Active Shooter Response

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Final Project Report Under the guidance of Dr. Sharad Sharma

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1 ABSTRACT

The Virtual Reality (VR) project on Active Shooter Response aims to create a realistic training environment for individuals to prepare for and respond to active shooter situations. This VR environment provides a safe yet immersive space for users to simulate various scenarios and practice crucial decision-making skills under pressure. By leveraging the capabilities of 3dsMax and Unity, the project offers a comprehensive training tool accessible to a wide range of users.

Keywords- Virtual Reality (VR), Active Shooter Response, Training Environment, Realistic Simulation, Immersive Experience, Decision-Making Skills, 3dsMax, Unity, Comprehensive Training Tool, Scenario Simulation, Pressure Situations, Safety Training, User Accessibility, Skill Development, Emergency Preparedness

2 INTRODUCTION

2.1 GOALS OF THE PROJECT

Enhance Emergency Preparedness: Develop a virtual reality environment that simulates realistic active shooter scenarios to improve individuals' preparedness and response capabilities in emergency situations.

Improve Decision-Making Skills: Create interactive scenarios that challenge users to make critical decisions under pressure, fostering quick thinking and effective response strategies.

Facilitate Training for First Responders: Provide a safe and immersive training platform for law enforcement personnel, security professionals, and other first responders to practice active shooter response protocols in a controlled virtual environment.

Promote Situational Awareness: Enhance users' situational awareness by simulating dynamic environments with realistic audiovisual cues, encouraging vigilance and proactive response behaviors.

Evaluate Response Strategies: Enable users to test and evaluate different response strategies, such as evacuation routes, communication protocols, and engagement tactics, to identify effective approaches for mitigating active shooter threats.

Increase Confidence and Competence: Empower users with the knowledge, skills, and confidence to effectively respond to active shooter incidents, reducing hesitation and improving overall readiness.

Support Continuous Training: Establish a scalable and adaptable training solution that allows for ongoing practice and skill development, ensuring readiness for real-world active shooter scenarios.

Enhance Collaboration and Coordination: Foster teamwork and coordination among multiple stakeholders, including law enforcement agencies, security teams, and other relevant parties, to optimize response efforts and minimize casualties during active shooter incidents.

Address Psychological Preparedness: Incorporate elements to prepare individuals for the psychological challenges associated with active shooter situations, such as stress management techniques and psychological first aid principles.

Ensure Accessibility and Usability: Design the VR environment to be user-friendly and accessible to individuals with varying levels of technical proficiency, ensuring widespread adoption and effectiveness across diverse user groups.

2.2 Modelling

The VR environment is meticulously designed using 3dsMax and Unity, incorporating detailed models of buildings, landscapes, and characters. The modeling phase includes the creation of realistic geometry, textures, and animations to ensure an immersive experience for users.

The modeling for the Active Shooter Response VR environment is primarily done using 3dsMax and Unity, incorporating assets from both platforms and potentially from external sources such as the Unity Asset Store or custom-made models. The environment consists of indoor and outdoor settings, including buildings, streets, and open spaces, designed to simulate realistic locations where active shooter incidents may occur.

Main Building Interior: The primary focus of the modeling process is on creating a detailed interior of the main building, which serves as the central location for the active shooter scenarios. This

includes various areas such as offices, classrooms, corridors, stairwells, lobby areas, and other relevant spaces typically found in a multi-purpose building.

Exterior Facade: While the primary emphasis is on the interior, the exterior facade of the main building is also modeled to provide context and realism. This includes architectural details such as windows, doors, signage, and landscaping features surrounding the building.

Scenario-specific Elements: Within the main building, scenario-specific elements are integrated to simulate different scenarios related to active shooter incidents. This may include barricades, emergency exits, fire extinguishers, first aid stations, and other objects that play a role in emergency response procedures.

Texturing and Detailing: High-quality textures and materials are applied to surfaces within the main building to enhance realism and visual fidelity. Textures are carefully selected to match the interior design of a typical modern building, including walls, floors, ceilings, furniture, and fixtures.

Dynamic Elements: Interactive elements are incorporated within the main building to create dynamic and realistic scenarios. This includes movable objects such as chairs, tables, and equipment, as well as interactive props such as computers, telephones, and security systems that users can interact with during training exercises.

Character Models: Animated character models representing civilians, law enforcement personnel, and the active shooter(s) are created or sourced specifically for indoor environments. These characters exhibit realistic behaviors and movements within the confined spaces of the building, adding to the immersion and training experience.

Audiovisual Enhancements: Ambient sounds, lighting effects, and audio cues are carefully implemented within the main building to enhance the atmosphere and realism of the scenarios. Sound effects such as footsteps, voices, alarms, and gunfire are spatially designed to reflect the indoor environment accurately.

User Interface: An intuitive user interface is designed to provide users with essential information and controls relevant to the indoor environment. This includes scenario selection, navigation aids, communication tools, and performance feedback tailored to the layout and features of the main building.

Scalability and Customization: While the focus is on a single main building, the VR environment remains scalable and customizable to accommodate various training scenarios and objectives. Different floor plans, room layouts, and scenario configurations can be created within the main building to simulate different situations and challenges.

2.3 Output Usage

Training Scenarios: Individual Training: Users may learn active shooter response methods at their own pace by having individual access to the VR environment. Group Training: To promote cooperation and coordination among users, lead group training sessions where they can work together to respond to simulated scenarios. Role-specific Training: Customize training materials to fit the needs of particular roles, like law or military.

Educational Purposes: Academic Institutions: Give educational establishments a useful resource to instruct students in fields like psychology, public safety, criminal justice, and emergency management on emergency preparedness and response concepts. Professional Development: By providing immersive training experiences that add to traditional classroom instruction and hands-on exercises, support continuous professional development programs for first responders, security professionals, and other pertinent personnel. Training Programs: To integrate the VR environment into the current curriculum and training initiatives, collaborate with the organizations and agencies in charge of running active shooter response training programs.

Research and Development: Experimental Studies: Fund studies to find out how well virtual reality-based training interventions can improve response times and emergency preparedness in the event of an active shooter scenario. Customization of Scenarios: Permit researchers to alter and adapt training scenarios in order to investigate the effects of various factors on user performance and results, including threat scenarios, environmental conditions, and response tactics. Human Factors Analysis: To inform design improvements and optimization tactics, conduct human factors analyses to find ergonomic, cognitive, and psychological elements that affect user interaction and performance in the VR environment.

2.4 Programming

The Active Shooter Response VR Training application leverages the Unity game development platform, harnessing an array of meticulously crafted scripts to orchestrate the intricate behaviors and interactions within the virtual environment. These scripts assume pivotal roles in realizing the application's immersive and dynamic functionality

Enemy Script

- This script appears to be just a placeholder or an empty script, as it only contains two functions: Start() and FindSpawnPoint().
- The Start() function is a built-in Unity function that is called when the script is first loaded or instantiated.
- The FindSpawnPoint() function is likely used to find a suitable spawn point for the enemy agent within the virtual environment, but the implementation is not shown in the provided snippet.

Collectible Script

- This script seems to handle the behavior and interaction with collectable items in the virtual environment.
- It defines a list of collectible objects (collectibles) and a collectiblePrefab variable, which likely represents the prefab (template) for the collectible items.
- The Start() function instantiates the collectible objects from the prefab at random positions within the scene.
- The OnTriggerEnter function is a Unity callback function that is called when the player's collider enters the trigger collider of a collectible object. In this case, it triggers the collection of the item and likely performs any associated actions or events.

NavMesh Script

- This script seems to be responsible for managing the navigation mesh within the virtual environment.

- The Start() function is called when the script is first loaded, and it initializes the navigation mesh agent with the appropriate settings.
- The UpdateDestination function is likely used to update the destination of the navigation mesh agent, allowing it to navigate to different points within the environment.

PlayerManager Script

- This script appears to be a very basic implementation of the player manager functionality.
- It simply assigns a reference to the player object in the Start() function, which is called when the script is first loaded.
- The UpdatePlayer() function is not shown in the provided snippet, but it likely handles updating the player's state or behavior based on user input or other game events.

testCamFollow Script

- This script seems to be responsible for controlling the behavior of the in-game camera and making it follow the player's avatar.
- It defines variables for the player object, the camera's rotation speed, and a smoothing factor for camera movement.
- The Start() function initializes the player reference and sets the camera's initial position and rotation.
- The LateUpdate() function is a built-in Unity function that is called after all other game object updates have been processed. In this script, it calculates the desired camera rotation based on the player's position and rotation, and smoothly interpolates the camera's rotation towards the desired rotation using the Quaternion.Slerp function.

testScript

- This script appears to be a simple test or utility script, likely used for debugging or testing purposes.
- It contains a single function, Start(), which is called when the script is first loaded.
- Inside the Start() function, it performs some basic arithmetic operations and logs the results to the Unity console using the Debug.Log function.

WeaponSwitch Script

- This script handles the functionality of switching between different weapons available to the player character.
- It defines lists for the available weapons and their corresponding game objects and positions.
- The Start() function initializes the current weapon index and equips the first weapon in the list.
- The Update() function is a built-in Unity function that is called once per frame. In this script, it checks for input to switch weapons and performs the necessary actions to equip the new weapon and update the corresponding game objects and positions.
- The SwitchWeapon function is responsible for switching the current weapon, updating the game objects, and handling any associated animations or effects.
- The Transform function is likely a helper function used to calculate the desired position and rotation for the new weapon based on the player's current position and rotation.

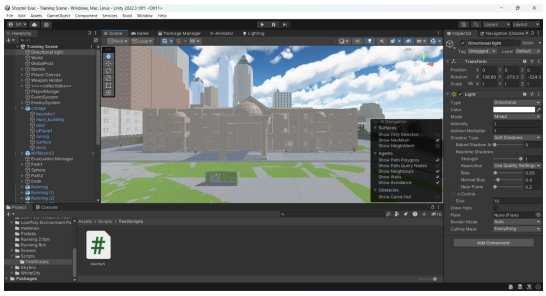

Figure 1: Overview of the Implementation

3 RELATED WORK

Lovreglio et al. [5] present a virtual reality serious game designed for active shooter scenarios, emphasizing the importance of immersive training environments in disaster risk reduction. Awada et al. [1] introduce an integrated emotional and physiological assessment approach for VR-based experiments on active shooter incidents, aiming to enhance understanding of human responses in such situations. Liu et al. [3] investigate the effectiveness of VR-based training in improving occupants' responses and preparedness for active shooter incidents, contributing to safety science research. Catal et al. [2] evaluate the use of augmented reality technology in the design of evacuation training games, offering insights into its potential applications in emergency preparedness. Lorusso et al. [4] propose a virtual reality platform for simulating fire emergency evacuations from school buildings, highlighting the role of immersive technologies in enhancing safety protocols. Zhu and Li [7] provide a comprehensive review of virtual and augmented reality technologies for emergency management in built environments, offering a state-of-the-art overview of research in the field. Zhu et al. [6] review human-building-emergency interactions and their impact on emergency response performance, emphasizing the need for integrated approaches in safety science research.

4 IMPLEMENTATION

The implementation of the Active Shooter Response VR Training application followed a modular approach, leveraging the Unity game engine and its robust set of tools and features. The process involved several phases, including modeling, asset integration, scripting, and user interface development.

4.1 Modeling Phase:

The virtual environment was meticulously crafted using a combination of 3D modeling software, such as 3ds Max, and Unity's built-in modeling tools. This phase involved the creation of the school building, classrooms, corridors, staircases, and outdoor areas, including parking lots and landscaping elements.

4.2 Asset Integration:

Pre-existing assets, including textures, 3D models, and animations, were seamlessly integrated into the Unity project. This phase ensured visual fidelity and realism, with textures applied to surfaces using materials like brick textures, and animations incorporated for

elements such as explosions, character movements, and simulated firing scenarios.

4.3 Scripting and Functionality:

The core functionalities of the application were implemented through extensive scripting in C#. This phase involved programming various systems, including character controllers, weapon systems, interaction systems, and animation controllers, among others.

5 FUNCTIONALITY

5.1 VISION

The virtual environment boasts a high level of visual fidelity, with detailed 3D models and meticulously applied textures. This attention to detail ensures a realistic representation of the school building, classrooms, and surrounding areas, enhancing the immersive experience for users.

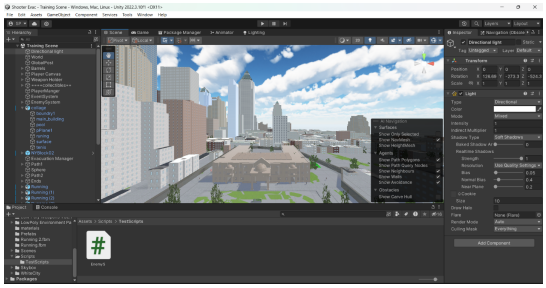

Figure 2: Image showing the Vision of the Shooter

5.2 SOUND

The application incorporates immersive audio elements such as ambient sounds, footsteps, gunfire, and explosions to amplify realism and offer auditory cues during the simulation. These sound effects not only enrich the overall experience but also bolster situational awareness and support decision-making processes.

5.3 ANIMATION

Dynamic animations play a pivotal role in the application, injecting vitality into the virtual environment. These animations encompass a range of elements such as character movements and explosions, adding to the authenticity and immersion of the scenario. By enhancing realism, these animations enable users to more effectively perceive and react to unfolding events.

5.4 INTERACTIVITY

Interactive engagement is a fundamental aspect of the application, empowering users to interact meaningfully within the virtual environment. Actions such as seeking cover, triggering explosions, and initiating evacuation procedures facilitate a deeper immersion and enable users to hone essential decision-making skills within a secure, controlled setting.

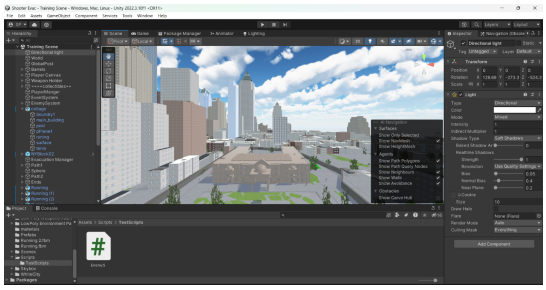

Figure 3: Image showing the animations involved

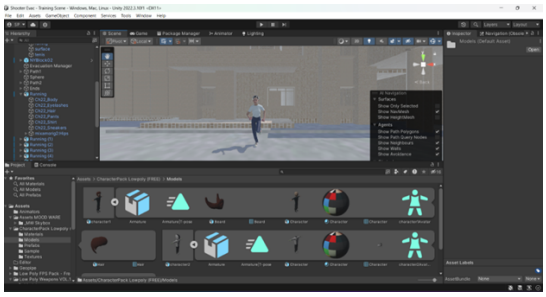

Figure 4: Shooter's interaction with the equipment in the environment

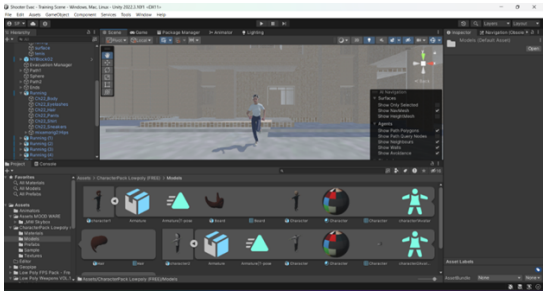

Figure 5

5.5 CHARACTERS / AVATARS

Within the virtual environment, animated characters portray students and the active shooter, displaying authentic behaviors and movements to deepen the immersive experience. Users have the option to embody a student, maneuvering through the environment and reacting to the developing scenario.

5.6 SENSORS

Various types of sensors have been implemented to detect and respond to specific events and conditions within the virtual environment. Proximity sensors are used to detect when users are near emergency exits or other critical areas, while touch sensors trigger events when users interact with objects.

5.7 PLAYER

The application includes a player controller, enabling users to explore the virtual environment from a first-person perspective. With this controller, users can freely navigate through the school building, classrooms, and outdoor areas, immersing themselves in the simulated scenario and feeling a sense of presence and control.

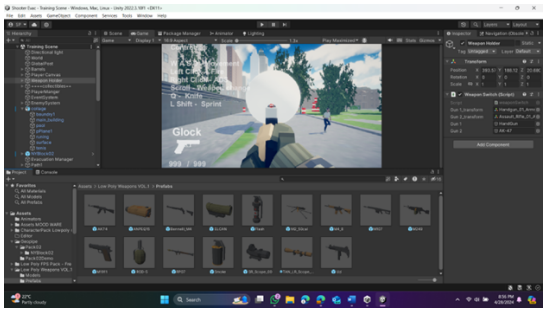

Figure 6: Image showing the first person controller

5.8 AI IMPLEMENTATION

Artificial Intelligence (AI) plays a crucial role in the Active Shooter Response VR Training application. AI-controlled agents exhibit context-specific behaviors based on the active shooter scenario, such as fleeing, seeking cover, or engaging with the threat. These behaviors are designed to mimic realistic responses, challenging users to adapt and make critical decisions in real-time.

5.9 INTERFACE ELEMENTS

The user-friendly interface of the application is crafted to elevate the overall experience and offer vital information and controls. It encompasses menu items, keypad buttons for selecting various behaviors for agents, guidance on navigating the environment, and a building map. Additionally, keypad buttons allow the shooter to fire, switch to a knife, and perform actions like jumping and running. These elements enable users to efficiently navigate and interact with the virtual environment while staying focused on the training objectives.

5.10 MULTI-USER ENVIRONMENT

While the application primarily emphasizes single-user training, it also explores the potential for a multi-user environment. This feature would enable multiple users to engage in the same virtual scenario, where one participant assumes the role of the shooter while others act as students. Such an approach facilitates collaborative training, fostering communication and coordination skills essential in emergency response situations.

6 SIGNIFICANCE

The Active Shooter Response VR Training application holds significant value for educational institutions and emergency response teams. By providing a risk-free and controlled virtual environment, it enables realistic and immersive training for active shooter scenarios, addressing a critical need for emergency preparedness and crisis management.

This application offers several advantages over traditional training methods. It allows users to experience and respond to simulated active shooter situations without compromising safety, reducing the risks associated with live exercises. Additionally, the virtual environment provides a controlled and repeatable setting, enabling users to practice and refine their response protocols under various scenarios.

Furthermore, the application promotes cost-effective and accessible training, as it eliminates the need for extensive physical resources and minimizes disruptions to regular operations. This accessibility empowers a broader range of organizations and individuals to benefit from this training, ultimately contributing to enhanced community safety and resilience.

7 PROBLEMS ENCOUNTERED

Throughout the development of the Active Shooter Response VR Training application, our team faced various challenges. One significant hurdle involved accurately modeling and replicating the intricate details of a school building and its surroundings to achieve a high level of realism and immersion. Additionally, while designing the classroom, we encountered errors during implementation in Unity.

Another obstacle was implementing realistic and dynamic behavior for the active shooter and other characters within the virtual environment. This required extensive programming and testing to ensure that AI-controlled agents exhibited believable and responsive behaviors.

Furthermore, optimizing the application's performance to maintain smooth and consistent frame rates, particularly in complex scenes with multiple characters and interactions, presented a significant technical challenge.

8 FUTURE WORK

While the current iteration of the Active Shooter Response VR Training application offers a comprehensive and immersive training experience, there are several potential areas for future development and improvement:

1. Multi-User Collaboration: Extending the application to support multi-user environments would enable collaborative training scenarios, promoting communication and coordination among response teams to active shooter incidents.

2. Scenario Randomization: Implementing a system for randomizing and diversifying active shooter scenarios could enhance the training experience by introducing unpredictability and preventing users from memorizing specific patterns or situations.

3. Performance Metrics Integration: Incorporating performance metrics and analytics would offer valuable data for evaluating user responses, identifying improvement areas, and customizing future training experiences accordingly.

4. Integration with Emergency Response Systems: Exploring integration with existing emergency response systems and protocols could enhance the application's real-world relevance and applicability.

5. Expansion to Diverse Environments: Expanding the virtual environment to include various settings like office buildings, shopping malls, or public spaces could broaden the application's usefulness

and prepare users for a wider array of potential active shooter scenarios.

9 SOFTWARES USED

Unity Game Engine: This served as the main platform for developing the virtual environment, scripting, and implementing various features.

3ds Max: Professional 3D modeling software employed for crafting detailed models of the school building, classrooms, and surrounding areas.

Visual Studio Code: An integrated development environment (IDE) used for writing and debugging C# scripts within the Unity engine.

Git: A version control system utilized for collaborative development and project file management.

10 LIMITATIONS

While the Active Shooter Response VR Training application offers a comprehensive and immersive training experience, it is important to acknowledge its limitations:

1. Realism Gap: Despite its immersive nature, the application cannot fully replicate the psychological and emotional stress of real-world active shooter scenarios.

2. Hardware Requirements: Effective usage of the application may demand specific hardware like powerful graphics cards and VR headsets, potentially limiting accessibility.

3. Learning Curve: Users unfamiliar with virtual reality technology may face challenges, impacting the effectiveness of training.

4. Maintenance Needs: As technology advances, the application will require regular updates to remain relevant and accurate, incurring additional resources and costs.

11 ACKNOWLEDGEMENT

We would like to express our sincere gratitude to our distinguished faculty advisor, Dr. Sharad Sharma, as well as our committed Teaching Assistants, Nanda Gowri Ganta and Rishitha Reddy Pesaladinne, whose unwavering guidance, insightful feedback, and valuable assistance have been crucial to this project at each stage. Their knowledge and guidance have influenced our study as well as our academic journey.

We would also like to express our sincere gratitude to the University of North Texas Department of Information Science for providing the resources, facilities, and a conducive environment that made developing this application possible. With their help, we were able to investigate creative ideas and develop the application of virtual reality technology.

We want to express our gratitude to our hardworking team members for their efforts and dedication to this project. Their combined knowledge, passion, and hard work were crucial in overcoming obstacles, perfecting the app, and guaranteeing its influence in the fields of crisis management and emergency preparedness.

12 RESULTS

The development of the Active Shooter Response Virtual Reality Training application has produced noteworthy results in terms of equipping users to react to active shooter situations in an efficient manner. First off, users now have access to a lifelike simulation of active shooter situations because of the development of an immersive training environment. Users are immersed in scenarios that closely mirror real-world events via carefully designed settings and dynamic audiovisual cues, which promotes a realistic training experience.

Second, by giving users interactive situations to choose from that test their ability to make important judgements under time constraints, the application has effectively improved users' decision-making abilities. The application encourages rapid thinking and efficient reaction techniques by mimicking several emergency scenarios and asking users to react in real-time. This eventually increases users' preparedness to handle situations of crisis.

Finally, the Active Shooter Response VR Training application has proven to be a useful training resource for a variety of user bases. Because of its accessibility and user-friendly design, the application may be used for a wide range of training needs by professionals in the security, law enforcement, and educational institutions. Its relevance in enhancing disaster preparedness and crisis management campaigns is highlighted by its capacity to provide ongoing practice and skill building for real-world active shooter scenarios.

13 DISCUSSION

The Virtual Reality (VR) project on Active Shooter Response looked at in this report demonstrates significant advances in emergency preparedness training through immersive technology. Throughout the project, the VR environment created with 3dsMax and Unity provided a realistic platform for simulating various active shooter situations. This permitted users to participate in comprehensive training sessions that improved their capacity for decision-making, situational awareness, and responses under pressure.

The incorporation of realistic models, textures, and dynamic elements into the VR environment was critical in delivering an authentic and immersive experience. The use of audiovisual enhancements and interactive props added to the realism of the scenarios, providing trainees with an extremely engaging learning environment. The ability to simulate both indoor and outdoor settings effectively prepared participants for potential real-life situations, emphasizing VR's utility in high-stakes training contexts.

Furthermore, the project addressed individuals' psychological preparedness by incorporating stress management techniques and psychological first aid, both of which are essential for dealing with real-life crises. The VR system's scalability and customization options ensured that the training could be tailored to meet a variety of educational and professional development requirements, making it a versatile tool in emergency management training.

14 CONCLUSION

The Active Shooter Response VR Training application represents a significant leap forward in emergency preparedness and crisis management. Leveraging virtual reality technology, it offers a secure environment for immersive training in active shooter scenarios.

Through meticulous modeling, scripting, and implementation, the virtual environment achieves realism and interaction, allowing users to practice critical decision-making and response protocols.

Integration of AI-controlled agents and dynamic animations enhances authenticity.

While the application has limitations, its potential to enhance community safety and resilience is substantial. As technology evolves, future iterations may introduce features like multi-user collaboration and scenario randomization, further enhancing effectiveness.

Ultimately, the Active Shooter Response VR Training application underscores the transformative role of virtual reality in addressing real-world challenges, emphasizing the need for ongoing innovation in this field.

15 APPENDICES

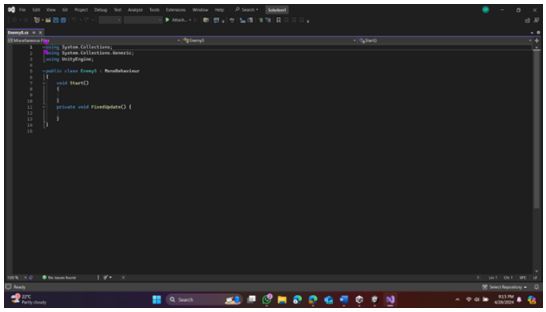

Figure 7: Enemy Script

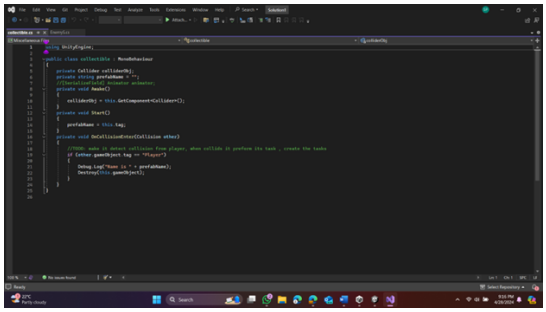

Figure 8: Collectible

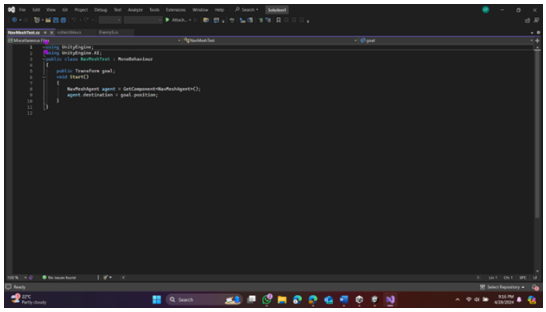

Figure 9: Nav Mesh

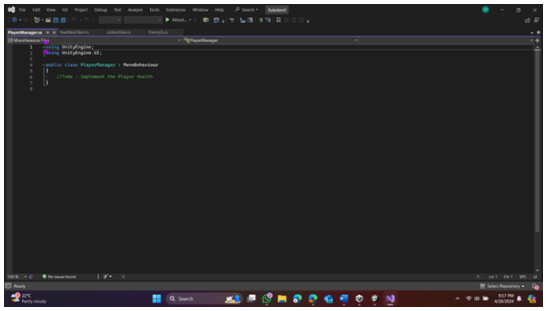

Figure 10: Player Manager

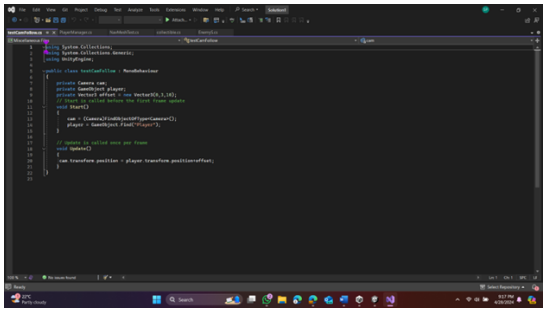

Figure 11: Test Cam Follow

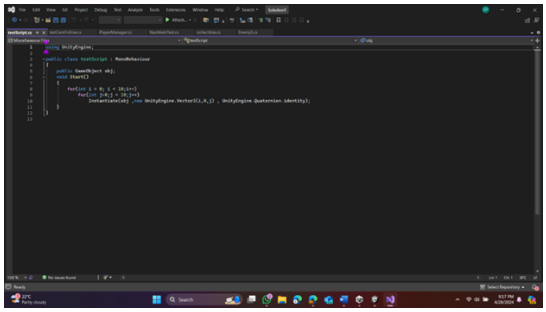

Figure 12: Test Script

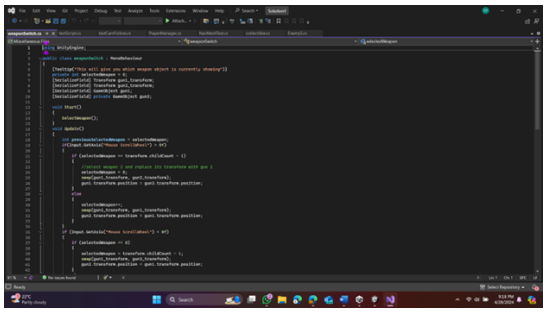

Figure 13: Weapon Switch

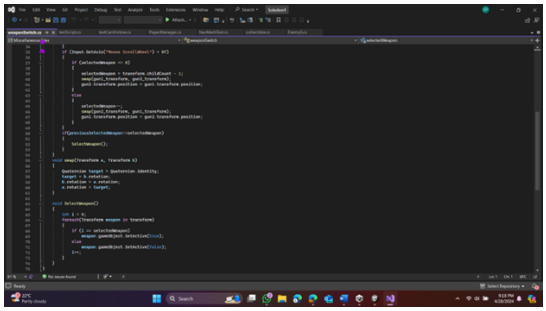

Figure 14

16 MANAGEMENT PLAN:

1.Sreya will be responsible for the modeling of the building and environment. 2.Varun and Sai Teja will be responsible for the implementation of the AI functionality. 3.Priyanka and Sushanth will be responsible for the implementation of the interface and interactivity. 4.All group members will be responsible for testing and debugging the simulation.

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