Hybrid Ray-Traced Ambient Occlusion

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Algorithm: Geometric rays are expensive compared to screen-space rays, but screen space rays produce artifacts due to missing data in the scene depth buffer (no data behind visible pixels, no data outside of the viewport).

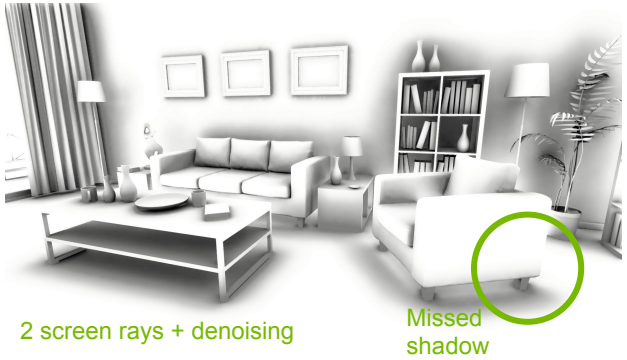
Send one screen-space ray and one geometric ray and linearly interpolate results from both methods and denoise resulting image.

Assigning 2/3 weight to the world-space ray gave the best empirical results.

Discussion: The inexpensive screen-space rays are used to reduce noise and the accurate geometric rays because the aren't prone to the failure cases such as under the chair (circled).

The geometric ray casting performance varies with alpha and geometric complexity, while screen-space performance is more predictable.

The main limitation is that the screen-space rays still bias the result, but the hybrid strikes a more practical balance of stability and correctness than either approach alone.



Related work: Missing-data artifacts from screen space rays can be removed by using multiple depth layers [Mara 2016] and guardbands around the viewport [Bavoil 09]. But doing that requires very involved modifications to an engine.

[Huang 2011] Separable Approximation of Ambient Occlusion Eurographics 2011
[Mara 2016] "Deep G-Buffers for Stable Global Illumination Approximation", HPG'16
[Bavoil 2009] "Multi-layer dual-resolution screen-space ambient occlusion", SIGGRAPH'09 talk

time	2 geometric rays	**1 geometric ray + 1 screen ray**	2 screen rays
Living Room (shown)	6.4 ms	**5.8 ms**	1.5 ms
Emerald Square	13.0 ms	**7.5 ms**	0.8 ms

GPU Tracing time on TITAN V 1080p using Unreal Engine 4 + DXR + RTX.