Ellipsoidal Path Connections for Time-Gated Rendering

Aditya Kumar Pediredla\textsuperscript{1,2}, Ashok Veeraraghavan\textsuperscript{1}, Ioannis Gkioulekas\textsuperscript{2}

\textsuperscript{1}Rice University, \textsuperscript{2}Carnegie Mellon University

TOF RENDERING TASKS

- LIDAR
- Amplitude modulated continuous wave
- Gated Cameras
- Transient Cameras

THEORY

Path integral for physically-based rendering

Steady state rendering: $I_1 = \int_\mathcal{X} \varphi(\mathbf{x}) d\mu(\mathbf{x})$, $\mathbf{x} \rightarrow$ Path, set of ordered vertices

$\varphi$ → Radiance of the path, includes photometric and geometric light loss

$\mu$ → Path Measure (area or volumetric)

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

Time-of-flight (TOF) renderer

Unified ToF Renderer: $I_j(f) = \int_\mathcal{X} f(\mathbf{x}) \varphi(\mathbf{x}) d\mu(\mathbf{x})$; $|\mathbf{x}| :$ path length

- LIDAR: $f = \delta(|\mathbf{x}| - \min_i t)$
- AMCW: $f = C_{\omega,\phi}(|\mathbf{x}|)$; $C$: cross-correlation
- Gated/Transient Camera: $f = \text{rect} \left( \frac{|x| - t}{\tau} \right)$

Ellipsoidal connections for efficient rendering

TIME-GATED RENDERING SCENARIOS

Transients for dynamic scenes

Time = 1s 
Time = 5s 
Time = 5.85 s

Gate location

4 ns
20 ns
23.4 ns

Proximity detection camera

Time = 0.4s 
Time = 1.34s 
Time = 1.74s

Gate location

16 ns
16 ns
16 ns

RENDERING CUSTOM TOF CAMERAS

CWAM-ToF with Depth Selective Codes \cite{2} 
Existing BDPT 
Ours

SNLOS: Non-line-of-sight Scanning through Temporal Focusing \cite{3}

Scene

Existing BDPT 
Ours

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/cmuci-lab/MitsubaToFRenderer

References


Acknowledgments: