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Virtual Reality Firefighter Training Simulation

INFO 5900 : Virtual Reality and its Applications
Prof : Sharad Sharma

ABSTRACT

It is well-known that simulations in virtual environments can be used for educational purposes to create engaging learning experiences. The design and development of a virtual reality application to teach firefighters how to respond in the event of an emergency fire disaster is the topic of this project. In terms of security, authenticity, and the variety of training scenarios, virtual firefighting is preferable to fire training in a real environment. It also provides a more interesting training experience while being a more affordable option. A 360-degree fire simulation is created using Firefighter Training Simulation and the advanced game development framework Unity, enabling students to interact with a fire in a secure environment. An external supervisor can control the scenario and provide feedback for professional learning. We were able to create a realistic and immersive learning environment that is also maintainable for further expansion through the use of visual effects, accurate lighting, appropriate shading techniques, and a physical representation of fire growth.

INTRODUCTION

Non-professional fire training can be costly, complex, and can typically be conducted in a limited setting to lower trainee risk. This project offers guidance on creating a practical training alternative by walking through the creation of a virtual fire training application.

The creation of efficient systems for training first responders might be viewed as a pertinent issue given the high complexity of the intervention scenario (fire operations, landslides, tsunamis, and earthquakes).

Virtual reality frameworks and development platforms have only recently appeared, despite the fact that virtual reality hardware has been thoroughly researched and developed over the past decade. This project serves as the foundation for a low-cost education for aspiring fire security officers and volunteer firefighters. This method does not replicate actual heat, but it instructs the user on how quickly fire can spread, how it grows, and how to use a fire extinguisher. The project is designed so that users can gain first-hand knowledge of a fire emergency situation.

A great training experience might make it easier to quickly recall the best options in emergency scenarios. Non-professional trainees are learning under constrained conditions and are not coping with the influence of smoke development and large fire growth in indoor rooms due to the safety security needs of a real fire training.
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MODELING

In this project, we have created a realistic virtual environment that simulates a fire accident scenario. The virtual environment is a street view with a variety of objects like building, traffic signal, road, vehicles, people and other objects that are part of a street view. In this street setup, we have included a fire hazard in a building. This fire is shown on top of a building. We then see a group of fire response team enter the situation. A troop of firefighters along with fire engine, ambulance and other equipment required enter the scene to work on the scene and work on extinguishing the fire in order to control the situation

IMPLEMENTATION

The project's purpose is to create immersive learning software that is also adaptable for future enhancements. We chose Unity as the framework since it is a high-level game engine that enables rapid development. The large amount of pre-installed functions, such as particle systems, shading programs, and lighting computations, is one of Unity's advantages. Several conditions were investigated before establishing an immersive experience. It is challenging to achieve powerful and fluent real-time performance with huge calculations, yet it is required for a virtual reality application to give a high-quality experience. The estimated fire growth should be as realistic as feasible in order for the user to understand fire dynamics in a limited scenario. Because we could use and modify built-in components, we were able to focus on customizing the framework to our needs. As opposed to traditional game development, creating virtual reality apps for cutting-edge head-mounted displays is a unique concept with unknown barriers. To allow the user to learn fire dynamics in a limited situation, the approximated fire growth should be as realistic as possible.

System Design:

Unity VR technology is used to deliver an immersive experience. Designing the user interface and adding VR controllers for interaction with the virtual environment are two examples. In each scene, there are combustible and non-flammable models. Unity is used to create a realistic virtual environment that accurately represents the simulated environment. This includes the addition of texture and lighting, as well as the creation of realistic fire and smoke effects. Non-flammable models are static and do not alter during run-time. In terms of architecture, the software should be as maintainable as possible for future upgrades, such as the addition of extra simulation complexity, customized simulation settings, and increased user participation opportunities. We used an object-oriented approach for the fire simulation, with component structures for specific object activities such as the fire extinguisher. In addition, a hybrid of the singleton and lazy initialization design patterns is used, with each object in the scene assigned responsibilities based on their real-world behavior.

Fire and Smoke Development:

Several functionalities are already incorporated and ready to utilize in Unity. Particle systems are available with a number of tuning options. We use a number of particle systems in our application, including fires, smoke, convection, water, and carbon dioxide. The latter two represent the liquid in a fire extinguisher. The convection particle system, which will be discussed further below, is employed to carry heat, whilst the other two represent the fire itself. Particle systems enable fast movement and texture rendering, simulating the appearance of a random shift in the shape of genuine fire or smoke. Textures and 3D models are used to provide a complete picture of the project. Textures define the appearance and feel of the environment, whereas 3D models show the items and characters. 3DS Max is used to implement textures and 3D models in a project. After finishing the models and textures, they are imported into the Unity VR engine to build the 3D universe.

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Vision:

Textures and 3D models are used to provide a complete picture of the project. Textures define the appearance and feel of the environment, whereas 3D models show the items and characters. 3DS Max is used to implement textures and 3D models in a project. After finishing the models and textures, they are imported into the Unity VR engine to build the 3D universe.

Sound:

Ambient sounds are used in the simulation to create a more realistic environment. The sound of a burning building, the crackling of flames, and the sound of water from the fire hose all contribute to the trainee's realistic experience. The sound of a fire engine is essential in creating a realistic and immersive experience because it produces a loud, trumpeting sound that breaks through other background sounds.

Animation:

Modeling fire behavior is a significant application of animation in a firefighter training simulation. This can involve showing how flames spread, how smoke behaves, and how different materials react to fire. By animating these occurrences, trainees can learn to anticipate prospective threats and plan their actions. The car animation can also be used to demonstrate how to interact with other road vehicles. Part of this is demonstrating how to blend into traffic, regulate intersections, and avoid collisions. By animating these conversations, trainees can learn the proper methods and develop the situational awareness needed to drive safely in traffic.

Interactivity:

Trainees are given the duty of planning and carrying out a simulated building evacuation. Identifying possible escape routes, establishing barriers, and cooperating with other reactions. In response to an emergency call, trainees ran a fire engine. This feature is activated when you engage the vehicle and start the engine. By including interactive smoke features in a VR firefighter training simulation, trainees can gain valuable experience navigating and handling the hazards connected with smoke in a controlled and safe environment.

Characters:

Characters in the environment (path-following behavior) may improve the realism of a virtual reality firefighter training simulation. Other firemen, victims, or other personnel that the trainee may encounter during a simulated emergency response can be represented by these agents. Trainees could act as if they were rescuing people from a burning building. The victims could be animated agents stationed throughout the facility, pursuing a predetermined path that the trainee must follow in order to locate and rescue them.

GOAL AND OBJECTIVES:

The goal of this project is to create a virtual reality training simulation for firefighters that uses AI to provide real-time feedback and coaching to users. The simulation will simulate different fire scenarios and provide feedback on how to respond to each situation.

This program serves as the foundation for a low-cost education for aspiring fire security officers and volunteer firefighters. This project does not imitate actual heat, but it instructs the user on how to deal with a fire mishap and the quick creation, growth, and spread of fire and smoke. The project is designed to help users comprehend a fire emergency situation.

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Argue briefly why this application is useful and why virtual reality is the appropriate technology for this project:
Virtual Reality (VR) is an immersive technology that allows individuals to experience a simulated environment and interact with objects and characters within it. This technology has the potential to revolutionize the way we train individuals in various fields, including firefighting.

Firefighting is a high-risk profession that requires extensive training and preparation to minimize the potential hazards and risks involved. VR-based firefighter training simulations offer a safe and controlled environment for trainees to learn and practice essential skills and procedures.

By using VR, trainees can experience various firefighting scenarios and practice responding to them, such as responding to a fire in a high-rise building, using fire extinguishers, and evacuating a building safely. They can also practice teamwork and communication skills in a virtual environment, which can be challenging to simulate in real-life situations.

Additionally, VR-based training simulations can help reduce the cost and time associated with traditional training methods. They can be easily updated and customized to reflect current firefighting practices and standards, and trainees can repeat scenarios until they feel confident and competent.

In conclusion, VR-based firefighter training simulations offer a safe, cost-effective, and efficient way to train individuals in firefighting. The immersive nature of VR makes it an ideal technology for this project, as it can provide a realistic and interactive training experience that is difficult to replicate in traditional training methods.

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VR is an immersive technology that allows individuals to experience a simulated environment and interact with objects and characters. It has the potential to revolutionize the way we train individuals in various fields, including firefighting. VR-based training simulations offer a safe and controlled environment for trainees to learn and practice essential skills and procedures. They can also help cut down on the expense and time involved with conventional training techniques.

While virtual reality-based firefighter training simulations offer numerous benefits, there are still some problems and shortcomings that need to be addressed to improve the effectiveness and practicality of the project.

One of the main issues encountered in VR-based training simulations is the lack of physical feedback, which can make the experience feel less realistic. While some haptic feedback devices exist, they are often costly and not widely available. Incorporating more physical feedback into the simulations could help enhance the realism of the training experience and better prepare trainees for real-life scenarios.

Another challenge is the limited field of view and resolution of current VR headsets, which can impact the trainee's ability to navigate and respond to virtual environments. As technology continues to improve, higher resolution and wider field of view headsets may become available, improving the overall effectiveness of the training simulations.

Additionally, creating realistic and accurate virtual environments that simulate various firefighting scenarios can be challenging and time-consuming. Future work could focus on improving the fidelity of virtual environments and creating more complex scenarios that reflect real-world challenges.

Lastly, it's important to ensure that trainees can transfer the skills and knowledge gained from virtual reality training simulations to real-life situations. While VR can provide a safe and controlled environment for trainees to learn and practice, there is still a need to validate the effectiveness of the training and ensure that trainees can apply what they have learned in real-life scenarios.

In conclusion, while virtual reality-based firefighter training simulations offer significant benefits, there are still challenges and shortcomings that need to be addressed to improve the effectiveness and practicality of the project. Addressing these challenges could help enhance the realism of the training experience and better prepare trainees for real-life firefighting scenarios.

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The screenshot above contains the basic environment of the project. The environment consists of all the elements in detail like streets, traffic, buildings etc.

Then the firefighters, fire engine and ambulance are added to the scene. We can observe fire on top of the building. When a fire hazard is encountered, the fire fighters along with fire engine and other required equipment enter the situation.