Virtual Reality based Disaster Response Training System: Fire and Earthquake

Abstract

Urban areas are becoming increasingly vulnerable to both natural as well as human-made disasters, particularly fires and earthquakes. Every year, these disasters cause heavy loss of life and damage to property. Existing disaster training approaches such as evacuation drills, classroom lectures and tabletop exercises have several limitations. These methods are often costly, difficult to organize repeatedly, pose safety risks, and usually fail to engage participants effectively. As a result, preparedness levels remain low among the urban population.

This project proposes a Virtual Reality (VR) based disaster response training system, that uses VR simulation and game-based learning techniques to improve preparedness for fire and earthquake emergencies. The main objective of this work is to develop an interactive, engaging, and scalable training platform that combines realistic disaster environments with entertaining learning components. By doing so, the proposed system aims to make disaster preparedness more accessible, more effective, and easier to understand for diverse groups of people living in urban areas.

Using VR head-mounted displays with movement tracking and customized simulation software, participants are placed inside realistic emergency situations where they must respond to scenarios such as fire alarms, blocked exits, falling debris, structural shaking and reduced visibility. The system incorporates multi-sensory feedback including visual, audio and limited haptic cues to recreate the stress and urgency of real disaster events. This helps in improving the accuracy of the learning experience and supports better retention of correct response behaviors.

Unlike traditional training approaches, the proposed VR system follows game-based learning principles. Users receive scores and performance feedback based on their movements, reaction time, decision accuracy and adherence to safety protocols. Features such as leaderboards, achievements and team-based challenges are included to maintain motivation, encourage repeated practice and develop teamwork skills, which are very important during emergency situations. By introducing gamification, we make training an engaging, repeatable activity rather than a one-time compliance requirement.