Caroline Lachanski & Grace Gilbert 4 November 2019
CIS 565 Final Project

Realtime Hair

Overview

We want to implement a real-time, interactive hair simulator. The simulation and rendering of hair is notoriously difficult, due to the amount of geometry required to create realistic hair (the average human has about 100,000 hairs on their head) and the unique visual and physical properties of hair (such as its anisotropy). Creating this functionality in realtime is even more challenging, and requires some approximations. To implement this pipeline, we plan to use Vulkan. We hope to implement the current state-of-the-art techniques in real-time hair simulation and rendering as best we can given the technology we are using and the time given.

The general structure of the simulation begins with applying physics to a set of guide strands. Each strand is a curve made up of various control points linked together, simulated with a hair-oriented version of position based dynamics. The strands will be pinned to the surface of a head geometry. External forces on the system are gravity, interactive user input, and adjustable wind. At this stage, we also implement collision detection between the strands. This will all be done in the compute shader.

Once the motion of the guide strands is in place, we interpolate between them to place the remaining strands using the tessellation shader. With all strands in place, we can render the hair using an approximated physically based hair shading model to create a realistic look.

Goals

Milestone 1

- Basic pipeline setup with compute and tessellation shader
- Basic physics with gravity on guide hair rendered as line segments

Milestone 2

- Finish physics simulation including wind and collision detection
- Get user input and add it to physics simulation
- Implement interpolation of guide hair curves to place the remaining strands

Milestone 3

- Convert the strands from line segments to mesh geometry
- Approximated physically based shading of hair strands (single scattering)

Final

- Finish shading (multiple scattering, shadowing)
- (Stretch goal) Art directability of hair properties, including shininess, stiffness, etc.

References

- Strand-based Hair Rendering in Frostbite (2019)
- Physically Based Hair Shading in Unreal (2016)
- Fast Simulation of Inextensible Hair and Fur (2012)
- Advanced Techniques in Real-time Hair Rendering and Simulation (2010)