CSE 566 Virtual Reality
Spring 2019
Assignment 1: Basic VR
Prof. Arie Kaufman
Due date: Tuesday, March 12, 2019, 11:59pm, Stony Brook Time.

Now that you have completed Assignment 0 and have gained some experience with working in Unity, let's use those skills and what you have learnt in class to design an interactive virtual environment. In this assignment, you will design a simple 3D virtual world where a user will have the ability to 'teleport' (transport instantly) to different locations in your virtual world, experience how your world looks during the day and at night, and finally, interact with some objects. For a true VR experience, we strongly recommend that you meet the following ***minimum*** hardware requirements:

- A Google Cardboard
- A mobile device with either Android version 4.1 or higher or iOS version 8.0 or higher

Optional hardware may include:

- A controller connected to your phone using either Bluetooth or USB
- Certainly, you may get as creative as you want! If you own a better head-mounted display than a Google Cardboard, or know a friend who has one, or would like to purchase one, and have a more powerful mobile device, then feel free to push the bounds of this assignment.
- The sky's the limit!

Overview

For this assignment, you will be designing a 3D virtual world. However, this world would probably be rather small. Your virtual world should have a **house**, a **car**, an **airplane**, and a **hot air balloon** floating in the sky. You do not have to create your own 3D models, you are free to download models from the Unity Asset Store, or any other source, provided you have permission to download them and cite each source properly in your documentation.

The scene will start with the user standing outside the house. The user should have the ability to teleport inside the house, the car, and the hot air balloon. Once teleported, the user should be able to see the virtual world from the new viewpoint. For example, if the user chooses to teleport in the hot air balloon, the user should be able to see what the virtual world looks like from up in the sky. Additionally, the user should also be able to experience how your virtual world looks during the day and at night.

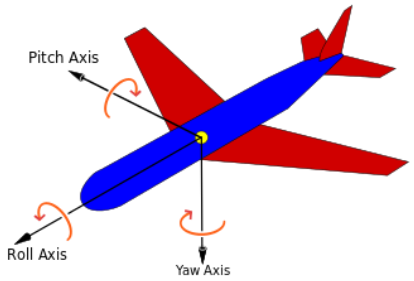
If you're excited and can't wait longer to start getting your hands on designing your (first) VR project, then read ahead for details, otherwise watch this video and this video to spark some excitement.

House

The house can be a downloaded model or designed using 3D simple polygons. The house should also have an interior with at least two point-light sources and a transparent window (through which the user may see the outside world and the light can reach the outside world). There should be a road that goes around the house and a lamp-post that illuminates the path leading up to the house.

Airplane

The airplane can be a downloaded model or designed using 3D polygons. The airplane should be in the sky and have a constant continuous motion. You are free to design a path in a script for the airplane's motion with all quaternion rotations. Once the airplane completes its path, the airplane should restart its motion automatically from the starting point.



Car

The car can be a downloaded model or designed using 3D polygons. The car should also have an interior with transparent windows. The car should be on the road around the house. The car should be stationary except when the user teleports inside the car. The car should also have headlights that turn on at night. The headlights should be two spot lights.

Hot air balloon

The hot air balloon can be a downloaded model or designed using 3D polygons. The trajectory of the hot air balloon in the sky should be similar to the figure below.

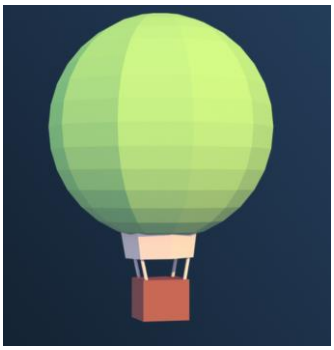


Fig. Example of a 3D hot air balloon

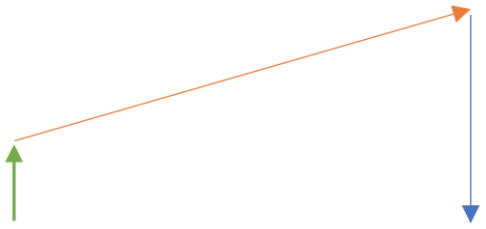


Fig. Diagram of the hot air balloon's trajectory

The trajectory arrows shown in the figure are perpendicular to the ground – so the arrow in orange shows the balloon gaining elevation while also moving to the right. The starting point for the hot air balloon should be above the ground, in the sky. You can choose any speed for the hot

air balloon to float in its trajectory. The figure shows the simplest path that is expected from this assignment, feel free to design any path that may be more complex than the one shown here, but remember, you don't want your users to get dizzy and fall off the balloon! Once the hot air balloon completes its path, you can either trace it back in reverse, or restart from the starting point. A user should be able to stand in the base of the hot air balloon and enjoy the view while the balloon floats.

Day and Night

Your scene should start during the day. For day-time, you will need a directional light source placed at infinity to act as the Sun and the Sun should start from the 'east' and travel to the 'west'. You are also expected to code for shadows and the shadows' direction should change as the sun moves. You may either have a button to trigger day/night modes, or you may code for the day/night cycle to be 5/5 minutes long.

For the night mode, you should have a moon that illumines the scene. Unlike the sun, your moon can be stationary. All the lights of the house and the headlights of the car should be turned on during the night mode. The intensity of the moonlight should be enough that the house, car, airplane and hot air balloon are visible. You may design your virtual world as beautiful as you want for the night mode, so that a user may enjoy the night-time view of the hot air balloon ride.

Interaction and camera

The user should be able to teleport in four different modes: the *default scene mode, inside-the-car mode, inside-the-house mode,* and *hot air balloon mode.*

Scene mode (default): The camera (i.e., the user's eye) should be initially located and oriented such that everything in the scene (the house, road, car, airplane and hot air balloon) is within its frustum. The camera orientation may change as the user navigates through the scene. Thus, this camera mode should cater for head rotation. Input from your mobile device's gyroscope will be used to adjust the parameters for the camera orientation.

Inside-the-car mode: Once teleported inside the car, the camera should be attached to a view that looks outside the car front windshield window. Only the user's head rotation should be tracked. When the user is teleported inside the car, the car should automatically start its motion. Once the user teleports out of the car, the car should be placed at its default location on the road and should be stationary.

Inside-the-house mode: Once teleported inside the house, the camera should be located near the window such that the user should be able to see the interior of a room, inside the house, as well as the view outside the house, through the window. The camera orientations may change as the user rotates his/her head.

Hot air balloon mode: Once teleported to the hot air balloon, the camera should be attached inside the basket of the hot air balloon. Only the user's head rotation should be tracked. The hot air balloon should continue to float while the user is inside the basket – therefore, the camera views should constantly change with respect to the hot air balloon's path.

Interaction

The main interactions in this assignment will be how to select and how to teleport. There could be several ways to do this. The simplest is by using a controller connected to your mobile device. Program each button on the controller to teleport you through the different scene modes. If you do not have a controller, you can be creative with the teleportation. An example is as follows:

- To teleport to either of the modes, the house, the car or the hot air balloon, stare at the object for 10 seconds. A loading icon should appear when staring at an object to show the user that she/he is ready to teleport. If the user looks away, the loader should disappear and the timer reset.
- If the user is inside the house, car or hot air balloon, staring down (at the feet) for 10 seconds could teleport the user back to the default scene mode. A loading icon should appear when staring down, to show the user that the game is ready to teleport. If the user looks away, the loader should disappear, and the timer reset.

Some guidelines

Before starting this assignment, if you are not familiar with Unity and have not tried out Assignment 0, we strongly suggest that you go through Assignment 0. Additionally, check out the Unity Manual and see the Unity reference page on Input for a comprehensive overview of its functionality.

Before starting the assignment, think carefully about how you structure your scene graph hierarchy. Begin by designing each object separately and test that your camera works fine. Then put all the modes together in your virtual world and test out your teleportation and navigation.

Submission

- The submission should be done on Blackboard. You are allowed multiple submissions, however, the submission closes strictly on Tuesday, March 12, 2019, 11:59pm, Stony Brook Time and your latest submission will be considered for grading.
- All your submission should be in a zipped folder. The zip folder should include the following for full credit: your Unity project folder, a report, and a video.
- Your Unity project folder should contain your Unity saved scene and all your Scripts and Assets that will be required to re-build your project. Please do not include your project executable in the folder.
- For your report, you should include *at least* the following:
    - A title: “CSE 566 Virtual Reality, Spring 2019, Assignment 1: Basic VR”
    - Your name and Stony Brook ID
    - Unity version
    - Hardware used
    - Directory hierarchy
    - Any extra functionalities/ features that you implemented for this assignment
    - Details on implementation: references to the downloaded 3D models or how did you design your own model; how the rotations in your scene were implemented;

how the lights and shadows in your scene were implemented; how the teleportation was implemented for each mode, to mention but a few.

- The video should be the recording of the stereo view (example: https://drive.google.com/open?id=1rAlSyb07uAHQ7wN3S4Y7Jxui-9yjIpti or here). The video should demonstrate all the features of your assignments, including the head rotations, teleportation modes, and the day and night modes.