World Space ReSTIR in Vulkan

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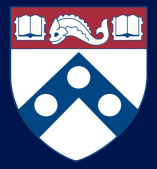
CIS 5650 - Final Project

Milestone 3



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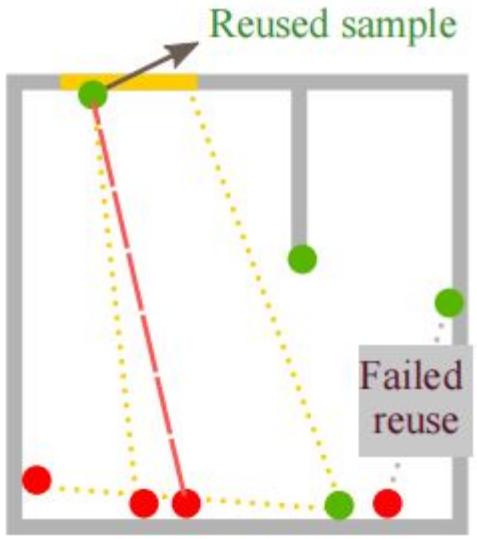
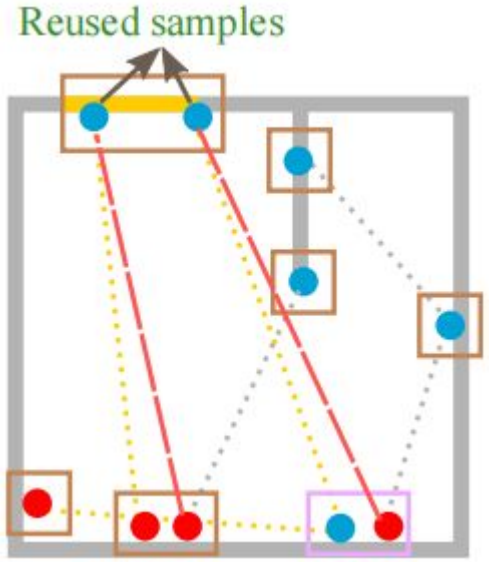
Recall

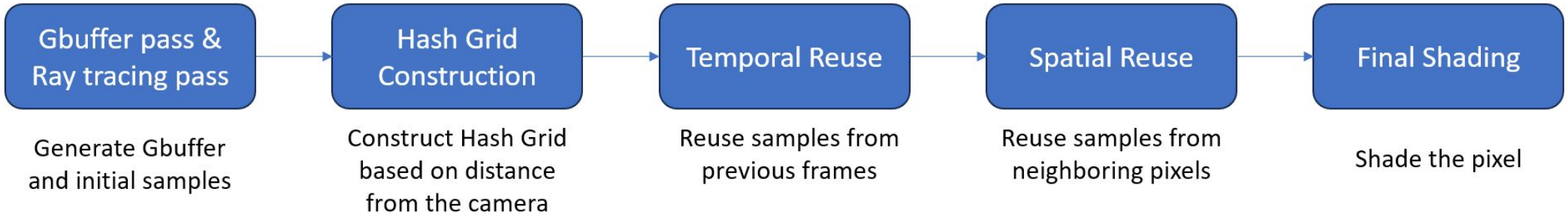
- **Goal:** Implement a real-time global illumination renderer based on world-space ReSTIR in Vulkan



Pure ReSTIR



Ours(World Space ReSTIR)



Progress

Milestone 1 (Nov 04 - 13)

- Basic Vulkan Ray-Tracing Pipeline Setup
- Hash Grid Data Structure Setup
- Research on RIS, Reservoir-based sample Algorithm and Denoise techs

Milestone 2 (Nov 13 - 25)

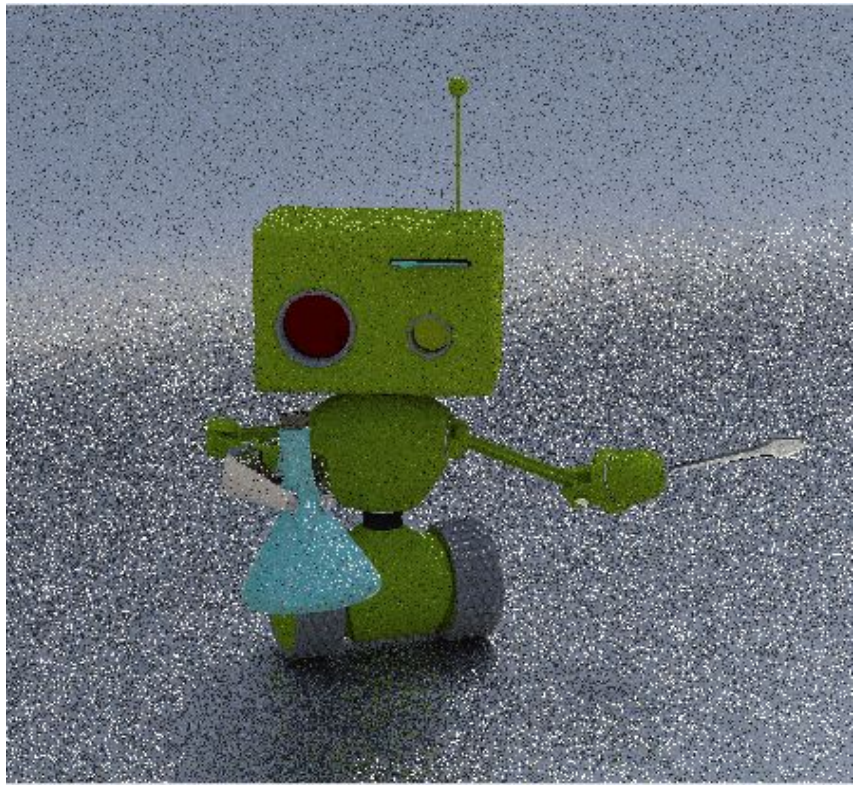
- Completed hash grid Construction & Visualization and ReSTIR DI
- Completed basic Denoiser integration

Milestone 3 (Nov 26 - Dec 02)

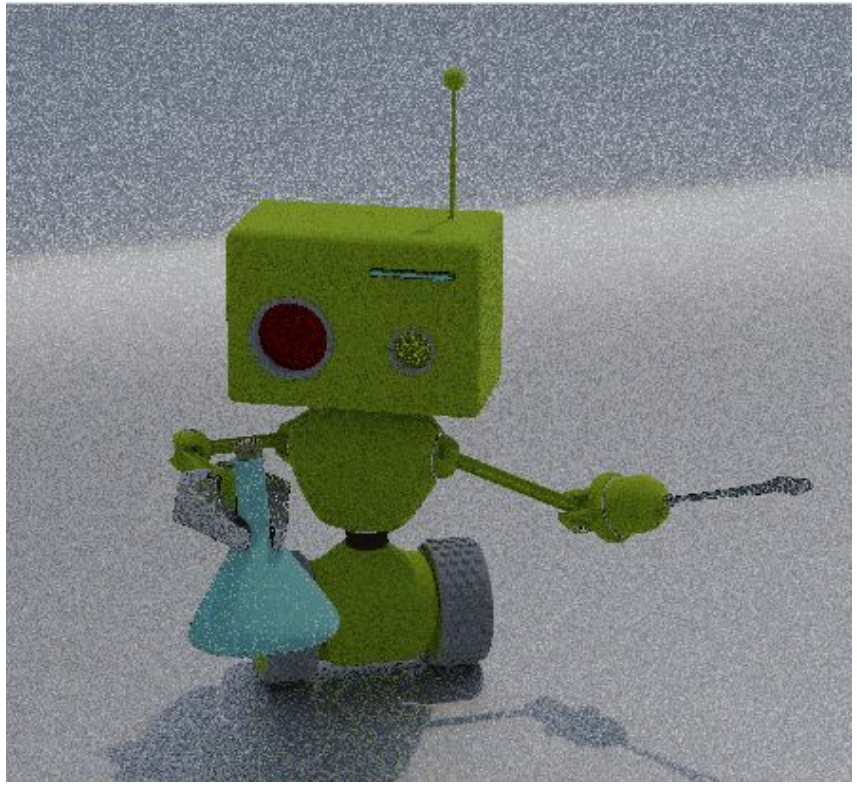
- Completed basic Spatial Reuse
- Fixed bugs for Temporal Reuse
- Fixed several bugs for DI
- Project refactoring and code optimization

M3 Progress

- Temporal Reuse

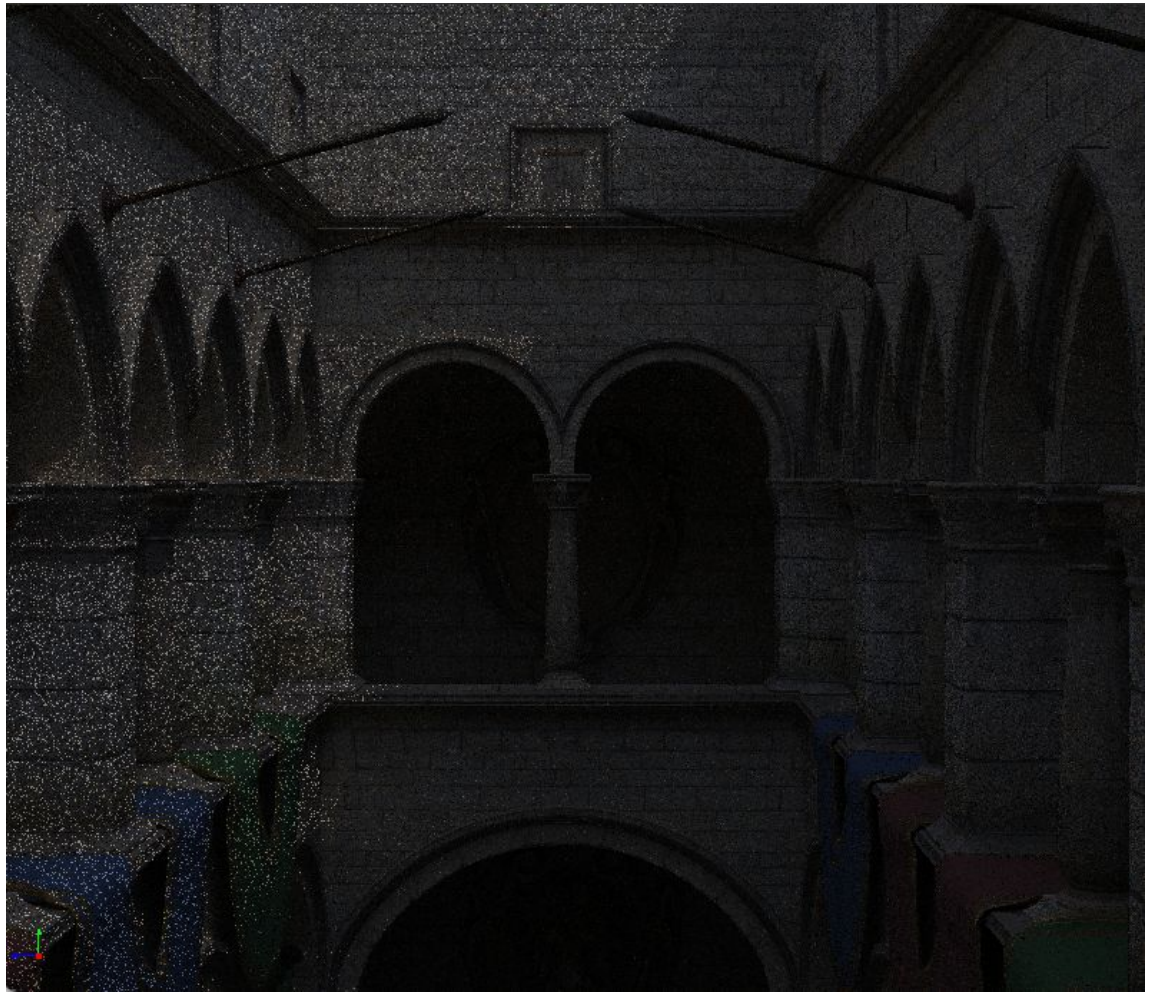


- Temporal & Spatial Reuse

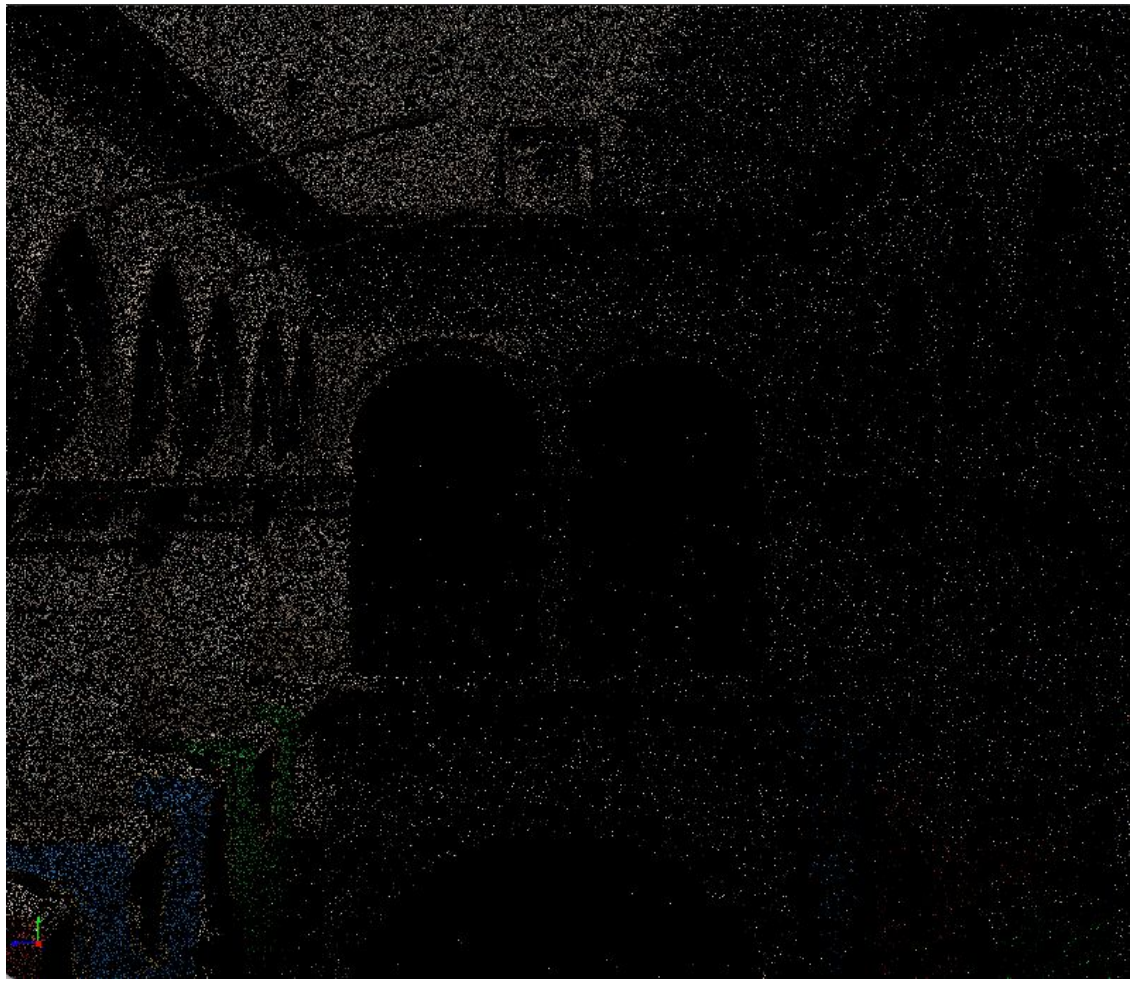


M3 Progress

- Ours(1 spp)



- Path Tracing(1 spp)



M3 Progress

- Ours

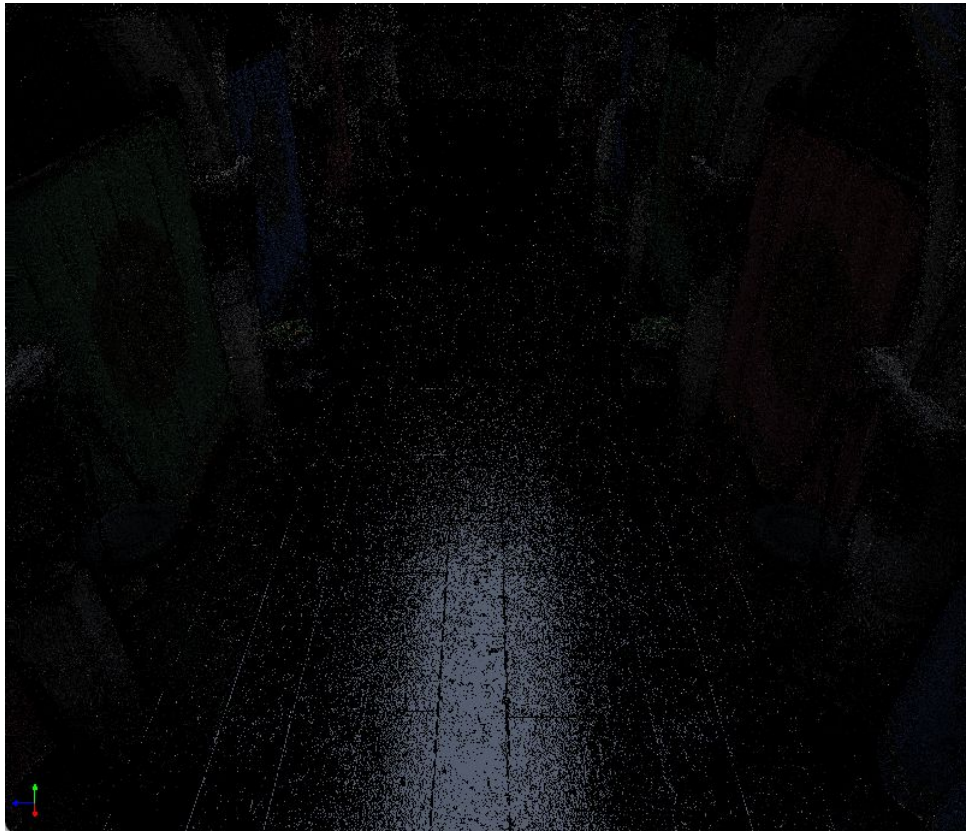
(1 spp, rough surface)

- Path Tracing

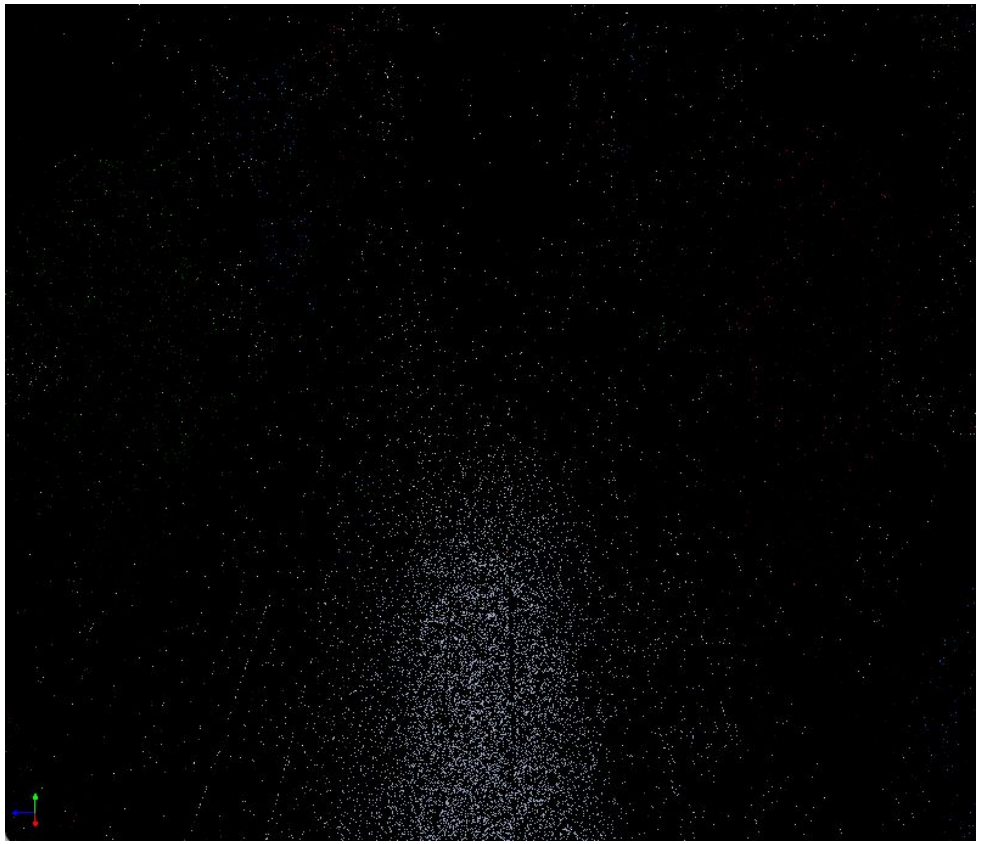
(1 spp, rough surface)

M3 Progress

- Ours
(1 spp, smooth surface)

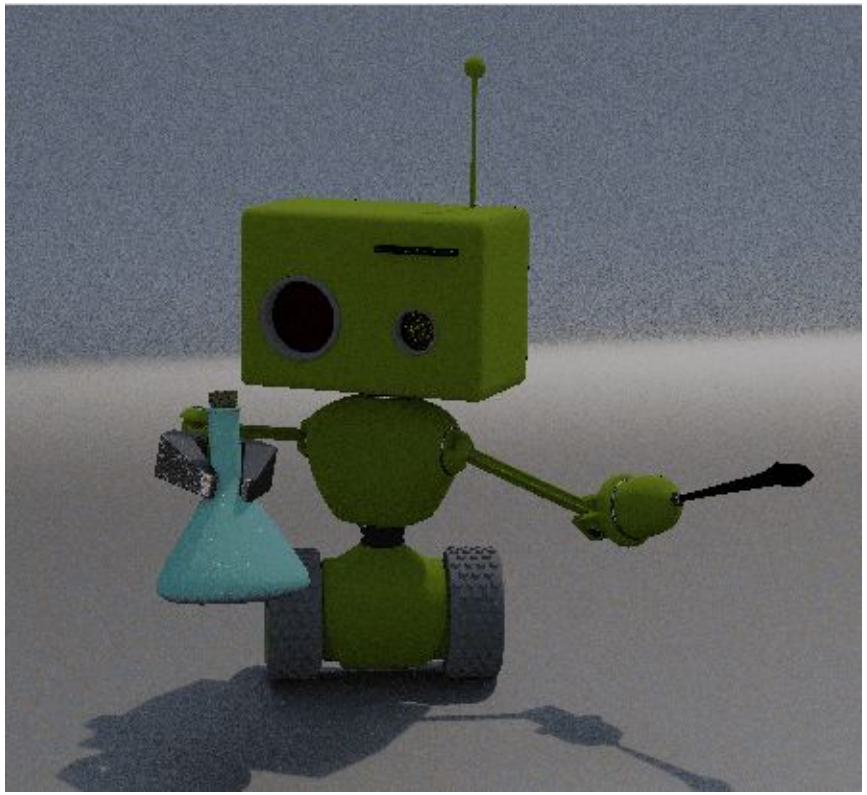


- Path Tracing(1 spp)
(1 spp, smooth surface)

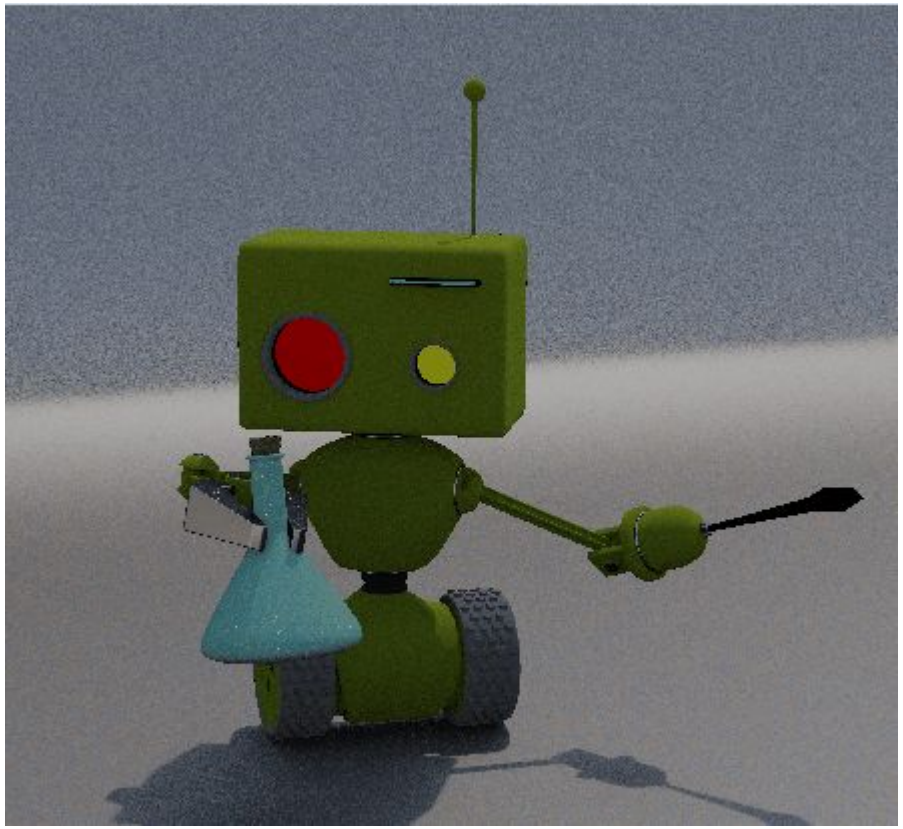


M3 Progress

- DI with bugs



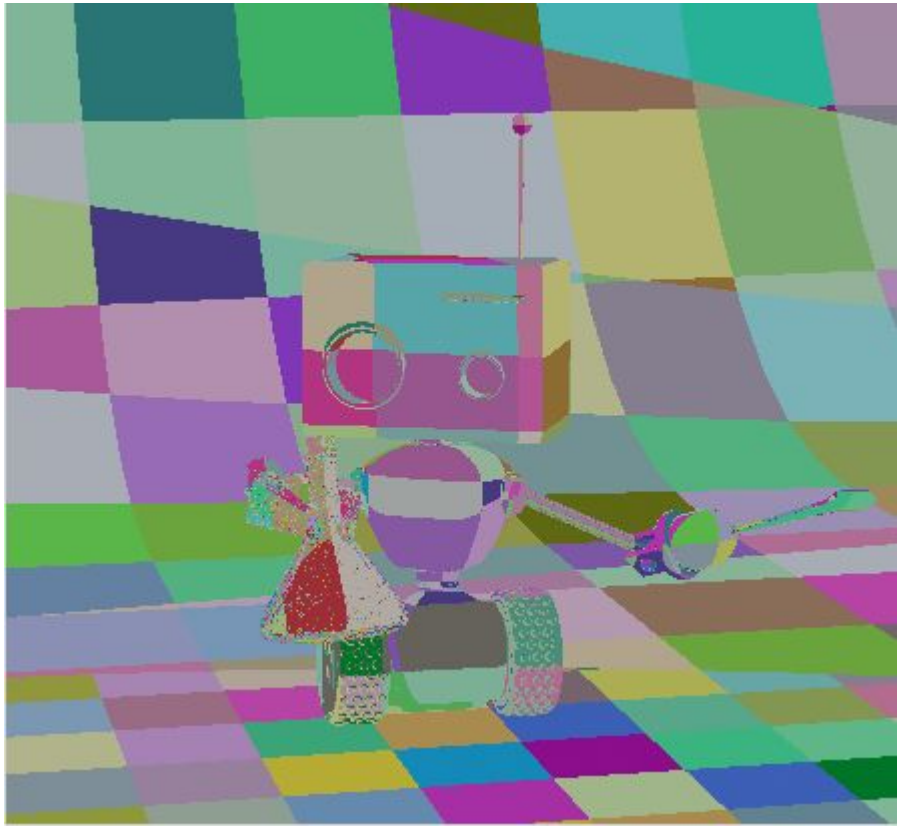
- Correct DI Result



M3 Progress

- Hash grid with bugs

- Correct Hash grid



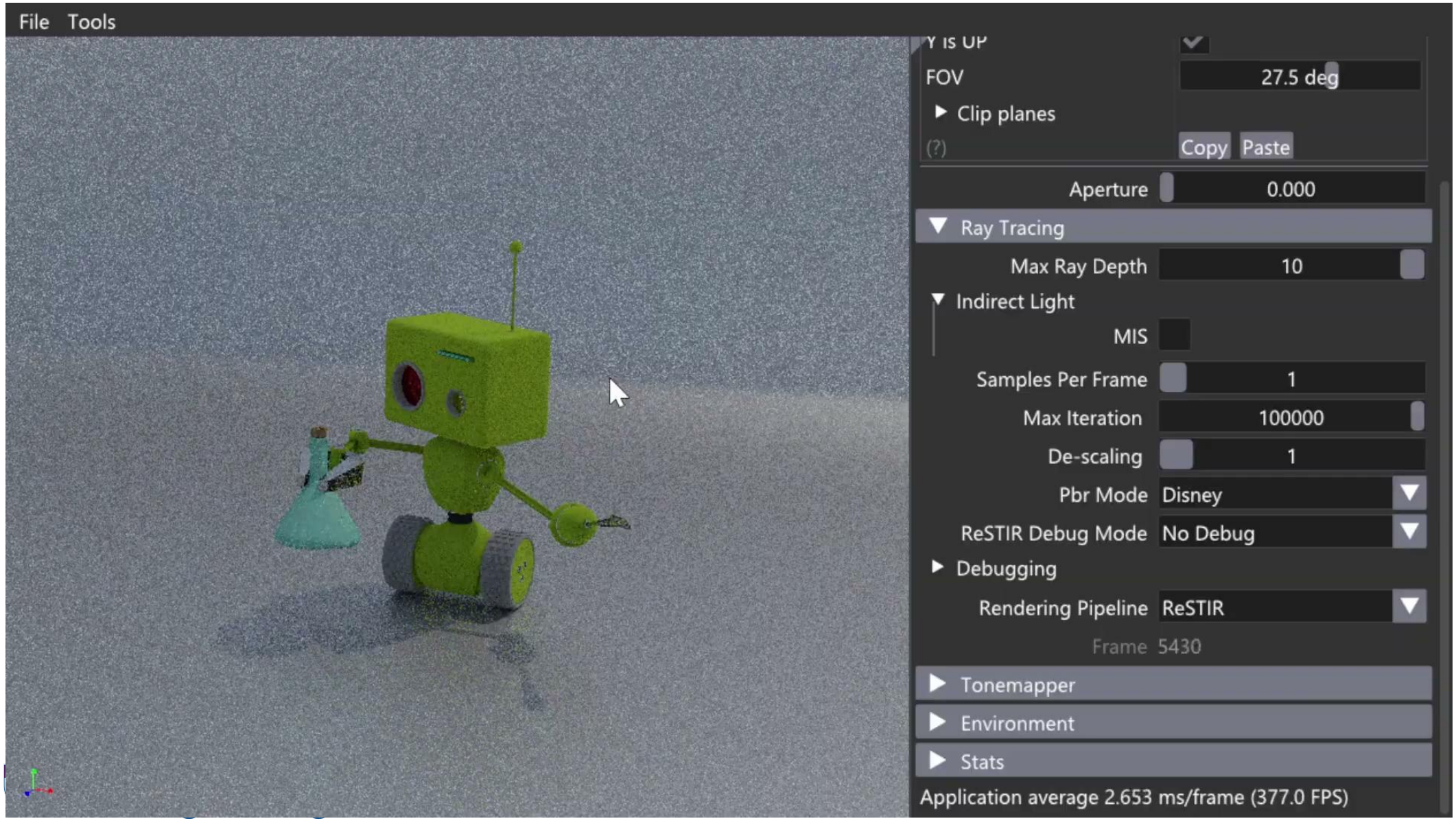
Next Step

- ~~Milestone 1~~(Nov 04 - 13)
- ~~Milestone 2~~(Nov 14 - 25)
- ~~Milestone 3~~(Nov 26 - Dec 02)

Final Presentation(Dec 3 - Dec 9)

- Polish code and Fix the remaining bugs
- Testing and Performance Analysis
- Preparing for Final Presentation

Demo

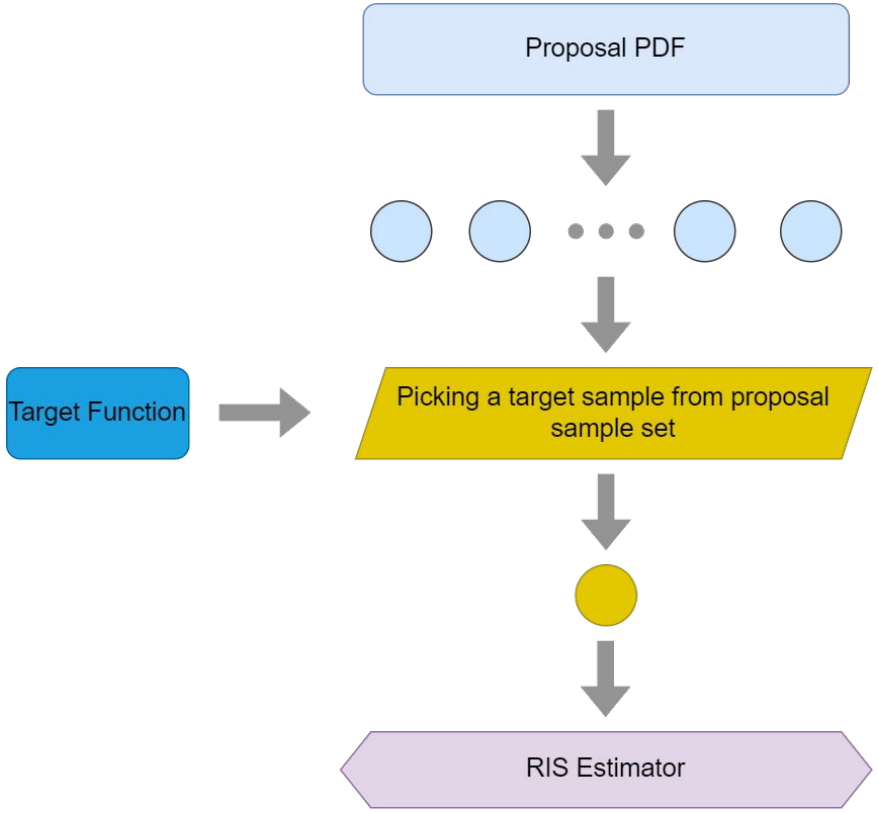

File
Tools
Y is UP
FOV
27.5 deg
Clip planes
(?)
Copy
Paste
Aperture
0.000
Ray Tracing
Max Ray Depth
10
Indirect Light
MIS
Samples Per Frame
1
Max Iteration
100000
De-scaling
1
Pbr Mode
Disney
ReSTIR Debug Mode
No Debug
Debugging
Rendering Pipeline
ReSTIR
Frame 5430
Tonemapper
Environment
Stats
Application average 2.653 ms/frame (377.0 FPS)

ReSTIR

- RIS: Resampled importance sampling. Draw **n** samples from a proposal distribution and select one based on a weighting function. This approach is progressively unbiased as **n** approaches infinity.

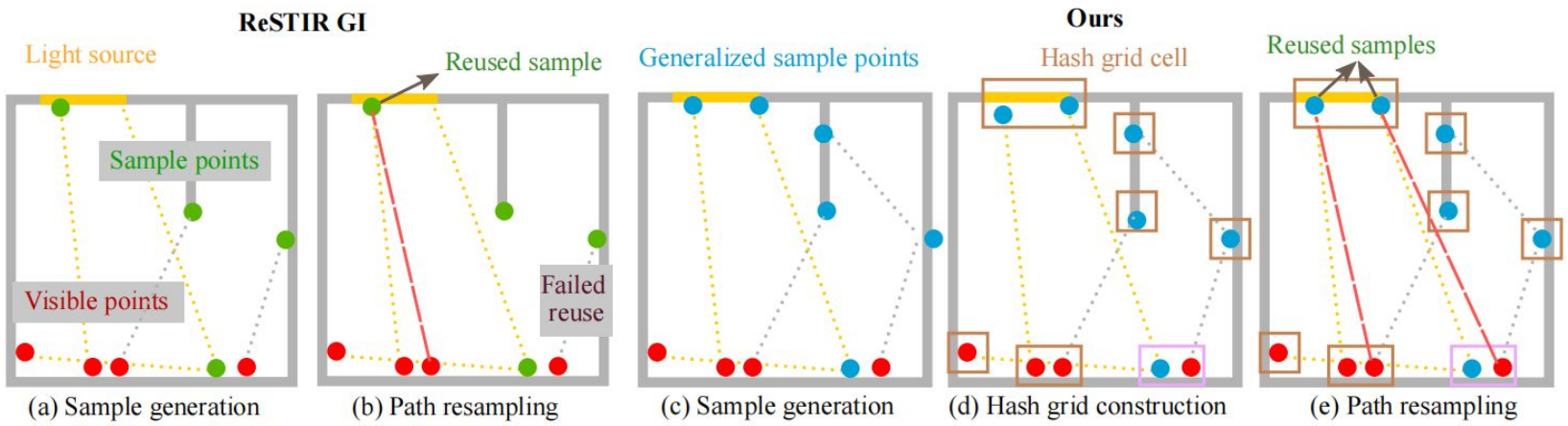
- WIS: Weighted Reservoir Sampling. The reservoir efficiently stores and manages samples without requiring all of them to remain in memory(we only need some statistical properties).

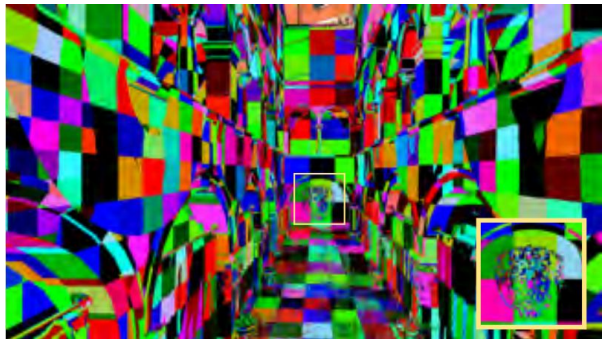
- Temporal / Spatial reuse: Reuse samples from neighboring pixels and previous frames, reservoir structure can help us to combine different reservoirs from different pixels and frames.



Paper

- Pure **ReSTIR GI** Operates in **screen space**. It optimizes global illumination sampling for primary rays and uses spatiotemporal resampling to manage indirect illumination. The reservoirs are tied to **screen-space pixels**.
- We extend it to **world space**. It divides the scene into a **3D grid**, with reservoirs distributed across these grid cells.
- To construct the grid, we use a hash function based on the world position and surface normal to map these cells, allowing us to locate sample points with similar geometric properties.





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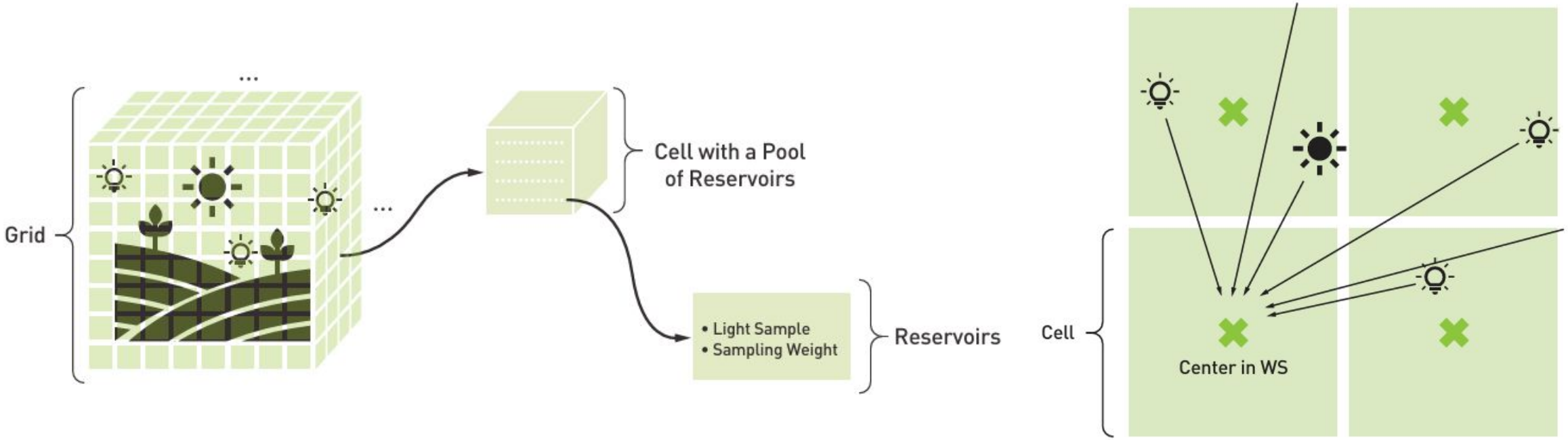
Overview

What is GRID-BASED RESERVOIRS(ReGIR)?

ReGIR (Reservoir Grid Importance Resampling) is an algorithm designed for **efficiently rendering scenes with many light sources** in real-time ray tracing. It builds upon existing techniques such as ReSTIR (Reservoir Spatiotemporal Importance Resampling) and applies them to world-space sampling using a grid-based structure to optimize light sampling for secondary rays.



Milestone Presentations – Do

- Strictly stick to time limits – N minutes is N x 60 seconds!
  - Default length will be 5 minutes, but may change – Will be posted on Ed Discussion
- **Show progress since last milestone**
- Videos, screenshots and demos
- Include goals for next milestone
- Know your audience
  - i.e. your fellow students, not the instructor or TAs
- Add presentation to your GitHub repo.

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Milestone Presentations – Do

- Use social media – Great time to show off your work
- **Get in touch with original authors** – They really like it
  - And do this earlier than later
- See the Cesium Presenter's Guide (or your favorite company) for tips on presenting
- Be sure to present as a team; for a great example, see http://www.youtube.com/watch?v=OTCuYzAw31Y

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Milestone Presentations – Don't

Doing any of these may result in grade penalties

- Don't exceed time limits for presentations
- Don't include code/math equations in your presentation
  - Exceptions: Something cool, good to know, or required for another part of your presentation.
  - If you need to walkthrough the code/math, don't include it

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