Project Proposal

Density Scalable Terrain Generation

Real-Time Renderers Members

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Introduction

Abstract
This project will be a terrain simulation where the polygon count of mesh models will increase/decrease the closer/further the camera comes to it. We aim to base this project on two papers we found. As such there are two parts to this project; natural, good looking terrain generation and distance-based re-meshing of models, combining to create our final product of an interactive terrain simulation.

Individual Tasks

Adam Goodyear: Low poly meshing

Topic: Mesh Optimisation
Methods: Progressively simplifying and flowing the offset mesh to bring it close to the input.
References: SIGGRAPH course note (Zhen Chen, Zherong Pan, Kui Wu, Etienne Vouha, Xifeng Gao, Robust Low-Poly Meshing for General 3D Models, 2023)
Technical Problems: I will be in charge of the implementation of the second part of the Low Poly Meshing algorithm. However I will need to wait for Marshall's part of the project to be completed before I can start on mine. As such I will attempt to help Marshall in his work on the first part as he will help with my work on the second part. This way we can get the first part done much faster allowing progress on the second part to start earlier.

Marshall Scott: Low poly meshing

Topic: 3D Mesh Extraction
Methods: Robustly extracting an offset surface mesh that is feature preserving, and guaranteed to be watertight, manifold, and self-intersection free
References: SIGGRAPH course note (Zhen Chen, Zherong Pan, Kui Wu, Etienne Vouha, Xifeng Gao, Robust Low-Poly Meshing for General 3D Models, 2023)
Technical Problems:
I will be doing the first part of the implementation of the Low Poly Meshing Algorithm, technical problems involve interfacing with vertex data generated from the Terrain Generation. The algorithm does have problems with certain levels of low poly and can create artifacts so these will have to be mitigated.

Tessa Power: User Interface, Global Illumination & Lighting, Shadow-mapping

Topic: Interactive user interfaces and lighting

References: ImGUI (GitHub), LearnOpenGL, SIGGRAPH Course Notes (Elmar Eisemann, Ulf Assarsson, Michael Schwarz, Michal Valient, Michael Wimmer, Efficient real-time shadows, 2013), SIGGRAPH paper (Ravi Ramamoorthi, Pat Hanrahan, An efficient representation for irradiance environment maps, 2001), I3D paper (Gregory S. Johnson, Warren A. Hunt, Allen Hux, William R. Mark, Christopher A. Burns, Stephen Junkins, Soft irregular shadow mapping, 2009)
Technical Problems: Efficiently rendering real-time shadows, propagating user interactions with the UI, click/collision detection with editable meshes, and interactive camera control.

Timothy Green: Terrain Generation

Topic: Procedural Modelling
Methods: Procedurally model a terrain mesh using noise functions
References: Eurographics paper (Eric Guérin, Adrien Peytavie, Simon Masnou, Julie Digne, Basile Sauvage, James Gain, Eric Galin, Gradient Terrain Authoring, 2022)
https://perso.liris.cnrs.fr/eric.galin/2024-2020.html
https://hal.science/hal-03577171/document
Technical Problems: Quick and efficient rendering time, cohesive mesh, noise algorithms

Shekinah Pratap: Mesh Editing, Texture Mapping

Topic: Mesh Deformation and Texturing
Methods: Deformable mesh editing using local transformations and boundary conditions, texture mapping
References: SIGGRAPH 2017 Course Notes | Rethinking Texture Mapping (Marco Tarini, Cem Yuksel, Sylvain Lefebvre), SIGGRAPH 2004 Technical Papers | Mesh editing with poisson-based gradient field manipulation (Yizhou Yu, Kun Zhou, Dong Xu, Xiaohan Shi, Hujun Bao, Baining Guo, Heung-Yeung Shum)
Technical Problems: Seamless deformation of terrain mesh, performance optimization of dynamic editing, texture mapping

Integration / Resources

Our final demo will be a real time simulation in which 3D geometry will be rendered based on the work done towards the Terrain Generation. The user will be able to zoom in and out from the model to increase or decrease the mesh detail. The mesh will be rendered with the shaders made by Tessa. The user will also be able to directly edit the final mesh with their mouse. This will show off the implementation of the terrain generation algorithm along with the ability to change and shape the landscape at will.

We will use the CGRA350 code template that uses glew, glfw3, glm, cmath using the existing mesh and shader constructs such as *basic_model, gl_mesh, mesh_builder* and *shader_builder*.

Integration plan

We will first test the mesh simplification on imported models while terrain generation is being implemented. To support this, base shaders and UI will be reused from previous projects. Terrain generation will also make use of these shaders and UI. While developing the shaders, user interface, and global illumination, simple 3D models like the Stanford Bunny will be used for testing. We will be working on these three parts separately, however we will test integrating components throughout the project to ensure compatibility. We aim to work collaboratively as a group and upon finishing individual

work members will assist others and help with the construction of their part. Once all components have been completed and successfully integrated the final project can be submitted.