Technical Project ESOF-2918

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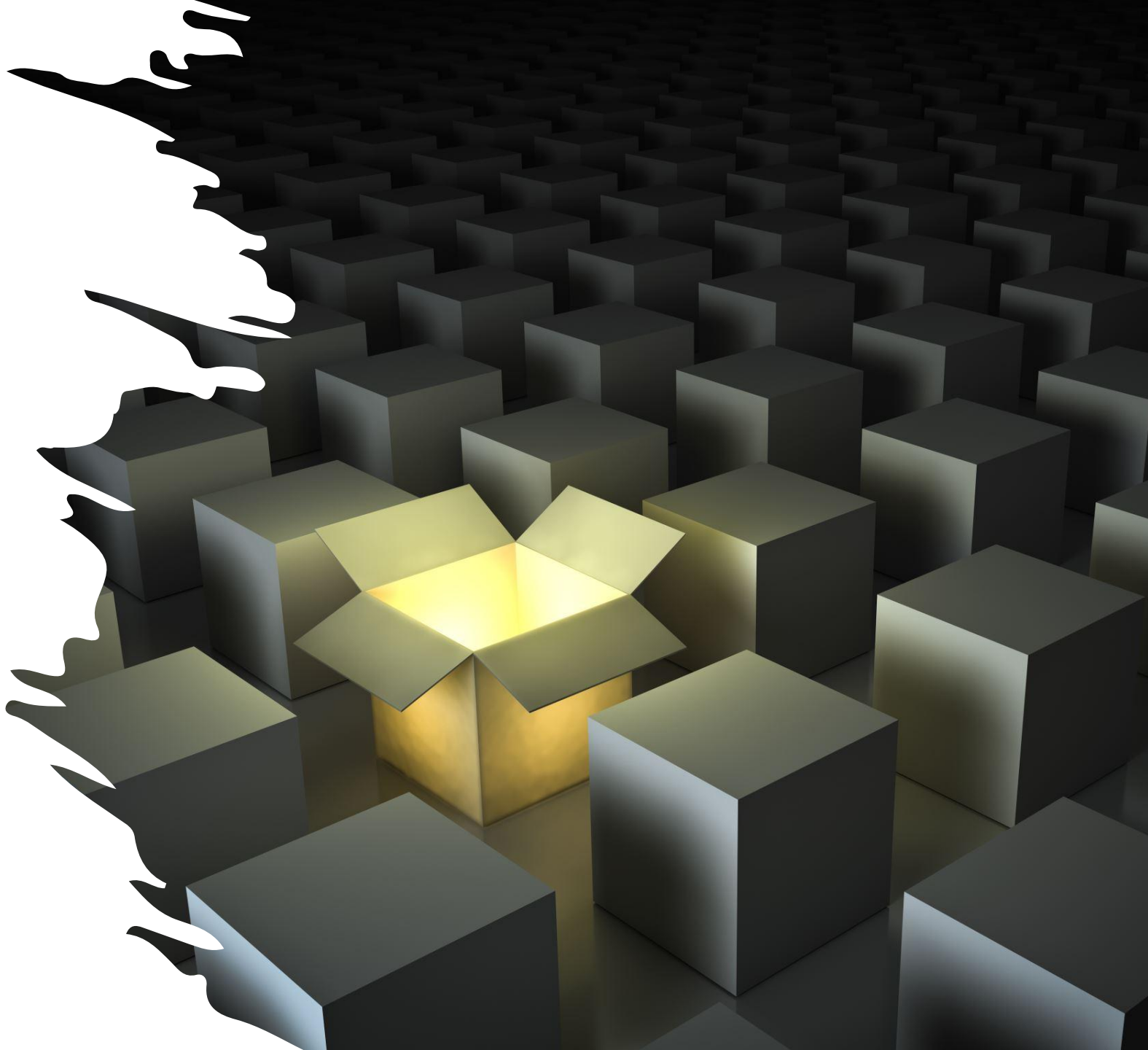
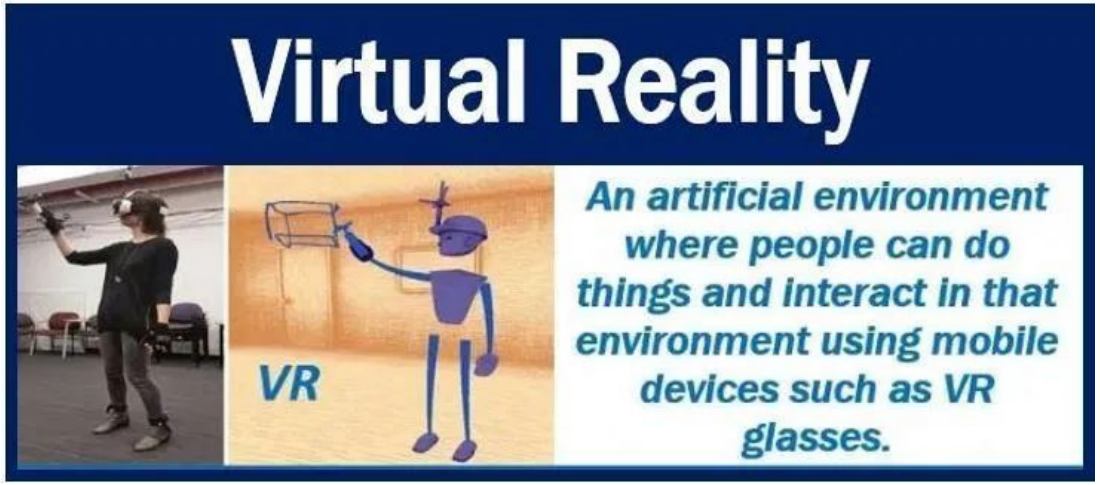


VR Introduction

- What is VR?
- Virtual reality (VR), with the features of immersion, interactivity and imagination, is described as a cutting-edge technology that allows learners to step through the computer screen into a 3-D interactive environment.



VR in Training (Research base)

- Used in medical industry to complement surgery training using simulation environments.

- The benefits of using VR to train employees is most beneficial when the employees are Law Enforcement Agencies (LEAs), first responders, etc.

Our problem

- The current process for training potential employees for the CBSA (Canada Border Services Agency) to search vehicles for illegal substances is **expensive** and **unrealistic**.
    - High travel costs to Quebec training location
    - Training cannot be dangerous to officers therefore limitation of what you could train
    - Every scenario has an illegal item in current training

Research ideas and objectives

- The limitation of current training procedure for the CBSA (Canada Border Services Agency) is expensive and unrealistic

- Our objective is to create a VR application to simulate the action of searching vehicles for illegal substances.

VR in Training (Research base)

- Overall, VR in general:
  - An effective new technique that can provide guidance on training purposes and a good platform to study the efficacy of the training in providing guidance for the procedures

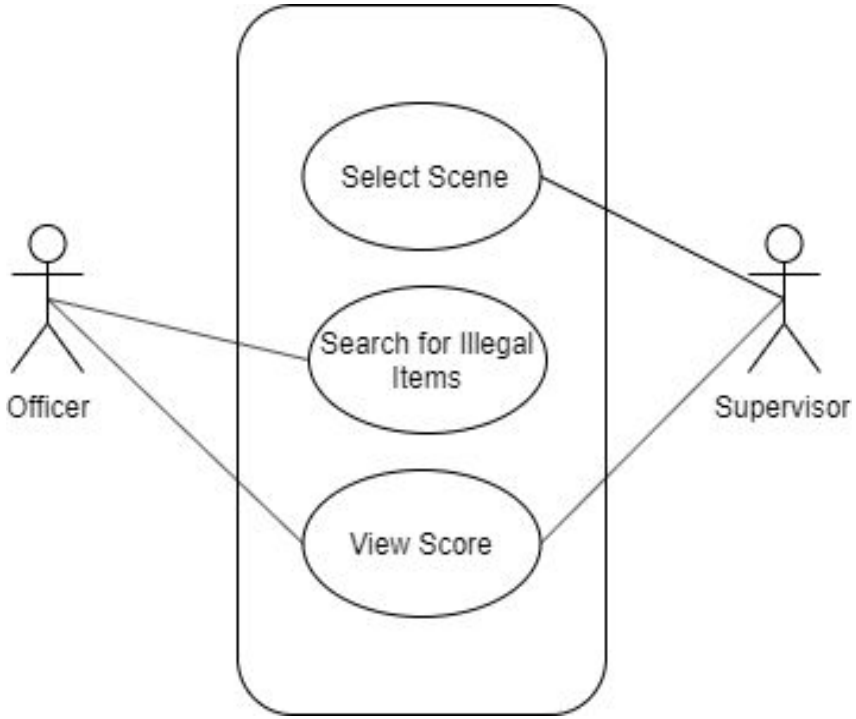
- No previous VR implementation of border security or searching vehicles

Our Solution

- Create a VR application that simulates the procedure of searching vehicles in CBSA
  - Make around 50% of the scenarios contain an illegal substance - more realistic
  - With VR we can include unlikely scenarios that are dangerous to officers, such as finding a bomb in a vehicle
  - The VR system could travel from port to port, eliminating high travel costs

Use case diagram:

- Two participants
  1. Officer
  2. Supervisor
- Three actions:
  1. Select scene
  2. Search for illegal items
  3. View Score



Formula for score calculation:

$$Score = \left(\frac{Number\ of\ illegal\ items\ found}{Number\ of\ illegal\ items\ in\ car} - \frac{Number\ of\ legal\ items\ wrongly\ selected}{Number\ of\ illegal\ items\ in\ car}\right) x\ 100$$

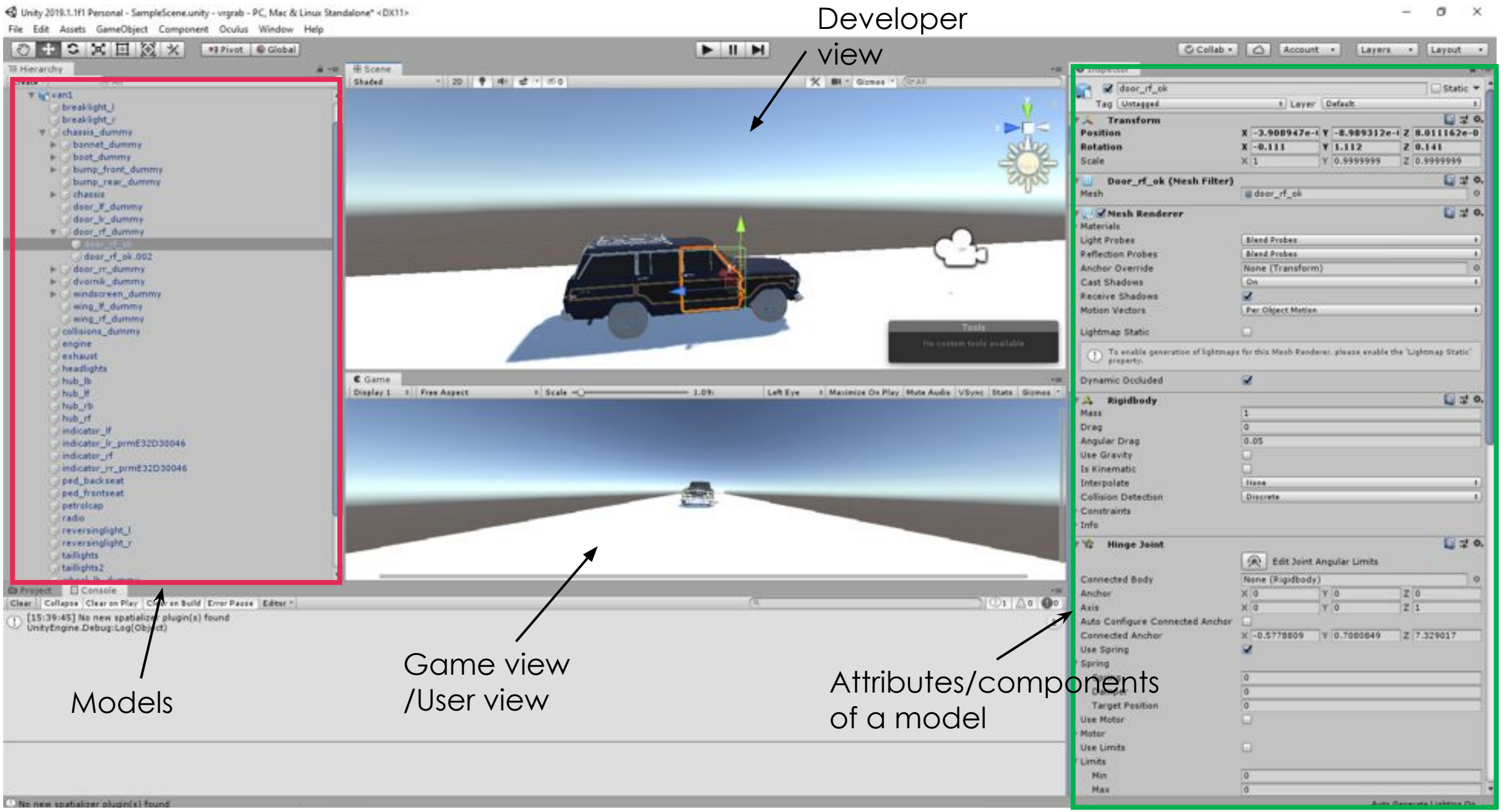
Example: 3 illegal items in car, 2 are found, 1 legal item is wrongly selected. Score would be 33%

System Design and Architecture

- VR Hardware: Oculus Rift
- Game Engine: Unity
  - Scripts for unity coded in C#
- Blender used for creating and fixing existing models

VR Hardware

- Camera and headset connected to computer
- Camera detects your motion based on position of headset and controllers
- Button on back of controllers are used for grabbing


Developer view
Models
Game view /User view
Attributes/components of a model

Project Procedure: 1

- Insert Plane in Unity
- Heart of game is quality assets
- Turbosquid and Blendswap / (.fbx) & (.obj) file extensions
- Paywall issues
- Got lucky to find 1991 Jeep Cherokee!

Project Procedure: 2

- **Import vehicle into Blender**
  - **Separate parts**
  - **Combined pieces**

- **Create door hinges in Unity**

Project Procedure: 3

- **Had to limit how much doors opened**

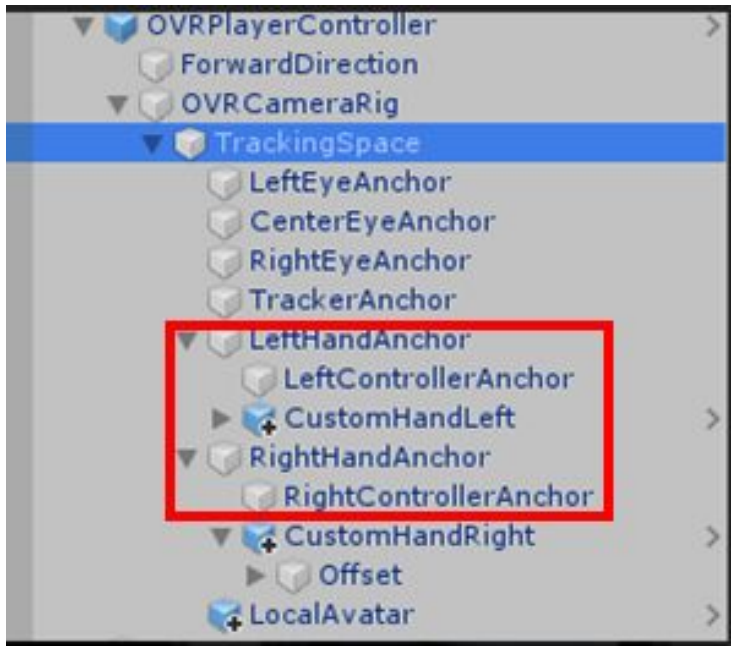
- **We edited properties. Script not necessary but good for reusability**

Project Procedure: 4

- Import oculus rift package from asset store

- Follow Valem's video tutorial on Youtube to incorporate VR aspects

- Had issue where hands wouldn't work, had to put "CustomHands" under "Controller Anchor"

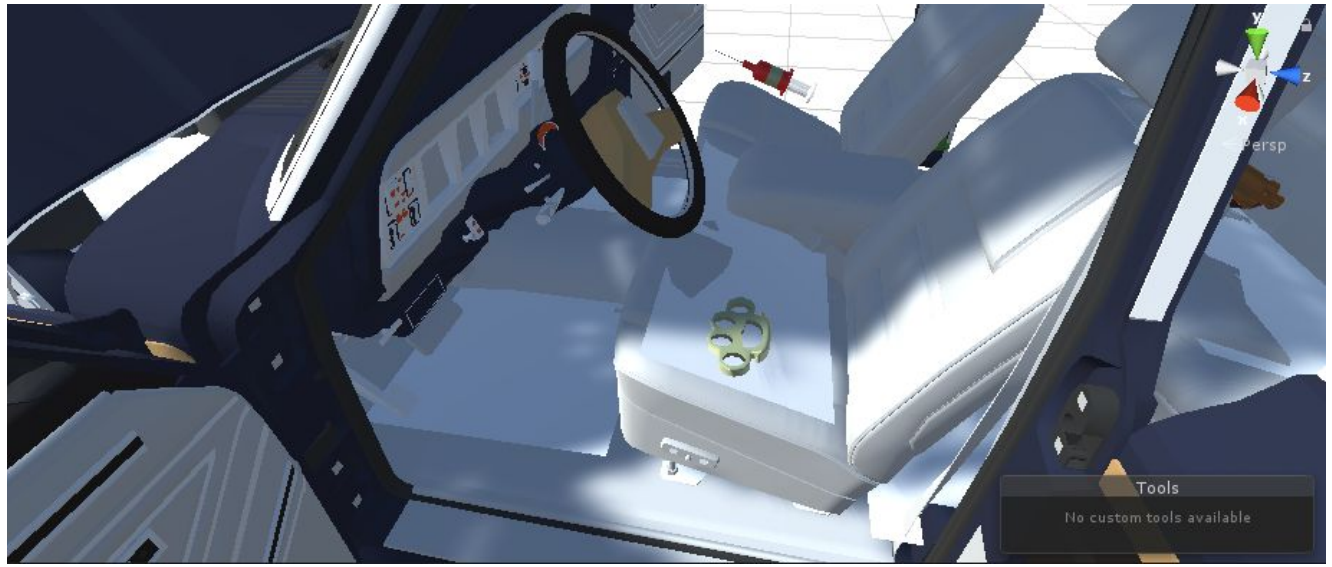


Project Procedure 5:

- Create Box - needed to count number of items dropped and number of illegal items
- Added a plane underneath box
- Used script with plane detection that incremented count and illegal item count upon collision.
- Plane flying, count incrementing too much
- Delete on contact script

Project Procedure: 6

- **Planes in Car**
- **Issues with Planes**



Project Procedure: 7

- Create Score Aspect
  - Tags
  - Scripts on contact
  - Delete on contact

- UI

In Game User Interface

- Display scores in developer scene, not in VR


```
0 references
void Awake()
{
    // Load the Arial font from the Unity Resources folder.
    Font arial;
    arial = (Font)Resources.GetBuiltinResource(typeof(Font), "Arial.ttf");

    // Create Canvas GameObject.
    GameObject canvasGO = new GameObject();
    canvasGO.name = "Canvas";
    canvasGO.AddComponent<Canvas>();
    canvasGO.AddComponent<CanvasScaler>();
    canvasGO.AddComponent<GraphicRaycaster>();


    // Get canvas from the GameObject.
    Canvas canvas;
    canvas = canvasGO.GetComponent<Canvas>();
    canvas.renderMode = RenderMode.ScreenSpaceCamera;


    // Create the Text GameObject.
    GameObject textGO = new GameObject();
    textGO.transform.parent = canvasGO.transform;
    textGO.AddComponent<Text>();

    // Set Text component properties.
    text = textGO.GetComponent<Text>();
    text.font = arial;
    text.text = "test";
    text.fontSize = 48;
    text.alignment = TextAnchor.MiddleCenter;

    // Provide Text position and size using RectTransform.
    RectTransform rectTransform;
    rectTransform = text.GetComponent<RectTransform>();
    rectTransform.localPosition = new Vector3(0, 0, 0);
    rectTransform.sizeDelta = new Vector2(200, 200);
}
```

Text properties

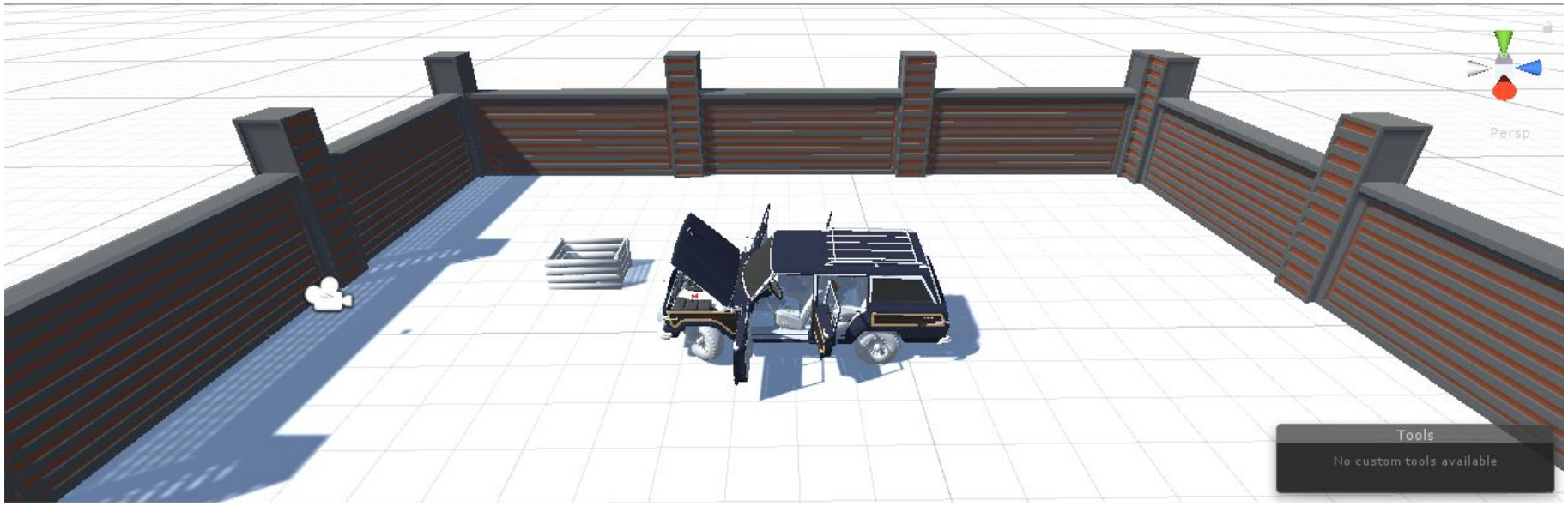
Size and location

```
0 references
void Update()
{
    num1 = ((illegal_item / 2) - ((total_count - illegal_item) / 2)) * 100;

   // num1 = illegal_item;
    text.text = num1.ToString();
}
```

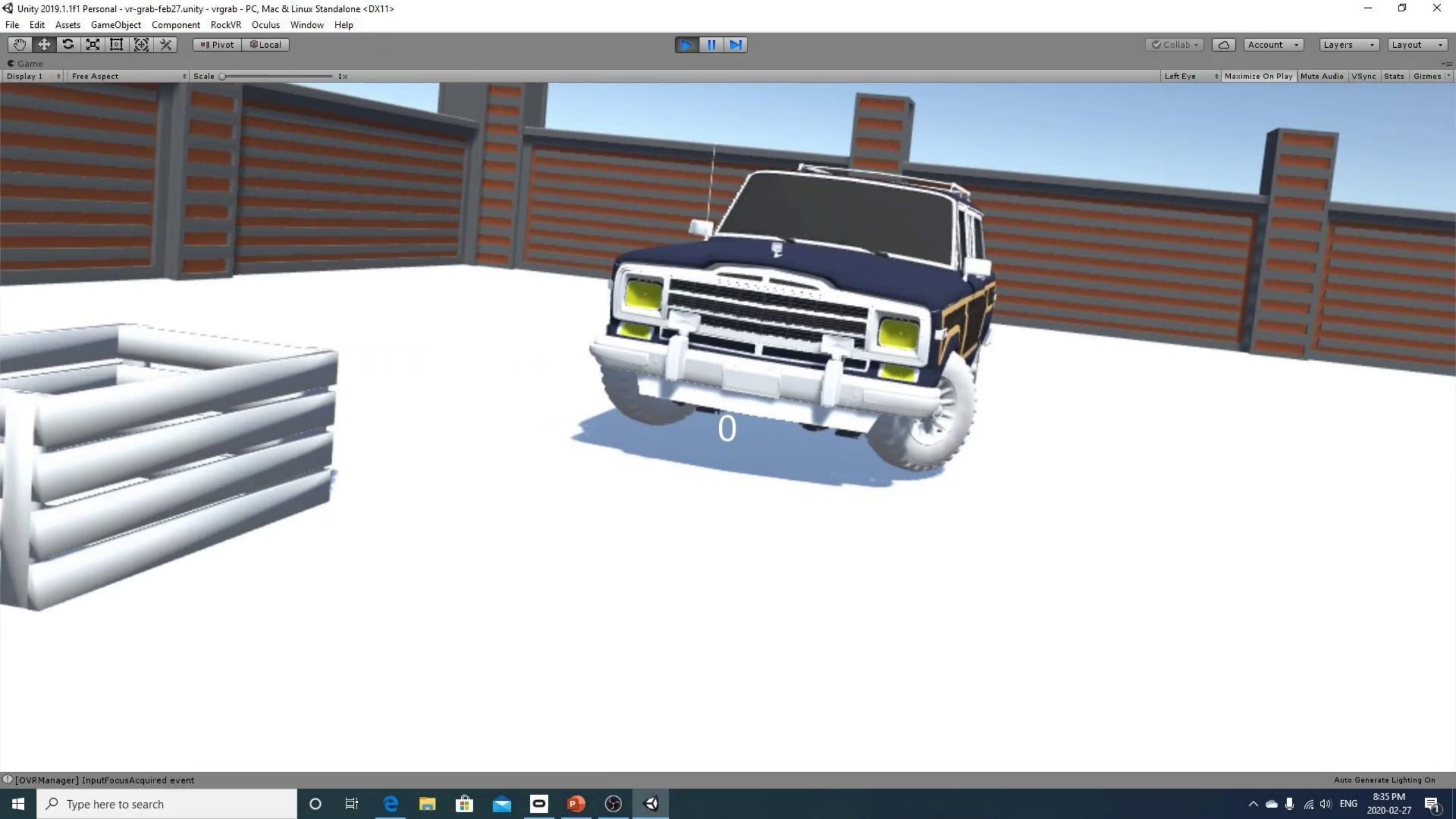
Project Procedure: 8

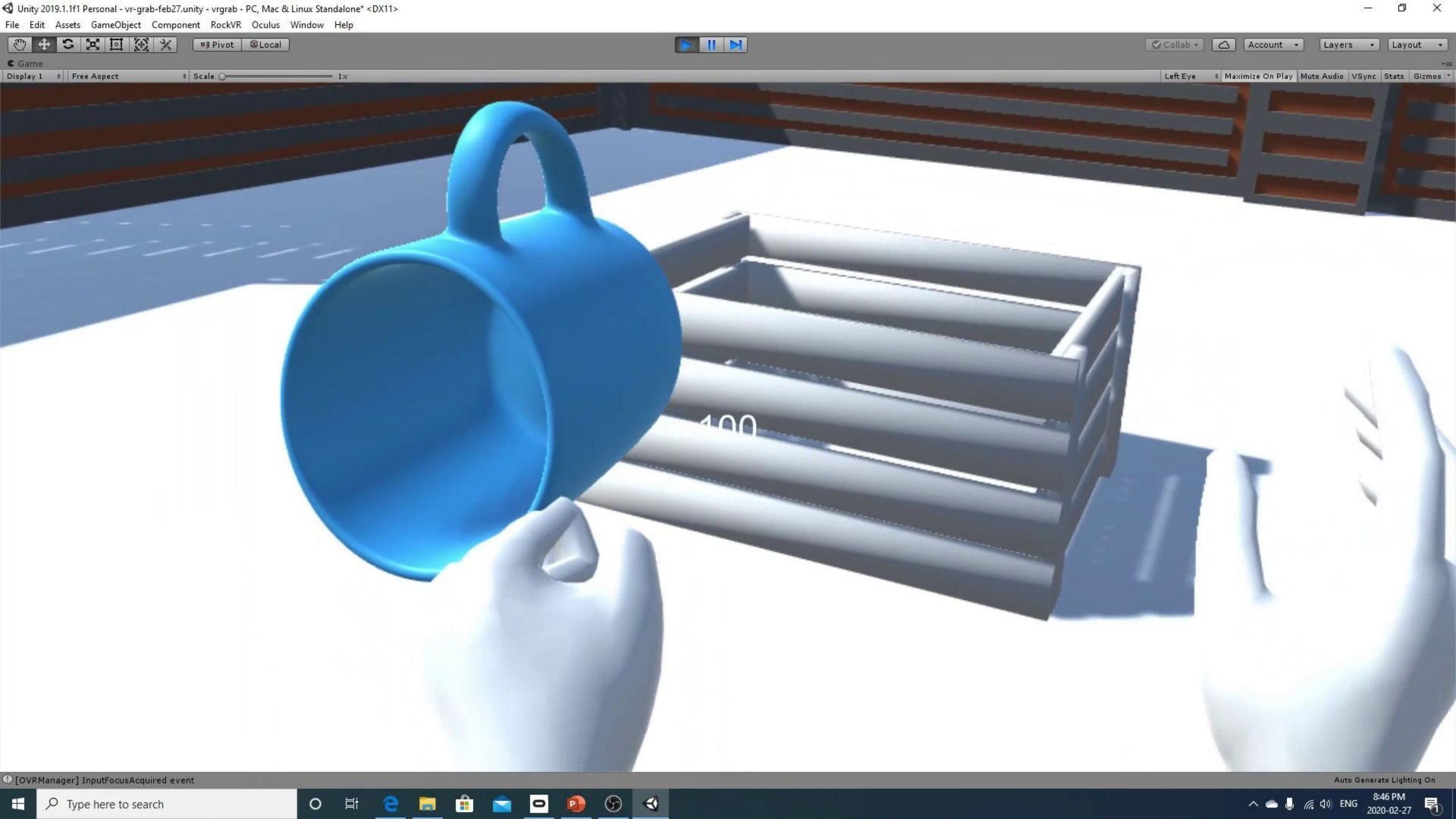
- Importing Assets
- Creating Background



Most Recent VR System Demonstration

We have done more work but we cannot access the ATAC machine to get videos or screenshots


Unity 2019.1.1f1 Personal - vr-grab-feb27.unity - vrgrab - PC, Mac & Linux Standalone <DX11>
File Edit Assets GameObject Component RockVR Oculus Window Help
Pivot Local
Collab Account Layers Layout
Game
Display 1 Free Aspect Scale 1x
Left Eye Maximize On Play Mute Audio VSync Stats Gizmos
0
[OVRManager] InputFocusAcquired event
Auto Generate Lighting On
Type here to search
ENG
8:35 PM
2020-02-27


Unity 2019.1.1f1 Personal - vr-grab-feb27.unity - vrgrab - PC, Mac & Linux Standalone* <DX11>
File Edit Assets GameObject Component RockVR Oculus Window Help
Pivot Local
Collab Account Layers Layout
Game
Display 1 Free Aspect Scale 1x
Left Eye Maximize On Play Mute Audio VSync Stats Gizmos
100
[OVRManager] InputFocusAcquired event
Auto Generate Lighting On
Type here to search
ENG
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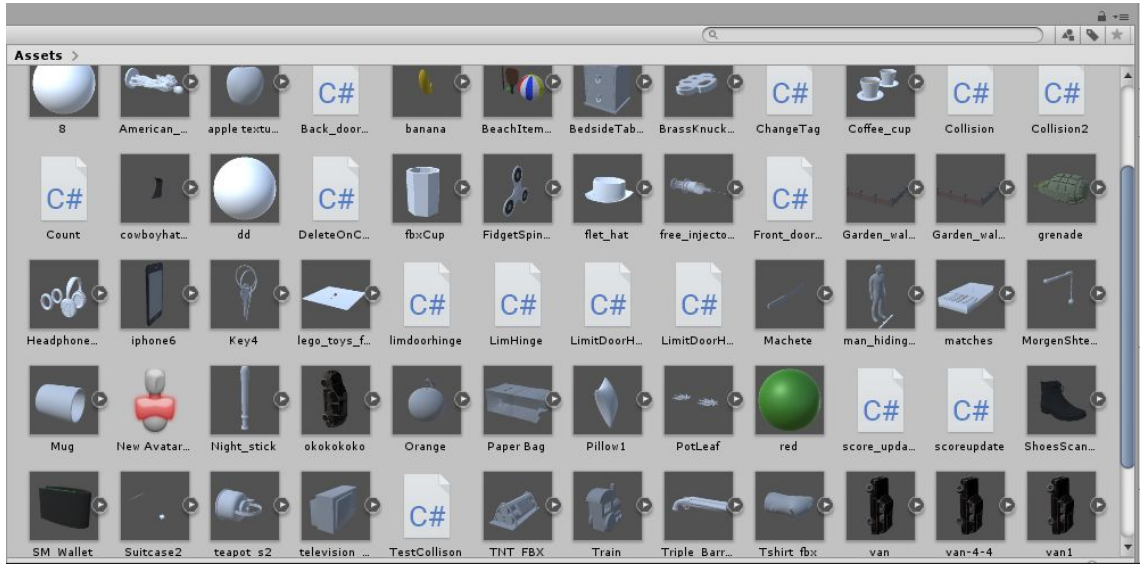
2020-02-27

What We've Done Since Then: 1

- Imported around 50 assets and created 5 unique scenes.

- In all 5 scenes we had the same car, so we found a semi, a truck, and other vehicles we were putting in place of the Jeep Cherokee

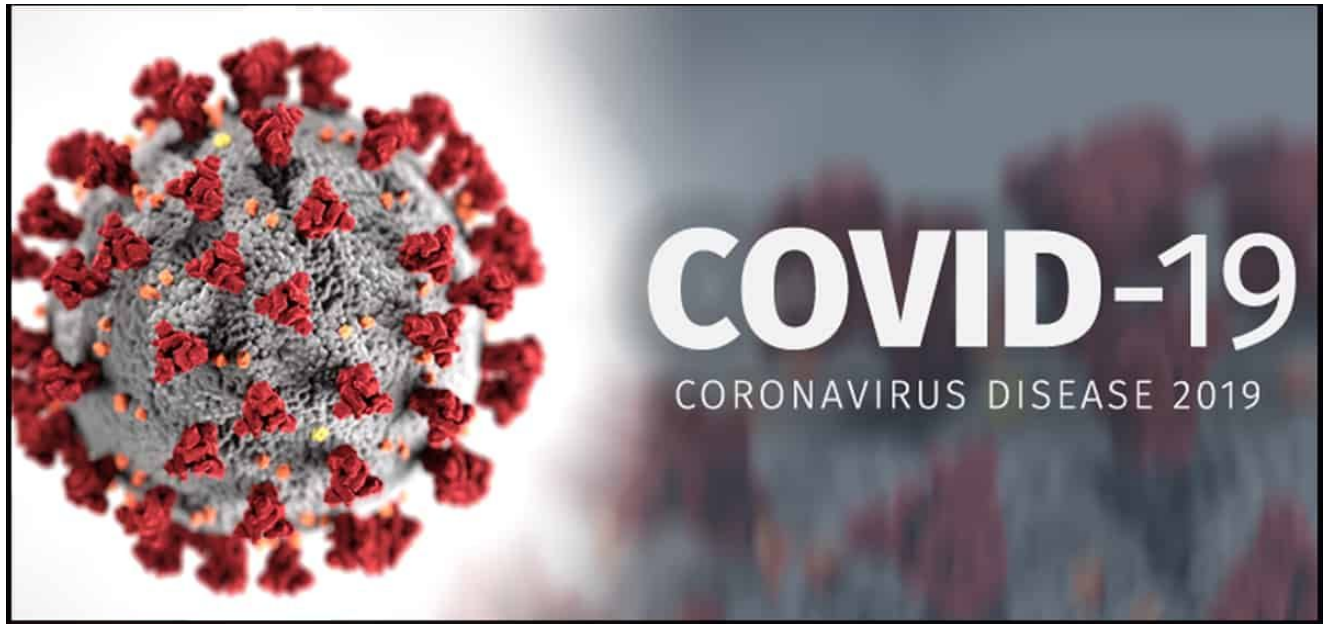


What We've Done Since Then: 2

Started creating a UI where users can select to

- Play
- Select certain scenes
- View score
- Quit

Everything Was Going Great! Until...



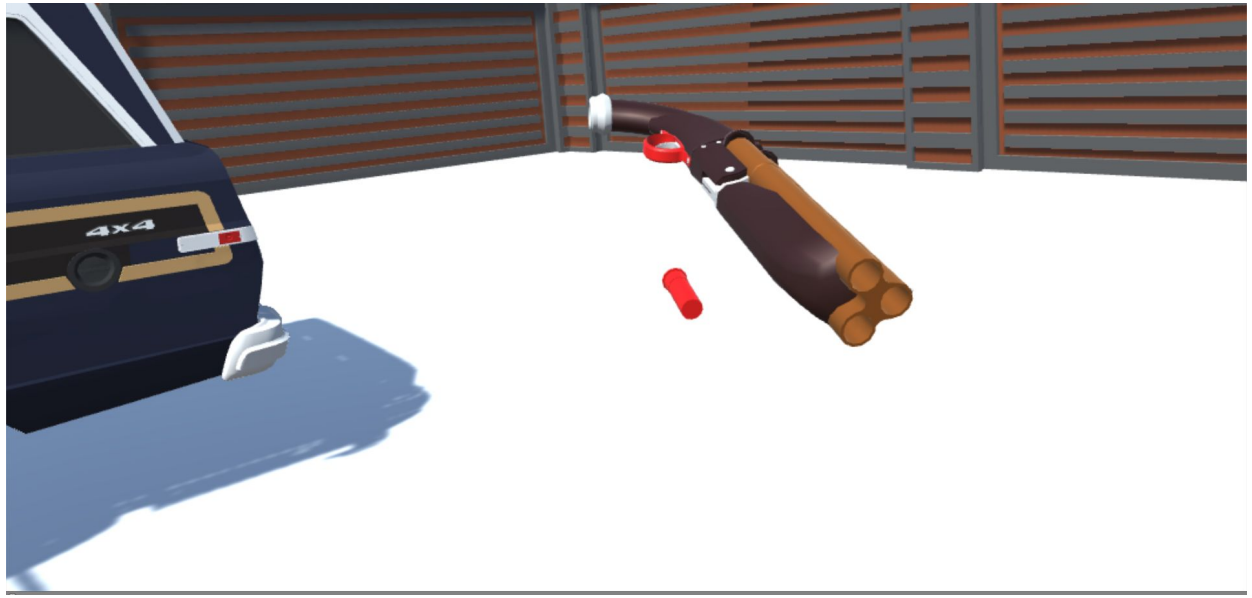
What We Still Needed To Do

- Randomizing objects being placed in vehicles
- Finish the UI
- Have a button to finish scene
- Finish the Score Aspect when a scene is finished

Issues encountered

- Shotgun hitbox

  (Fixed) We put the grabbable script on component



- User climbs over planes in vehicle (Not fixed but have an idea)

Issues encountered

There are 3 issues as we testing the door:

1. When “grabbing” the door to open it, you can just pull the door apart from the car and carry it around. (Not Fixed, but have idea)
2. You can grab the door anywhere and not just the handle (not fixed, but have idea)
3. To open the door you needed to slam it, and to close it you had to have the motion as if you were opening the door. (Fixed)

Limitation

- Lack of Flexibility
  - Lack of scene variety, unless we can randomize
  - Not realistic, doesn't emulate people hiding things in unique places
  - Very hard to design our own assets, need to use whatever is created
- Usage Limitation:
  - Designed for Border agent training, not robust for something else.

Questions?

References for Slideshow

Other references listed in report

- [1]. J. Saunders, S. Davey, P. S. Bayerl and P. Lohrmann, "Validating Virtual Reality as an Effective Training Medium in the Security Domain," 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), Osaka, Japan, 2019, pp. 1908-1911.
- [2]. A. Kanazawa and H. Hayashi, "The Analysis of Training Effects with Virtual Reality in Simple Task," 2017 6th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI), Hamamatsu, 2017, pp. 345-350.
- [3]. W. Tsai, L. Su, T. Ko, C. Yang and M. Hu, "Improve the Decision-making Skill of Basketball Players by an Action-aware VR Training System," 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), Osaka, Japan, 2019, pp. 1193-1194.
- [4]. C. Li, R. Gu and J. Chen, "Research on instructional design model for VR supported skill training," 2010 9th International Conference on Information Technology Based Higher Education and Training (ITHET), Cappadocia, 2010, pp. 232-235.
- [5]. S. de Ribaupierre, R. Armstrong, D. Noltie, M. Kramers and R. Eagleson, "VR and AR simulator for neurosurgical training," 2015 IEEE Virtual Reality (VR), Arles, 2015, pp. 147-148.