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Looking Around Flatland: End-to-End 2D Real-Time NLOS Imaging

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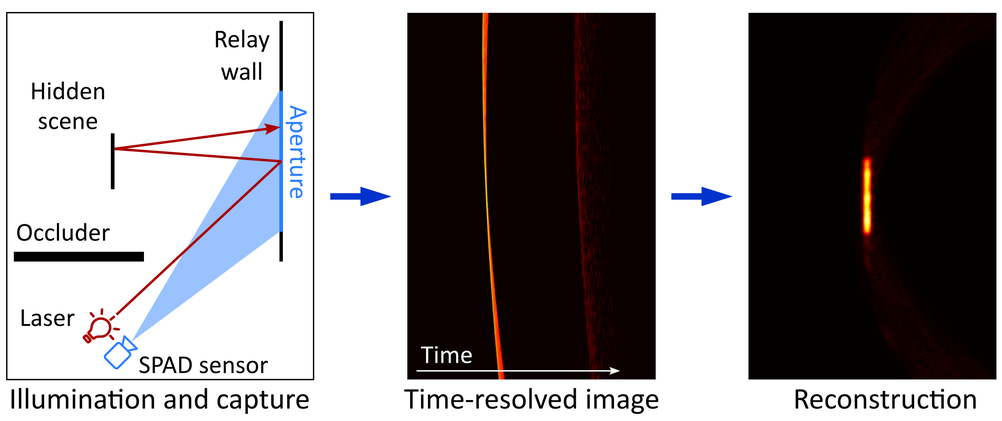
Non-line-of-sight (NLOS) imaging methods reconstruct scenes hidden around one corner using indirect third-bounce illumination with high temporal resolution on a visible surface. Unfortunately, acquiring or simulating this information is expensive. We present a simulation-based NLOS imaging pipeline for scenes with two spatial dimensions to enable fast prototyping and analysis.

NLOS imaging Pipeline



An ultra-fast laser pulse illuminates the relay wall and scatters towards the hidden scene. A SPAD-based sensor captures time-resolved indirect illumination at the relay wall. Based on the time of flight of third-bounce light paths, we reconstruct the hidden scene.

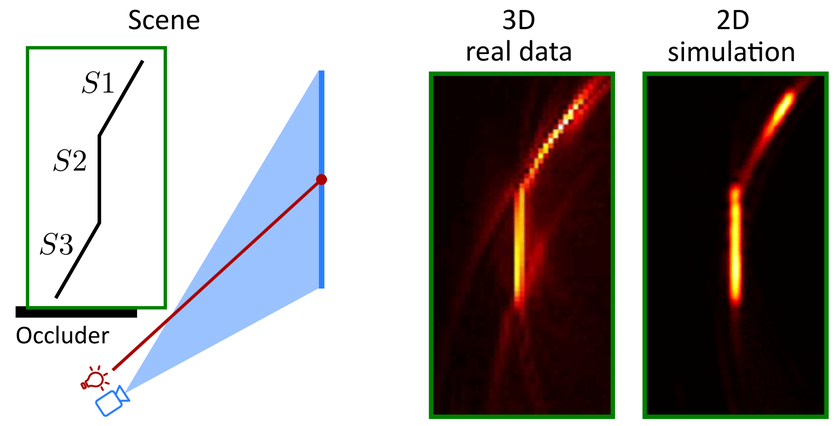
Simulation allows for additional control over scenes. However, it is computationally and memory expensive. We remove one spatial dimension to make the entire pipeline operate in real-time.

Our 2D End-to-End Simulation System

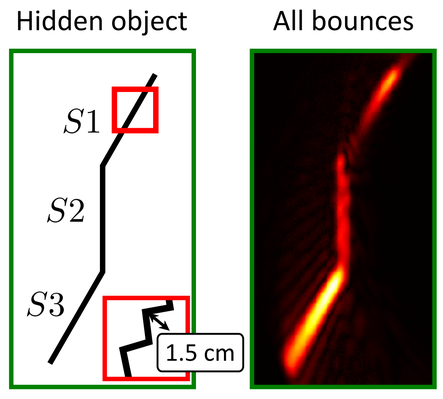
Our system extends the WebGL-based 2D rendering engine Tantalum [1] to simulate the capture process, and uses the phasor-field formulation [2] to implement different virtual imaging models.

It offers many configuration options, involving scene properties, capture configuration and reconstruction parameters.

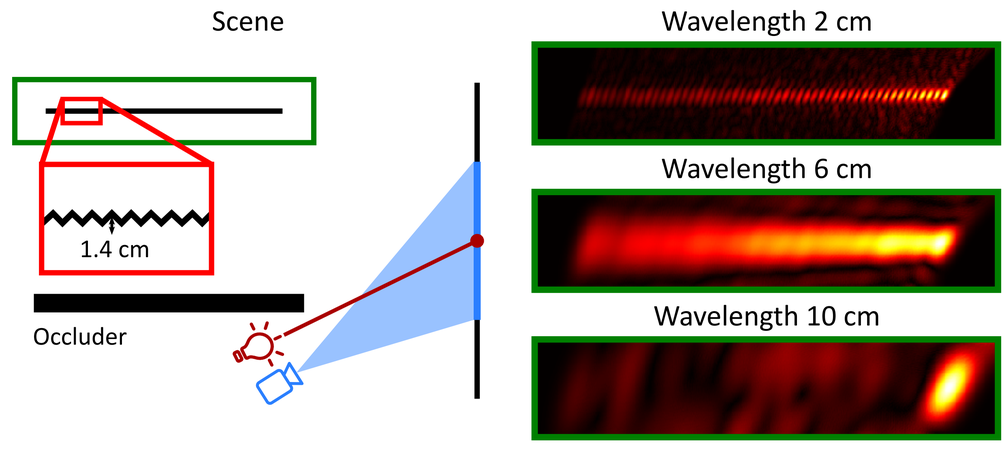
Results



We validate our system by replicating previous works [3] in our 2D simulation system. Known visibility problems remain and prevent us from reconstructing S3.



We use our system to further analyze visibility and change the local structure of the object. In the presence of facets, we can image S3.



We explore the effect of filtering with different central wavelengths to reproduce local features on a globally planar object. Depending on the relationship between feature size and the chosen wavelength, we reconstruct the object with different levels of detail.

References

[1] - Bitterli, B. 2015. The Secret Life of Photons. URL: https://benedikt-bitterli.me/tantalum/.
[2] - Liu, X. et al. 2019. Non-line-of-sight imaging using phasor-field virtual wave optics. Nature 572.7771.
[3] - Liu, X. et al. 2019. Analysis of Feature Visibility in Non-Line-Of-Sight Measurements. CVPR.

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