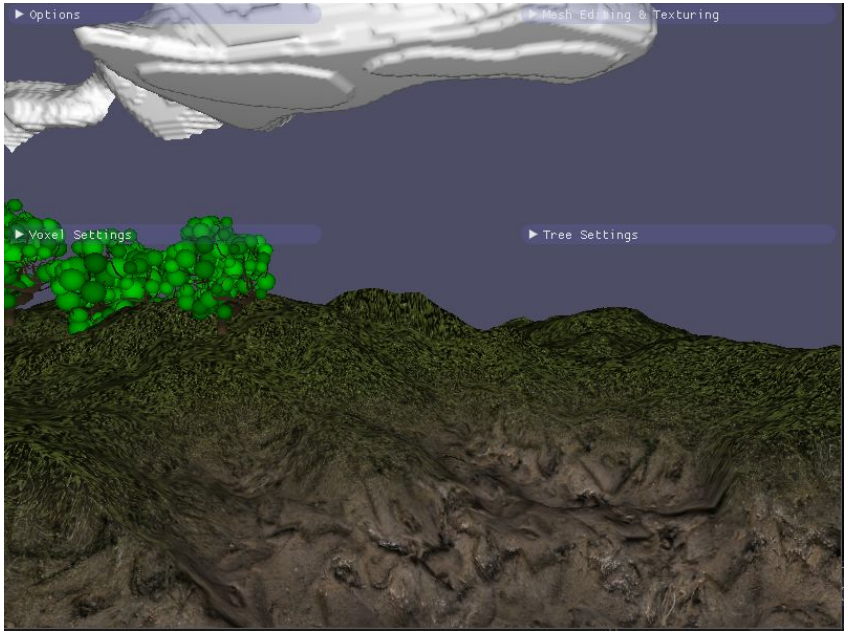
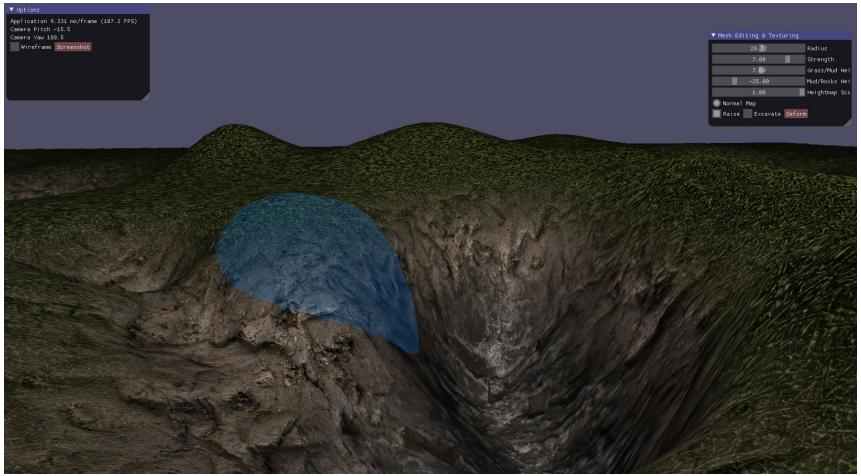
Mesh Generation

- Mesh generation/deformation using Perlin Noise algorithm.
- Generates a height map using a uniformly distributed permutation table to generate random 3D vectors in a unit cube. The gradient between these and a point in the cube is linearly interpolated to determine the height.
- LOD is increased by increasing the number of octaves/iterations over the final height value. Frequency and amplitude of the noise is increased/decreased per octave due to the lacunarity and persistence values.



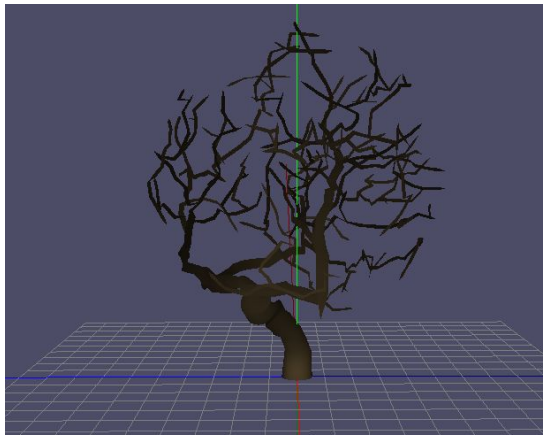
Mesh Editing & Texturing

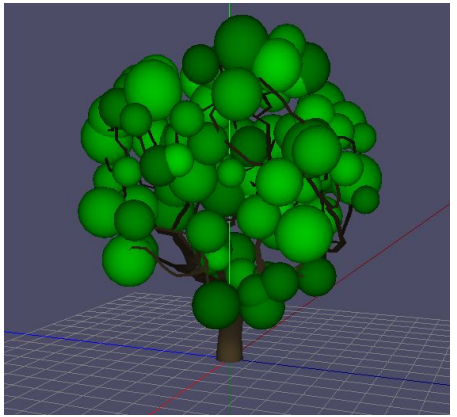
- Deformable mesh editing using local transformations and boundary conditions, vertices within the radius have stronger deformations the closer they are to the center
- Uses dynamic textures that respond to height with normal and height mapping, textures are blended in-between texture changes, texture highlighted blue if within the selected region
- Mouse interaction with mesh to select area for deformation via Möller–Trumbore ray-triangle intersection algorithm

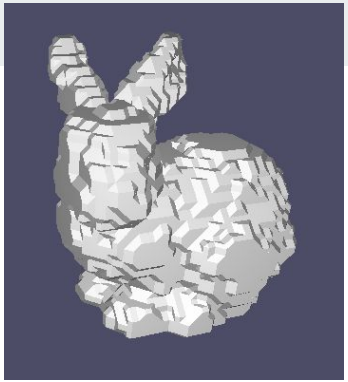


Tree Generation

- Generate procedurally generated Trees via populating 3D area with “attractors” and iteratively growing branches to form the “Tree” shape
- Generated custom mesh for tree with exponential decay in branch radius and rotations applied to vertices.
- Used the algorithm described in Modeling Trees with a Space Colonisation Algorithm paper (Adam Runions, Brendan Lane, Przemyslaw Prusinkiewicz)

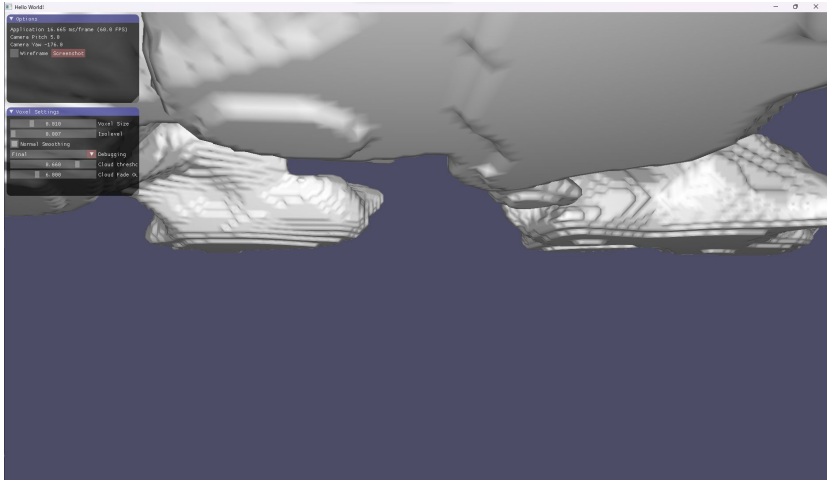






Marching Cubes Mesh Simplification

- Turns a 3d mesh into a sdf / voxel grid, then runs an algorithm to mesh-ify it again at different voxel resolutions which reduces vertex and index count dynamically.
- Clouds generated from perlin noise using the marching cubes half of the algorithm.
- Optimisation paper was not meant for real time so octrees, kdtrees, multithreading were all attempted until I innovated a reverse lookup method improving performance 400x



Lighting & User Interaction

- Interactive camera control with keyboard and mouse adjusts the viewing matrix.
- Explore the scene by flying around the terrain.
- Cannot go through the terrain mesh thanks to Möller–Trumbore ray-triangle intersection algorithms created for mesh editing.
- Skybox creates a sense of immersion & scale.
- WIP: Lighting with Soft Shadows.