simulator is constrained by the nature and format of the content it can present, featuring a limited viewing area that cannot adapt to ocular motions, thus failing to provide an immersive experience for the user. Depicted in Figure 3 is the composite content illustrating the virtual moment of force.

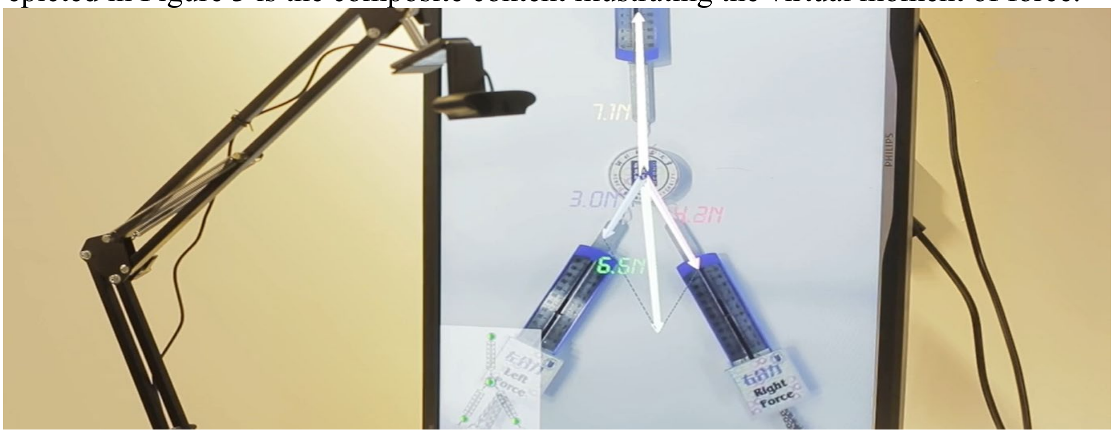

Figure 3 Glasses-style visual simulation simulator.

The inherent technical attributes of the glasses-type visual simulation simulator allow it to present preset information within specific positions or ranges, enabling users to conveniently apprehend detailed data or the particular composition and structure of certain objects without obstructing their observation of the external environment. This feature facilitates understanding without altering the user's perceptual experience of the observed subject. Consequently, the glasses-type simulator is particularly apt for use in vehicle construction and operational training contexts.

3.5. Projection Visual Simulation Simulator

The principle of projection visual simulation simulator and screen explicit visual simulation simulator is similar; they aim to overcome the limitations of small display sizes by utilizing a projector. This enhances the projection of a larger visual range at an appropriate distance, thereby expanding the application scope of such simulators. For instance, an actual car can be placed in front of the projection screen, creating a simulated environment for driving training. As depicted in Figure 4, it illustrates a simulated driving training system designed for cars.

Figure 4 Projection visual simulation simulator.

4. Conclusion

Using visual simulation systems for practical training is a developing, far-reaching, and potentially valuable new digital education method, which can narrow the gap between education and the social needs, change learners' ways of thinking, and even affect learners' views on the world, time, space, and themselves. In the future, visual simulation systems will develop in the direction of miniaturization, lightweight, intelligence, automation, and multi-function to meet the diversified needs of teaching methods in teaching.

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