Abstract

Introduction and Rationale

The purpose of the project, detailed below, is to conduct research into the most efficient and highest fidelity way of creating procedurally created planets, that are also a realistic scale. The finished product should allow for the fast generation of scale detailed, randomly generated 3d planets. These planets will have features such as: multiple biomes, level of detail system, terrain manipulation, oceans and procedurally textured surfaces. This area is being investigated because, although all of these areas have been individually researched and refined, they have yet to be combined together into a single library/experience.

Aims and Objectives

The main goal of this project is to create an executable that demonstrates the research done and implementing a complete procedural planet generation system. The final executable will allow the user to set parameters for the generation of the planet, then proceed to explore the generated planet with a flying camera.

Following are all the components and problems that must be solved and researched in order to complete the project. These are the components completely necessary to the project and must be completed before the project deadline.

* Generating initial sphere mesh
* Float point precision errors
* Generated Terrain on Sphere
  + Basic Terrain Generation
  + Biome generation
* Level of Detail (LOD) system
* Planet atmosphere system

In addition to these main components, there are some stretch goals that would ideally be featured in the final version but will only be added if time allows. Theses additional components are listed below.

* Multithreaded generation
* Terrain manipulation
* Ocean support

Literature Review

In order to gain a base understanding of the work done in all the fields listed above in the aims and objectives section, a literature review was conducted to understand current techniques and implementations of the induvial components that are intended to be made.

The first area that was investigated was the best method for creating the vertices for a sphere in a 3d virtual space. This was necessary as a base mesh is required for the creation of the planets. In this specific space, there are many methods for planet generation. Some of the most popular ones are UV spheres, normalized cubes, specified cubes and icosahedron (Cajaraville 2019). Unfortunately, all these different techniques have both positives and negatives associated with them. An ideal technique would be where the distribution of points is even, and close to as possible to the points on the actual sphere. Although all these techniques would work for the implementation, the distribution is still not as even as preferred. As such an alternative was found, called the Fibonacci sphere(S 2022). This is known as a “a well-known approach to generate a very uniform sampling of the sphere” (Keinert et al. 2015), and as such would be perfect for generating procedural terrain, if wrapped and triangulated correctly.

The next area that was investigated was the issues that would be experienced with floating point numbers at the intended scale. This is because floating point values would begin to loose precision at 1000km (O’Neil 2022). Using some of the techniques outline by Sean O’Neil in his article; such as manipulating the view matrix, scaling the planets and using doubles, this issue should be resolved.

The next major part that would require some research would how to actually generate the terrain of the planet and all of its features.

Methodology

Upon starting this project, the first thing that will be conducted is a further literature review to verify all of techniques discovered in the preliminary view seen above.

Project Plan

Shown below, and attached with this document, is a Gannt chart outlining the stages in which the project shall be completed, as well as all additional and associated deadlines.

Cajaraville, O. S., 2019. Four Ways to Create a Mesh for a Sphere. *Medium* [online]. Available from: https://medium.com/@oscarsc/four-ways-to-create-a-mesh-for-a-sphere-d7956b825db4 [Accessed 2 Feb 2022].

Keinert, B., Innmann, M., Sänger, M. and Stamminger, M., 2015. Spherical fibonacci mapping. *ACM Transactions on Graphics*, 34 (6), 193:1-193:7.

O’Neil, 2022. *A Real-Time Procedural Universe, Part Three: Matters of Scale* [online]. Available from: https://www.gamasutra.com/view/feature/131393/a\_realtime\_procedural\_universe\_.php [Accessed 4 Feb 2022].

S, A., 2022. *Delaunay+Voronoi on a sphere* [online]. Available from: https://www.redblobgames.com/x/1842-delaunay-voronoi-sphere/ [Accessed 4 Feb 2022].