CIS 565 GPU Programming Final Project Pitch

Global Illumination Based on Surfels and Multi-lights Support

Introduction

Indirect lighting can greatly improve visual quality while saving the work on scene lighting. When hardware ray tracing is introduced to more devices, how to make use of this new technique to add realism to the game matters. Global Illumination based on Surfels is a solution for calculating indirect diffuse illumination in real-time. The solution combines hardware ray tracing with a discretization of scene geometry. This method requires no pre-computation, no special meshes, and no special UV sets. Sufel, as a new irradiance cache data structure, is also compatible with many modern GI techniques like ReSTIR and Megalights. Therefore, Surfel GI has great potential.

Goals and Outcome

Implement Surfel GI using Vulkan. Try to introduce some modern GI optimizations to the system, like spatial and temporal filtering, hardware ray tracing and GPU driven pipeline. If possible, we'd like to integrate some core ideas from megalight to the system to support multiple dynamic lights in the scene.
To reduce the complexity of the project, we'd only focus on static scenes with no transparent objects.

Platforms and APIs

- Platform: Windows
- Graphics API: Vulkan
- Hardware Requirements: GPUs with hardware ray tracing support

Milestones Schedule

Milestone 1 (Nov. 13):

1. A complete deferred pipeline with PBR material support in Vulkan (Since Gbuffer is needed)
2. Pipeline backbone set up (Empty pass through compute and graphics render passes)
3. Ray tracing and TLAS BLAS features set up.

Milestone 2 (Nov. 25):

1. Surfelization
2. Surfel recycle and update
3. Surfel acceleration structure
4. Surfel raygen & ray trace.

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Milestone 3 (Dec. 2)

1. Spatial temporal filtering
2. Final gather & direct lighting

Due date (Dec. 8)

1. Multiple lights importance sampling

Code Base

https://github.com/nvpro-samples/vk_raytrace

Reference/Third party code

GIBS 2024 Presentation
GIBS 2021 Presentation
Stochastic All the Thing
Unreal Engine 5.5 Source Code
https://github.com/W298/SurfelGI