PROD321 - Interactive Computer Graphics and Animation

Assignments Overview

Overview

This year in PROD321, we are tweaking the assessment a bit to support students in building higher quality games they can use as part of their portfolio. To achieve this, the assignments are being aligned better so that, instead of working on a separate demo for each assignment, students can develop a single game throughout the entire course, with each assignment adding a bit more to the game. We have also aligned the assessment with PROD323, so that students can work on a single game across both PROD321 and PROD323, developing the graphics in the former, and the AI in the latter.

This is all optional of course, and you are free to work on individual games for each piece of assessment, or each course, or whatever you like.

To better support students with different backgrounds, experience and interests, we are also allowing students to work in pairs on their assignments this year, and we suggest that the best results might come from a team with one artist and one programmer.

Again, this is optional, and students are free to work individually. Group projects will have higher work expectations than individual projects, so you will not be penalised if you choose to work alone.

Things to consider when choosing your game

If you choose to develop a single game across the entire PROD321 course (either in conjunction with PROD323, or independently), you should try and choose a game which you can use for each assignment. The requirements for Assignment 1 Part 1 are set out below, and while Assignments 2 and 3 are yet to be fully confirmed, it's likely that the topics included in the requirements will be:

Assignment 2:

- Image Based Lighting/Rendering (e.g. Bump/Normal/Height Maps, Ambient Occlusion, Emission, Environment Maps)
- Shadows
- Reflections

- Projective Textures
- Particle Effects
- Decals
- Post Processing Effects
- Custom Shaders

Assignment 3:

- Rigid Body Animation
- Rigged Animation
- Humanoid Animation
- Blend Shape Animation
- Animation State Machines
- Animation Blending
- Animation Masking
- Inverse Kinematics

However, as you will see below, there will be plenty of flexibility around how you can implement these topics. Don't worry too much about trying to think about the perfect game - just leave yourself some flexibility in your game choice (e.g. Don't say you will only have non-humanoid characters, otherwise it will be hard to do humanoid animation).

Grading

Because different games have different features, you will be able to choose between a range of tasks you can do depending on what best suits your game. Each of these tasks will be worth a certain number of points, which correspond to the maximum grade you can get for this task. The actual grade you get will depend on how well you implement each of these tasks.

For example, say you choose the following tasks:

1. Implement 3 different biomes using a triangle mesh - 10 points
2. Implement animation on at least one biome - 15 points

You could get a maximum grade of 25 points, although your actual grade will depend on how well you have done these tasks - if you do a good job of Task 1, you might get the full 10 points, but if you do a bad job of Task 2, you might only get 8 marks, for an actual grade of 18 / 25.

For each part of each assignment, we will state how many points you need to do for a maximum grade of 100% in that Part - for example in Assignment 1 if you are working individually, you must do 50 points in Part 1, and 50 points in Part 2. You are welcome to do more points than required, and your actual grade will be the sum of the grades for the tasks that you've done - capped to the maximum value (i.e. you could tasks worth a maximum of 60 points for Part 1, get an actual grade of 55, but your final grade for Part 1 will be capped to 50).

If you are working as part of a pair group, the number of points you are required to do is multiplied by 2 - so for Assignment 1, if you are working in a group of 2, you must do 100 points in Part 1 (2 x 50), and 100 points in Part 2 (2 x 50). With your submission you must include a text file saying the percentages of each task (e.g. Task 1 - Adrian (30%), Nikita (70%)), and this will be used to determine your individual final grades.

Assignment 1

In this assignment, you will be designing and implementing some experiences which demonstrate the material covered in Topic 1 "Foundations of Computer Graphics" and Topic 2 "The Rendering Pipeline".

This assignment is worth 25% of your total grade for PROD321.

The assignment is due 11:55pm on Sunday the 4th of April. Late submissions without prior approval will have 15 points deducted per day they are late (i.e. 1 day late = maximum score of 85%, 2 days late = maximum score of 70% … 7 days late = 0%). If you need extra time, please contact us as soon as possible - we will be as accommodating as we can be as long as you let us know early.

Submit your assignment via the Learn system, or you can upload it to Dropbox and email Adrian/Nikita, give it to one of us on a flash drive by prior arrangement.

Any material provided in class (including the in-class/lab Unity examples) may be used in the assignment. Any external code and resources (3D

Models, etc) is fine as long as they are not fundamental to the assignment, and the resources are all referenced/linked to in your submission (e.g. you can download a model from Turbo Squid to use in your assignment, but you cannot download a height map based biome mesh generator and upload it as your own work).

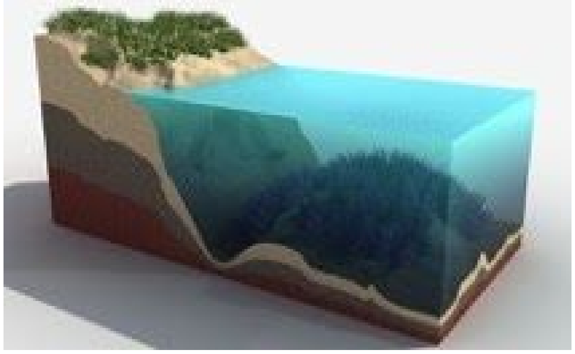
This assignment hand out is a "living document" and will be updated - but we will not alter the grades of, or remove tasks which have been published at any time.

Part 1 - Terrain Generation

Minimum Number of Points Required for 100%: 50 per person

In class we learnt about creating meshes in code. We're going to use this to create some terrain for our game.

For this part of the assignment, we will use the term "Biome" to refer to environments with different climate properties. For example, a Desert biome might have regular rolling sand dunes, with rocky valleys in the dunes, and cacti and tumbleweeds scattered across the terrain, while a Mars biome might be mostly flat and rocky, but with a large snow-capped mountain, and rockets and space stations on the surface.

	
https://free3d.com/3d-model/3d-mars-environment-4601.html	https://free3d.com/3d-model/ocean-part_2-923.html

Required Tasks:

3. Create three different biome inspired terrains using heightmaps, either:
    - Based on triangle meshes - 6 points (2 points per biome)

   or

    - Based on spheres - 15 points (5 points per biome)

4. Colour your three terrains relative to the biomes they represent, either:
    - Using UV Maps - 6 points (2 points per biome)

   or:

    - Using Vertex Colours - 12 points (4 points per biome)

5. Place objects on your terrains suitable for the biomes they represent, either:
    - Using a text-file - 9 points (3 points per biome)
        - The text file should contain the object type (how you want to represent that is completely up to you), as well as the X and Z coordinates to place the object at. For example, your text file might say "cactus, 2, 10", which will place a cactus object on your terrain at X = 2, Z = 10. The objects should be placed to be sitting on the ground at those locations, regardless of the heightmap (as in the sphere example in Lab 2).

   or:

    - Using a Object Placement Map - 12 points (4 points per biome)
        - An object placement map is a texture map with at least 2 different colours (one per type of object), with these colours indicating the type of object to be placed, and the position to be where they will be placed. For example, you might have a texture with a blue dot at pixel X=2, Z=10, and at that coordinate on your terrain there will be a cactus, while a red dot at X=50, Z = 80 will place a tumbleweed at that coordinate. The objects should be placed to be sitting on the ground at those locations, regardless of the heightmap (as in the sphere example in Lab 2).

6. Record a video fly through of your biomes, include footage of every other task you have implemented - 6 points (2 points per biome)

<u>Optional Tasks:</u>

7. Create a minimum of 6 objects which can be placed on your terrain (2 per biome) - 18 points (3 points per object)

8. Use mesh animation on one biome (e.g. Water, Lava) - 10 points

9. Support heightmaps larger than 256 x 256 Resolution (by spawning multiple meshes, using sub meshes, etc). Create 1 biome showing this. - 15 points

10. Implement a way to blend between different biomes (e.g. place a mountain biome next to a sea biome and it will do some blending between heightmaps). Show how this works between a minimum of 2 biomes. - 30 points

11. Create a heightmap editor - at a minimum allow raising and lowering of individual vertex heights by hovering over with the mouse and using keys on the keyboard to raise/lower vertexes, and save out a texture - 25 points

12. Create an object placement map editor - at a minimum allow placing of objects at specific vertices by hovering over with the mouse and using keys on the keyboard to select object, and save out a texture - 25 points

13. Implement simple season changes by using color themes on your terrain (e.g. autumn: orange-brown theme),
    <u>either:</u>
    - Using UV Maps - 2 points per theme, max 6 points

    <u>or:</u>
    - Using Vertex Colours - 4 points per theme, max 12 points

14. Using a heightmap, generate a terrain completely underwater (reversing the height scale of the heightmap) - 3 points

15. Implement a simple day and night cycle - 10 points

16. Suggest an idea to Nikita and/or Adrian, get it approved, and then implement it - TBD points

Part 2 - Deferred Rendering and Visibility Determination

Minimum Number of Points Required for 100%: 50 per person

In Part 2 of this assignment, you will look at how the deferred rendering path can be used to make your environments more visually appealing. You will also be adding some characters to the environments you built in Part 1, and use some of the visibility determination methods we looked at in class and lab as the initial steps towards giving them the ability to perceive the environment.

You are not required to make the models for your own NPCs, as long as you reference where you got them from. You are not required to have any objects/light sources/etc added in Part 2 defined in your object placement map or height maps from Part 1 - feel free to just have them sitting in the scene and then when the height map is created they're just approximately in the correct place.

If you are struggling to get these things to work on your Biomes from Part 1, feel free to use different terrain (e.g. the examples from Lab 1 or just a mesh created in a 3D modelling program/downloaded from somewhere) for these parts. Although you won't be marked down, you may get additional points if you're able to make things work with your biomes from Part 1 (especially if you have created spherical biomes).

Required Tasks:

1. Create a new scene for your biomes for a deferred rendering path (make sure you keep a copy of your original scene and call it something like Part1-ForwardRendering). In this scene, change your camera render path to Deferred, then start populating the biomes with light sources - 15 points (5 points per biome)
    a. You could have light sources as part of the environment (for example, if you have a lava biome perhaps you could add a bunch of light sources around lava areas), or as part of objects in the environment, for example fireflies with point light sources attached, lamp posts, cars, buildings with lit windows, etc.
    b. When you've finished adding lots of light sources, try changing the camera rendering path between forward and deferred and see what happens to the quality of your scene, the render frame rate, etc. Check the number of pixel lights in the Unity Project->Quality settings, and see how good you can make the forward rendering path version compared to the deferred. Make a note of your observations (what is the visual difference, what is the performance difference) in a text file in your project.

2. Implement Frustum culling on your camera, and use that to determine what objects are visible in your biomes - 9 points (3 points per biome)
    a. You don't need to show or hide objects in your biome. You can make the visibility sphere material transparent if you don't want them to appear in the scene, but make sure the objects in the camera's frustum appear in the "GameObjectsInFrustum" list on the camera (the code to do this is already in the lab/lecture examples).
    b. The definition of "object" is deliberately vague - it could be objects in your object placement map, it could be NPCs in the game. It doesn't have to be every object, just the ones that you think it makes sense to have some sort of visibility determination on.

3. Implement some form of Occlusion culling in your game. This could be either Portals or Occlusion Volumes (Anti portals). It is up to you how this is implemented - it could be to give the player character (or camera if it's a God view game) a view in the world that you use for a "fog of war" or similar behaviour (not that you are not required to implement this), or make an NPC who is able to see other NPCs the player character. This only needs to be implemented on 1 biome - 15 points (15 points total).
    a. You don't need to implement any of the logic for what your NPCs do, or implement fog of war, but you should illustrate what the visibility determination means
        i. For example, if occlusion culled visibility determination is enabled on your character/camera, any object not visible could have it's mesh renderer turned off to make it invisible, or just use the visibility spheres as in the lecture
        ii. If it's an NPC, perhaps the NPC has a boolean "ShouldAttackPlayer" or "ShouldRunFromPlayer" which is set to true when the player is visible and not occluded, or "ShouldHunt" or "ShouldFlee" if they see another predator or prey NPC.

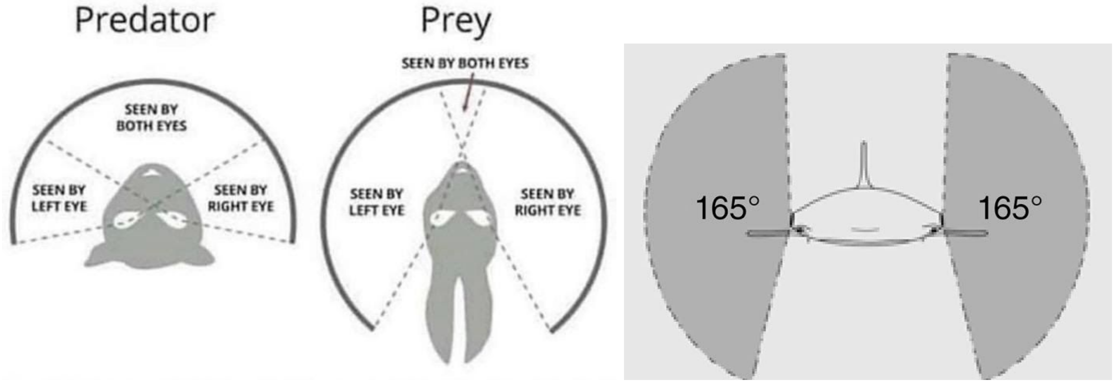
4. Record a video fly through of your biomes, showing the difference between forward and deferred rendering paths with all your additional lighting, and the frustum culling and occlusion culling visibility determination - 9 points (3 per biome)

Optional Tasks:

5. Using the deferred lighting path, make some of your NPCs have their own light sources - for example an alien NPC who has bioluminescence or a weapon that glows - 12 points (4 points per NPC maximum of 3 NPCs)

6. Create your own 3D models for custom NPCs - these do not need to be rigged/animated unless you want to - 24 points (8 points per NPC, maximum of 3 NPCs)

7. Implement an NPC with predator vision, and one with prey vision - 15 points (5 for predator, 10 for prey)
    a. The predator vision can use a single frustum which points in front of the predator, but the prey vision system should use two frustums, one for either eye. The prey's frustums may overlap (like a rabbit) or may not (like a hammerhead shark) - it is your choice.
    b. Your predator/prey vision doesn't have to do anything (although you're welcome to implement this as part of Task 3 as well), but can just render the frustum views of those NPCs
    c. The frustums don't have to be circular as in the below diagrams - a standard camera frustum is fine



https://www.nhstateparks.org/getmedia/e9e30fbf-fa20-4666-bd8b-83b7537641b9/Reading_a_skull_worksheet
https://onlinelibrary.wiley.com/doi/full/10.1111/cxo.12823

8. Implement an object that can provide x-ray vision when worn or activated (20 points).
    a. It's up to you how to implement this, but one idea would be to use frustum culling on environmental objects but not NPCs.

9. Extend the day night cycle idea from Part 1 Task 15 to incorporate the light sources for deferred rendering (e.g. during night time, street lights turn on, fireflies turn on, etc) - 21 Points (7 per biome)

10. Implement an OctTree/QuadTree for some aspect of your game - e.g. either for visibility determination (actually culling optional) or a minimap view - 15 points

11. Suggest an idea to Nikita and/or Adrian, get it approved, and then implement it - TBD points