# Rendering Computational Light Transport

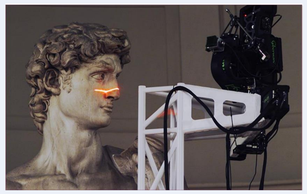
Jiatian Sun  Ioannis Gkioulekas
Carnegie Mellon University

SEE BELOW THE SKIN

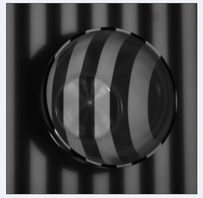
## Target Imaging Modalities

**Problem:**
Many existing physical modern imaging camera systems don't have corresponding simulation tools:

- Structured Light



*Digital Michelangelo Project*



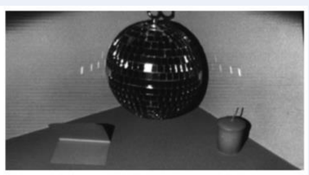
*[Gupta et al. 2013]*

- Light Transport Probing System

*Scene under white Illumination [O'Toole et al. 2012]*

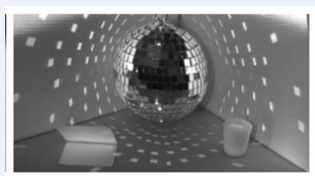
*Global Illumination Component [O'Toole et al. 2012]*

- Epipolar Imaging



*Epipolar Imaging*

*[O'Toole et al. 2015]*

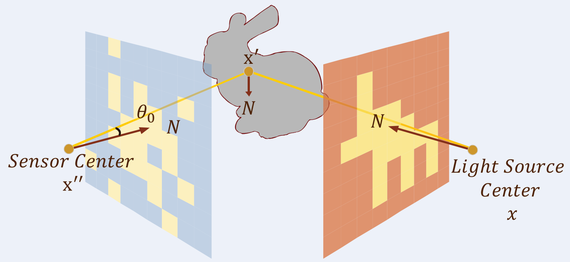


*Non-epipolar Imaging [O'Toole et al. 2015]*

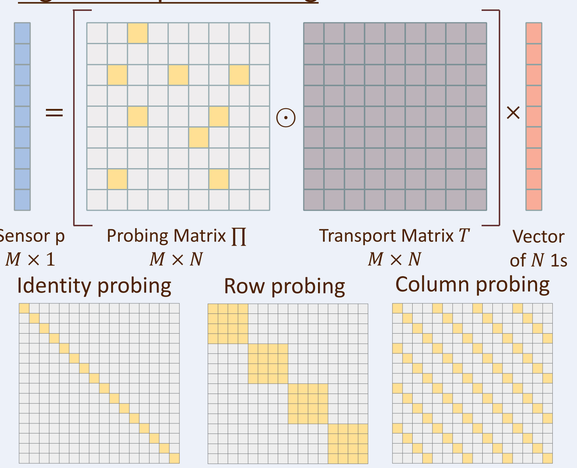
## Rendering Capabilities

- Structured Light & Coded Cameras

Efficient rendering by importance sampling sensor and projector planes

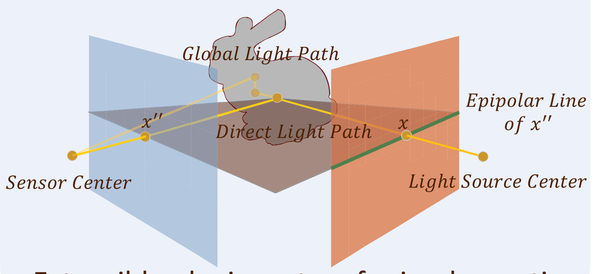



- Light Transport Probing




- Epipolar Imaging

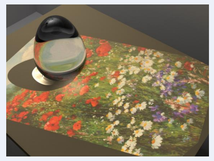
Bidirectional path tracing with importance sampling based on epipolar constraints



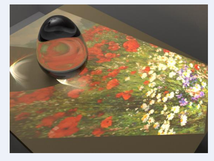

- Extensible plugin system for implementing arbitrary probing patterns

## Rendering Examples

- Perspective and Orthographic Projectors

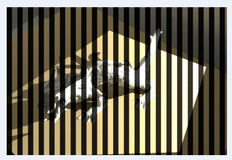


*Perspective projector*



*Orthographic projector*

- Coded Perspective & Orthographic Cameras

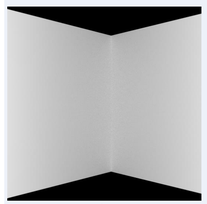


*Coded perspective camera*

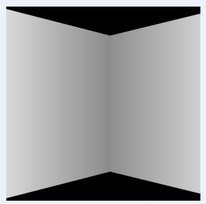
*Coded orthographic camera*

- Light Transport Probing

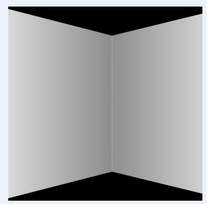
Remove global illumination using epipolar probing



*White illumination*

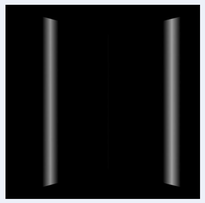


*Direct-only rendering*

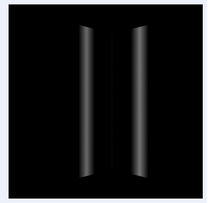


*Epipolar probing*

Capture light from certain depths using disparity probing



*stereo disparity = 39*



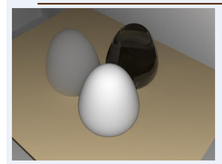
*stereo disparity = 35*

**Renderer Publicly Available**

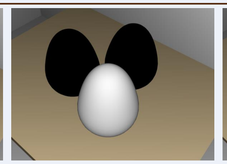
https://github.com/cmu-ci-lab/mitsuba_clt

## Applications

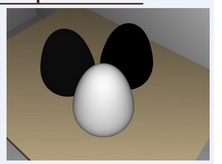
- Direct and Global Illumination Separation



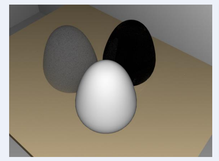
*White illumination*

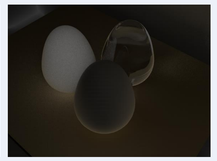


*Direct-only rendering*



*Epipolar probing*

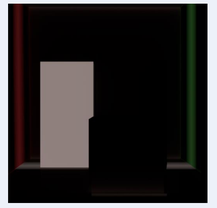




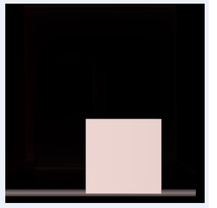
*Direct and global components using high-frequency illumination*

- Light Curtain

*White illumination*

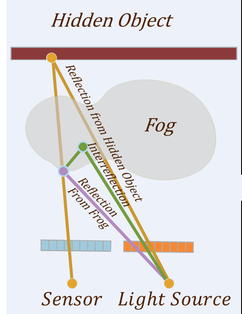


*Probing with stereo disparity = 16*



*Probing with stereo disparity = 23*

- Seeing Through Fog




*White illumination*

*Direct-only rendering*

*Epipolar probing*

*Disparity probing*

## References


- Gupta et al., "A Practical Approach to 3D Scanning in the Presence of Interreflections, Subsurface Scattering and Defocus," IJCV 2013.
- Nayar et al., "Fast separation of direct and global components of a scene using high frequency illumination," SIGGRAPH 2004.
- O'Toole et al., "Primal-dual coding to probe light transport," SIGGRAPH 2012.
- O'Toole et al., "3d shape and indirect appearance by structured light transport," CVPR 2014.
- O'Toole et al., "Homogeneous codes for energy-efficient illumination and imaging," SIGGRAPH 2015.