Development of a virtual reality system for aquatic ecosystem exploration and education

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Abstract

A computer-generated simulation made up of hardware and software is called virtual reality (VR). Immersive virtual reality (IVR) and non-immersive VR are the two types of VR that have been developing for years. The most recent version gives the impression of physically presenting in a non-physical setting, whereas the previous uses a computer-based environment that displays a simulated reality. The concerns surrounding the usage of a virtual reality application as a tool to expose students to the actual world while they are studying and gaining practical knowledge of a site as it is depicted in the virtual environment are the main focus of this work in e-learning. The topics covered in the study pertain to the creation of virtual reality applications from the standpoint of combining various forms of data about the actual world and educational resources. The study's lessons could be applied to other educational and training settings, such architecture, transportation, and firefighting training—all of which need students to apply what they have learnt in the classroom to real-world scenarios. The findings of this study have a number of significant ramifications for scholars and developers.

Keywords: Virtual reality, Underwater virtual reality, Education

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Introduction

Underwater virtual reality (UVR) experiences require users to be in aquatic settings, such as shallow water or pools. An immersive 360-degree video experience is provided by the underwater HMD, which is made up of a waterproof phone implanted in a scuba diving mask. There are numerous applications for UVR technology, including training, education, gaming, and entertainment. Furthermore, UVR proved its ability in areas like environmental conservation, marine tourism, and aquatic physical rehabilitation (Nair and Rathi, 2023). The usefulness of using virtual reality in an underwater setting, however, has not been thoroughly investigated (Chaidir *et al.,* 2024). Virtual reality (VR) holds promise for addressing various environmental challenges (Azizova et al., 2024). Human well-being is impacted by the condition of our world, so people must be able to comprehend and deal with environmental challenges, which highlights the need of environmental literacy (Yogamadhavan and Mannayee, 2024). The ocean, which is essential to human health, is changing noticeably as a result of human activity. In this sense, the dearth of marine education occurring in schools has been largely attributed to the absence of ocean literacy (OL), and education is essential to raising awareness of the ocean's significance (Tarng *et al.,* 2010). OL entails being aware of the ways in which the ocean and humans interact (Reddy and Thomas, 2024). It entails being aware of how the ocean works, communicating about it clearly, and making wise choices regarding its resources (Khalikova *et al.,* 2024). In addition to the more recent component of nature-connectedness, OL was highlighted as a complex idea with ten dimensions: knowledge, communication, behaviour, awareness, attitude, emotional connection, access and experience, adaptive capacity, trust, and transparency (Sadeghi, 2024; Menon, and Deshpande, 2023). The idea of this project is to create an instructional UVR experience that explicitly promotes OL. The design of UVR activity has been driven by the constraints noted in the current literature, such as a lack of suitable instructional content and insufficient research to show the usefulness of UVR (Kapoor and Gupta, 2023; Escobedo *et al.,* 2024).

It is the duty of large educational institutions to promote the adoption, advancement, and application of technology in instruction (Tarng *et al.,* 2014; Azoury *et al.,* 2024). The creation of novel learning settings can boost student motivation, facilitate shared experiences, and stimulate active participation via repeated practice (Anand *et al.,* 2024). Course content is increasingly being delivered via the World Wide Web, which is now a powerful educational resource that encourages and facilitates student learning (Jaiswal and Pradhan, 2023). People are inspired to develop interactive applications by virtual reality's creative appeal and technological content. In order to create the illusion of virtual reality, the real-time interactive capabilities enable users to be aware of the response of their actions at any time. Using a visualisation tool encourages curiosity and interest (Klopfer and Squire, 2008). The applications seem to promise more dynamic and natural e-learning tasks through the use of virtual reality environments. Users who use a browser that supports 3D viewing can access a 3D environment that allows them to zoom in on the scene, view the entire environment in 360 degrees, and swiftly navigate through the world's diverse locations while seeing it from different perspectives. Increased user attention and interaction with the items, like in the real world, is the result of 3D object modelling (Bakhshanian, 2024). Therefore, a system that allows for the quick and easy development, editing, and updating of a virtual environment is needed.

Methodology

In order to gain knowledge, the suggested research enables students to engage with a virtual environment that mimics real-world scenes and explore them from a variety of perspectives (Kamarainen *et al.,* 2013). Industries are looking into cost-effective training strategies to help their staff members develop the necessary skills. A thorough understanding of a factory's operations is essential for increased efficiency and safety. Applications for desktop and online e-learning give business owners new resources to improve their knowledge and proficiency in maintenance-related fields. The need for virtual machines and a factory to enhance engineering courses is fuelled by the widespread use of computers. By simulating a factory and the process of building steel structures like beams and columns from raw iron blocks, industries use this capability to provide training. Among all the technologies that enable a knowledge management system, e-learning has become more and more significant as the need to develop and retain continuous capacities grows (Ou, Chu and Tarng, 2021). The majority of e-learning platforms are built on HTML, which makes them less appealing to students. A realistic 3D environment can be presented in real time by utilising virtual reality technologies. A comparison of several teaching methods, including conventional e-learning, virtual reality e-learning, and traditional (classroom) learning, is conducted. Analysis is done on how well students learn, how satisfied they are with the activities they complete, and how interested they are in online learning. The efficiency of educational activities and components was examined from the perspective of the students. A dynamic production of three-dimensional scenes could be used to visualise the vast amount of information held in databases. Numerous recent scientific studies have demonstrated that modern learners find 3D training to be far more interesting than old 2D teaching approaches shows in figure 1.

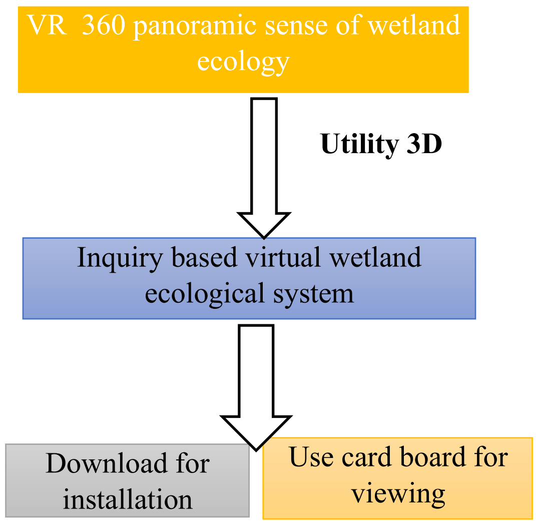

Figure 1: Proposed framework.

The simulated data-based web-based virtual factory serves as an example of a successful strategy for enabling students to learn in a digitally created setting. It has been discussed how to teach industrial continuous improvement strategies in a web-based virtual learning environment. This demonstrates how actual industrial data is used to create a simulation environment that allows students to experience a realistic training scenario without having to visit the actual facility or forfeit the opportunity to learn fundamental engineering concepts. Students learn through discussion and competition on the website, which also acts as a platform-independent feature that promotes collaboration in the learning process. The students will proceed to a synthetic process, which can be thought of as a real-time system with linkages to the machinery, when they have gained the necessary expertise utilising the simulated data. Additionally, this environment may be used to anticipate process optimisation effectively and will eventually be able to connect to actual online systems.

Experimental Results

The following performance metrics (before and after deployment) were gathered from the outsourcing firms by individuals with different levels of experience following the suggested virtual reality.

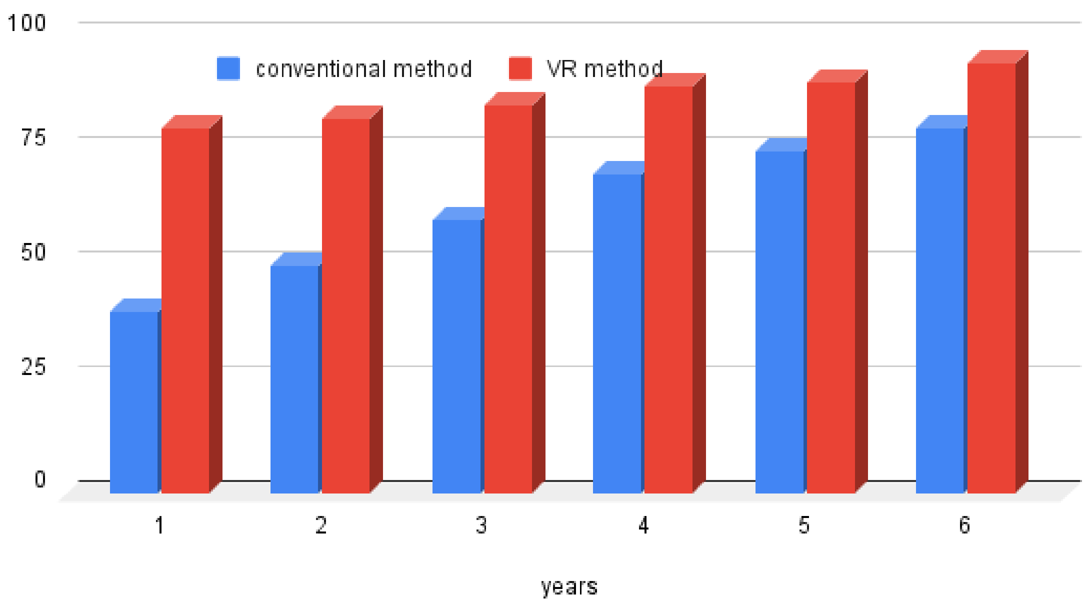

Figure 2: Data input for the depth of understanding the manufacturing sequence.

The level of comprehension among employees with varying years of experience was examined. Figure 2 and Figure 3 compare and illustrate the depth of comprehension in the traditional method and the VR method. I can tell that the VR approach demonstrates a deeper knowledge of the work, and it is also more noticeable in groups with less expertise.

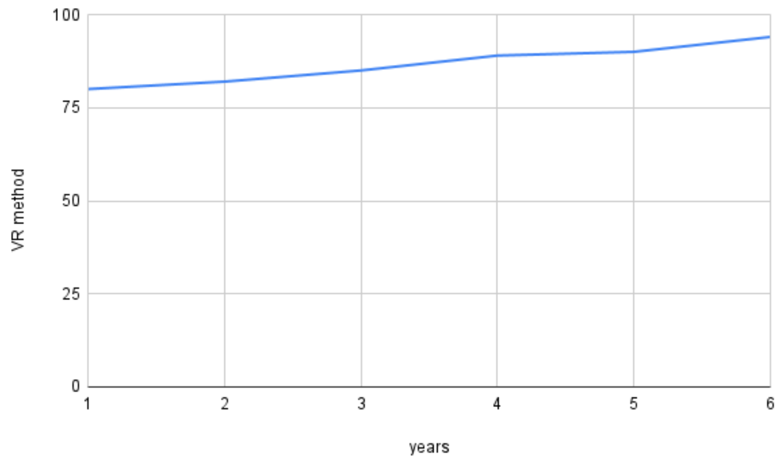

Figure 3: Data input for the Cycle Time of operation of the end product.

The efficacy of VR techniques is demonstrated graphically in relation to four factors. However, the paired samples t-test for four parameters must be used to determine whether or not null hypotheses are accepted. SPSS has been used to perform statistical tests on the representative sample. The Statistical Package for the Social Sciences sheds light on the issue or aids in the formulation of concepts or theories for prospective quantitative study.

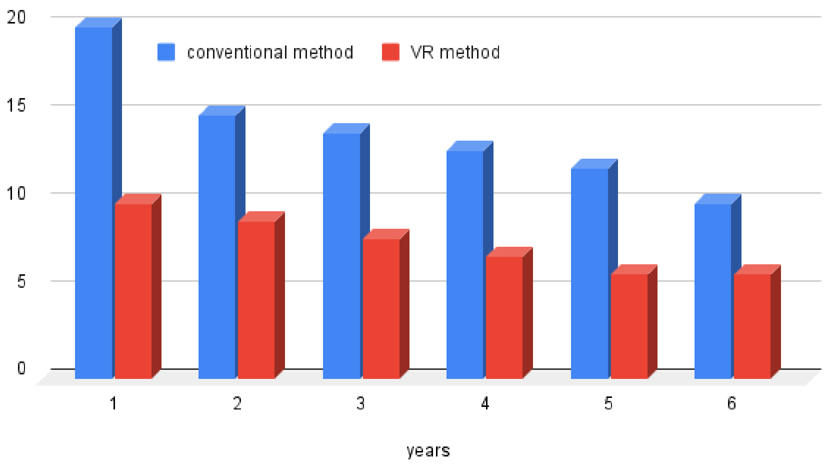

Figure 4: Data input for the Chances for rework- rejection.

VRML is used to represent the manufacturing process as three-dimensional web content. Using VRML, the production process is represented as three-dimensional online content for two goods displays in figure 4. The effectiveness of this innovative web-based communication has significantly increased. The benefit of this approach is more noticeable for new technical personnel than for seasoned professionals. It is evident that the benefit of the suggested approach is that it shortens the operating cycle time and lowers the possibility of rework or rejects. The organisation eventually saves money as a result of this. For new technical force, this method's advantage is more noticeable than for seasoned.

Conclusions

These days, e-learning is a novel approach to instruction. With the use of virtual reality (VR) technology, which can provide a user-friendly interface between humans and machines, it continues to advance and improve. The use of virtual reality technology in the classroom has significantly improved instruction. Incorporating virtual reality and e-learning technology into teaching methods enhances students' problem-solving and analysis skills. The significance of VR technology in e-learning and e-training is demonstrated by this research study. The educational landscape is changing dramatically. Students' lives are significantly impacted by technology these days, and schools can no longer adequately serve their requirements with just classroom-based learning.

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