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Retraction

Retracted: Research on the Application of VR Technology in Oil and Gas Engineering Education: Taking the Well Control Emergency Rescue Robotic System as an Example

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Z. Guili, L. Pengxi, Y. Yinglong, L. Zhao, and Z. Hanyue, "Research on the Application of VR Technology in Oil and Gas Engineering Education: Taking the Well Control Emergency Rescue Robotic System as an Example," *Mobile Information Systems*, vol. 2022, Article ID 8064131, 7 pages, 2022.

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Research Article

Research on the Application of VR Technology in Oil and Gas Engineering Education: Taking the Well Control Emergency Rescue Robotic System as an Example

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Oil and gas engineering is a talent-intensive, technology-intensive, and capital-intensive field. The final teaching is insufficient and unsatisfactory, and while oil and gas engineering instruction, particularly experimental practise teaching, is hampered and restricted by many working conditions such as huge scale, large equipment, high cost, high safety risk, and enterprise production system, and so on VR technology has developed rapidly in recent years, which has brought great impacts to teaching; this study uses VR technology to build and produce a well control emergency rescue robotic system, combining knowledge points with VR technology and applying the system to the course of Drilling and Well Completion Engineering. This teaching practice makes teaching more vivid and makes the process that cannot be reproduced fully displayed in front of students' eyes. Such an attempt has achieved such good teaching effects that students can solve problems through interactions.

1. Introduction

With the construction and development of China's economy and society, the demands for oil and gas are increasing and it is related to national security as an important strategic resource. However, oil and gas development projects have a large investment, which are high-danger, high-risk, knowledge, and technology-intensive projects. To safely and efficiently establish a high-quality oil and gas flow channel involves the collaborative operation of multiple types, whose engineering operation involves to work in the desert, Gobi, ocean, and other harsh working environment as well as high temperature and high pressure deep stratum environment. Experiment, practice, and training are indispensable important links in the process of oil and gas engineering related discipline talent training. However, most of the experiment and engineering practice skills training cannot be completed through conventional experiments and on-site physical operation due to large scale, equipment, high cost, safety risk, and enterprise production system restraints and restrictions. With the rapid development of information technology, the virtual simulation is the inevitable trend of the development of oil and gas development and teaching and it is urgent to establish a virtual simulation experimental training platform of oil and gas development engineering. The use of virtual reality technology to address the experimental practice teaching of oil and gas engineering-related professional students is an effective solution to avoid a bad environment, a huge scale, a large expenditure and investment, and a high risk.

"*Drilling and Well Completion Engineering*" is the core main course of undergraduate students majoring in petroleum engineering with a total class hour of 56 class hours including 50 class hours of class teaching and 6 class hours of practical teaching. The classroom teaching content mainly includes well body structure design, drilling fluid, drilling fluid process technology, rock and bit, drilling process technology, well control technology, borehole trajectory measurement and control technology, well cementing and well completion method and reservoir protection technology, environmental protection and HSE, and so on. The well control emergency rescue is covered in the well control technology chapter occurring after blowout out of control, and there are certain disposal procedures. Students are required to master the standard operation procedures after blowout out of control and deal with them in case of emergency. The blowout process is impossible to replicate, and regular instruction and teaching can only be introduced through photographs and videos if students lack a strong sensation of entering, but these methods are also ineffective.

With the development of petroleum industry, it is difficult to comprehensively realize the organic combination of theoretical teaching and engineering experimental practice for students related to oil and gas engineering and is difficult to timely cultivate and meet the demand of oil field enterprises for high-quality talents under the original practice teaching conditions and mechanism of petroleum universities and the existing production system of the oil field. The team conducted research and exploration to compensate for the shortcomings of practical teaching of oil and gas engineering related majors, and they believe they designed and developed the well control emergency rescue robot system by combining virtual reality technology, simulation technology, multimedia technology, human-computer interaction technology, database technology, network technology, and other technologies with the oil and gas industry. It is an effective way to effectively carry out experimental practice teaching of the oil and gas engineering related majors and to avoid harsh environment, large scale, large investment, and high risk. The system has strong practicality and uses VR technology to realize the restoration of the accident-processing process after blowout out of control so that we can let learners learn knowledge in virtual reality scenarios [1].

2. Application of the System

The project development results are applied to the practice and theory teaching of *Drilling and Completion Engineering* and become an important teaching resource for the course used for undergraduate teaching in petroleum engineering major. In addition, the course offers online MOOC courses on platforms such as Xuetang Online, China University MOOC, and Xueyin Online with the total number of courses selected more than 16,000 courses. The results of the project are also used for the teaching contents in the HSE training system of the three major oil companies with more than 2,000 trainees.

The interactive "operation site" constructed by the system is used to emotionally understand the theoretical research objects, contents, and theoretical application places involved in the course, stimulate students' enthusiasm for active learning and exploration through the interactive participation of students, cultivate innovation abilities, and improve the teaching and learning efficiency and effect. The main application modes are as follows:

(i) "Cognition internship" before the professional class

Before studying the professional courses, students who have never been to a work site can visit the "operation site," which was built using a physical simulation model, a semiphysical simulation model, or a fully digital dynamic model to give students a thorough understanding of the site operation environment, main equipment use, and main processes, among other things through the land and the ground of the offshore oil engineering work site environment, shaft and underground environment of dynamic virtual roaming, and real-time 3D animation, so that students can obtain the perceptual understandings, understand the place and goals of "learning for practice," cultivate students' engineering consciousness, and lay a foundation for professional theory teaching and learning [2].

"On-site theory application" in the process of professional theory teaching

Students can apply the theories they have learned into the project system. Through this figurative theoretical application experiment, students are trained to truly digest and master the knowledge they have learned, improve the abilities to apply the learned knowledge and connect theory with practice, and stimulate students to further explore and expand the learning desire of relevant theories [3].

The systematic "production internship" after learning the professional theoretical knowledge

After the completion of professional theory, the digital simulation experimental platform can be used to carry out comprehensive and systematic practical skills training before graduation design. It makes up for the insufficiency of "can only have a limited view without touching absolutely" such as the long-term production practice cannot go on the drilling floor and enable to operate on the drilling site. It can also make up this "tube peep leopard" type of internship defect that in limited time and limited practice places, student can only understand a certain aspect of the production process without a comprehensive understanding of the main production process in the whole field of petroleum engineering [4].

Practices at home and abroad show that through this kind of systematic, comprehensive, and up-to-date simulation practice training, students graduated from school and arrived at the scene and then they can soon be familiar with the site work in a very short time to complete the students to the enterprise worker transformation and combine the learned theory well with the field application. This kind of talents is exactly what companies require [5].

The system truly restores the blowout out of control process, uses the environmental monitoring robot to realize the evaluation of the blowout site and collect the peripheral data of the blowout, uses the wellhead detection robot to realize the imported macro information collection, uses the cooling cover robot to conduct the whole cooling operation, and uses the barrier cutting robot to realize the cleaning and reset of the wellhead. The project design has achieved the expected design effect, realized the integration of VR technology and teaching knowledge points, and changed the original single teaching mode [6].

3. Design and Development of the System

The implementation difficulties of system design and development are in the combination degree of the practical production process and VR technology. Any tool serves the teaching content. According to the needs of teaching, developers can grasp the immersion degree and development cost of VR in the process of operation and put forward the best solution. There is also the transformation of the interaction provided by the VR development environment and the interaction needed for the actual engineering [7].

3.1. Teaching Design

3.1.1. Teaching Objectives. (a) It can judge whether the blowout has occurred according to the data provided. (b) It will be able to describe the concepts of well control, blowout, and out of control blowout in their own language with the flexible application. (c) It can analyze the blowout site by scientific methods and initially judge the cause of the blowout according to the site survey data. (d) It can classify blowout prevention and choose the appropriate disposal plan according to different classification conditions. (e) It can know the institutional setting of blowout emergency disposal, understand the division of labor, clarify the contents and nature of their own group work, and complete the group work. (f) It can meet the needs of emergency rescue team personnel who is skilled in operating all kinds of emergency rescue equipment in the case of emergency situations through daily learning and professional training. (g) It can conduct the emergency treatment in accordance with the process requirements of blowout out of control treatment, to deal with it according to the rules, in an orderly manner.

3.1.2. The Key Points and Difficulties in Teaching. Knowledge points include chapter-related concepts: well control, blowout, and out of control blowout; what is the harm of the blowout out of control; what is the reason for the blowout out of control; how to prevent when the blowout is out of control; method of blowout emergency disposal (key and difficult points); and blowout emergency rescue team requirements (key points).

Skills points include operation of emergency treatment equipment (key and difficult points) and analysis of well control reasons (key and difficult points).

3.2. Design Ideas. The concept behind VR design for out-of-control blowout emergency disposal is given as follows: earners personally experience the harm caused by blowout accidents by relying on an emergency rescue robot system to restore the real blowout process. The control processing of the blowout process is completed by different robots, allowing learners to become familiar with the key processing processes and equipment operation.

3.3. Design Scheme. The emergency rescue robotic system is suitable for high temperature, high radiation, high toxic gas, and high-risk environment rescue after blowout out of control. It simulates artificial emergency rescue and realizes an unmanned automation and intelligent whole process near the wellhead to avoid personnel injury. Figure 1 shows restoration of the blowout site.

The system includes environmental monitoring robot, wellhead reconnaissance robot, cooling and covering robot, barrier removal and cutting robot, wellhead reset robot, and control command center. The robots transmit the information back to the control and command center to issue the command, and the robot reacts and operates according to the instructions.

The environmental monitoring robot consists of vertical take-off and landing fixed-wing drones, pods, and high-definition cameras and sensors. Weather, wind direction, road, well site layout, temperature field distribution, and the distribution of toxic, harmful, and combustible gases are all collected using high-definition cameras equipped by the UAV. Meanwhile, the above information will be transmitted back to the control and command center then to issue instructions to the wellhead reconnaissance robot for wellhead reconnaissance. Figure 2 shows environmental monitoring robot.

The wellhead reconnaissance robot consists of a high-temperature mobile platform, environmental detection sensor, infrared thermal imager, image acquisition system, and data remote transmission system. The situation around the wellhead is transmitted back to the control command center through the wellhead imaging, so that the cooling cover robot and the barrier removal and cutting robot are in place and adjust the position according to the instructions. Figure 3 shows the wellhead reconnaissance robot.

The cooling and cover robot is made up of a water cannon, a snow cannon, a self-spray cooling device, and a data remote transmission system that enhance the layout and range of the water cannon and snow cannon to cool and dilute the water mist for each robot according to the instructions of the control and command center. Figure 4 depicts a robot that is cooling and covering itself.

The barrier removal and cutting robot consists of a barrier clearing tool, cutting tool, temperature sensor, and data remote transmission system, which is adjusted and the barrier removal and cutting speed is optimized according to the instructions of the control and command center, and the barrier removal and cutting progress were fed back to the control center in real time.

The wellhead reset robot consists of a reset boom, a bolt fastening tool, an image acquisition system, a temperature sensor, and a remote data transmission system. The robot temperature is monitored by the temperature sensor, the wellhead location is determined by image acquisition, and those are transmitted back to the control command center in real time. In addition, it will be cooling and hoisting the new

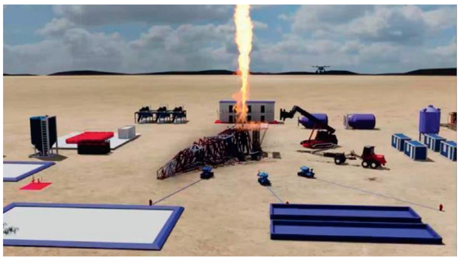

Figure 1: Restoration of the blowout site.

Figure 2: Environmental monitoring robot.

Figure 3: Wellhead reconnaissance robot.

Figure 4: Cooling and covering robot.

wellhead according to instructions of the control center. Figure 5 shows the barrier removal and cutting robot.

The control and command center are the information convergence center of the whole rescue robot system, composed of three-dimensional situation rapid processing system, near-wellhead image processing system, emergency rescue big data system, multisource information integration, and emergency command system. It can receive the information collected by the robot in real time, analyze the data, and issue specific instructions.

Figure 5: Barrier removal and cutting robot.

Through the artificial intelligence, the emergency rescue robot system can realize the unmanned operation near the wellhead, reduce the operation risk of emergency rescue personnel, avoid casualties, quickly respond to the blowout out of control, improve the efficiency of decision-making, and reduce the expansion of accidents and social impact.

3.4. Production Contents

(i) System production scheme design

We build a systematic scheme, locate the integration of VR technology and subject knowledge points, and check the scheme's practicality before forming a project implementation plan.

(ii) Design and production of the system model

We sketch the design according to the design scheme and conduct modeling work according to the sketches.

(iii) Model optimization and material processing

Considering the compatibility of the system, all models are optimized, and the model is given a material to improve the texture of the model.

(iv) Animation design and production

We need to perform animation design of the blowout process and the robot system.

(v) Model and animation are integrated in the EVRC software system

We need to import the model and animation into the integrated environment of EVRC while optimizing the model and animation matching software requirements.

(vi) Design the VR interaction

VR interaction design is conducted through a graphical interface in an integrated environment to integrate knowledge points with VR technology.

(vii) System release and debug

We release and debug the system on HTC VIVE and PC ends. Figure 6 shows the system development process.

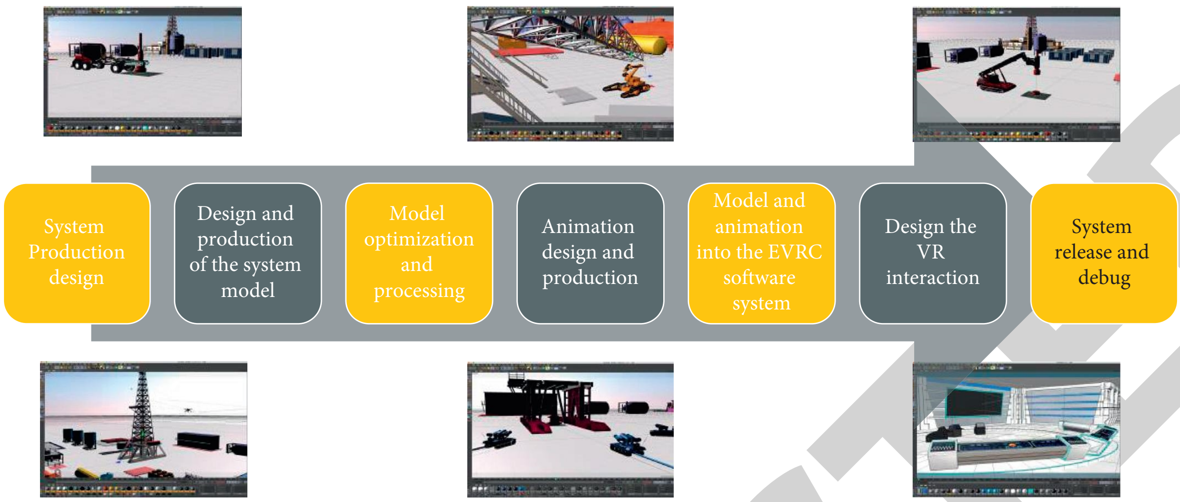

Figure 6: System development process.

4. Application Effect of the System

After four rounds of teaching applications, we used the Likert scale to randomly select 200 people from the system users for the questionnaires and the questionnaire evaluates the application effect of the system from three aspects of usability, functionality, and satisfaction [8]. Table 1 shows learner's evaluation of the application effect of the system.

The "usability" factor mainly investigates the difficulty of learners to operate the system including three indicators. The average value of the factor was 4.75 with the standard deviation of 0.35, and the survey results show that the user thinks the system is very convenient to operate. For the specific index analysis shows that 92% of users indicated that the man-machine interface design of the system is in line with the usage habits, 96% of users believed that the learning cost of operation is low, and 94% of users believed that the interface of the system is simple. Figure 7 shows the usability factor.

The "functionality" factor mainly investigates learners' evaluation of the main functions of the system including three technical indicators: the degree of on-site reduction (scene creation and design), the degree of VR technology and knowledge integration, and the evaluation of test answers. According to the analysis, 93% of learners believe that the system can well restore the scene of blowout accident, so that they can have the experience of the scene; 89% of the learners believe that VR technology can be well combined with the blowout rescue-related knowledge to achieve vivid images; and 90% of learners think that the answer evaluation of the test can reflect their learning effect well. The average value of this factor is 4.28 with a standard deviation of 0.72. Figure 8 shows the functionality factor.

The "usefulness" component, which includes four indicators, focuses on the system's auxiliary role in the learner's information acquisition. According to the survey results, 97 percent of learners believe that the system will allow them to focus on the learning materials, which is the highest scoring item of all the survey results, showing that the technical form of VR is more favorable to learners' concentration; 88% of the learners believed that the system helped them improve the accident handling ability in case of a blowout; 78% of learners believed that the system met their expectations for the feedback given, which is the lowest score of all the survey results indicating that more intelligent options need to be added to the system design to meet the diverse needs of learners; and 90% of the learners believed that they had relearned the blowout accident treatment process through learning of the system. The average value of this factor is 4.51 and has a standard deviation of 0.77. Figure 9 shows the usefulness factor.

From the overall data, both extreme data appear in the factor of "serviceability" indicating that the design in this part needs to continue to further improve the usefulness of the system. From the average and standard deviation of each factor, the "functionality" factor scores the lowest indicating that the function design of the system should consider more about the integration of technology and the course content to realize the moisten silently. The maximum standard deviation appears in the "usefulness" factor indicating that learners have the greatest difference in their evaluation of the factor.

5. Summary

In the current blowout emergency treatment section of the "Drilling and Well Completion Engineering courses", the function of a "Well Control Emergency Rescue Robot System" can address the deficiencies in teaching experiments and training and organically combine various technologies with theoretical teaching. This establishes petroleum engineering virtual simulation experimental teaching platform and the emergency operation skills under various complex working conditions that may occur in the operation process more quickly, easily, and comprehensively in the limited space and time with real and safe experimental and practical training process. It overcomes the issues of dangerous environment and difficulty to simulate experimental projects enabling the experimenter to truly experience the accident

Table 1: Learner's evaluation of the application effect of the system ($N = 200$).

	Usability	Functionality	Usefulness	Overall evaluation
Average	4.75	4.28	4.51	4.51
Standard deviation	0.35	0.72	0.77	0.61

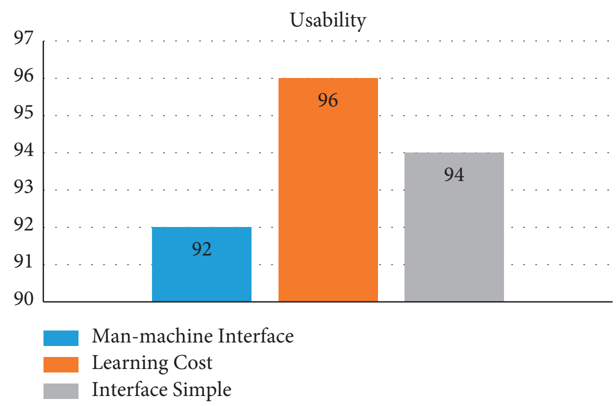

Figure 7: Usability factor.

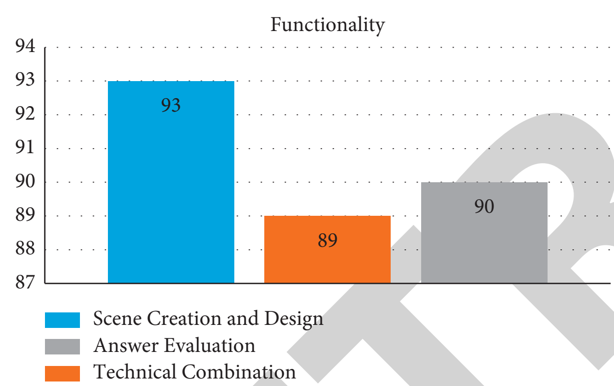

Figure 8: Functionality factor.

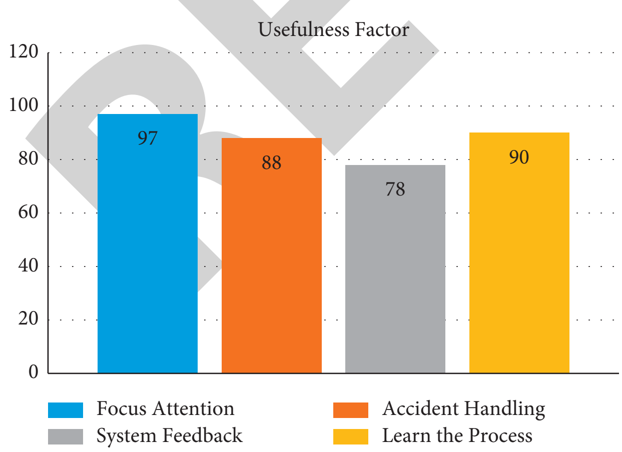

Figure 9: Usefulness factor.

process without suffering any danger and damage by adopting the virtual experimental platform.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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