Towards Decontamination Facility Training in VR

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Abstract

This paper presents the ongoing development of a Proof-of-Concept Virtual Reality (VR) system for staff training for Tan Tock Seng Hospital mass decontamination of Hazardous and Toxic Materials (HAZMAT) and/or radioactively contaminated casualties. As a Proof-of-Concept, the initial prototype focuses on allowing users to practice using a chemical scanner device that would be used to scan casualties for left-over chemical hazards. The preliminary development demonstrates the advantages of utilizing VR to simulate training scenarios for supplementing current decontamination training in a safe and economical way.

Introduction

Decontamination involves removing or neutralizing hazardous substances from HAZMAT or radioactively contaminated casualties. In the Tan Tock Seng Hospital (TTSH) in Singapore, mass decontamination training is essential for medical, nursing, administrative, and ancillary hospital staff. They are required to undergo training when they join the organization, and every 2 years thereafter to ensure maintenance of competency, due to regulatory requirements. TTSH has an Open Decontamination Facility (ODF) as the hospital's primary decontamination site. This training involves disrobing and scrubbing casualties, distributing supplies, scanning for remaining chemicals, and guiding patients. However, the current training approach requires lengthy lectures and live training sessions, posing challenges due to limited staff availability and increased planning time. Group lectures make it difficult for trainers to identify individual mistakes. Additionally, when the ODF is not used for decontamination, the hospital utilizes it to accommodate patients, making it challenging to conduct live training.

Existing research has already demonstrated that VR is beneficial in medical staff training. VR promises the benefits of conducting training and practice in a safe and cost-effective manner. This paper presents the ongoing development of a Proof-of-Concept VR system for supplementing current decontamination training. The preliminary development focuses on allowing users to practice using a chemical scanner device that would be used to scan casualties for left-over chemical hazards. It showcases that VR can be helpful in identifying individual mistakes easier and providing a safer and more cost-effective supplementing solution.

Related Work

VR for Medical Training

The healthcare industry has successfully utilized VR to enhance staff training and improve performance in various procedures (Farra and Miller 2013). These training programs typically focus on specific roles and have received positive feedback, such as simulations for nurses practicing urinary catheterization (Kardong-Edgren et al. 2019), ambulance bus training for equipment familiarization (Koutitas, Smith, and Lawrence 2021), and a simulator for medical students to make diagnoses and decisions based on equipment measurements (Harrington et al. 2018). In addition to VR simulations, serious games offer another training approach that does not require VR equipment. Serious games are interactive computer applications that challenge users to learn real-world skills, knowledge, and attitudes (Kanat et al. 2013; Gue, Ray, and Ganti 2022). For instance, a serious game was developed to teach blood transfusion practices to nursing students based on actual course materials (Tan et al. 2017). While serious games lack the immersive experience of VR, research suggests that increased immersion enhances learning effectiveness (Lerner et al. 2020).

These research projects demonstrate the effectiveness of VR in teaching simple decision-based medical procedures but do not provide in-depth analysis on replacing real-life training procedures entirely (Lerner et al. 2020). Therefore, instead of seeking to replace traditional training, the design decision has been made to complement the existing training.

VR for Decontamination Training

There is a limited amount of research available on the use of VR for decontamination training, specifically in chemical emergencies. Existing work primarily is about VR applications for triage training in mass casualty events (Mills et al. 2020). The review study (Farra and Miller 2013) also highlighted the prevalence of papers related to triage training. Some related work exists on VR simulations for fire emergency response (Zhu and Li 2021), and a few studies address training civil servants in triaging and investigating

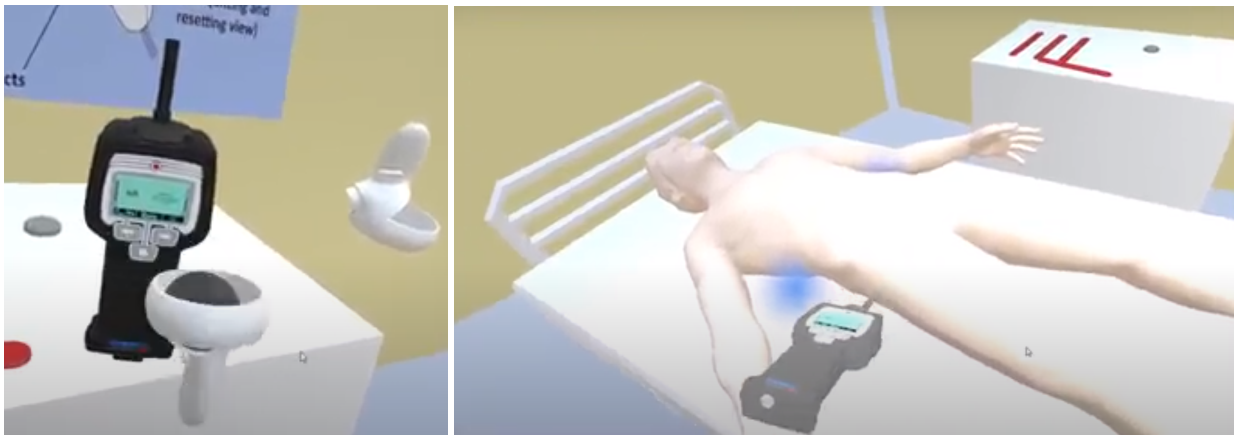

Figure 1: A VR scenario of operating the chemical scanner device using the VR controller to scan the casualties.

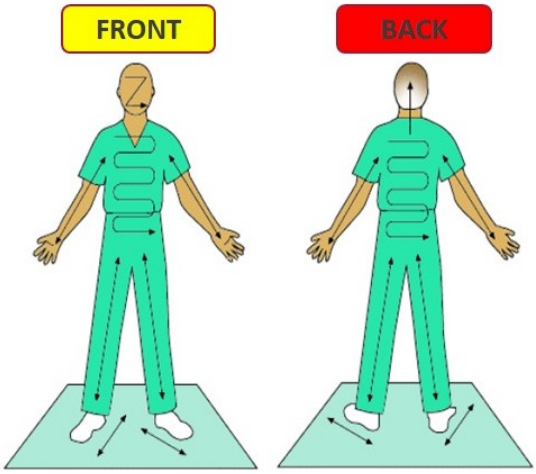

Figure 2: Scanning procedural illustration.

Figure 3: The scanning result of using the proposed method.

Chemical, Biological, Radioactive, Nuclear, or Explosive (CBRNE) emergencies (Heinrichs et al. 2010; Altan et al. 2022). However, none of these papers directly address the decontamination procedures for chemical hazards.

One research project explored the use of VR to train student nurses in performing irrigation procedures independently (Farra et al. 2015). No research was found specifically targeting the training of staff to scan casualties for chemical hazards. Other related research outside the healthcare sector includes a VR application designed to train military personnel in cordoning areas affected by CBRNE threats (Lamberti et al. 2021), which differs from the focus of the current study. Similarly, a VR training program for industrial workers involves responding to chemical incidents and controlling leaks, with only a small section dedicated to decontaminating equipment and staff (An et al. 2019).

Given the limited research available on the topic of scanning CBRNE casualties, this study aims to contribute novel research by utilizing a VR application for training in this specific area.

Decontamination Training VR Preliminary Implementation

The initial implementation involves a single VR scenario where the trainee takes a chemical scanner device using the VR controller to scan the casualties Figure 1. The virtual intelligent trainer is implemented based on heuristics and checking a sequence of steps. For simulating the scanning, the heuristics rules are defined based on the guidelines from the existing training.

According to the guidelines, the scanner nozzle should be directed towards the casualty, following a scan pattern similar to Figure 2. The scanner needs to be held close to the casualty without making physical contact for accurate detection. To simulate this, the system includes an extended area from the nozzle that detects if the user meets the scanning conditions. As the user scans the casualty, a line is drawn, generating an image file displayed in Figure 3, illustrating the scanning process. The purpose is for the trainer to review

this image file and assess whether the users have followed the general pattern.

The trainee's errors can be identified, including instances of contact with the casualty or missing scans of certain body parts. Compared to real training, it simplifies and improves the assessment process, reducing both the tedious efforts and the potential for errors. The implementation is done in Unity and Meta Quest 2.

Conclusion and Future Work

This paper presents the ongoing development of a Proof-of-Concept VR decontamination training system. At the current stage, users are allowed to practice using a chemical scanner device to scan casualties for leftover chemical hazards. In the future, the complete decontamination training process will be simulated and implemented within the VR environment. A comprehensive user study including a control group study will be conducted to evaluate this training VR. Additionally, there is potential for integrating artificial intelligence (AI) into this training VR, enabling more intelligent and authentic training and assessment methods while enhancing the overall user experience. One possible approach involves utilizing deep learning-powered computer vision methodologies to analyze and assess the scanning result image's content (Figure 3).

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