

A Virtual Reality based Fire Safety Training Application for Fire Safety Personnels in India

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ABSTRACT

Fire and Fire related dangers are very common and they pose a big safety issue. Fire Fighters play a huge role in such cases to save lives and infrastructure. Hence, highly trained staff are crucial to ensure safety. However, the training process has a lot of gaps, mainly the lack of proper infrastructure to support training. In the paper, we present a work-in-progress towards developing a VR based fire-safety application that can be utilized to train staff remotely and sensitise them to the intricate details on fire-safety and provide them with a robust knowledge base to prepare them for advance hands-on training. Various training modules and interaction design aspects have been discussed. It is posited that VR can improve the efficiency at which the personnel & the staff performs, reducing overall in-person training time. The paper discusses three modules which can be used in succession to train Fire Safety Personnel and Staff.

Keywords: Fire Safety, Training, Virtual Reality

Index Terms: Human-centered computing~Human computer interaction (HCI)~Interaction paradigms~Virtual reality

1 INTRODUCTION

Over the last decade VR has become one of the more capable solutions in various fields due to decreasing computer equipment costs and increasing processor speeds. These advances have made uses of VR more viable and broadly applicable. VR allows a virtual environment to be created and users can fully experience and even manipulate it. Therefore, VR can be used for training in situations where it would normally be too dangerous [1] or can be used as a supplement to the process of in-person training.

VR Training can help improve the cognitive receptiveness of a trainee [2]. VR can help build up the core knowledge that can reduce the overall in-person training time by allowing the users to prepare by practicing remotely in a virtual environment. Training in a virtual environment can help prevent injuries that may be faced by trainees in a real-life scenario [6]. Furthermore, VR Training can also reduce the probability of injuries or mishaps as they will be cognitively trained and sensitised to the environment beforehand.

VR enables immersion which helps promote behavioral learning. VR can help build and improve behavioral skills related to fire hazards and response. These behavioural learning can easily be transferred into real-life scenarios [4].

VR proves to be an effective tool when training people in time-bound scenarios. As the level of difficulty can gradually increase depending on the participant, which helps create a more competitive yet supportive training environment.

As per the ADSI-2019 report, there were 11,037 fire accidents reported across the country in 2019. It is estimated that about forty-two 42 females and 21 males die every day in India due to fire.

2 LITERATURE RESEARCH

Sarah et al., (2021) Shows that VR promotes procedural learning which can be especially helpful in training for specialised tasks such as Fire Safety Training. The study also discusses the interaction between sense of presence and immersion does not affect procedural or conceptual learning, both being favourable towards VR as a mode of training and an efficient modal to communicate information.

Moohyun et al. (2012) showed that a VR simulator can be used to track real-time performance which can in turn help trainors analyse the results better while Ünal el at. (2019) demonstrated that behavioural skills are transferable for a VR environment to real-life easily.

Harrington et al. (2003) is a good example of how long-term care staff can be trained using VR with no setback, the study done 289 nursing facility staff was proven to successful using computer based instructions

Huseyin el at. (2006) shows that response to stimuli such as fire can be improved using VR and can increase the overall response time. These developments can go a long way in training more effective fire safety personnel

3 SCENARIO BASED SYSTEM DESIGN

Scenario Based Design [] System was used for the creation of the training environments using Unreal Engine to create FPV (First Person View) Experiences. For learning about fire-safety, the users are sensitized and made aware about different types of fires, smoke behaviours and the material properties. This knowledge forms a foundational understanding to the users and also as a first step towards learning about fire hazards. Based on the curriculum/ and interface modules created for VR training. These are discussed as follows.

3.1 Simulating Realistic Fire

There are several types of fire- Flammable Gases, Flammable Liquids, Wood Paper & Textiles, Electric Contact Cooking Oils & Fats. Each needed to be recreated in a Virtual Environment. The attention to detail was necessary as the accuracy in differentiating types of flames will help users with faster cognitive recall.



Fig. 1 Types of Fire in VR

3.2 Realistic 3D Modelling

As an effort to make cognitive connective connections as strong as possible we worked meticulously on making the elements/objects of the virtual environment very accurate. Extinguishers were modelled and rendered using Photoshop and Blender.



Fig. 2 Realistic fire extinguisher 3D models

3.3 Scene Design

We focused on the most common places for fire outbreaks and modeled our scenes based on that. The spots for fire organization, Reflections, Entry & Exits were kept in focus during the construction of these spaces. Two highly rendered spaces were created. A warehouse & a hospital. These 2 spaces covered a broad range of areas broadly categorising them in 2 categories- a) Open Spaces & b) Closed Spaces.

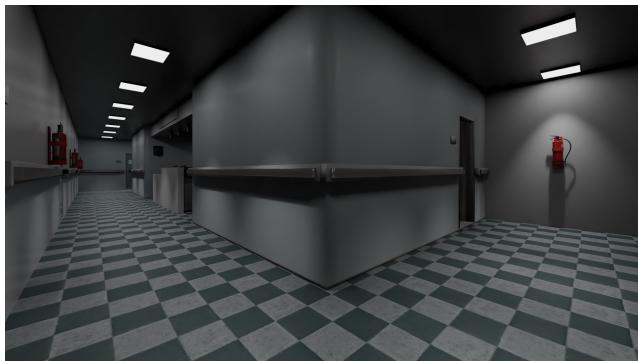


Fig. 3 3D Render of a hospital



Fig. 4 3D Render of a hospital (Alternate View)



Fig. 5 3D Render of a warehouse



Fig. 6 3D Render of a warehouse (Alternate View)

3.4 Interaction Design

Since the headset we were using was Oculus Quest. For the Interaction Design, We use Oculus Quest Guidelines for designing VR Experiences to design- Locomotion, Tracking, Users Inputs & Safety Guidelines[11]. The following interaction capabilities were defined during the process.

3.4.1 Pointing

Pointing and picking up the extinguishers using Quest Controllers, we defined a clearly visible pointer that is opaque and visible in different scenarios.



Fig. 7 Pointing in VR

3.4.2 Selecting

The selector turns green as the activates the trigger and the selection is made.



Fig. 8 Selecting in VR

3.4.3 Manipulating

In the manipulating state the cursor changes and shows all the possible movement possibilities.



Fig. 9. Manipulating/ Moving in VR

3.5 Designing the Modules

The Modules were extensively planned for the users to go through the entire training process from basics to executing step by step, the modules are designed to be self-sufficient on their own but can also be used in conjunction as a complete training guide.

3.5.1 Module 1- Learning the Basics

This module teaches the user about the basics of fire safety,

	Water	Foam Spray	ABC Powder	Carbondioxide	Wet chemical
Wood, paper, textiles	✓	✓	✓	✗	✓
Flammable liquids	✗	✓	✓	✓	✗
Flammable gases	✗	✗	✓	✗	✗
Electric contact	✗	✗	✓	✓	✗
Cooking oil & fats	✗	✗	✗	✗	✓

Fig 10. Rubric for type of fire vs type of extinguisher

3.5.2 Module 2- Learning to Operate

In the second module, the users learn to operate the virtual fire extinguisher and application methods on different types of fire.



Fig 11. Pointing, Elective & Manipulating/ Moving in VR

3.5.3 Module 3- Scenario Based Test

In the third module, the user go through one of the two training areas to complete a series of tasks, namely-

1. Assess the situation
2. Find and pick the correct extinguisher
3. Go to the designated areas to put out the fire
4. Exit the area/building



Fig 12. Burning hospital in VR, The scene is deliberately created to be realistic that includes smoke behaviour and fire behaviour.



Fig 13. Burning hospital in VR (Alternate View)

4 CONCLUSION

Fire Safety Training is a difficult process to recreate in VR as behavioural skills development happens at different rates in different individuals and in cases like Fire Safety Training it takes time for correct behaviors to form. However, VR applications propose a good framework for complicated scenarios and training protocols to be developed.

The Open-World feel of VR Application helps users to interact with their environment as they see fit and they can learn in unconventional ways which is indicative of the real world while still providing enough structure to facilitate learning.

Since VR training can be done remotely, this presents a huge opportunity for countries with smaller and more concentrated infrastructure for Fire Safety Training like- India.

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