Ellipsoidal Path Connections for Time-Gated Rendering

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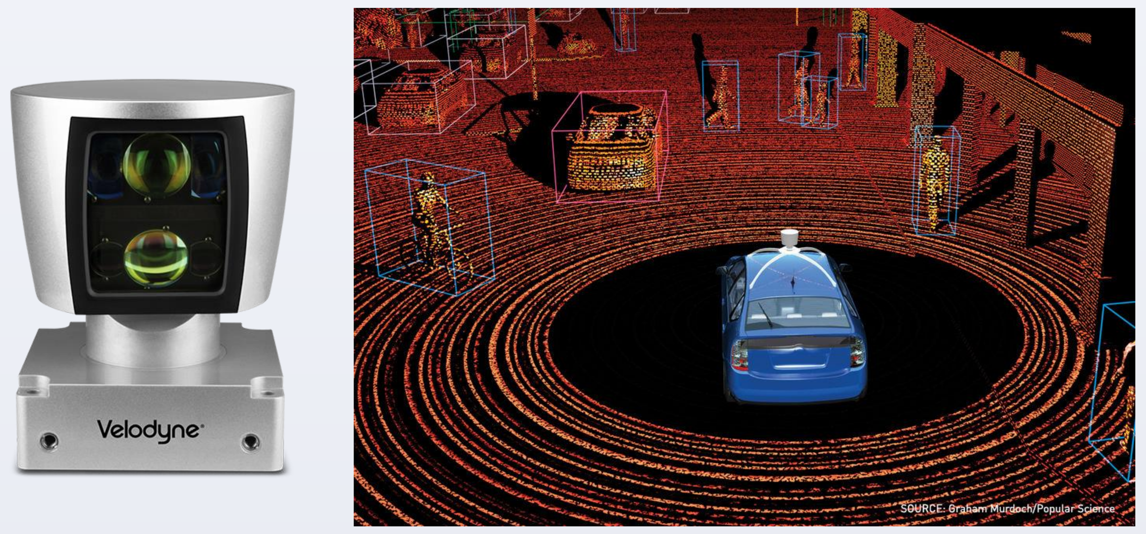
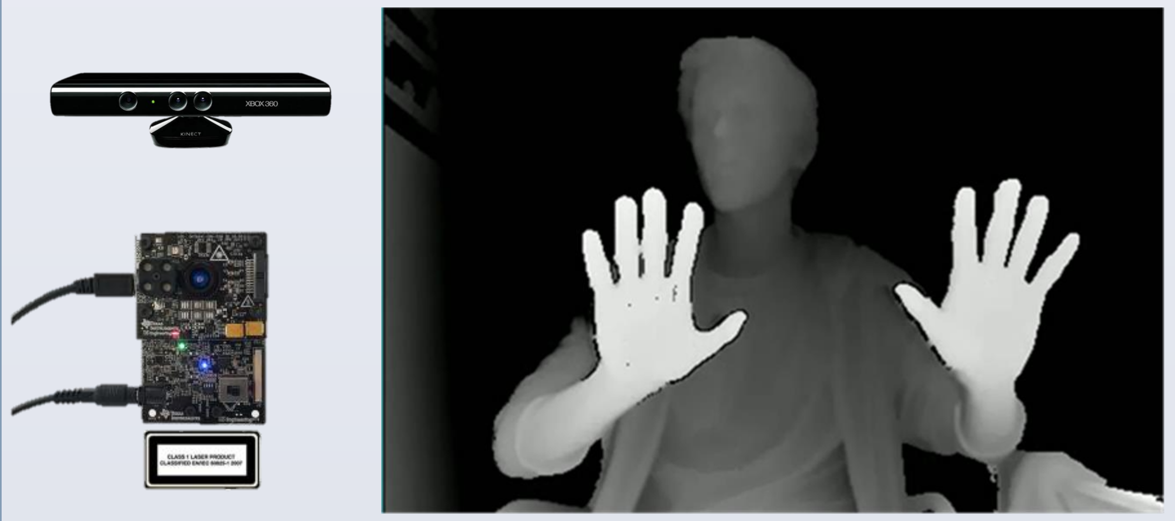
TOF RENDERING TASKS

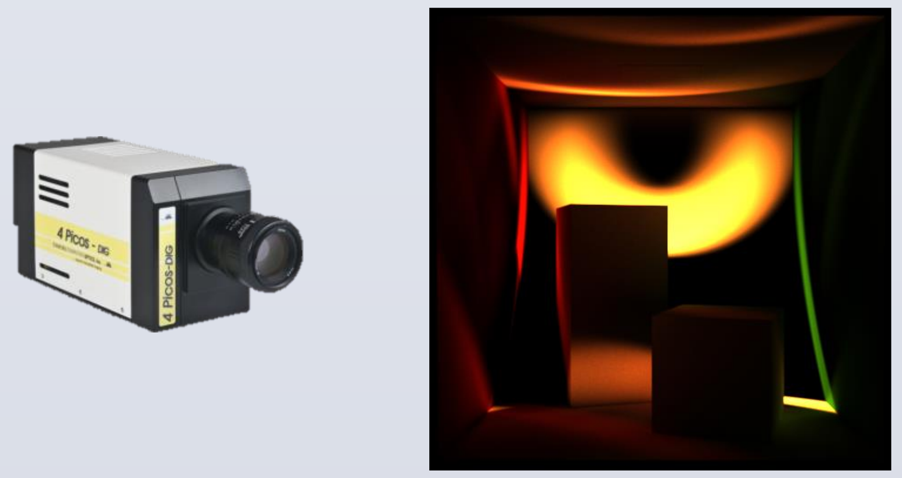
- LIDAR



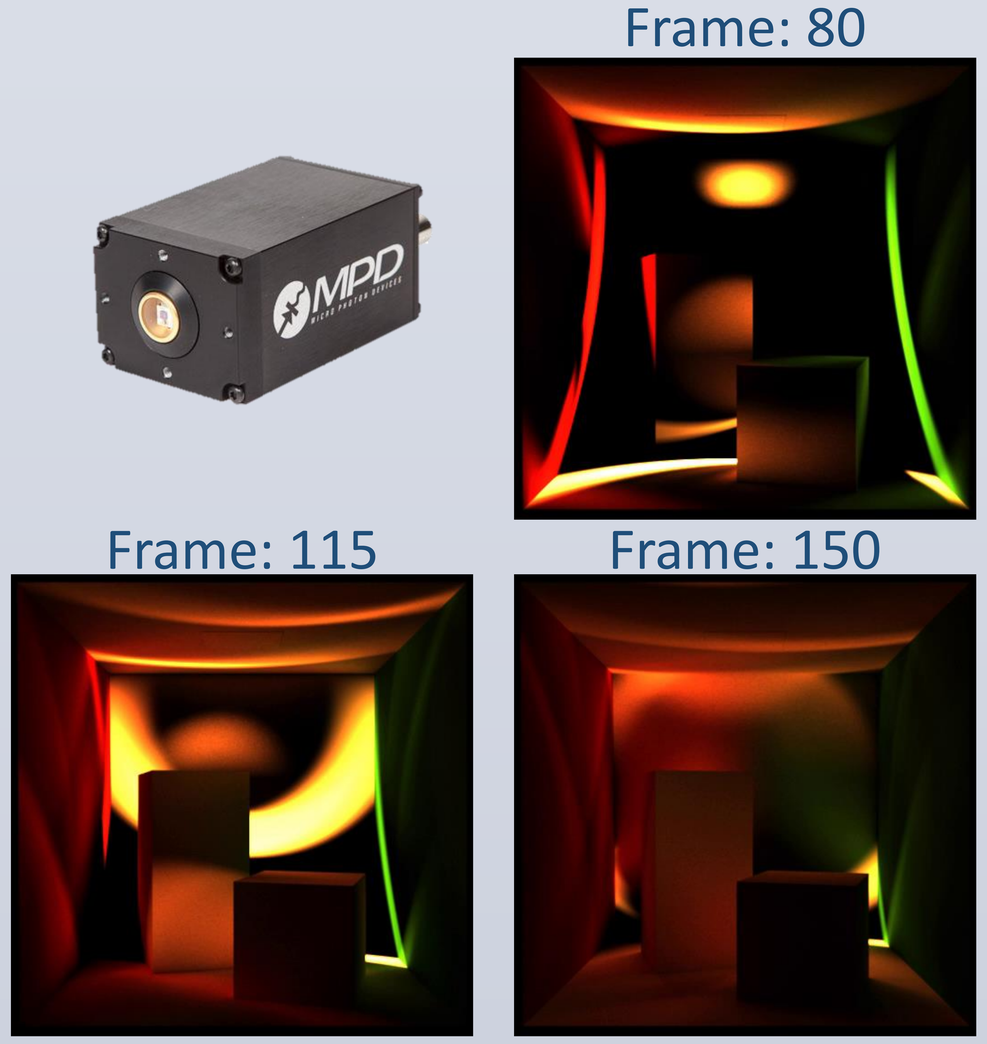
- Amplitude modulated continuous wave



- Gated Cameras



- Transient Cameras



THEORY

Path integral for physically-based rendering

Steady state rendering: $I_j =: \int_{\mathcal{P}} \varphi(\bar{\mathbf{x}}) \mathrm{d}\mu(\bar{\mathbf{x}})$,

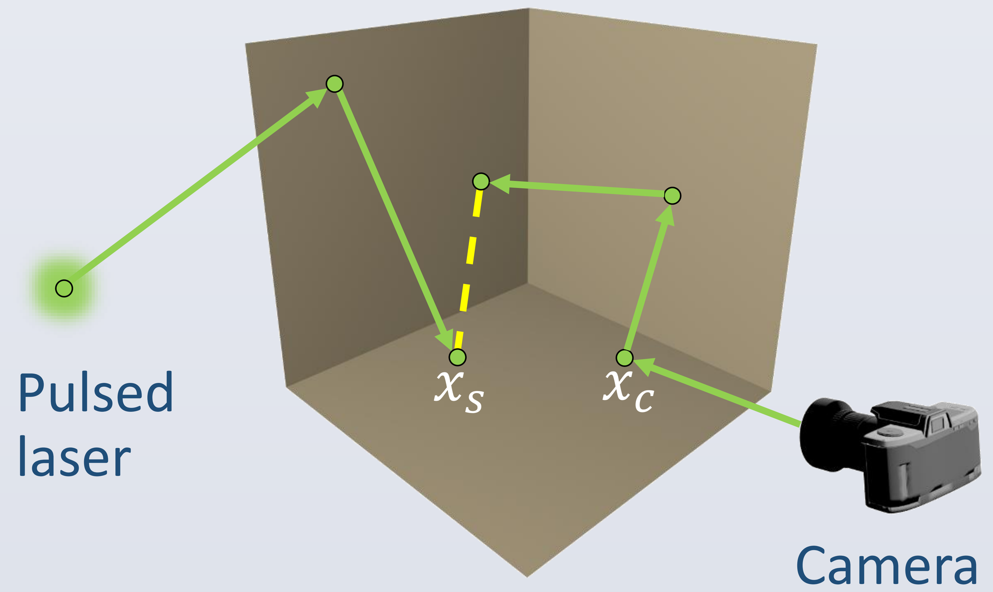
$$\approx \frac{1}{n}\sum_{i=1}^{n} \frac{\varphi(\bar{\mathbf{x}}_i)}{p(\bar{\mathbf{x}}_i)}$$

$\bar{\mathbf{x}}$ → Path, set of ordered vertices

φ → Radiance of the path, includes photometric and geometric light loss

μ → Path Measure (area or volumetric)

$p(\bar{\mathbf{x}}_i)$ → Probability of path $\bar{\mathbf{x}}_i$ that depends on sampling strategy and the measure ($\boldsymbol{\mu}$)



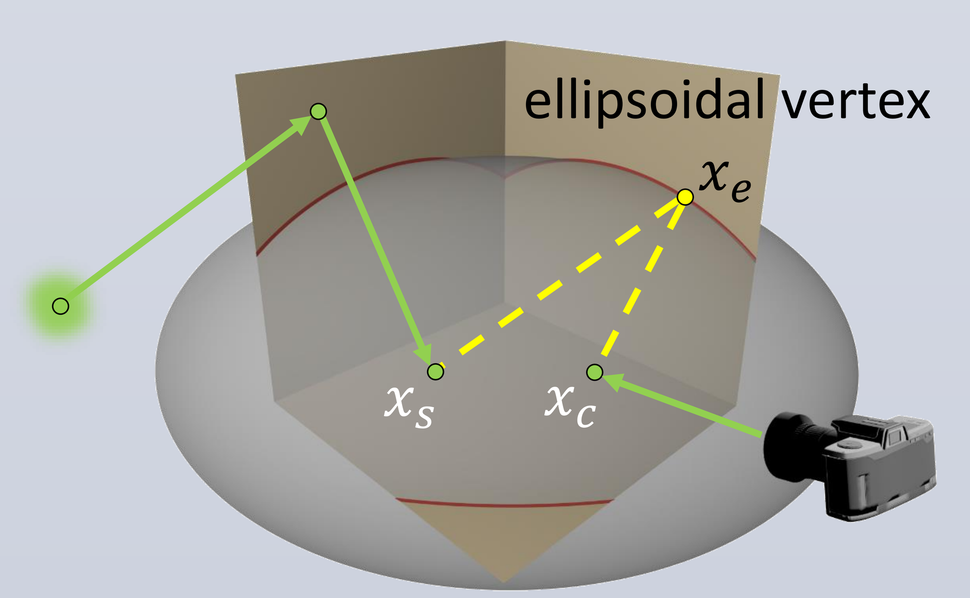
Time-of-flight (TOF) renderer

Unified ToF Renderer:

$I_j(f) \coloneqq \int_{\mathcal{P}} f(|\bar{\mathbf{x}}|)\varphi(\bar{\mathbf{x}})\mathrm{d}\mu(\bar{\mathbf{x}})$; $|\bar{\mathbf{x}}|$: path length

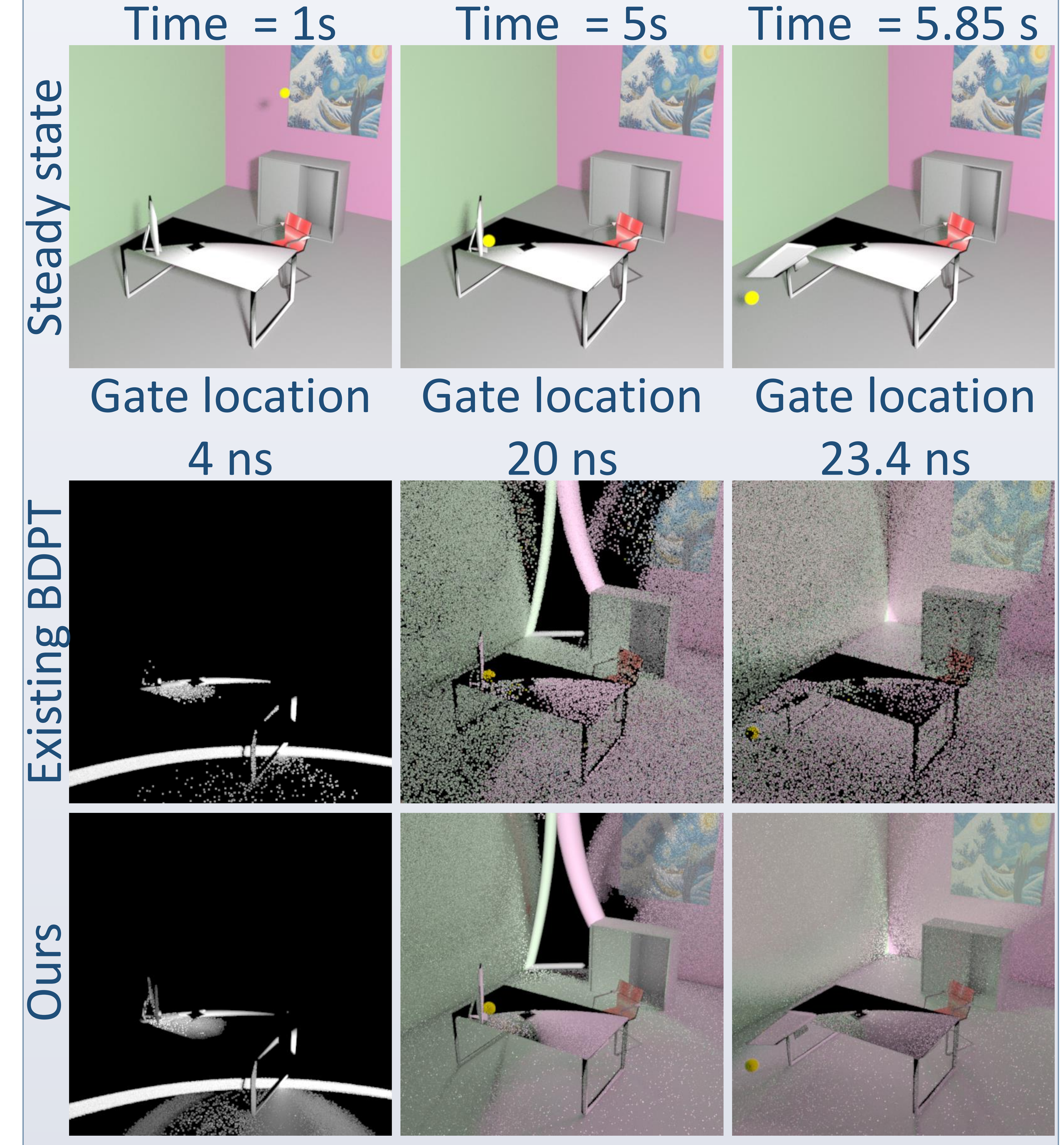
- LIDAR: $f = \delta(|\bar{\mathbf{x}}| - \min_{I(t)>0} t)$
- AMCW: $f = C_{\omega,\phi}(|\bar{\mathbf{x}}|)$; C: cross-correlation
- Gated/Transient Camera: $f = \mathrm{rect}\left(\frac{\tau - |\bar{\mathbf{x}}|}{Y}\right)$

Ellipsoidal connections for efficient rendering

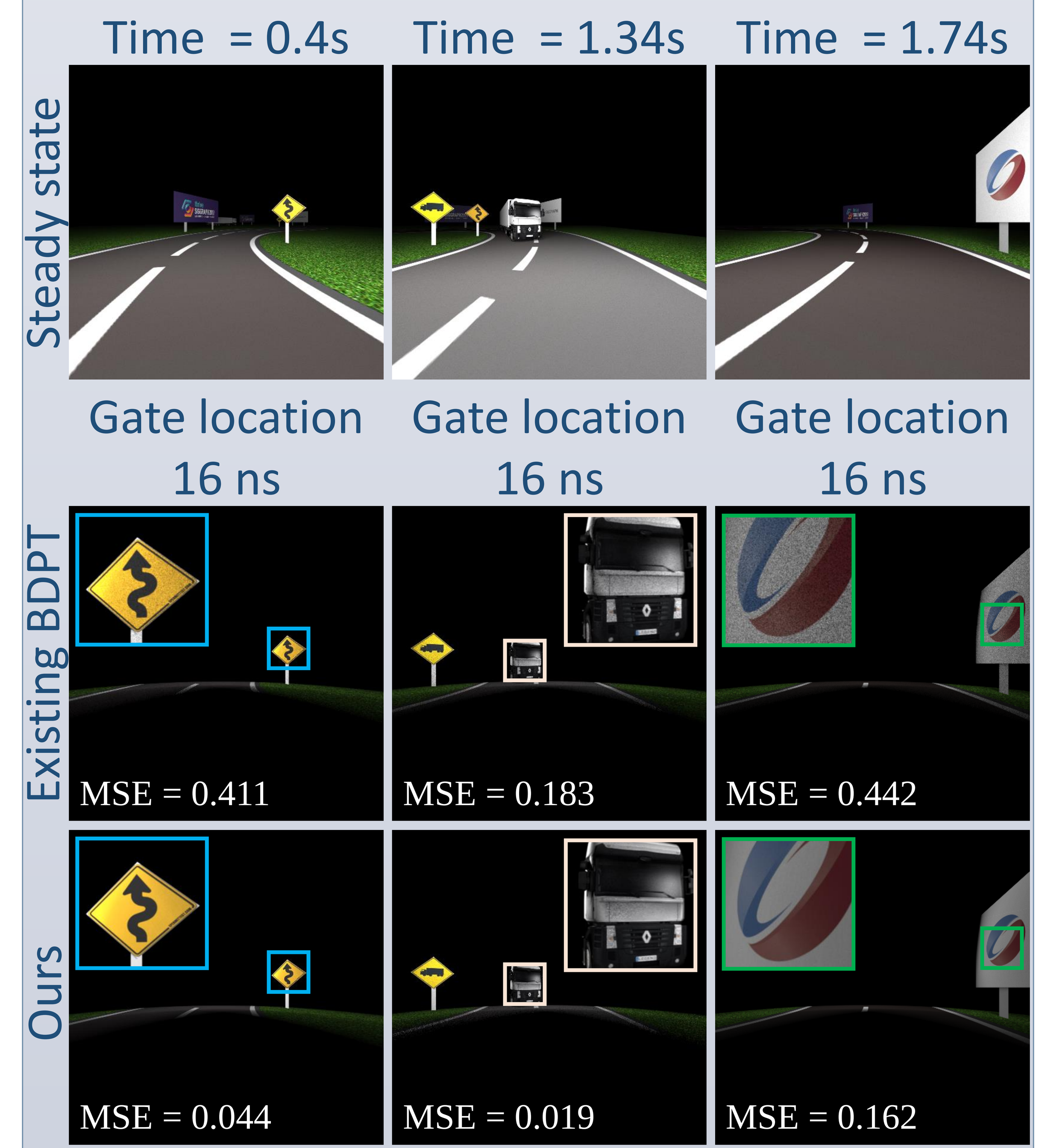


TIME-GATED RENDERING SCENARIOS

Transients for dynamic scenes



Proximity detection camera



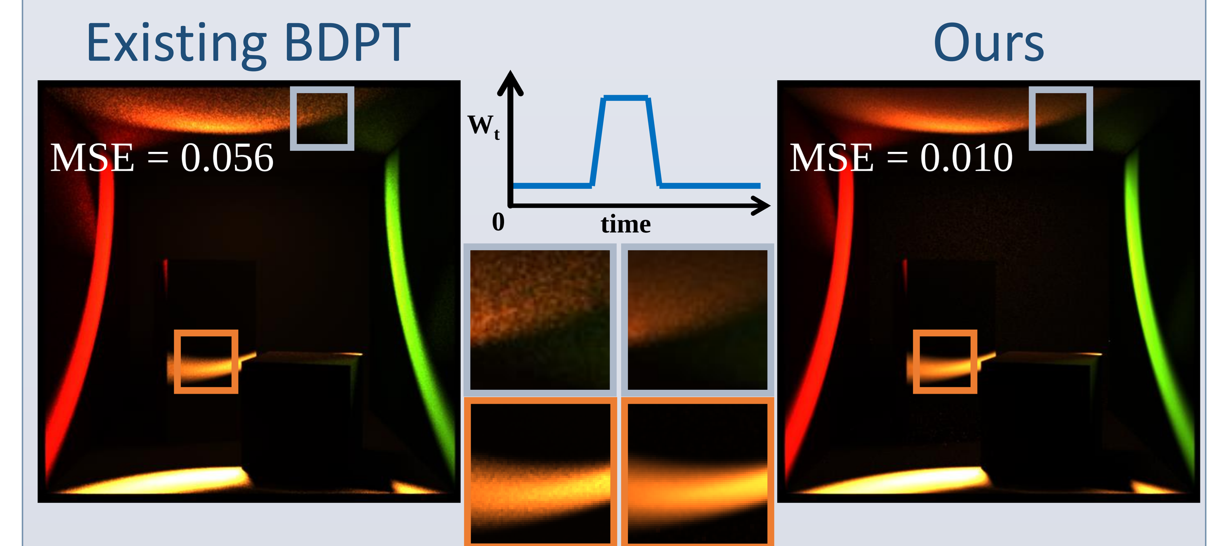
PUBLICLY AVAILABLE SOURCE CODE

- Launch-and-play image file for Amazon Web Services clouds (ami-28308957).
- Trivially scales on multiple cores, CPUs, cloud clusters

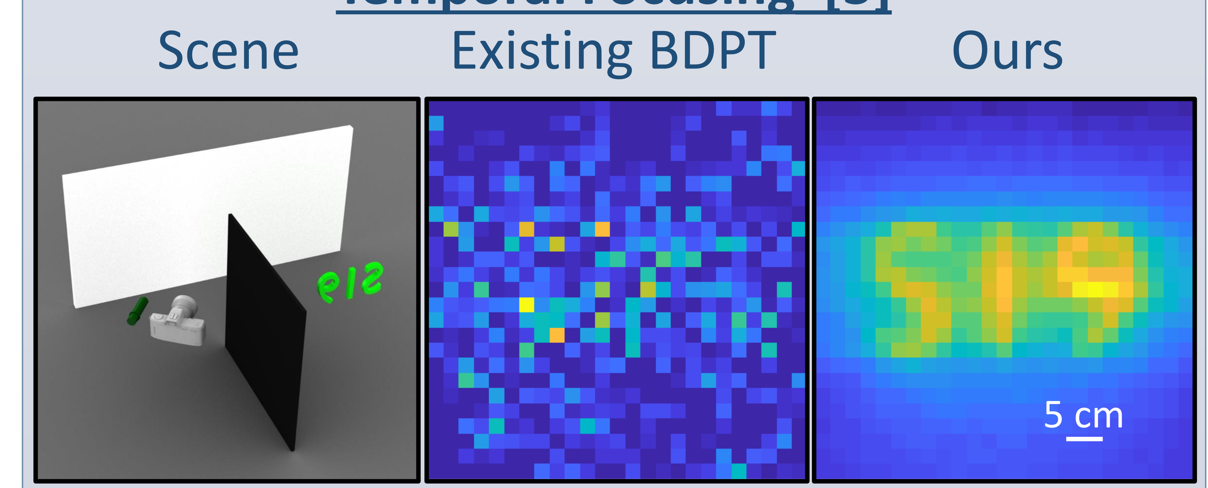
https://github.com/cmu-ci-lab/MitsubaToFRenderer

RENDERING CUSTOM TOF CAMERAS

CWAM-ToF with Depth Selective Codes [2]



SNLOS: Non-line-of-sight Scanning through Temporal Focusing [3]



References

[1] Tadano, R., Kumar Pediredla, A. and Veeraraghavan, A., Depth selective camera: A direct, on-chip, programmable technique for depth selectivity in photography. In *Proceedings of the IEEE International Conference on Computer Vision (ICCV),* (pp. 3595-3603).

[2] Pediredla A., Dave A., and Veeraraghavan A. 2019. SNLOS: Non-line-of-sight Scanning through Temporal Focusing. 2019 IEEE International Conference on Computational Photography (ICCP).

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