

International Journal of Advance Research in Computer Science and Management Studies

Research Article / Survey Paper / Case Study

Available online at: www.ijarcsms.com

Design of Fire Control Simulation Training System Based on Virtual Reality Technology

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Abstract: *Based on virtual reality technology and utilize 3D modeling tech, a simulated training system of accidental fire is constructed to visually show the execution of emergency operations in case of fire accidents. The system can help fire rescue groups to get familiar with the actual environment and cultivate their emergency handling ability in case of fire situation, provides scientific reference for improving the practical application level of emergency plans.*

Keywords: *Virtual reality technology (VR); emergency plan; 3D modelling; simulated train of fire control.*

I. INTRODUCTION

It is important for promoting the modernization of emergency management system to adapt to the trend of scientific and technological development, depending on which to improve the level of emergency management in aspects of science, profession, intelligence, sophistication, etc. The emergency drill is an essential part of the preparation for emergency management. At present, the main popular methods among the world are desktop drills, 3D systematic drills, and comprehensive drills. However, as an indoor programme, Desktop drills lack vividness. In the actual operation process, 3D systematic drills and comprehensive drills also face problems such as long-time organization, increasing expenditures, and low implementation frequency. The application of VR technology provides a solution to this issue.

At present, there has been some progress in the research of simulated fire emergency plans based on VR technology: For instance, Shuo Wang, Shiyong Zhu, etc, developed a virtual model of subway emergency which bases on Anylogic software. Liu Wanying et al, Utilized 3DsMax + OSG + QT development mode and Visual 2010 platform, developed a large-scale storage tank fire and explosion simulation software. An Emergency simulation evacuation subject for ultra-high-rise elevators studied by Andree Christin et al., Sweden. Virtual technology analysis of emergency evacuation of cruise ships and other personnel-intensive ships studied by Konstantinos V. Kostas of Greece, etc. Have produced positive and profound effects in related fields all over the world. However, the designation of above-mentioned systems does not carry out research on an individual's first-person perspective, and cannot be used by users for personalized development.

In order to solve these problems, this research is based on virtual reality technology, according to different exercise goals, tasks and the real production scene, through the means of 3D modeling and virtual reality technology, to achieve a 1: 1 reduction of the real scene; the driller wear VR equipment in order to realize the real-time dynamic exercise of the entire process from the start of the plan to the end of the emergency response, furthermore, help the emergency rescuers understand the effective measures to be taken in the event of an accident.

II. CONSTRUCTION OF FIRE SIMULATION TRAINING SYSTEM

This fire simulation training system based on virtual reality technology, developed on the Amazon "Sumerian" platform.

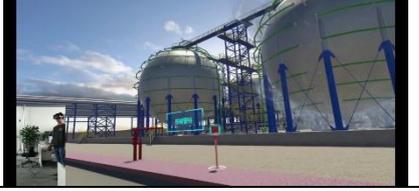
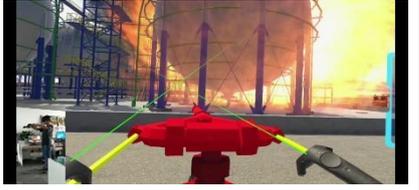
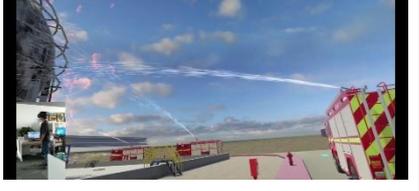
A. Building a virtual fire scene model database

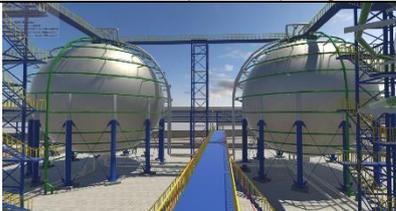
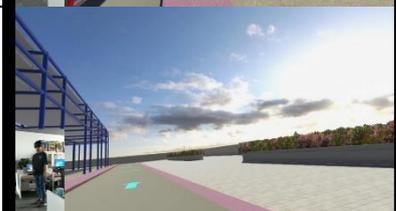
Virtual scene model database including firefighting and rescue equipment, background environment, building facilities and fire scenes. Combine the geographic information and the spatial location information of the model to load the constructed virtual scene model database into the 3D scene through 3D modeling to present a 3D virtual reality simulated scene. Through the digital screen and human-computer interaction, load the exercise simulation scene and retrieve the pre-stored disaster rescue plan database. The driller wears a VR device, which starts to display the drill simulation scene and traces the line of sight of the driller to show the corresponding angle scene. Collect the specific operation information, real-time status information, location information and surrounding environment information of the driller, process the collected information and display it in the digital simulation scene.

B. System functions and operations

The fire simulation training system mainly includes many functions such as the main menu, accident animation restoration, fire scene setting, interactive experience operation, etc. The detailed functions and operations of the fire simulation training system are shown in Table 1.

TABLE 1 Functions and operations of fire simulation training system

Functions	Operations	Patterns
Main menu	In the main manu, the operator can choose a variety of fire simulation modes such as petrochemical industry and storage transportation.	
Accident animation reduction	Choose to watch the plane and 3D simulation video animation on the start interface to learn more about the accident.	
Fire scene setup	Based on the flame pattern model provided by the system, a model of a fire in a leaking storage tank is constructed in a VR scene and a fire scene that matches the deduction is generated in a short time.	
Interactive practice operation	Select the combination mode of HTC vive wireless dual-mode positioning and tracking technology and the control handle in the interactive devices, select the "handle-ray interaction" in the interactive technology options.	
Fire-control facilities inquiry	In the VR scenario, you can check the configurations of the water source, fire pipe networks, emergency passages, fire hydrants, and fixed fire extinguishers. Use the roaming function to view the location information of various fire protection facilities.	

Scene roaming	Operators can conduct free investigation routes and select any viewing angle modes for investigation of fire scene conditions.	
Fire-control force deployment	An automatic combat deployment mode is available, other deployment modes will be developed in the future for operators to choose.	
Evacuation route instructions.	During the deduction, if it is determined that the fire condition out of control, the operator can direct the fire fighting vehicles and personnel to evacuate the scene according to the route of the evacuation instructions.	

III. VALUES AND PROSPECTS OF FIRE SIMULATION TRAINING SYSTEM

A. Conception of System Development

Combining immersive virtual reality technology (VR) with STEAM concept and creative spirit, based on VR / AR resource editor, relying on self-built 3D model database of fire accident and fire fighting, combining traditional classroom with virtual classroom, combine Video animation, three-dimensional scene deduction, and VR virtual reality experience together to form a closed loop of education, so that trainees can experience real-time dynamic accidents. Turn the learners into creators.

B. Application value of the system

Considering the high-risk accidents and the worst consequences entailed by the early construction of gas station and the aging of storage tank process, Qualitative Risk Assessment software developed by China Academy of Safety Science and Technology (CASST-QRA) is used in the study for calculating the individual and social risk in fire and explosion of storage tanks in the gas station. A comparison is made between the outcomes and risk standard, evaluation conclusions are obtained and relevant countermeasures to reduce the risk are proposed.

C. Development prospects of the system

On the background of the increasingly mature information technology, terminal display technology and hardware technology, VR experience-based simulation systems will gain more important technical and funds support. The application of 5G networks has broaden the way for system simulation of more complex and wider areas. At present, virtual reality technology has been widely used in emergency planning simulation drills. With the continuous advancement of technology and the improvement of functions, the market demand for fire simulation training systems based on virtual display technology will continue to expand.

IV. CONCLUSION

Based on the practice of fire emergency simulation drills, and through the study of actual situations, a fire simulation training system based on VR technology is designed. The system provides rich interaction methods and functions. The sensors interact with any object in the virtual environment in the most natural way, such as using sound, body sensation, gaze, expression, etc. The application of the system provides guidance for the design and implementation of enterprise emergency plans, effectively improves the response capabilities of emergency rescue personnel, reduces and controls the losses and consequences by fire accident.

Due to the actual fire is affected by various factors (wind, humidity, climate, etc.), it is necessary to further construct the fire simulation scene in detail and improve the refinement of the model to improve the applicability of the system in various fire situations.

ACKNOWLEDGEMENT

This paper is supported by Educational Reform project of China University of Labor Relations (JG1705).

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