Realtime Vulkan Hair

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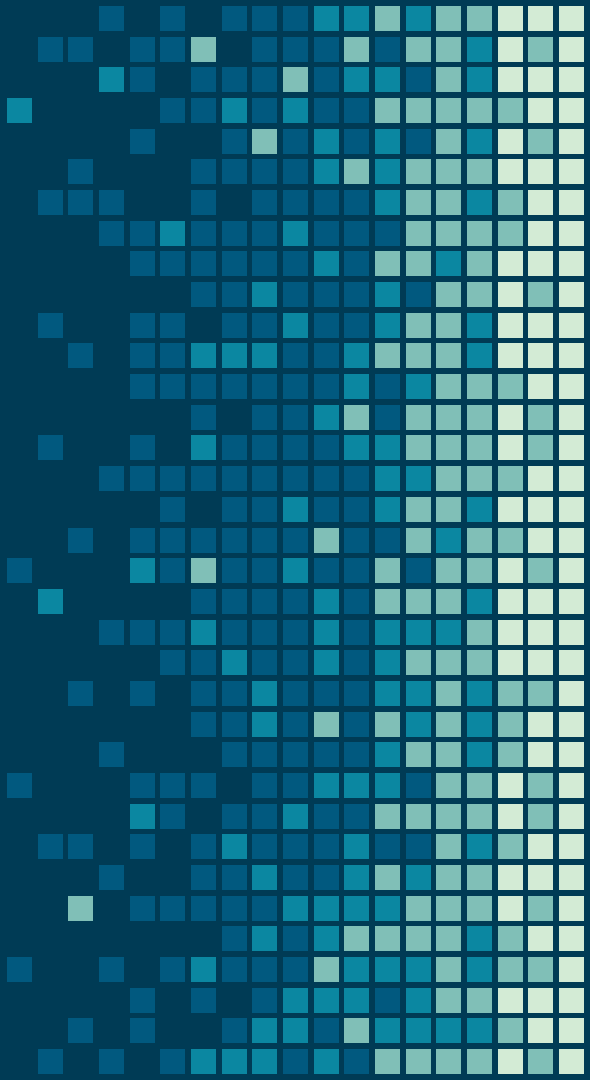
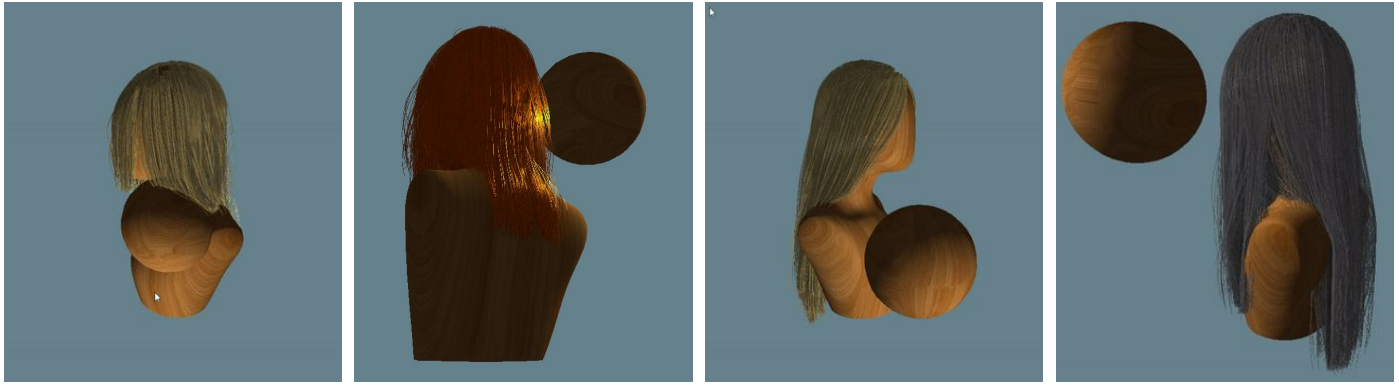


Project Overview

- Interactive realtime hair simulation and renderer in Vulkan
- Hair is difficult: **many** individual strands with complex physics, interactions with each other, other objects, and light



Physics Simulation

- Guide strands
- Compute shader
- Follow the Leader, Position Based Dynamics
  - Ellipsoid collisions
  - Hair-hair interaction

Hair-ellipsoid collisions

Wind forces

Hair-hair friction

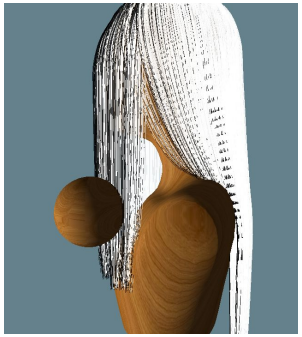
Tessellation

- Within strand: Bezier interpolation
- Between strands:
  - Single strand interpolation
  - Multiple strand interpolation
  - Random deviation
- Geometry shader: Isolines → camera-facing quads

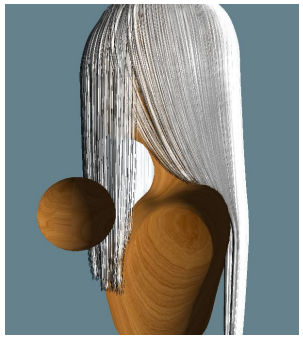
Random deviation shapes

Rendering

- Single scattering based on Marschner model
- Multiple scattering
- Percentage closer filtering (PCF) shadow mapping



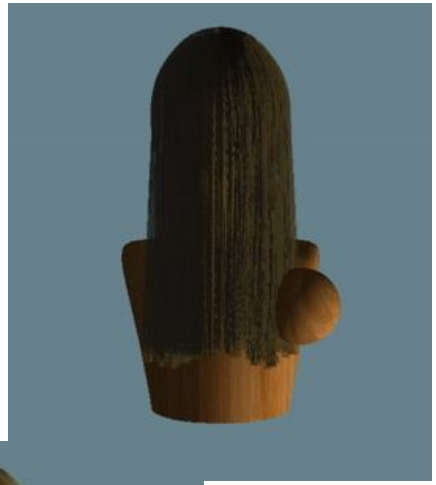
No PCF



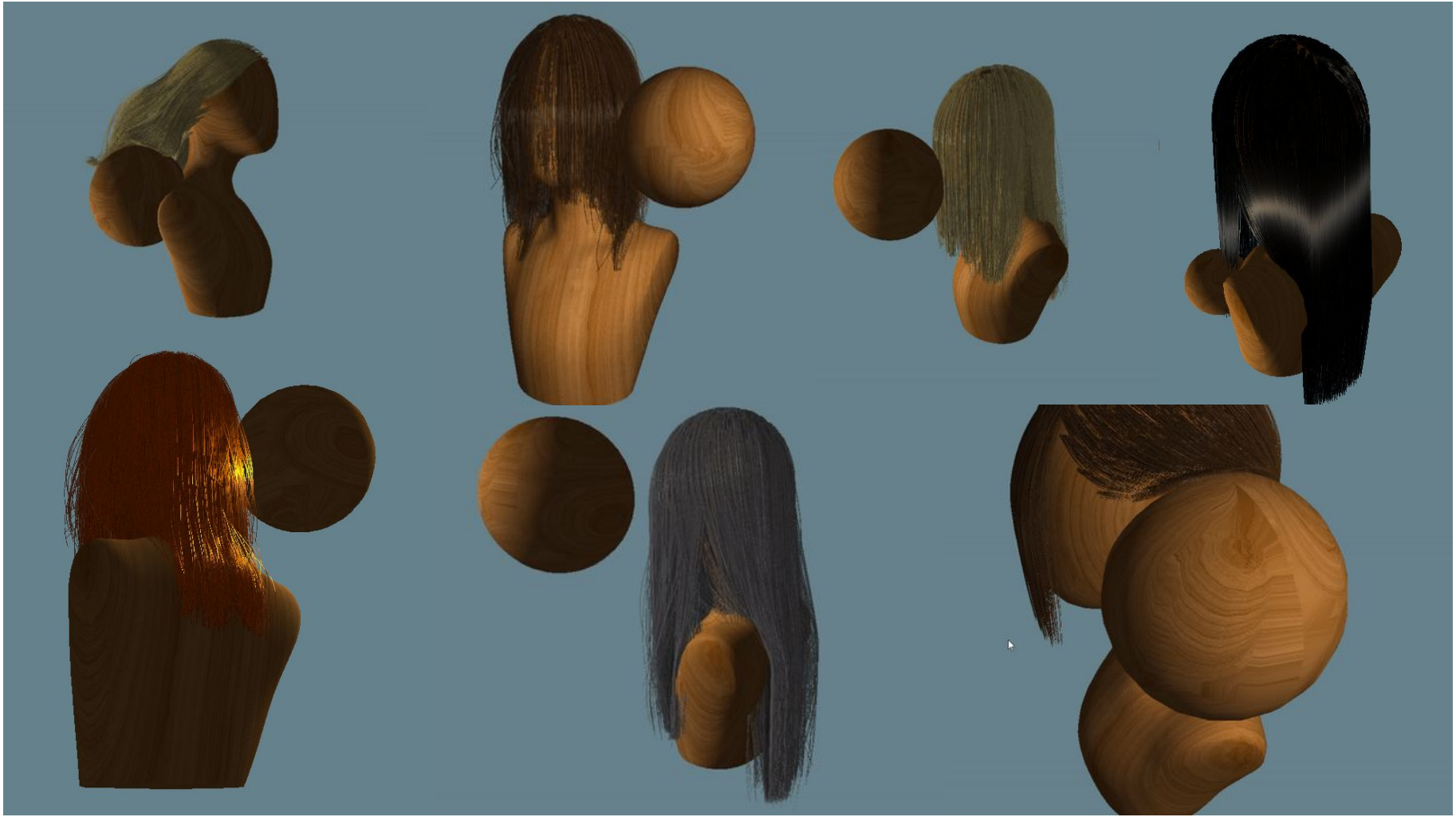
36-spp PCF

Single scattering alone

Multiple scattering alone



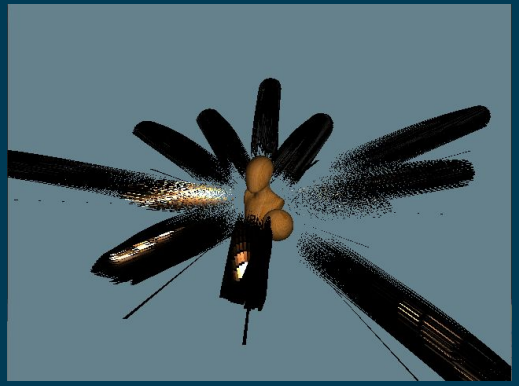
Full model
(with ambient light)

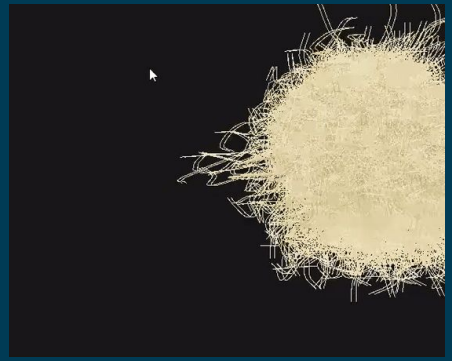


Live Demo

Thank You

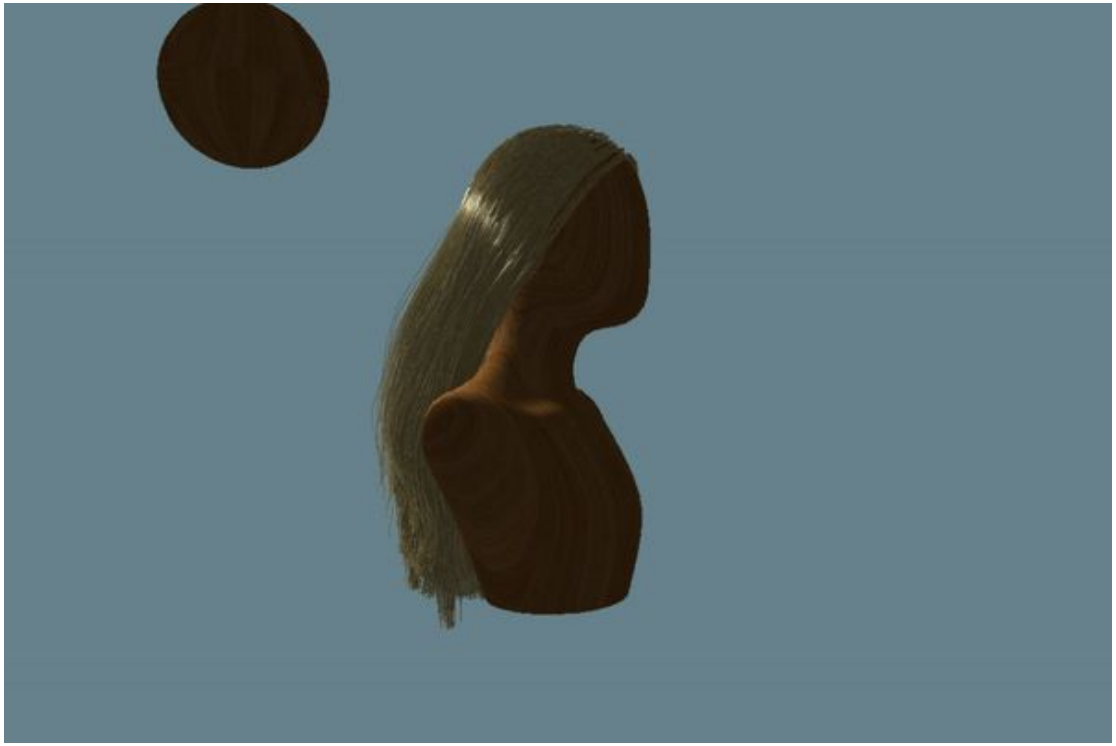
- Dr. Chenfanfu Jiang
- Sascha Willems





References

- Fast Simulation of Inextensible Hair and Fur, Müller et al. (2012)
- Volumetric Methods for Simulation and Rendering of Hair, Petrovic et al. (2005)
- Position Based Dynamics, Müller et al. (2006)
- Real-Time Hair Rendering, Markus Rapp (2014)
- Light Scattering from Human Hair Fibers, Marschner et al. (2003)
- Physically Based Hair Shading in Unreal, Brian Karis (2016)
- Deep Opacity Maps, Yuksel and Keyser (2008)
- Real-Time Hair Rendering on the GPU, Tariq (2008)
- Sascha Willems' Vulkan dynamic buffer example
- Sascha Willems' Vulkan shadow mapping example
- CIS 563 Course Material, Chenfanfu Jiang
- CIS 562 Course Material, Stephen Lane



Questions?

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