IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Next-Gen Virtual Reality Disaster Management Training & Rescue Operation

[1]Ameen Aga, [2]Harsheet Jani, [3]Shravani Pawar, [4]Makarand Kadam, [5]Renuka Nagpure

[1]Student, [2]Student, [3]Student, [4]Student, [5]Professor

[1]Information Technology, Engineering

[1]Atharva College of Engineering, Mumbai, India

Abstract: The Next-Gen Virtual Reality Disaster Management Training & Rescue Operations project integrates Virtual Reality (VR) technology to enhance disaster preparedness and response. The project focuses on creating immersive VR training simulations that allow individuals to practice decision-making and crisis management in realistic disaster scenarios, such as earthquakes, floods, and fires. Utilizing platforms like Unity and Blender, the training fosters cognitive and emotional resilience, equipping participants with essential skills in high-pressure situations. By offering a safe, controlled environment, the program addresses gaps in traditional training methods, ensuring a more interactive, effective, and holistic approach to disaster management and response readiness.

Keywords - Virtual Reality (VR), disaster management, immersive training, emergency preparedness, Unity, realistic simulations.

I. INTRODUCTION

Disasters, both natural and man-made, are becoming more frequent and severe, posing major threats to communities. Effective disaster management is crucial to reducing loss and ensuring a coordinated response, but traditional training often fails to prepare individuals for real-world complexities. The Next-Gen Virtual Reality Disaster Management project leverages VR technology to create immersive simulations of scenarios like earthquakes, floods, and fires. Using advanced platforms like Unity and Blender, it provides realistic, hands-on training to improve crisis management, decision-making, and emotional readiness, ultimately enhancing disaster preparedness and response outcomes.

A. Problem Formulation

Traditional disaster management training methods often lack the immersive quality needed to fully prepare individuals for high-stress, real-world emergency scenarios. These methods typically rely on classroom-based education or basic simulations that fail to address the psychological and emotional stressors of actual disasters. The need for more effective, hands-on training that simulates the chaos and urgency of real-life situations is critical, especially as disaster events increase in frequency and severity due to factors like climate change and urbanization.

B.Motivation

With an increasing frequency of catastrophic events, such as earthquakes, floods, and fires, the preparedness and response of communities and first responders are more crucial than ever. Traditional training methods are no longer sufficient to ensure readiness, especially in high-pressure situations where quick decision-making and emotional resilience are key.[8] This project was motivated by the need to enhance disaster response capabilities by providing more realistic, interactive, and effective training solutions.

II. METHODOLOGY

1.Input Layer: User Input and Preferences
Disaster Scenario Selection: Allow users to select specific disaster scenarios such as earthquakes, floods, or fires.
Personalization: Let users set preferences like difficulty levels, environmental settings, and role specifications.

2. System Initialization Layer: Environment Setup
Unreal Engine: Initialize assets, physics, and environment dynamics.
VR Hardware: Calibrate headsets, controllers, and haptic devices for user interaction.
Scenario Configuration: Load predefined settings for selected disasters, including scale, timing, and complexity of events. Enhance immersion with realistic audio-visual effects and environmental conditions. [5]

3. Training Module Layer: Simulation Modules
Create modular scenarios representing various disaster types. Incorporate event triggers, such as aftershocks for earthquakes or water level rises in floods, to add unpredictability.
Real-Time Physics: Use physics engines for accurate representation of disasters (e.g., falling debris, flooding water).

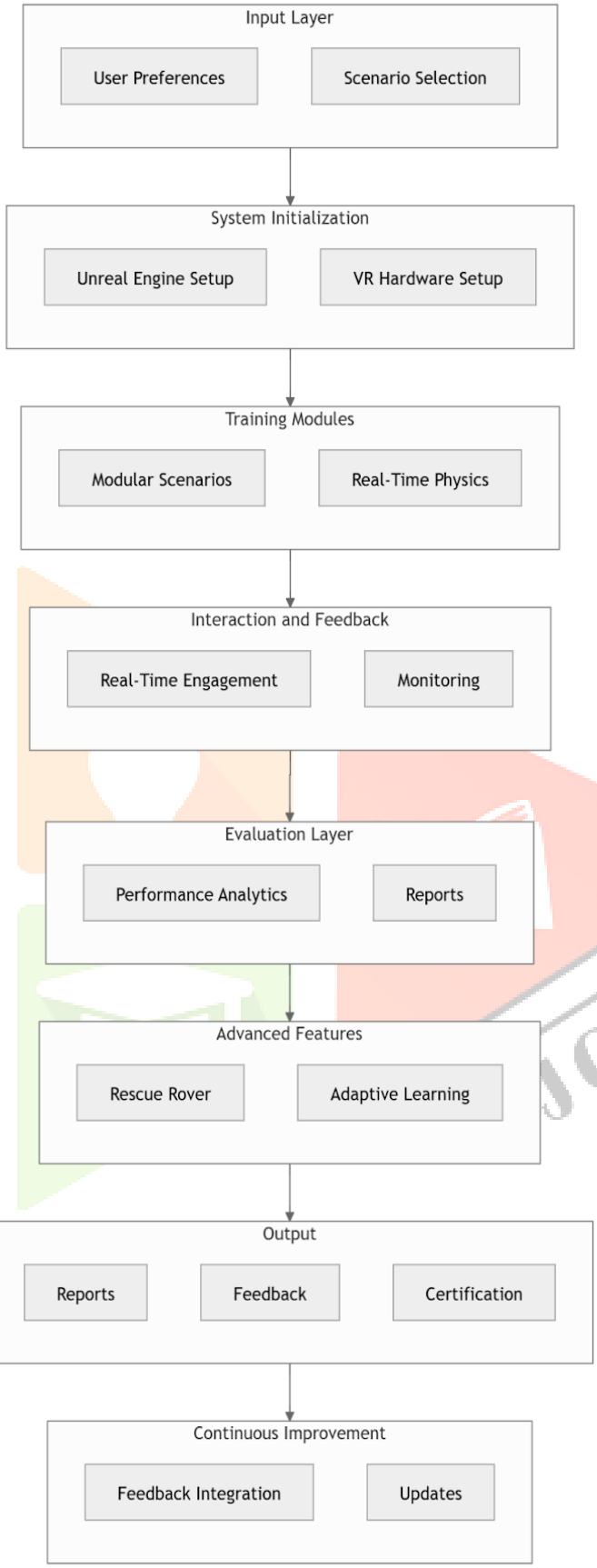
4. Interaction and Feedback Layer User Interaction
Allow users to engage with objects and the environment (e.g., extinguish fires, assist injured NPCs). Introduce time-sensitive tasks to mimic real-life emergency pressures.
Feedback System: Provide real-time feedback during the training, such as performance ratings, missed steps, or critical errors. Incorporate visual (e.g., on-screen prompts) and auditory (e.g., alerts) feedback.

5. Evaluation Layer Tracking and Analytics
Track user actions, decision-making, and task completion times. Monitor physiological responses like eye-tracking and reaction times using VR sensors. [9] Performance Assessment: Evaluate users based on predefined metrics (e.g., accuracy, efficiency, collaboration). Generate detailed reports summarizing strengths and areas for improvement.

6. Advanced Features Layer Rescue Rover Simulation
Integrate a rescue rover module for remote navigation during disaster scenarios. Equip the rover with HD cameras, real-time obstacle detection, and video transmission features.
Adaptive Learning: Implement AI-driven scenario adjustments based on user performance to provide personalized learning experiences.

7. Output Layer Reports and Feedback
Provide users with a post-training summary report, including performance analytics and improvement suggestions. Save session data for longitudinal analysis to track progress over multiple training sessions.
Certification: Award certifications based on user performance and competency levels. [1][2]

III. ARCHITECTURE



IV. RESULTS

VR Training System: Users will experience immersive disaster scenarios like earthquakes and floods, practicing emergency responses with real-time feedback to enhance decision-making, teamwork, and critical thinking.

Rescue Rover: The rover will navigate disaster zones, transmitting live video and data via the VR system, improving situational awareness and reducing risks for rescuers.

Integrated System: Combining VR training with the rescue rover ensures a seamless transition from training to real-world application, creating a scalable solution for enhanced disaster preparedness and response.

Fig1. Fire Scene

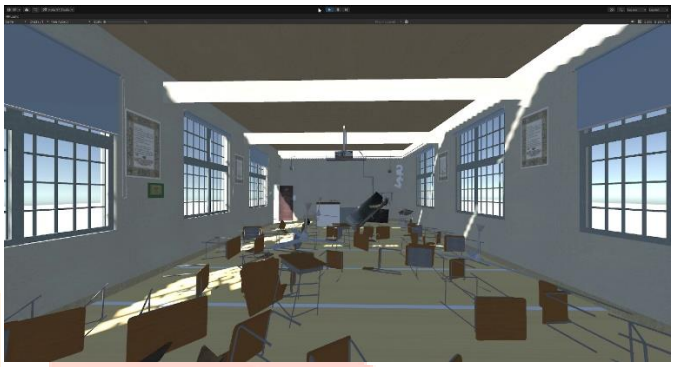


Fig2. Earthquake Scene

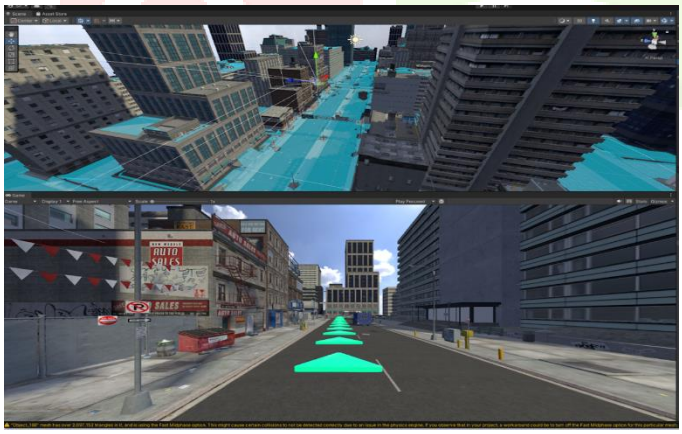


Fig3. Flood Scene

Fig4. Simulation

V. FUTURE SCOPE

- Designing and building rovers capable of navigating inaccessible areas to detect signs of life and assist in survivor rescue.
- Integrating diverse and complex disaster simulations, addressing emerging challenges such as pandemics and cyberattacks.
- Adapting the technology for industrial safety, military preparedness, and educational training to broaden its impact.
- Enhancing global accessibility with localized adaptations to address specific disaster risks in developing regions.

VI. CONCLUSION

In conclusion, the integration of a VR-based disaster training system and an innovative rescue rover offers a comprehensive solution for improving disaster preparedness and response. The VR training provides a safe, immersive environment for individuals and teams to practice decision-making in high-pressure situations, enhancing their cognitive and emotional readiness. The rescue rover complements this by enabling real-time, remote assessment and navigation through disaster zones, improving the efficiency and safety of search and rescue operations. Technically, economically, and operationally feasible, the project leverages advanced technologies such as VR, robotics, and wireless communication to create a scalable and sustainable disaster management tool. By addressing legal considerations and ensuring compliance with data, safety, and operational standards, this project stands as a valuable and forward-thinking contribution to disaster response and training efforts.

REFERENCES

[1] Priyam Jain, Mehul Jain, Akshali Jain, Mayank Patel, "Disaster Management and Simulation using Virtual Reality", published International Advanced Research Journal in Science, Engineering and Technology (IARJSET), Volume 11, May 2024.
[2] Silvia Garcia, "Intelligent VR-AR for Natural Disasters Management", published ResearchGate, August 2021
[3] Mohit Patel, Harsh Amin, Geetesh Pandey, Ganesh Wadmare, "Enhancing Disaster Response Training through Immersive AR/VR Simulations", published IEEE, March 2024
[4] Jigyasa Agarwal; S. Shridevi, "Procedural Content Generation for Disaster Evacuation Using VR", published IEEE, Sept 2023, Volume 11.
[5] Joseph Orji; Amelia Hernandez; Biebelemabo Selema; Rita Orji, "Virtual and Augmented Reality Applications for Promoting Safety and Security" published IEEE, Dec 2022.
[6] Lorenzo Romagnoli; Gabriele Proietti Mattia; Roberto Beraldi, "Energy Efficiency in Edge-Assisted VR for Disaster Management", published IEEE, Oct 2023
[7] A. Carvajal; V.R. Garcia-Colon, "Virtual Reality Training System for Disaster Preparedness", published IEEE, Oct 2003
[8] Rino Sekhar Rajasekharan; Robert Bestak; Gilles Dusserre, "A Study on Disaster Management Databases", published IEEE, Aug 2021
[9] Vinh T. Nguyen; Kwanghee Jung; Tommy Dang, "VRescuer: A Virtual Reality Application for Disaster Response Training", published IEEE, Dec 2019
[10] Mohit Patel, Harsh Amin, Geetesh Pandey, Ganesh Wadmare, "A Review on Applications of Big Data for Disaster Management", published IEEE, April 2018