GNG 1103

Deliverable K - Design Project User and Product Manual

Submitted by:

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December 10th, 2023

University of Ottawa

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Table 1. Acronyms

Acronym	Definition
L.A.W.S	Lethal Autonomous Weapons System
MAC	Mines Action Canada
UPM	User and Product Manual

Table 2. Glossary

Term	Acronym	Definition
Lethal Autonomous Weapons System	L.A.W.S	A system in which weapons have been programmed to target specific individuals.
Mines Action Canada	MAC	Canada's leading humanitarian disarmament organization
User and Product Manual	UPM	A manual which describes the use and purpose of a product to the user.

1   Introduction

This User and Product Manual (UPM) provides the information necessary for VR users, Mines Action Canada, decision makers (world leaders), engineering students and professors, and any interested individual, to effectively use the HTC Vive for this VR simulation and for prototype documentation.

Mines Action Canada (MAC) is an organization whose aim is to eradicate the effects of indiscriminate weapons, such as land mines, autonomous weapons, explosives, and more. We have been tasked by MAC to create a VR world that simulates an environment in which autonomous weapons systems are in use. This world should reflect how people would adapt to this scenario if it were to happen in the future, which is a possibility. This document dives into the details of our project, more specifically, how to access and use the system, troubleshooting and support, product documentation, and concluding with recommendation for future work.

This project was put together by Group 16 of the course GNG1103 of the 2023 Fall Semester from the University of Ottawa.

2   Overview

Autonomous weapons pose a threat to the wellbeing of everyone around them. These weapons have the ability to select and harm their target without human input. They possess various types of sensors which aid them in choosing their target, such as heat sensors, facial sensors and movement sensors. The data collected from these sensors is compared against a target profile. The object or person will be selected as a target to the autonomous weapons based on how close the data matches this target profile.

Having this ability can pose a great risk if the sensors mistake an innocent civilian for a target. To protect the lives of innocent citizens and to prevent catastrophe due to autonomous weapon misfires, Mines Action Canada has made it a priority to ensure that these weapons are never created.

Our group, Team Fire (Group 16), has collaborated with Mines Action Canada to create a virtual reality (VR) simulation of what the world could look like if these autonomous weapons were to be invented. This immersive experience puts the user in a seemingly regular city that has been touched by the destruction of autonomous robots. The user is able to interact with this environment through various objects and is encouraged to

This simulation was created using Unity. This simulation is playable using the HTC Vive VR headset and can be run on any computer which supports Steam VR.
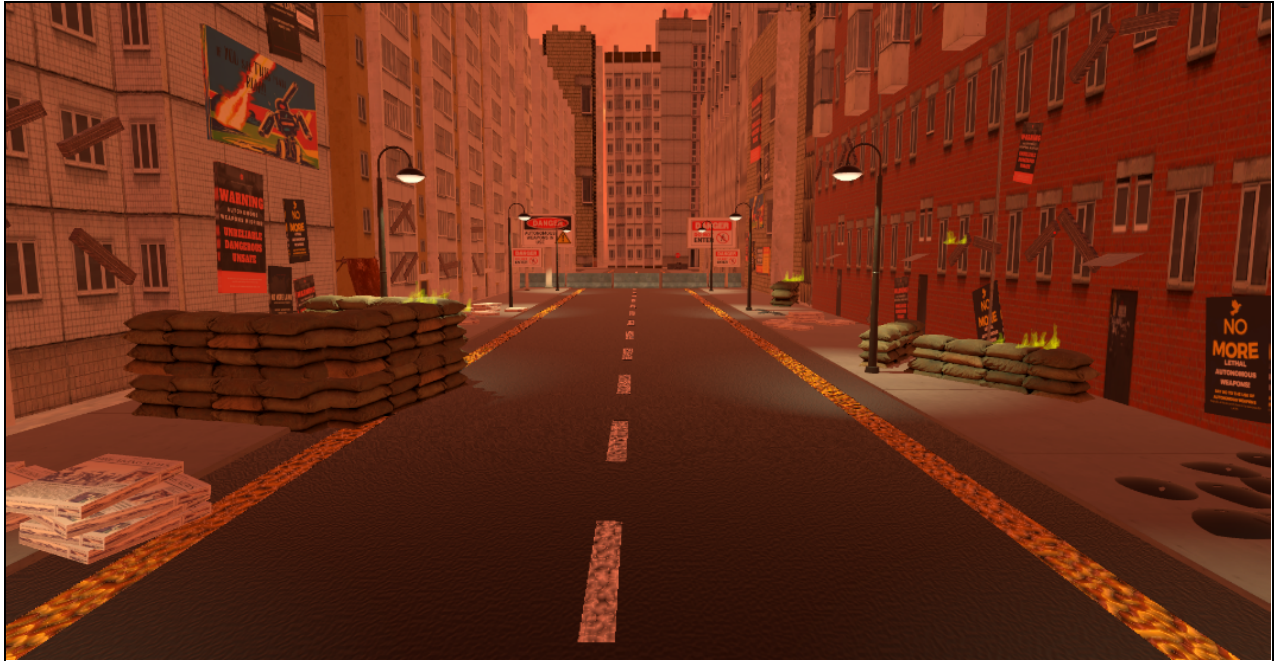
Figure 1: Image of VR Simulation

2.1 Cautions & Warnings

This simulation may contain triggering or sensitive material for some audiences. This simulation includes triggering sound effects (explosions, sirens and screaming) and suggests violence.

3 Getting started

This section will focus on instructions for how to set up the VR simulation. Instructions will feature links to softwares needed to be installed, what equipment will be needed and how to open the simulation.

3.1 Configuration Considerations

In this virtual environment, the sky is red and cloudy to give a sense of urgency. The cityscape looks damaged and abandoned, with posters, sandbags, barricades, and fire covering the roads. These assets were built into the environment, and some can be interacted with. The newspapers and the masks lying on the ground all over the map can be picked up and interacted with. The system has a built-in audio that will automatically play once the "play" button is pressed. The sole requirement for this feature is headphones that are attached to the VR headset, or that can be plugged into the PC. Finally, a teleportation feature was implemented into the system, to allow for complete exploration of the map created, without needing a large room to walk around in. This feature can easily be utilised with the VR controllers. First, the controllers must be turned on and plugged into the PC. Then, by pointing with the controller at the region where the user would like to move to, the user must press the main button on the controller and they will be teleported to that location in game.
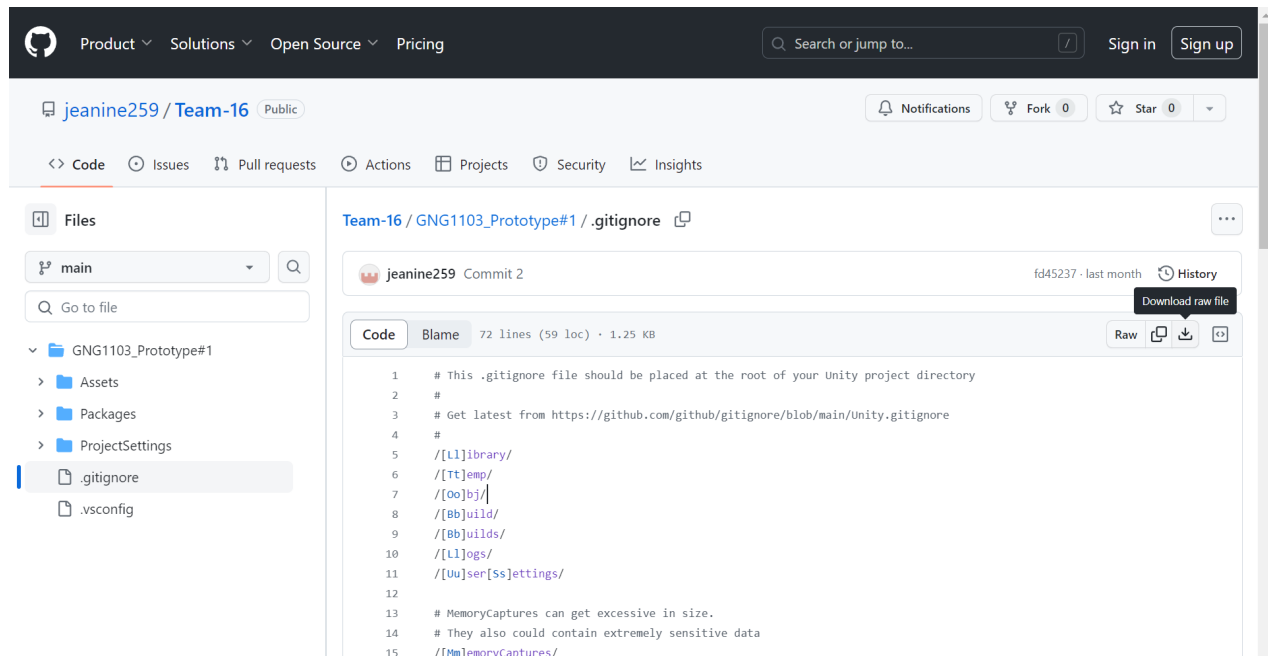
3.2   User Access Considerations

The purpose of this prototype was to convince decision makers on the use of autonomous weapons. This prototype was designed for the use of Mines Action Canada and politicians that make decisions on the use of autonomous weapons. This virtual environment includes audio that may be triggering to those with post traumatic stress disorder from war, violence, and/or weapons. The audio in our system does not have closed capturing, so those who are hearing impaired. The last accessibility restriction is potential motion sickness from the VR headset itself. The system includes a teleportation feature with the handheld controllers, so physical movement is not required.

3.3   Accessing/setting up the System

To access the VR environment, Unity, Steam VR and Unity SteamVR plugin must be installed onto the PC. These applications can be downloaded here: https://unity.com/, https://store.steampowered.com/app/250820/SteamVR/, https://assetstore.unity.com/packages/tools/integration/steamvr-plugin-32647.

Once Unity and Steam VR are installed onto your PC, the VR environment can be downloaded from Github at the following link: https://github.com/jeanine259/Team-16.

Figure 2: Github Group 16 Repository

After setting up your software, a VR headset must be connected to your PC along with the two VR cameras. The type of VR headset is dependent on the user's budget, and whether the user wants headphones attached with the VR headset. Use of the HTC Vive VR headset is recommended.

3.4   System Organization & Navigation

Once Unity is installed to your PC, you can open it and create an account or sign in. When logged in, make sure you have the version 2022.3.10 LTS installed to your computer by going to Installs → Install Editor.
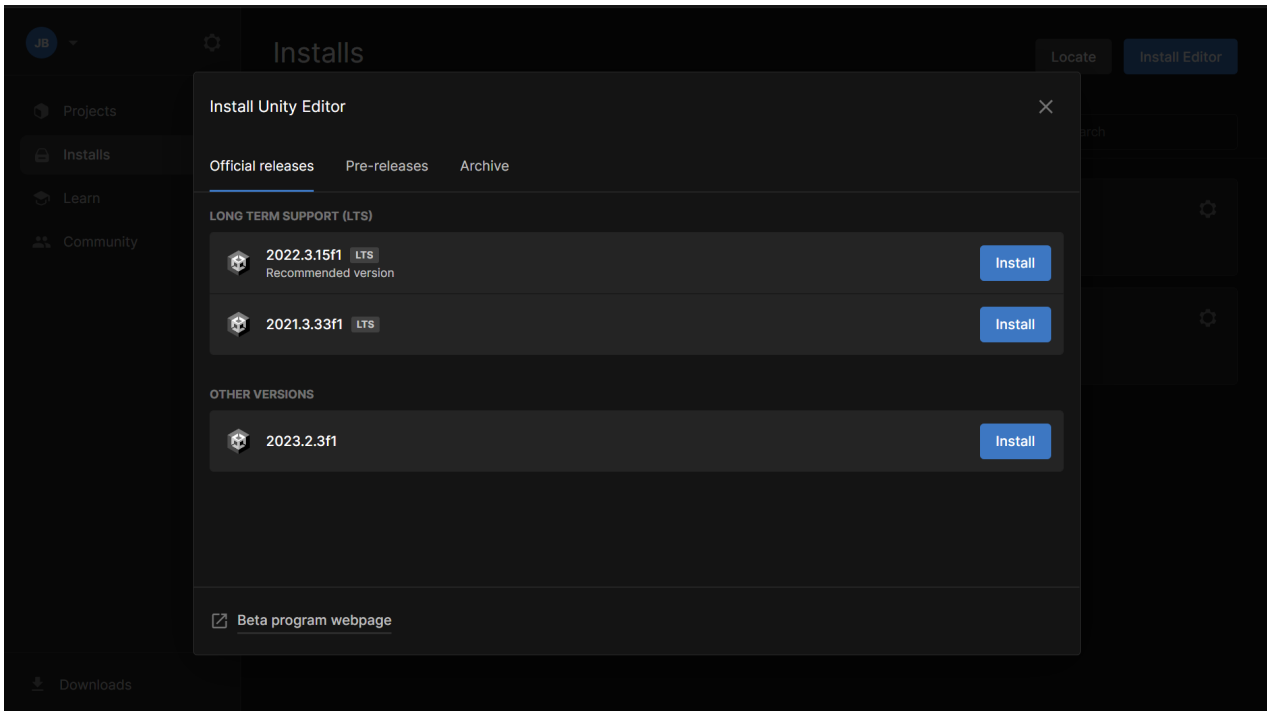
Figure 3: Installing Unity version 2022.3.10 LTS

To access the simulation on Unity, go to the Projects tab and click on add. Select the downloaded simulation from your file explorer. Now the VR simulation should appear in your projects list. Click on the simulation to open it.
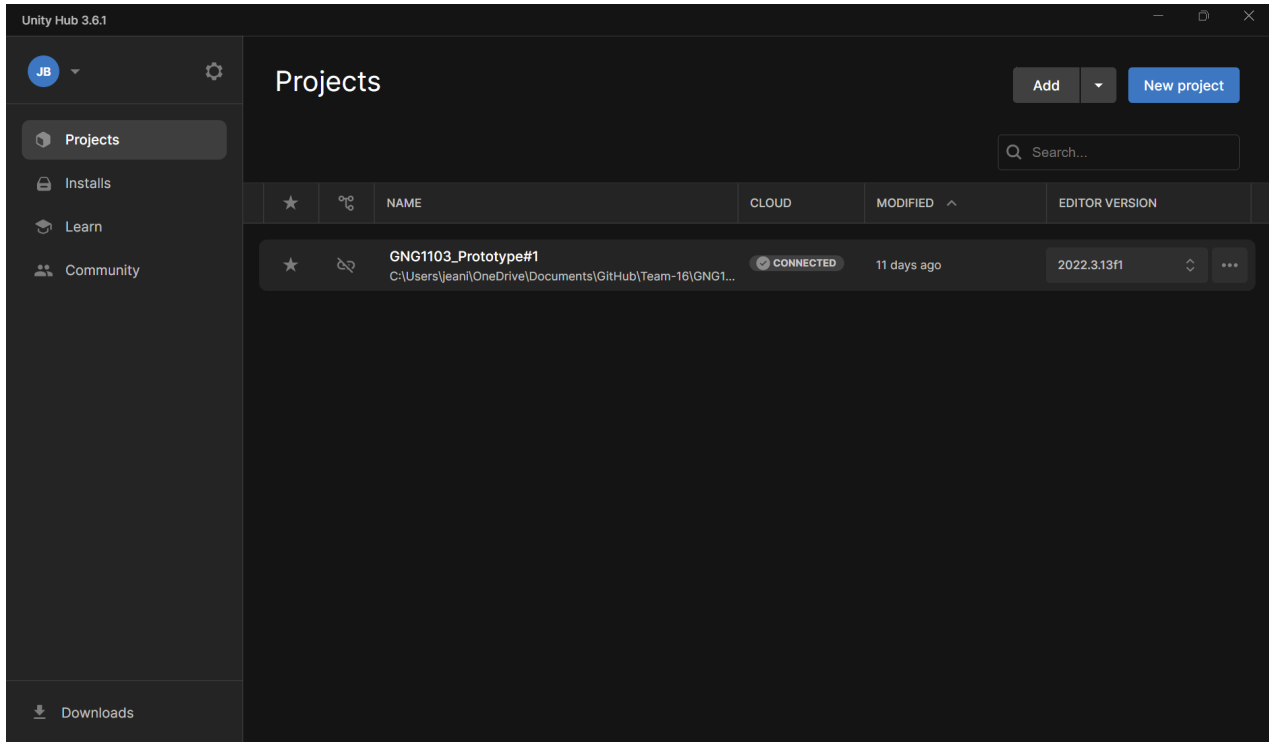
Figure 4: Accessing the VR simulation

The home page for the system is the main Unity workspace. Here you will find a preview in the middle of the screen, the assets, objects, and textures used listed to the left of the preview, and all files and scripts at the bottom of the workspace.

All that is required to launch the system is to press on the blue play button at the top of the screen as shown in the figure below:
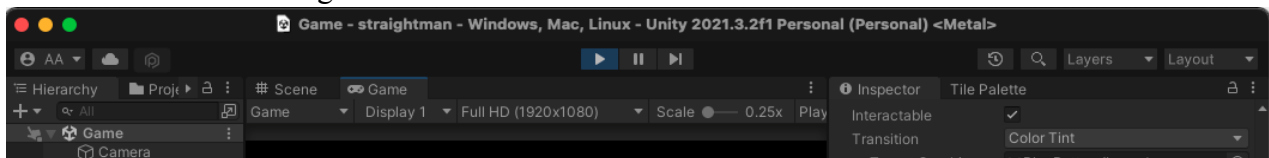
Figure 5: Unity workspace

Once the simulation has been played, the SteamVR application should open with a preview of the player's VR headset view (the following image does not have this as there was no available VR headset at the time of demonstration).

Figure 6: Playing the VR simulation

3.5   Exiting the System

To begin, remove the VR headset from the user's eyes and the VR controllers from the user's hands. Next, to exit the play mode, press the same play button as shown in Figure 3 to stop the game mode. Unity can now be closed, and the VR headset can be turned off. Lastly, turn off the computer.

4   Using the System

The following subsections provide detailed, step-by-step instructions on how to use the various functions or features of the HTC Vive VR headset and controller. The figure below, found on the Unreal Engine Forum, shows the HTC Vive's controller and its buttons and functions. The buttons are what help us activate the features discussed in the next section.
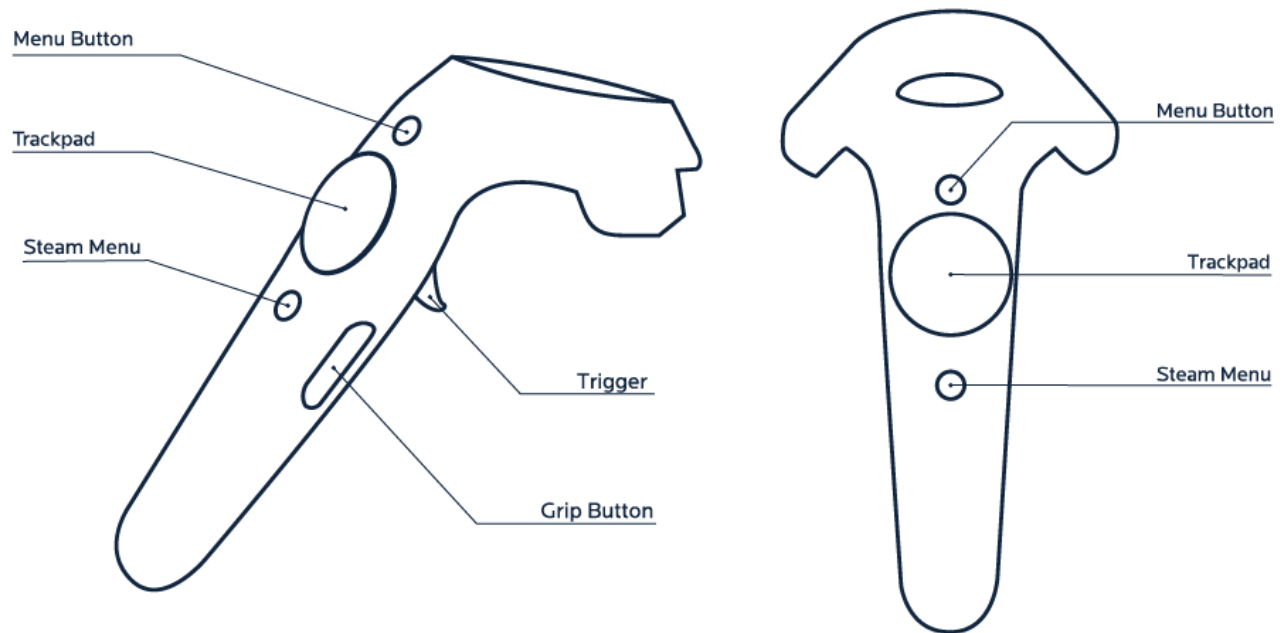
Figure 7: HTC Vive VR Controller (image taken from https://forums.unrealengine.com/t/vive-controller-rotation-axis-to-skeletal-mesh-head-bone/466537).

The trackpad and the trigger are the two main components of the VR controller that will be used by the user with our VR simulation. They both have a button function which allows the player to select/use different features in the VR simulation.

4.1   Movement

For movement, we opted for a teleportation style of movement. In order to move around in the VR simulation, the user would use the trackpad. The following subsection entails steps on how to activate the different movement styles, namely teleportation and side to side movement.

4.1.1   Teleportation

Press on the upper section of the trackpad while pointing towards the region the user desires to move to. An arc will appear in front of the user ending on the position of the plane in which they will be in once the trackpad button is released. The figure below illustrates the arc

formed from the controller in the VR simulation.
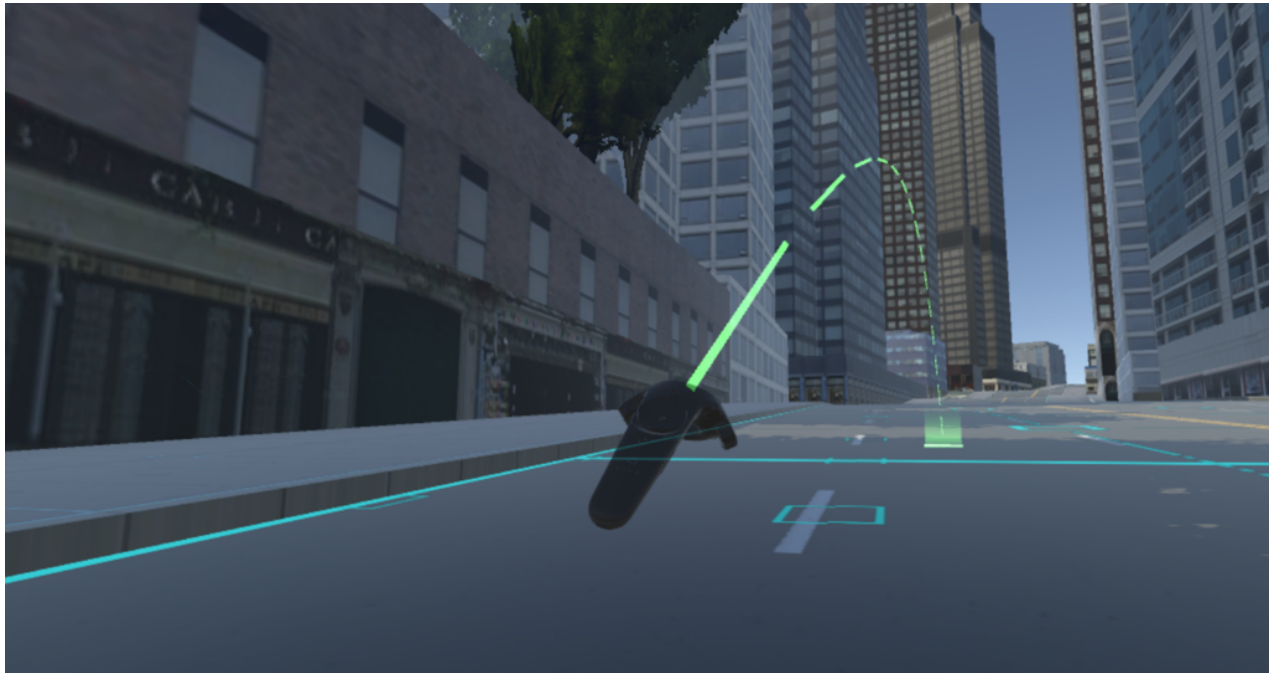
If the arc turns red, it indicates that the teleportation operation cannot be done as it is not in the bounded region.

4.1.2   Side to side movement

For side to side movements, press the right and left sections of the trackpad to move in the respective positions.

4.2   Pick up feature

The pickup feature can be used to pick up newspaper scattered from the floor (can be seen in bottom left of Figure 1). In order to pick up the newspaper, the user must physically lower themselves to an appropriate level to be able to pick up the newspaper, as one would do in real life. Press the trigger to activate the pickup feature and pick up the newspaper. The newspaper should be attached to the user's hand in the virtual world as long as the trigger is being held. To release the newspaper simply release the trigger on the controller.

5   Troubleshooting & Support

5.1   Error Messages or Behaviors

When handling the product, there may be an error in Unity where the user is unable to properly move around the scene when out of game mode. This is due to a compatibility

issue with Steam VR and Unity. There are methods to solve or remedy this problem. The remedy is to use an alternative method of movement when editing the scene. This entails the user using the arrow keys on their computer instead of the traditional "WASD" keys to move. A solution to this problem would be to first launch the project file in unity. You would then hover your cursor over the assets portion of the Unity editing interface which is in the bottom right of the Unity workspace. Once you find yourself in this section of the interface, you will find the search bar applicable to this section of the interface. Prompt into the search bar "GNG 1103 Prototype 1" and the correct scene file should pop up. Click on it. After you click on this file, the scene should be visible in the middle of the interface. Once this is launched, if you notice that the typical methods of movement when editing a scene in Unity are not functioning, you might consider fixing it. To do this, head back into the assets portion of the workspace previously mentioned, go to the search bar, and type "Steam VR". If you want to solve this issue, you will need to right click on each of the major Steam VR assets and simply delete them. Once you do this you will notice that the typical controls become active once again. The Steam VR assets can be added back into the project at a later date if desired.

5.2 Maintenance

It is always a good idea to ensure that the drivers on the computer you are using are up to date in order to ensure the most optimal performance when handling this product. It is also a very good idea to ensure that Unity is installed with respect to its latest release so that any bugs or glitches that have been found by Unity programmers are resolved when you launch this product.

5.3 Support

If any issues arise regarding this product. The user is encouraged to make good use of the Unity support page on the internet. https://support.unity.com/hc/en-us

6 Product Documentation (Marho)

1. Unity VR Environment Design:

Design Considerations:

- Identify key VR experience goals, such as creating empathy and awareness about the dangers of autonomous weapons.
- Consider user interaction within the VR environment to effectively convey the anti-autonomous weapons message.
- Choose appropriate VR assets, textures, and lighting to create an immersive and emotionally impactful experience.
- Ensure that the proportions of the buildings in relation to billboards or humans are realistic.

2. Interactive Elements Development:

Design Considerations:

- Define the interactive elements within the VR environment, such as simulations of autonomous weapons.
- Consider user interface design for menu navigation and information display.
- Plan for realistic and engaging interactions to promote user involvement.

Coding and Testing:

- Develop scripts for interactive elements using Unity's C# scripting language.
- Implement VR controls and gestures for user interaction.
- Test for user engagement, responsiveness, and overall immersion in the VR environment.

3. Storyline and Narration:

Design Considerations:

- Develop a compelling narrative that effectively communicates the dangers of autonomous weapons.
- Consider pacing and sequencing to maintain user interest throughout the VR experience.
- Plan for audio elements, including background music and voice overs.

Coding and Testing:

- Implement dialogue and narration through Unity's audio system.
- Test for synchronization of audio and visual elements.
- Gather user feedback on the storyline and adjust as needed.

4. Material and Asset Selection:

Considerations:

- Identify key objects and scenes that require specific textures or 3D models to convey the intended message.
- Consider the ethical implications of using realistic representations of weapons in the VR environment.
- Analyze the emotional impact of chosen assets on the user.

Feasibility Analysis:

- Test alternative textures and assets to find the right balance between realism and emotional impact.
- Consider user feedback on the choice of assets and adjust accordingly.

5. Iterative Testing and Optimization:

- Conduct iterative testing with VR users to gather feedback on the overall experience.
- Optimize graphics, interactions, and performance based on user feedback.
- Ensure compatibility with VR hardware devices.

6.1 Subsystem 1 of prototype

6.1.1 Bill of Materials
The Bill of Materials is shown below in Table 3.

Table 3. Bill of Materials

Parts/Materials	Library/platform	Price
Fire	Unity Store https://assetstore.unity.com/packages/vfx/particles/particle-pack-127325#reviews	$0
Masks	CAD Onshape https://cad.onshape.com/documents/9861c9509da0b8c4f08d1d19/w/4e0ac2cee3a183c0c15f7c1a/e/347c4e0bb24e4de5b5247cf8?renderMode=0&uiState=6576558e4acfe91135135d41	$0
Skyline/weather	Unity Store https://assetstore.unity.com/packages/2d/textures-materials/sky/sunset-skyboxes-pack-1-2352	$0
Sandbags	Unity Store https://assetstore.unity.com/packages/3d/props/exterior/realistic-sandbags-95964	$0
Tarps	Unity Store	$0

	Bush-Craft Extension Pack | 3D Tools | Unity Asset Store	
Road Blocks	Unity Store https://assetstore.unity.com/packages/3d/props/exterior/road-blocker-663	$0
Audio	FL studio	$0
Buildings	Unity Store https://assetstore.unity.com/packages/3d/environments/urban/russian-buildings-lowpoly-pack-80518	$0
Roads	Unity Store https://assetstore.unity.com/packages/vfx/shaders/substances/customizable-road-material-shader-260181	$0
Posters	Canva	$0
Billboard	Unity Store https://assetstore.unity.com/packages/3d/environments/urban/road-props-pack-51319	$0

6.1.2   Equipment list
- Steam VR
- Github
- Vivo headset
- Oculus headset
- Vive VR headset
- Canva
- FL studio
- Unity
- CAD

6.1.3   Instructions

Below is a list of instructions on how to create this type of VR environment:

- Add the plane & camera
- Add all base assets, including buildings, skyline, roads, sidewalks, street lamps, etc.
- Add all other Assets, including billboards, Posters, Newspapers, Sandbags, Fire, etc.
- Make sure to arrange all assets to your liking, manipulate and change textures and dimensions settings of Assets.

- At this point you can test that all assets placed in the scene are compatible with each other and fix any errors that come up along the way.
- Add your scripts. We operated 2 main scripts, the 360 degree camera view script and the intractability script.
- The 360 degree script can be obtained by referring to the GNG 1103 lab manual
- Test the functionality of all cameras by troubleshooting each view individually
- Please visit: gng1103/teamfire.pleasecanwegetanA+/help.com for further instructions

6.2   Testing & Validation

Table 4. Tests

Test ID	Test Objective (Why)	Basic Test Method (What)	Analysis/Results
1	Determining if all assets are compatible in a single VR environment	Place buildings/props/audio on the plane and play the Unity game. Search for any defects.	Running the game on the PC alone, there were no issues detected. Using the desktop computer and VR headset there were no issues detected. Therefore, it passed the Test.
2	Determining if audio is properly activated by user interaction (radio).	Add audio into the unity scene and play the Unity game to check if the audio is playing/can be heard by the user.	The audio was cracking in some areas but this was due to how the sound was transferred, the original audio was fine. The Audio was imported into unity again and it sounded better. We used the Vive Vr headset to test if you could hear the Audio as the game was being played. Yes you could. Therefore, it passed the test.
3	Determining if the user can look around with a 360° view.	Add the scripts and play the Unity game. Use the arrow keys to check if the 360° camera works.	We easily tested this using our personal computers and it worked. We went further to test this using the Vivo VR headset and it worked. Therefore, it passed the test.

4	Testing if users can teleport/move past the barriers.	Will be tested by using the VR headset and controllers and seeing if we are able to move past the barriers. The test will be indicated as failed if users can pass past the barriers, and indicated as a pass if they can't.	For this to work we had to add a new plane in the VR and set the boundaries for the teleportation then add the script to the road. This worked perfectly fine. We just need to explain this before the user tries out the VR. Therefore, it passed the test.
5	Testing newspaper and poster intractability.	Will be tested by using the VR controllers to see if it is possible to pick up the posters and move them around. The test will be indicated as failed if the user can't pick up the newspapers and posters, and indicated as a pass if they can.	It was a little bit hard to interact with the Newspapers and Masks at first. So we had to make them rigid bodies first, then assign a mass. We also increased the height of the Newspapers to make them easier to reach. After all this we were able to successfully pick up the newspapers and even throw them. Therefore, it passed the test.
6	Testing if the user's height is appropriate for gameplay in the scene	Will be tested by using the VR controllers. Testers will give feedback on if the scale of their bodies compared to the buildings is proportionate. The test will be indicated as failed if the user says the proportions are not realistic, and indicated as a pass if it is realistic.	All users found the buildings large enough, height did not matter. Therefore, it passed the test.
7	Testing if the user is able to understand the context of the storyline.	Will be tested with non-group member testers using the VR headset and controllers. Testers will give feedback as to what they think the scene is trying to convey. The prototype will have failed the test if users are not able to understand the key points as listed in a document (Ex. "autonomous robots", "hiding from autonomous weapons" etc.)	Users were able to understand the context, through the posters and the signs. The audio message made it better. Therefore, it passed the test.

7   Conclusions and Recommendations for Future Work

In conclusion, our team was able to accomplish a variety of different things with regards to the design project. We were able to assemble a simulation with an environment, audio, and user intractability. These elements resonated together to create an immersive virtual reality experience with the ultimate goal of evoking a sense of concern from decision makers. This sense of concern, when achieved, would ideally lead to decision makers passing a bill to ban autonomous weapon systems. Together, we have learned many different things related to teamwork, time management, and design thinking. However, there is still room for improvement. To be specific about what could have been done better, it would be most insightful to first talk about these elements of our design. The environment of our simulation was good, however, there are many things that we could have changed if we were given more time. For example, one of our goals for the design was to provide the user with a realistic environment that made them feel like they were actually present in the simulation. We accomplished this to a certain extent, but one of our roads leads directly into a residential building. Consequently, this would make the user feel like they were in an unrealistic environment.

With regards to the audio element, there were many things we could have done differently. This could have been done correctly in a variety of different ways. We chose to take a specific direction where we aimed to provide the user with only the ambience of the environment. This means we had no narrator, no real storyline, and we stuck with having audio that would make the user feel present. If we were given more time, we would have added a narrator. This would make the simulation seem much more engaging and would add some personality to the design.

Regarding the element of user intractability, we had to make a few sacrifices. Initially, we planned on having the user interact with a variety of different things such as newspapers, physical radios, and the masks that were designed. However, due to time constraints, we were only able to finish making the newspapers in our simulation intractable. If we were given more time, we would have made the masks intractable in the sense that the user would actually be able to wear it and we would have also added physical radios where the user could push a button to prompt a variety of different audio files.

8   Bibliography

3D Visualization & Analytics. (2017, September 12). *GIS2VR: From CityEngine via Unity to HTC Vive.* https://www.esri.com/arcgis-blog/products/3d-gis/3d-gis/gis2vr-from-cityengine-via-unity-to-htc-vive/

Frank_o_Malley. (2020, June 10). *Vive controller rotation axis to skeletal mesh head bone.* https://forums.unrealengine.com/t/vive-controller-rotation-axis-to-skeletal-mesh-head-bone/466537

International Committee of the Red Cross. (2023, October 18). *What you need to know about autonomous weapons.* https://www.icrc.org/en/document/what-you-need-know-about-autonomous-weapons

APPENDICES

9   APPENDIX I: Design Files

MakerRepo link:
https://makerepo.com/rohangopaul/1888.gng1103-stop-killer-robots-vr-simulation

Table 5. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Team_Contract_GNG1103_Group 16	📄 Team_Contract_GNG1103_Group 16	Sept 24th, 2023
GNG1103 Deliverable B Group 16	📄 GNG1103 Deliverable B Group 16	Sept 29th, 2023
GNG1103 Group 16 Deliverable C	📄 GNG1103 Group 16 Deliverable C	Oct 5th, 2023

GNG1103 Group 16 Deliverable D	📄 GNG1103 Group 16 Deliverable D	Oct 8th, 2023
GNG1103 Group 16 Deliverable E	📄 GNG1103 Group 16 Deliverable E	Oct 15th, 2023
GNG1103 Deliverable F Group 16	📄 GNG1103 Deliverable F Group 16	Oct 29th, 2023
GNG1103 Deliverable G Group 16	📄 GNG1103 Deliverable G Group 16	Nov 5th, 2023
Project Deliverable H	📄 Project Deliverable H	Nov 12th, 2023
Client Meeting Presentation	🟨 Client Meeting Presenation	Nov 3rd, 2023
Final Presentation: GNG1103 Group 16	🟨 Final Presentation: GNG1103 Grou…	Nov 12th, 2023
Group Fire (16): Pitch	🟨 Group Fire (16): Pitch	Nov 28th, 2023