Analyzing the impact of simulation fidelity on VR-enabled hazard detection on construction sites – A case study on crane lift operation

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Abstract. Crane operator training is an essential part of construction safety and is attracting extensive attention from researchers worldwide. Virtual reality (VR) is considered an effective tool to improve training outcomes by providing users with an immersive, risk-free experience in various environments. However, previous VR-based training platforms mainly focused on the scenario and task design; few studies attempted to investigate the impact of simulation fidelity on training efficiency. This research aims to explore the effect of simulation fidelity on training outcomes by comparing user performance in two scenarios. A typical construction site was modelled in a game engine using two rendering approaches; an eye-tracking system was adopted for data collection. The results from a subject experiment indicated the high efficiency of VR in operator safety training and demonstrated the usefulness of eye-tracking in measuring hazard detection performance. Findings showed that a higher level of simulation fidelity might not significantly improve the training efficiency, especially in hazard detection aspects.

1. Introduction

Cranes play a significant role in construction processes and are extensively utilized in transporting materials and equipment. Unfortunately, cranes are also involved in a considerable number of fatal accidents. It is reported that in the Australian construction industry, 359 workers lost their lives due to work-related causes from 2004 to 2013, 22 of which involved the use of a crane [1]. Previous studies showed that these accidents are associated with multiple operational and environmental factors such as weather conditions, dynamic environment, and operational status [2]. For severe accidents such as crane overturning, operating failures were found to be a significant contributor [3]. To mitigate the impact of operational failure, research on the causes affecting workers' operations has been carried out. Results showed that hazard detection plays an essential role in the development of accidents caused by operational errors [4]. It was also found that the ability of workers to detect hazards is often compromised by poor safety awareness and inadequate knowledge about risks [5].

Different tools have been used to reduce hazard detection failure and improve the safety awareness of construction workers, especially for crane operators. New technologies such as sensing systems, crane simulators, and mounted eye-trackers are gradually emerging in hazard detection to improve training efficiency. Among these new tools, VR, a unique approach for providing realistic scenario simulation, delivers situational contexts for risk-free training at low cost. VR can also be based on a variety of scene designs to give users an immersive experience close to reality in an artificial environment. With these advantages, the VR environment will significantly benefit the training outcomes for detecting workplace risks.

The immersive VR technology was widely used with diverse scenes in previous studies. Some studies developed simple risky scenarios, such as a temporary external platform or a crane cabin, to focus on improper behaviors while operating construction equipment and safety protection devices [6], [7]. Others relied on high-fidelity scenario designs with simple tasks to impress participants, supported by the three-dimensional game environment and the head-mounted display system [8], [9]. However, few studies focused on analyzing the impact of simulation fidelity on VR-enabled hazard detection. The difference in the level of simulation fidelity is noticeable as it may lead to disparities in participant reactions during safety training and hazard detection experiments.

Motivated by existing studies, the overarching goal of this work is to explore the impact of simulation fidelity to hazard detection outcomes. A comparative experiment was carried to reveal the effects of naturalistic simulation scenarios on crane operators' hazard detection. Participants were asked to complete the lifting and hazard detection tasks in different high-fidelity and low-fidelity scenarios. Details for the entire experiment design can be found in the methodology section. Results and discussions are included in the findings section, focusing on participants' behavior and gaze patterns. Based on these findings, the authors concluded that VR could be used as an effective training tool for crane operation with the assistance of eye-tracking technology.

2. Literature Review

2.1. Hazard identification in construction sites

Risk perception by workers is still one of the most critical aspects of hazard exposure control and injury reduction on construction sites. Even though workers are responsible for identifying dangers and responding appropriately to avoid unfavorable outcomes and uncontrolled risks, accidents nevertheless occur due to workers' inattention while detecting potential or current hazards [10]. Given the importance of hazard identification in preventing injuries, various works have been conducted on multiple hazard-identifying methodologies to improve safety management, such as developing job hazard analysis [11] and building an information retrieval framework [12]. However, the dynamic characteristic of the construction environment and the lack of standardization in the operation workflow make these methods less effective than expected in preventing hazardous events [13]. According to latest research [14], roughly 57% of construction dangers remain unnoticed on the worksite, which leads to unmanaged risks. Therefore, enhancing workers' safety awareness and hazard identification capabilities is imperative to improve site safety.

2.2. Safety training for crane operators

In the current practice, regular training sessions are organized to improve workers' safety perception. In general, these safety training programs are premised on the principle that information transmission will be most effective in an instructor-centered classroom setting. However, this lecture-based training is found not sufficiently valid for acquiring hazard identification skills. It has been pointed out that the amount of user involvement, real-time visualization and analysis, and knowledge retention over a longer period were some of the missing links in traditional crane safety training approaches [7]. This may be because the safety skill is tacit and cannot be easily verbalized and transferred through passive forms of training [15]. This issue is particularly acute in the training of crane operators due to the lack of dynamic situational contexts. Such situational contexts play a significant role in forming crane operators' safety awareness. They are expected to be aware of the type, position, and timing of placing the building materials, which is usually based on constant vigilance and extensive working experience [16]. In other words, it is easier for crane operators to develop safety skills through immersive and repeated practice, which cannot be achieved in traditional lecture-style instruction.

2.3. Virtual reality and eye-tracking technology in hazard identification

Immersive technologies are considered as an ideal alternative that could make up for the shortcomings of traditional training. Such tools are usually based on emerging technologies, such as Virtual Reality, Augmented Reality (AR), and Augmented Virtuality (AV) environments. These technologies and the simulated scenarios in which they are used were first applied in the medical field to provide participants with a highly realistic experience [17]. Previous research then introduced these scenario design methods into the safety science field and proved the positive outlook of these technologies' application for enhancing safety education by providing users with immersive experiences [18]. VR is frequently chosen over other options due to its wide range of application scenarios and its ability to integrate multiple technologies. It contributes to various safety management systems to train site workers by providing virtual scenes to identify hazards. Participants in these experiments showed similar responses in the virtual environment compared with the real world, demonstrating that the VR-based immersive environment substantially benefits training for avoiding hazards on-site. Nevertheless, due to the limitation of technologies (e.g., user behavior tracking), results concerning real-time tracking and behavioral studies were insufficient [19]. Therefore, data collection tools, such as eye-tracking technology, were introduced to VR-based training to evaluate participants' recognition [20]. Based on these investigations, eye-tracking technology is acknowledged to be a reliable method for monitoring participants' hazard identification performance.

2.4. Level of simulation fidelity in VR-based training

The level of simulation fidelity is an essential component affecting human vision to perceive in the virtual scene, especially for VR-enabled displays. The Unity platform developed with the High Definition Render Pipeline (HDRP) achieved a higher level of simulation fidelity by improving the lighting and rendering effects. This pipeline provides more realistic materials and shaders utilizing physically based lighting techniques and configurable architecture [21]. Compared with traditional rendering approaches, scenarios supported by HDRP can present more vivid images, allowing users to have a visual experience closer to reality. Due to the flexibility of VR, there were differences in the environment recreation, resulting in various scene designs depending on multiple levels of simulation fidelity. For example, Pedro et al. [22] built a safety education and assessment system with virtual job site scenarios, proving that this system could transmit safety knowledge and engage users through experiential learning. However, the simple scene design lacked immersion and was insufficient to support accurate performance assessment, weakening the training effect. Xu and Zheng [9] developed a multi-client safety training platform based on high-fidelity scenarios, providing users with an immersive experience. Nevertheless, the authors pointed out that high-fidelity simulation scenarios may increase the probability of causing simulation sickness in participants. As a result, the impact of different levels of simulation fidelity needs to be analyzed to give a direction to future work on designing safety training scenarios in a VR environment.

3. Research Methodology

To explore the effectiveness of high-fidelity scenarios in safety training, this study takes advantage of VR technology for platform development. In particular, it consists of three stages: simulation platform development, lifting experiment, and data processing. Two VR scenarios with different levels of simulation fidelity were developed, including a naturalistic and a normal three-dimensional (3D) environment. In terms of the experiment, this case study focuses on the crane operating missions in construction sites, such as basic lifting tasks under various situations. Human-subject experiments were then conducted for the data collection. Participants' perceptions and reactions were measured with the assistance of the simulation platform, and their performance was compared to reveal the impact of simulation fidelity on the crane operator's safety training efficiency. Figure 1 illustrates the workflow of this study.

3.1. Stage 1: Simulation platform development

The working zone was established referring to a basic construction site that contains machinery, workers, and plants. The environment recreation used two software, namely 3D Studio Max and Unity 3D, and the scene development consisted of 3D modelling and 3D rendering. This environment also adapted the HDRP for realistic scenario recreation at the system rendering stage. Such a rendering approach is considered a new approach to develop high-fidelity scenarios, providing users with a highly realistic visual experience. Compared with the typical 3D scenario, it could offer high-quality shadows, stronger anti-aliasing, and dithering effects [23]. These visual enhancements benefit the simulation scenario enormously, achieving more realistic performance even based on similar datasets.

A series of C# scripts worked collaboratively to activate and maintain the interactions between virtual objects, in which crane operation was the principal function. As the crucial part of the platform, the crane hoist cable was modelled using Obi Rope, a game development package [24] that provides a realistic physics simulation of the lifted load. Besides, the scene also contains moving workers and machinery to reflect the dynamics and diversity of the construction site.

3.2. Stage 2: Experimental design

3.2.1. Task Procedure

Crane operation tasks under various scenarios were created in the study. Three types of hazards were set as environmental factors: static, dynamic, and environmental. The static issue contained obstacles such as power lines or mobile crane that was not in operation; the dynamic issue contained animated people and an operating excavator; the environmental issue presented different weather conditions, including fog and rain. All simulated scenarios delivered a fully immersive environment with similar elements in two levels of fidelity (high and low). In terms of the experiment, a total of twelve tasks in two levels of simulation fidelity were prepared for six participants. Each participant was asked to complete six tasks, covering all three types of hazards (one task for each type) in two versions (normal and HDRP). Participants were required to operate the crane in the virtual environment during each task. In addition, potential hazards are present when the container is lowered to a height of about ten meters from the target area. Participants had to press a button to indicate the detection of these hazards. There was a three-minute break between every three tasks to minimize fatigue during the experiment.

The experiment consisted of five steps: (1) brief introduction and demographic information questionnaire; (2) three-minute image-based safety training session; (3) lifting task: lift the container to the target area; (4) hazard identification task: during the lifting task, press the alarm button if a hazard was identified; (5) questionnaire survey: fill the questionnaires regarding 3D cybersickness before and after each task; fill the questionnaires regarding the simulation quality at the end of the experiment.

3.2.2. Participants and Apparatus

Six participants (three males and three females) from Monash University were recruited through the personal contacts of the researchers for the experiment, and a total of 36 tasks were conducted. Participants' ages range from 22 to 28 years (Mean = 27, STD = 2.14), with normal or corrected-to-normal eyesight. Ethics approval for the experiment was obtained from Monash University to protect the physical and mental health of the participants. Prior to the start of the experiment, all participants have voluntarily signed the consent form for the questionnaire and data collection. A simple training session was also conducted individually with typical accident images and a brief explanation of the experimental procedure. The experiment was carried out on a PC with an RTX 3080 GPU and an HTC Vive Pro Eye VR headset with a built-in Tobii eye tracker (Figure 1). Moreover, two joysticks were configured to resemble the actual crane control mechanism.

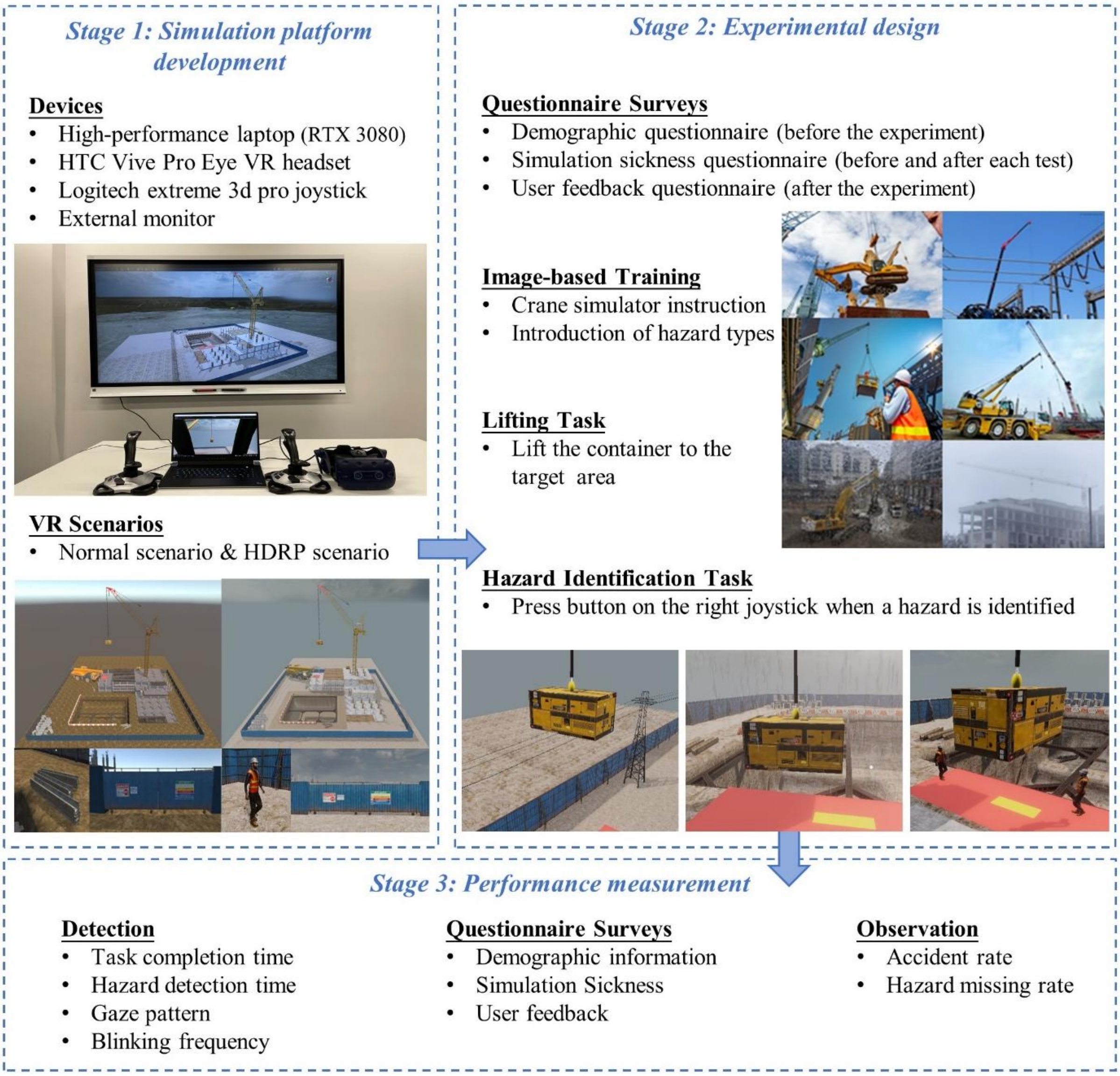

Figure 1. Workflow of the simulation system and its application.

3.3. Stage 3: Performance measurement

Various subjective and objective data were collected during the experiment. Performance indicators such as task completion time, hazard detection, hazard missing rate, and the number of accidents was measured to reveal participants' reactions in the simulated environments. With the assistance of an eye-tracking system, participants' gaze information throughout the tasks was analyzed as perception evidence. Questionnaire surveys were also used as subjective evaluations. In addition to the demographic questionnaire to obtain subjects' basic information, a specifically designed simulation sickness questionnaire (SSQ) [25] was incorporated to monitor the participants' 3D motion sickness. Every individual was required to fill the SSQ before and after each task. Lastly, a questionnaire survey regarding the feedback of the simulation platform was conducted to receive user feedback. Table 1 shows a summary of data collected in this study.

Table 1. Data Collection Structure.

Data Collection Method	**Type**	**Measurement**	**Content**
Detection	Task completion time	Detecting function in simulation	Time from lifting the container to loading it appropriately
	Hazard detection time	Press-button based activation	The operator can press a button if he/she detects a potential hazard
	Gaze pattern	Tobii Eye-tracking system	Subjects' gazing pattern during the experiment
	Blinking frequency	Tobii Eye-tracking system	Subjects' eye blinking frequency during the experiment
Observation	Accident rate	Frequency	Potential failure or unexpected accident during the operation
	Hazard missing rate	Frequency	Operator misses the hazard detection during the operation
Questionnaire survey	Demographics	Mean & STD	Gender; age; construction experience; previous experience with VR
	Simulation sickness	Four-point scale	Assess general discomforts; including fatigue.
	User feedback	Likert seven scale	Feedback on the realism of scenarios with different levels of fidelity and the effectiveness of the simulator in improving safety training.

4. Results and Discussion

4.1. Reaction time and hazard detection time

The performance of participants was measured by indicators such as task completion time and hazard detection under the impact of simulation fidelity. Both task completion time and hazard detection time were calculated from when participants started operating the crane. Task completion time refers to the time from the start until the container was successfully placed in the target area. And the hazard detection time refers to the time from the beginning until pressing the button representing the detection of a hazard. Generally, participants took longer to complete the task in a normal (low-fidelity) scenario, while the average hazard detection time was higher in the HDRP (high-fidelity) scenarios.

Detailed comparison of participants' reactions to hazards in the two scenarios was conducted regarding the task completion time. Hazard types seemed to affect the duration significantly in the low-fidelity scenario ($p = 0.0037$), while no noticeable impact was found in the high-fidelity scenario. Participants spent the shortest time completing the task in the low-fidelity scenario when the challenges were presented by environmental issues and spent the longest time under the impact of the static issues. Although a more dispersed distribution was found in male subjects in the low-fidelity scenario, the p-value was still too large to justify the influence of gender. When evaluating the effect of participants' prior experience on hazard detection, similarly high p-values were observed. There were no significant variations in detection time between participants with and without previous construction or VR experience. As for the hazard identification, all the datasets showed uniform distribution with high p-values, which means none of these variables was the main factor.

During the experiments, accidents caused by crane operations and hazard missing events were also observed. Specifically, one participant missed the environmental hazard in both scenarios, resulting in a 5.56% miss rate for this hazard identification test. In addition, the overall accident rate was 8.33%, as two participants collided with the power line in the low-fidelity scenario, and one participant entered a non-target area accidentally in the high-fidelity scenario.

4.2. Gaze pattern

The gaze pattern provides a good understanding of the participants' hazard identification performance. Some typical gaze distributions in two scenarios under the impact of issue types are shown in Figure 2, where the green dots represent the gazing points. It was found that in high-fidelity scenarios, participants were more likely to be distracted by surrounding objects, while they focused more on the loading container and target area in the low-fidelity scenario. Such patterns could explain the results regarding task completion and hazard detection time. Participants first completed the lifting and hazard detection tasks in the low-fidelity scenario, which could be regarded as a training process. Then they were asked to complete the missions in the high-fidelity scenario after the three-minute rest time. As a result, they demonstrated faster completion speeds during that period, which proved VR as an effective crane operation training tool. Based on the presupposed settings, the crane operator cannot see the hazard until putting the container around 10 meters in height to the target area (except for the environmental challenges). Interestingly, participants spent more time looking around in the high-fidelity scenario and showed a slower loading speed and extended hazard detection time.

The eye-tracking system also captures participants' eye blink frequency. Past studies have shown that blink frequency is a promising indicator of workers' level of concentration and mental workload in visual display terminal experiments [26]. When the participant is not completely engaged in his or her work, the blink frequency tends to rise [27]. The results in this study showed that participants' average eye blink rates of 15.52 and 17.30 in low-fidelity and high-fidelity scenarios, respectively. The results are in line with a previous study that concluded that the average blinking frequency while using a VR headset is 15.1 blinks per minute [28]. Given that more realistic scenarios and stronger reflection effects were applied in the high-fidelity scenario, participants were less concentrated on the loading task and blinked more.

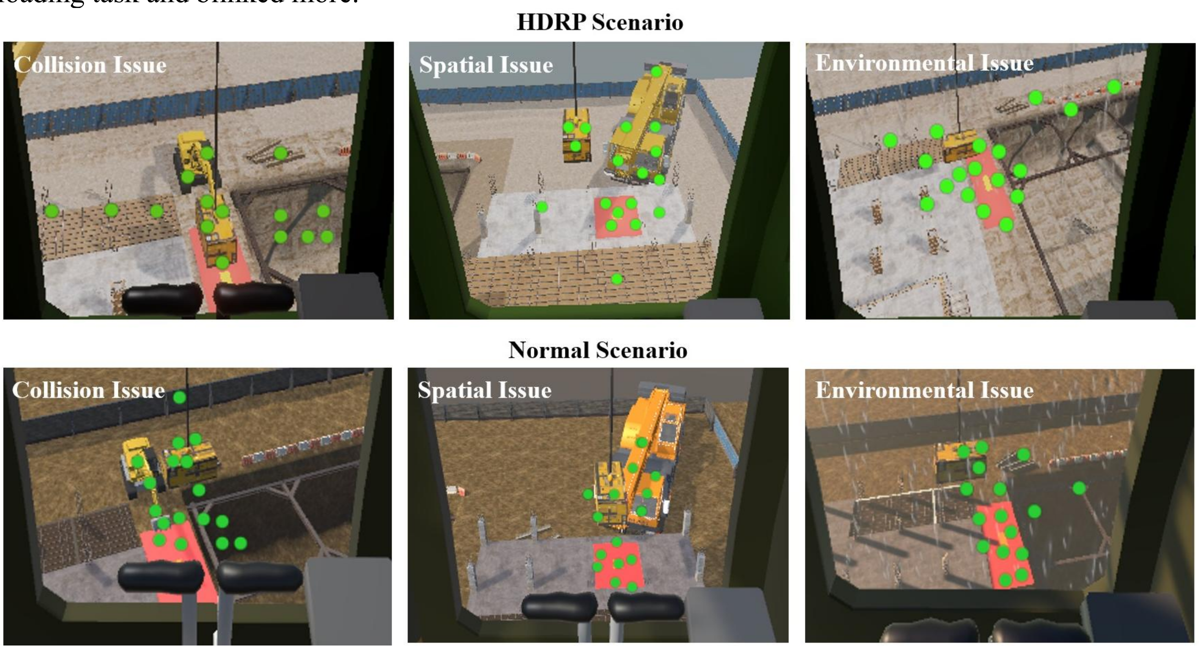

Figure 2. Comparison between participants' gazing pattern in the HDRP and normal scenarios.

4.3. Questionnaire Surveys

The SSQ was used before and after each task to reveal and alleviate the symptom of 3D simulation sickness. One participant showed burping, vertigo, and dizziness (eyes closed) after the first test in the low-fidelity scenario. Half of the participants presented dizziness (eyes open) after completing the tasks in the low-fidelity scenario, while one participant felt increased eyestrain. In terms of the degree to which participants had difficulty concentrating, there was a gradual decrease in the trend as the task progressed. However, most feedbacks indicated that participants felt slightly uncomfortable due to the simulation sickness caused by VR. Comparing two tests in different levels of fidelity, only one participant got a moderate headache and dizziness (eyes open) after the test in the high-fidelity scenario. Two more people also felt fatigued after the second test, while symptoms of burping and vertigo disappeared. In addition to the qualitative assessment, the SSQ was also used as a quantitative indicator of the severity of simulator sickness, with higher scores reflecting more severe symptoms [29]. After standard converting of scores, there was no significant difference in the SSQ scores after participants completed the experiment in low-fidelity (M=62.24) and high-fidelity (M=63.18) environments. Thus, for the basic lifting and hazard identification tasks involved in this study, it would be hard to state the difference between high and low fidelity affects participants' degree of simulator sickness.

5. Conclusions and Further Research

This study explored the effect of simulation fidelity in VR training scenarios for crane operators. A high-fidelity immersive simulation platform was developed to demonstrate the effectiveness of VR as a safety training tool. The effect of the HDRP scenario was verified through objective experiments and correlation analysis. The assessment also includes subjective questionnaires to measure the impact of participants' motion sickness during the experiment. Study results showed that participants took less time to complete similar tasks after training in an immersive VR environment. These results demonstrated that VR could be utilized to develop crane operations skills and provide workers with a low-risk, high-impact training environment. However, the findings also suggested that high-fidelity scenarios may not improve participants' reactivity significantly, especially in hazard detection. High-fidelity scenarios may also trigger eyestrain and dizziness. Thus, further research should focus on the impact of simulation fidelity to investigate how to balance the simulation fidelity of scenario development and the training effectiveness. In addition, eye tracking was also proven to be an effective data collection technique for measuring the trainee's attention.

Several limitations still existed in this study. Firstly, the experiment used a small sample size consisting of six individuals. Although the researchers have set a significant number of tasks (six tasks for each person), the experimental bias may still impact the results. In addition, participants were students rather than experienced workers, leading to discrepancies between experiment results and field construction. Secondly, the participants did not get enough training before the formal experiments, which led to the unfamiliar operation of joysticks, especially in the first task. This insufficient pre-experiment training resulted in a prolonged average completion time for the first task. Lastly, the testing tasks were set to lift and load the container and press the button when perceiving hazards. Although researchers have provided different challenging issues to increase the difficulty, such task design may still be too simple to cover all the skills needed for actual crane operation.

To overcome these limitations, researchers can make some attempts in future work. For example, it would be better to set a larger sample size and invite construction workers to participate in the experiment as subjects. Recruiting professional workers as volunteers will also lead to more straightforward training steps before the experiment, as experienced workers will be more familiar with the operation of the crane than students. More complex construction tasks, such as collaborative tasks or tasks with multiple difficulty levels, could also benefit the task design. Tasks closer to the actual crane operation may help reveal such behavioral insights even deeper.

6. References

[1] Gharaie E, Lingard H, Cooke T 2015 Causes of fatal accidents involving cranes in the Australian construction industry, *Constr. Econ. Build.* **15**(2):1-2

[2] Shin IJ 2015 Factors that affect safety of tower crane installation/dismantling in construction industry, *Saf. Sci.* **72**:379-90

[3] Neitzel RL, Seixas NS, Ren KK 2001 A review of crane safety in the construction industry, *Appl. Occup. Environ. Hyg.* **16**(12):1106-17

[4] Fang Y, Cho YK, Durso F, Seo J 2018 Assessment of operator's situation awareness for smart operation of mobile cranes, *Autom. Constr.* **85**:65-75

[5] Jeelani I, Albert A, Gambatese JA 2017 Why do construction hazards remain unrecognized at the work interface?, *J. Constr. Eng. Manag.* **143**(5):04016128

[6] Leder J, Horlitz T, Puschmann P, Wittstock V, Schütz A 2019 Comparing immersive virtual reality and powerpoint as methods for delivering safety training: Impacts on risk perception, learning, and decision making, *Saf. Sci.* **111**:271-86

[7] Dhalmahapatra K, Maiti J, Krishna OB 2021 Assessment of virtual reality based safety training simulator for electric overhead crane operations, *Saf. Sci.* **139**:105241

[8] Das S, Maiti J, Krishna OB 2020 Assessing mental workload in virtual reality based EOT crane operations: A multi-measure approach, *Int. J. Ind. Ergon.* **80**:103017

[9] Xu Z, Zheng N 2021 Incorporating virtual reality technology in safety training solution for construction site of urban cities, *Sustainability,* **13**(1):243

[10] Hasanzadeh S, Esmaeili B, Dodd MD 2017 Impact of construction workers' hazard identification skills on their visual attention, *J. Constr. Eng. Manag.* **143**(10):04017070

[11] Zheng W, Shuai J, Shan K 2017 The energy source based job safety analysis and application in the project, *Saf. Sci.* **93**:9-15

[12] Goh YM, Chua DK 2009 Case-based reasoning for construction hazard identification: Case representation and retrieval, *J. Constr. Eng. Manag.* **135**(11):1181-89

[13] Abdelgawad M, Fayek AR 2012 Comprehensive hybrid framework for risk analysis in the construction industry using combined failure mode and effect analysis, fault trees, event trees, and fuzzy logic, *J. Constr. Eng. Manag.* **138**(5):642-51

[14] Liao PC, Sun X, Zhang D 2021 A multimodal study to measure the cognitive demands of hazard recognition in construction workplaces, *Saf. Sci.* **133**:105010

[15] Cavusgil ST, Calantone RJ, Zhao Y 2003 Tacit knowledge transfer and firm innovation capability, *J. Bus. Ind. Mark.* 2003 Feb 1

[16] Rosenfeld Y 1995 Automation of existing cranes: from concept to prototype. *Autom.* **4**(2):125-38

[17] Alinier G 2011 Developing high-fidelity health care simulation scenarios: A guide for educators and professionals, *Simul. Gaming*. **42**(1):9-26

[18] Bhandari S et al 2020 Using augmented virtuality to examine how emotions influence construction-hazard identification, risk assessment, and safety decisions. J. *Constr. Eng. Manag.* **1**(2):04019102

[19] Zhang H, He X and Mitri H 2019 Fuzzy comprehensive evaluation of virtual reality mine safety training system. *Saf. Sci.* **120**:341-51

[20] Li J et al 2019 Evaluating the impact of mental fatigue on construction equipment operators' ability to detect hazards using wearable eye-tracking technology. *Autom.*105:102835

[21] Unity3d 2021 High Definition Render Pipeline overview - *Available from:* https://docs.unity3d.com/Packages/com.unity.render-pipelines.high-definition@13.1/manual/index.html

[22] Pedro A, Le QT and Park CS 2016 Framework for integrating safety into construction methods education through interactive virtual reality. J. Prof. Issues Eng. Educ. Pract. **142**(2):04015011

[23] Alghonaim R, Johns E 2021 Benchmarking domain randomisation for visual sim-to-real transfer. In2021 *IEEE International Conference on Robotics and Automation (ICRA).* pp. 12802-12808

[24] Obi Rope 2021 *Available from:* http://obi.virtualmethodstudio.com/index.html

[25] Kennedy RS, Lane NE, Berbaum KS and Lilienthal MG 1993 Simulator sickness questionnaire: An enhanced method for quantifying simulator sickness. *Int. J. Aviat. Psychol.* **3**(3):203-20

[26] Yamada F 1998 Frontal midline theta rhythm and eyeblinking activity during a VDT task and a video game: useful tools for psychophysiology in ergonomics. *Ergonomics.* **41**(5):678-88

[27] Ishiguro Y, Mujibiya A, Miyaki T and Rekimoto J 2010. Aided eyes: eye activity sensing for daily life. *InProceedings of the 1st Augmented Human International Conference*. (pp. 1-7)

[28] Marshev V et al 2021. Impact of virtual reality headset use on eye blinking and lipid layer thickness. *J. Fr. Ophtalmol.* **44**(7):1029-37
[29] Dużmańska N, Strojny P and Strojny A 2018 Can simulator sickness be avoided? A review on temporal aspects of simulator sickness. *Front. Psychol.* **9**:2132