Adaptive Frameless Rendering with NVIDIA OptiX

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Introduction

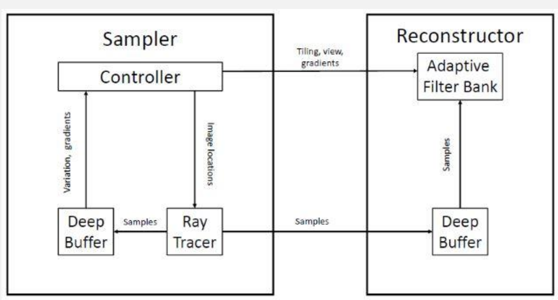
Frameless Rendering

[BGE94]

Frameless rendering eliminates frames. It renders random pixels directly to the display by using the latest input available, thus reducing latency. The result is a much more up–to–date but temporally incoherent image, with the incoherence visible during change as "pixel dust".

Adaptive Frameless Rendering (AFR) [DAD05]

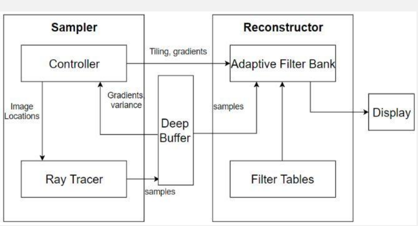
To improve rendering quality and minimize image artifacts in frameless rendering, AFR uses adaptive sampling and filtering based on patterns of spatio-temporal change. However, the original implementation was not real time, parallel or unified into a single application.



New Challenges

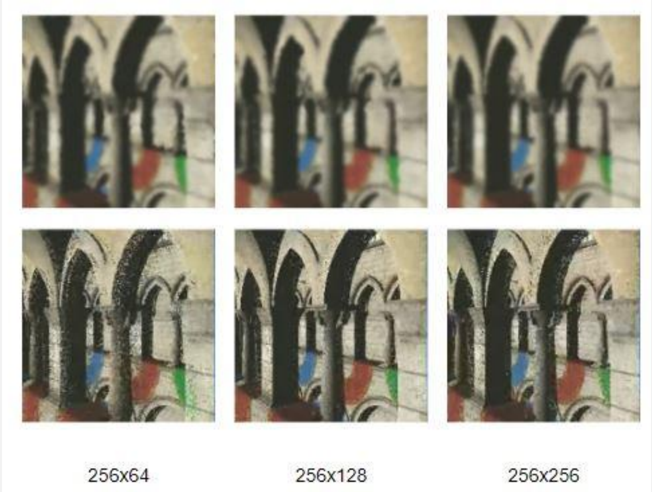
Our AFR Prototype

With renewed interest in adaptive display and the advent of real-time ray tracing hardware, we are building a real-time, parallel version of AFR. We are implementing it using NVIDIA's OptiX ray tracing API, which also takes advantage of RTX architecture.



We see three challenges in this work. *Parallel conflicts* happen when two threads shoot rays into the same pixel. *Integrated control* manages algorithmic flow between system components. *Tasking balance* debates how many new samples needed to be collected before reconstruction.

Preliminary Results



Our imagery (top) compared to frameless rendering (bottom) at various thread allocations (sampling x reconstruction).

Our prototype makes better imagery than a non-adaptive frameless renderer. At changing regions, it blurs to reduce dust and latency. At static regions, it sharpens edges.

Our prototype's speed is related to motion. Without motion, filter support shrinks, sharpening edges and reconstructing quickly. With motion, support grows to blur the image, reconstructing more slowly.

Conclusion

- An early implementation of adaptive frameless rendering on Nvidia OptiX
- Design challenges and choices in current implementation

Future Work

- Better reconstruction to improve quality
- Parallelizing sampling and reconstruction
- More computation on the GPU, avoiding bandwidth and communication overhead
- Using OptiX AFR for low-latency VR/AR display.

Reference

[BGE94] BISHOP G., FUCHS H.. et al.: Frameless rendering: Double buffering considered harmful. Proc. 21st conf. Computer graphics and interactive techniques (1994), ACM, pp. 175–176.

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[PSA10] PARKER S., BIGLER J. et al.: Optix: a general purpose ray tracing engine. ACM Trans. Graphics (TOG) 29, 4 (2010), 66.