CS559: Computer Graphics

Lecture 36: Raytracing

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Many Slides are from Hua Zhong at CUM,
Paul Debevec at USC

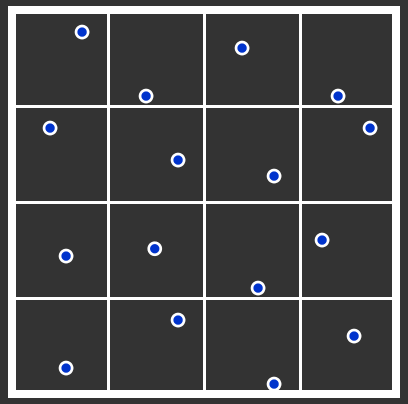
Today

- ray tracing, image based rendering

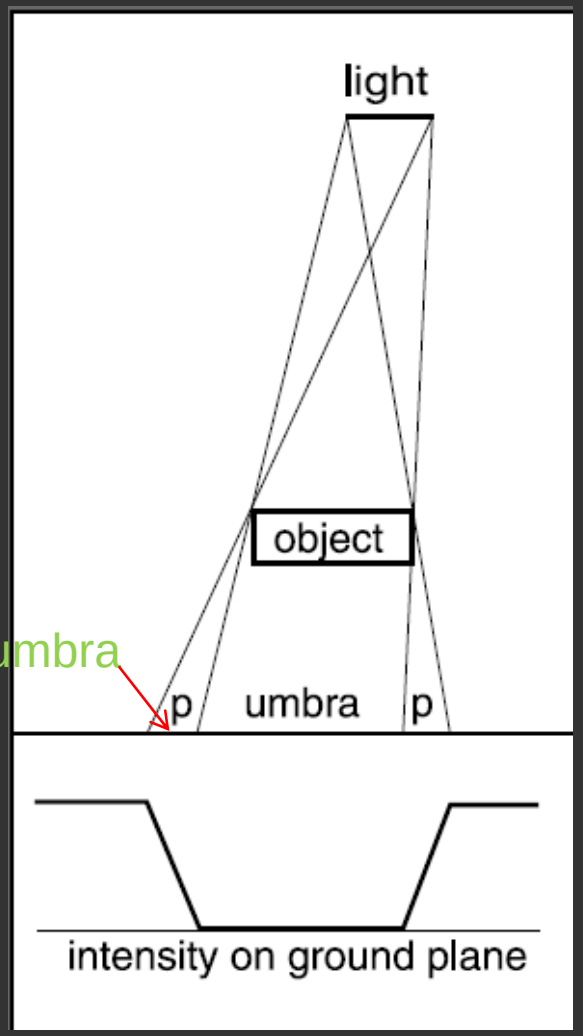
- Reading
  - Shirley Ch 10 on ray tracing, except for ch 10.10
  - Shirley Ch 25 on image based rendering
  - (Optional) Levoy and Hanrahan, Light Field Rendering, SIGGRAPH 1996, http://portal.acm.org/citation.cfm?id=237199

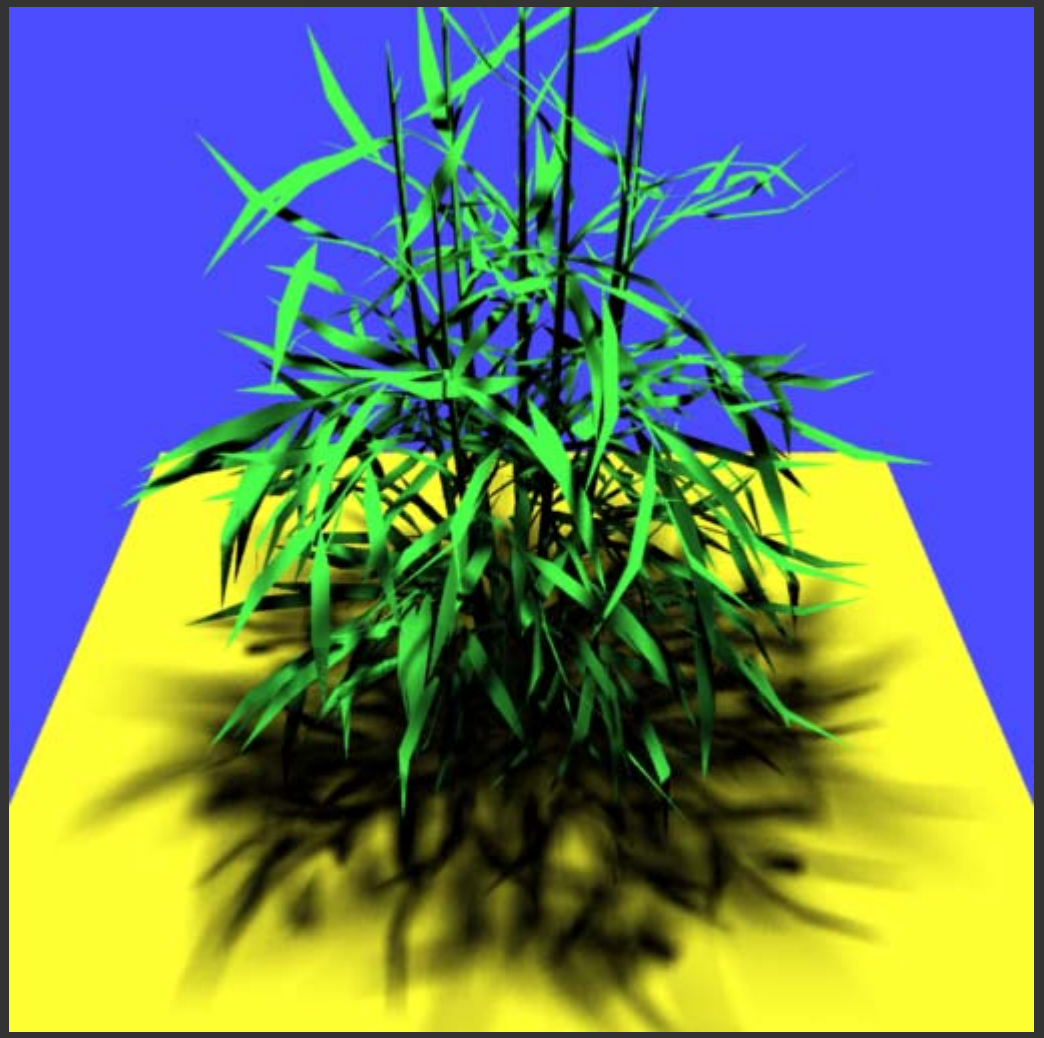
Jittered Sampling

- AKA *stratified sampling*,
- Divide pixel into a grid of *subpixels*
  - Sample each subpixel at a random location
- Combines the advantages of both uniform and random sampling
  - filters high frequencies
  - frequencies greater than subpixel sampling rate turned into noise
- Commonly used

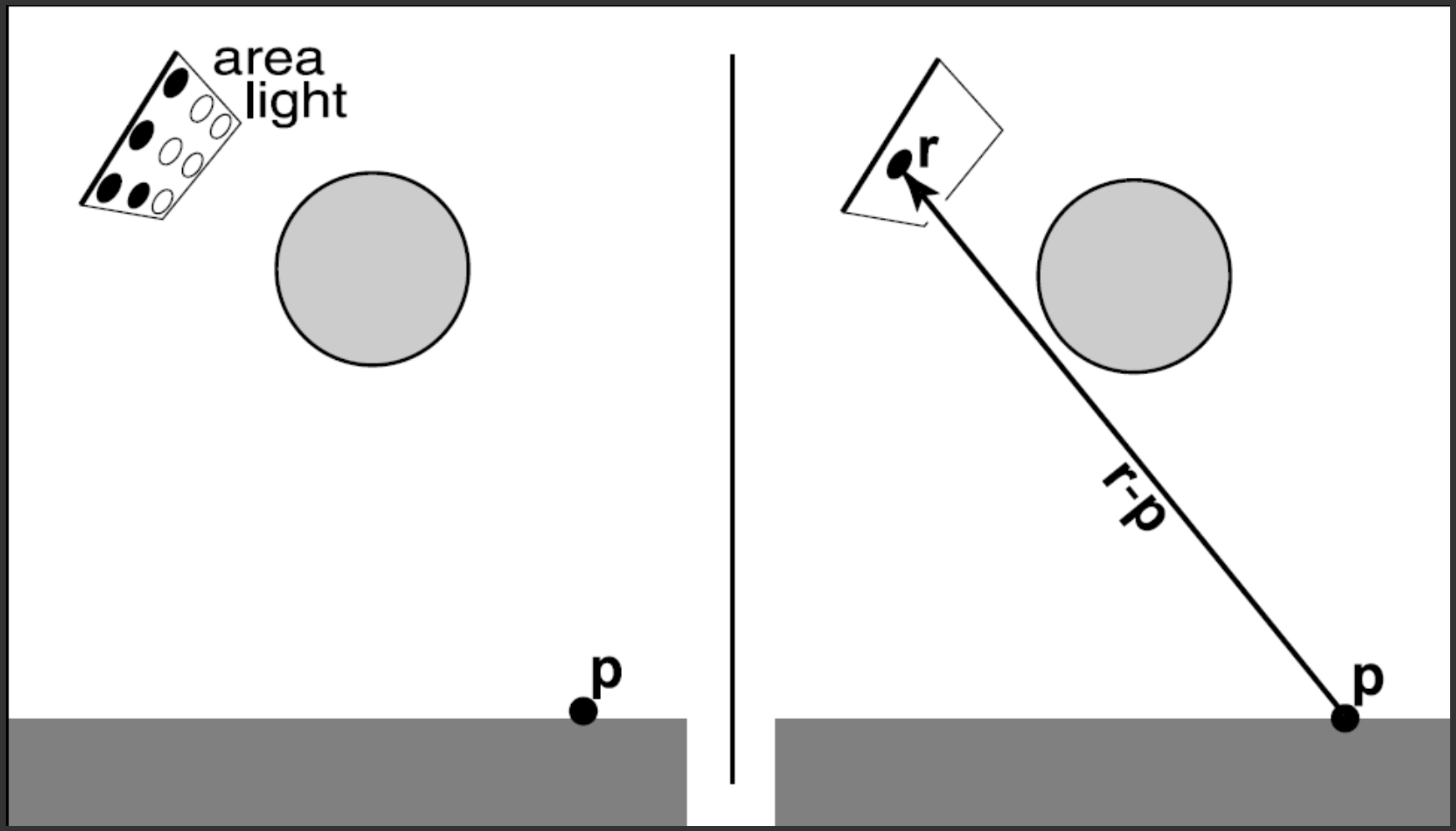


Soft shadow

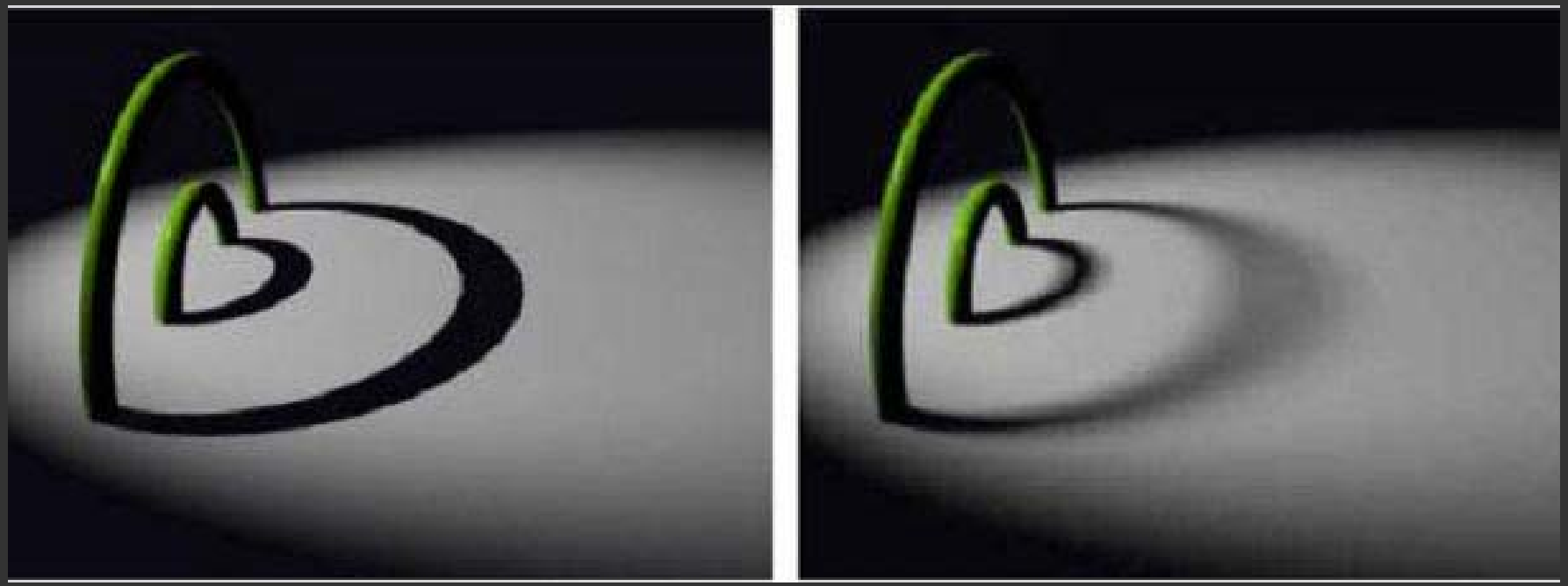




Soft Shadow



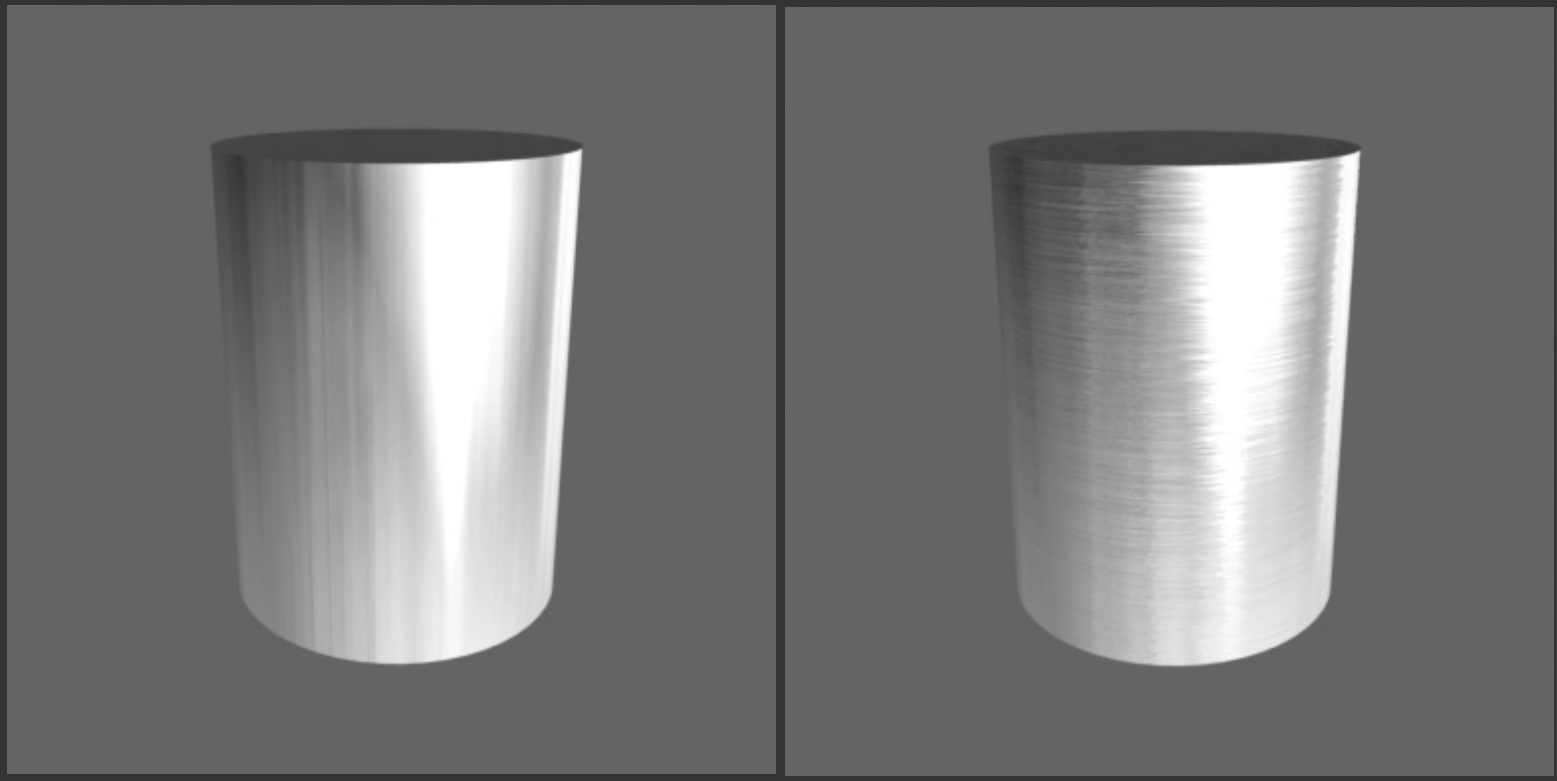
Comparison



Glossy Surface

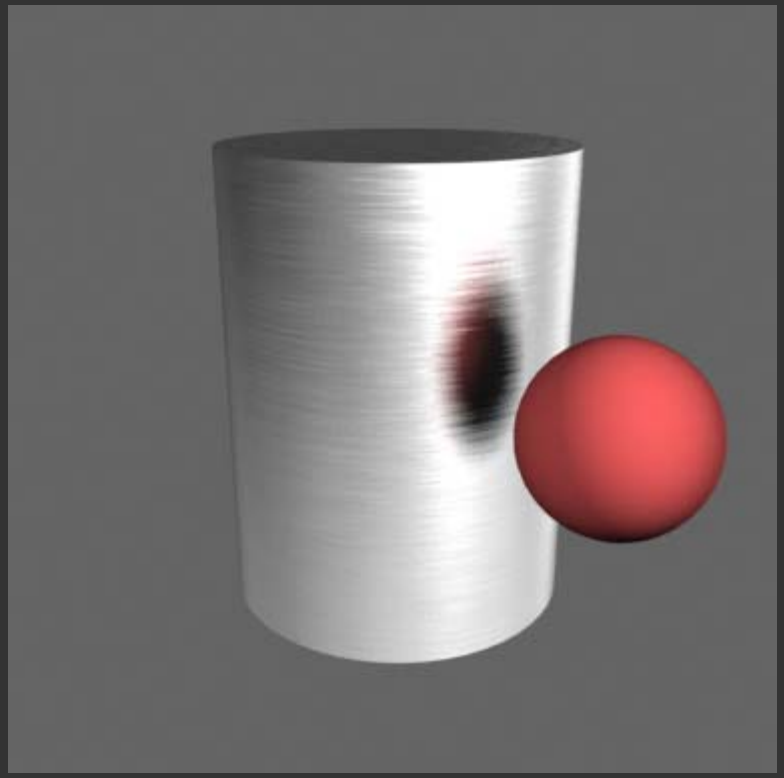
http://www.neilblevins.com/cg_education/brushed_metal/brushed_metal.htm

Vertical vs Horizonal roughness



http://www.neilblevins.com/cg_education/brushed_metal/brushed_metal.htm

Ray tracing a glossy surface



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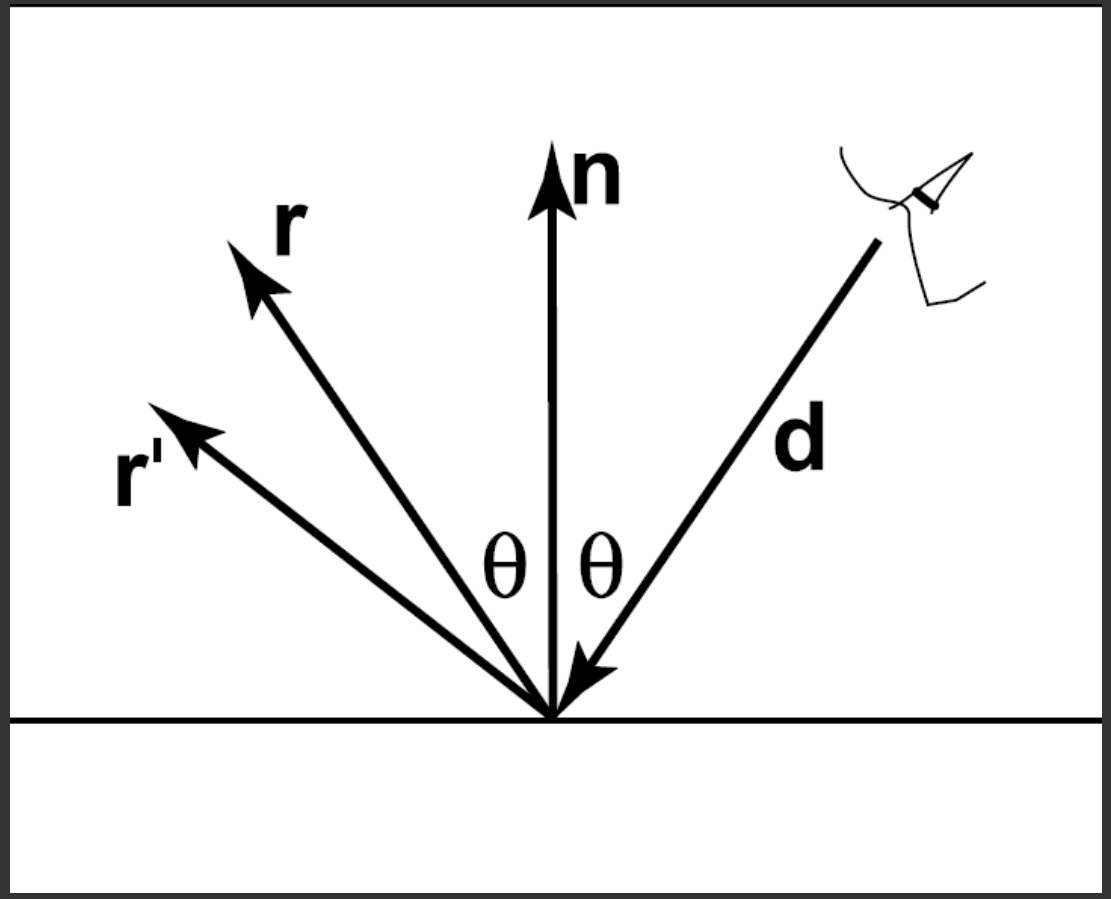
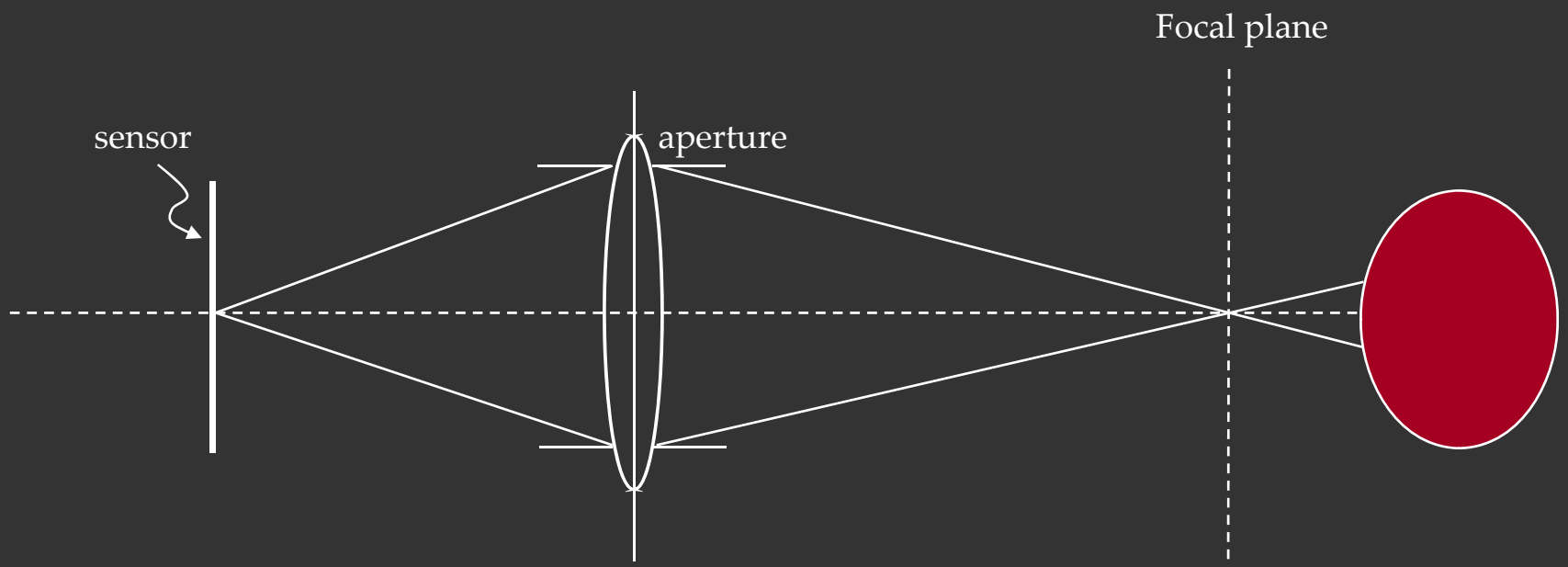
Ray tracing a glossy surface

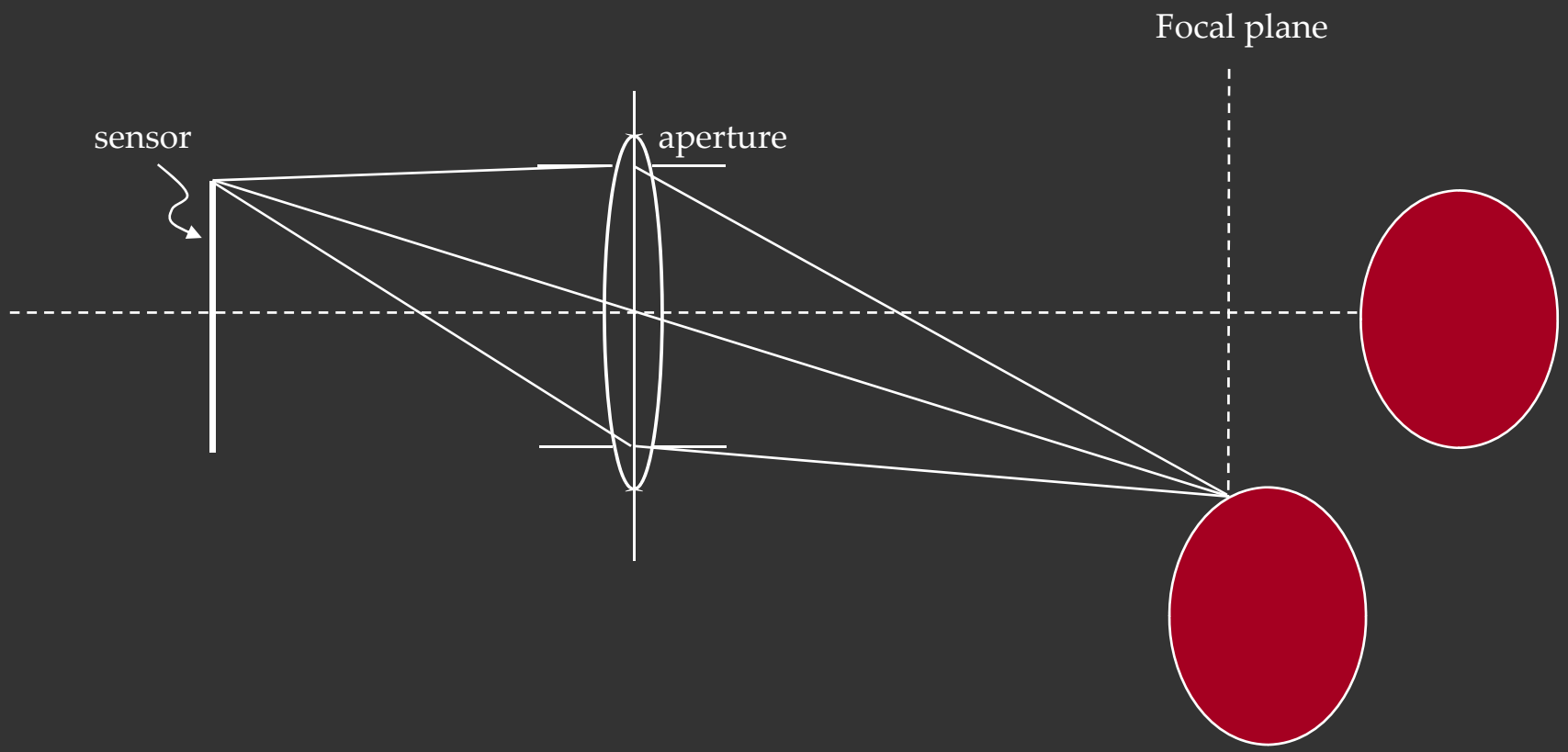


Depth of Field

Depth of Field



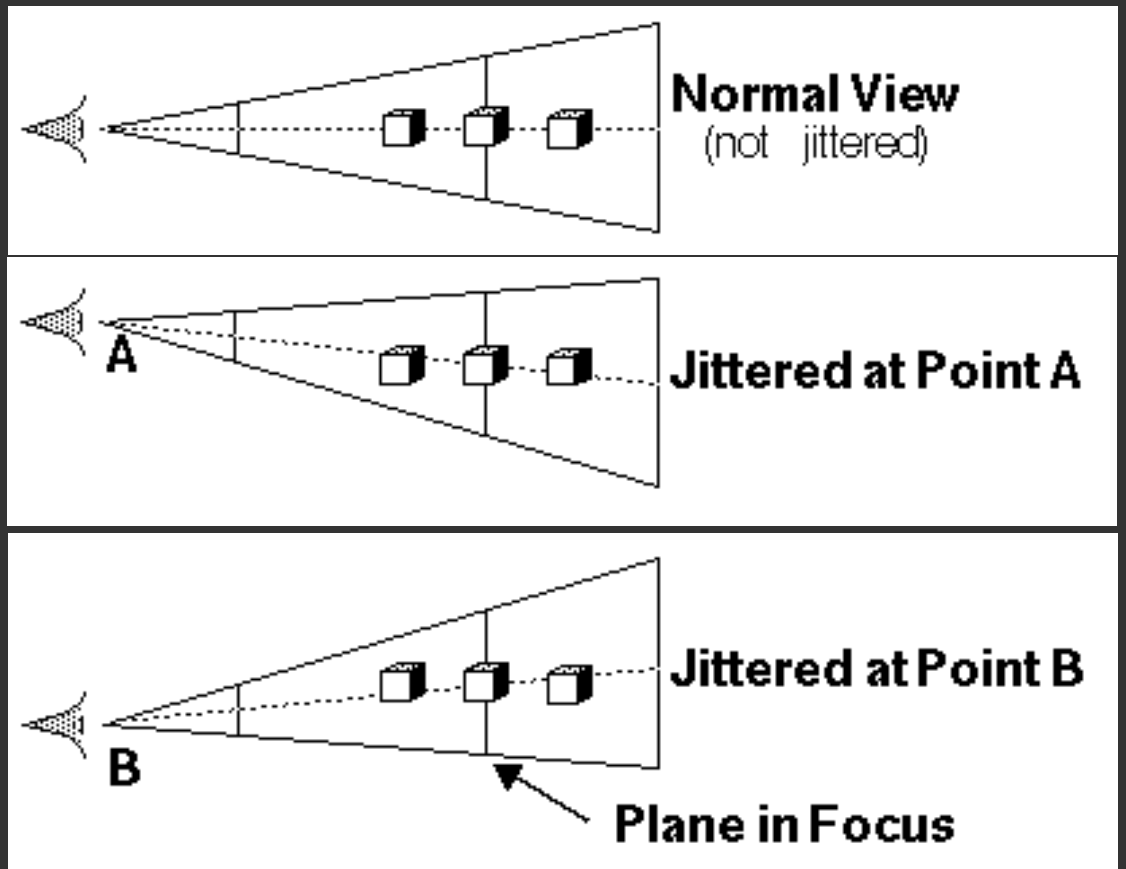
Depth of Field



Depth of Field in OpenGL

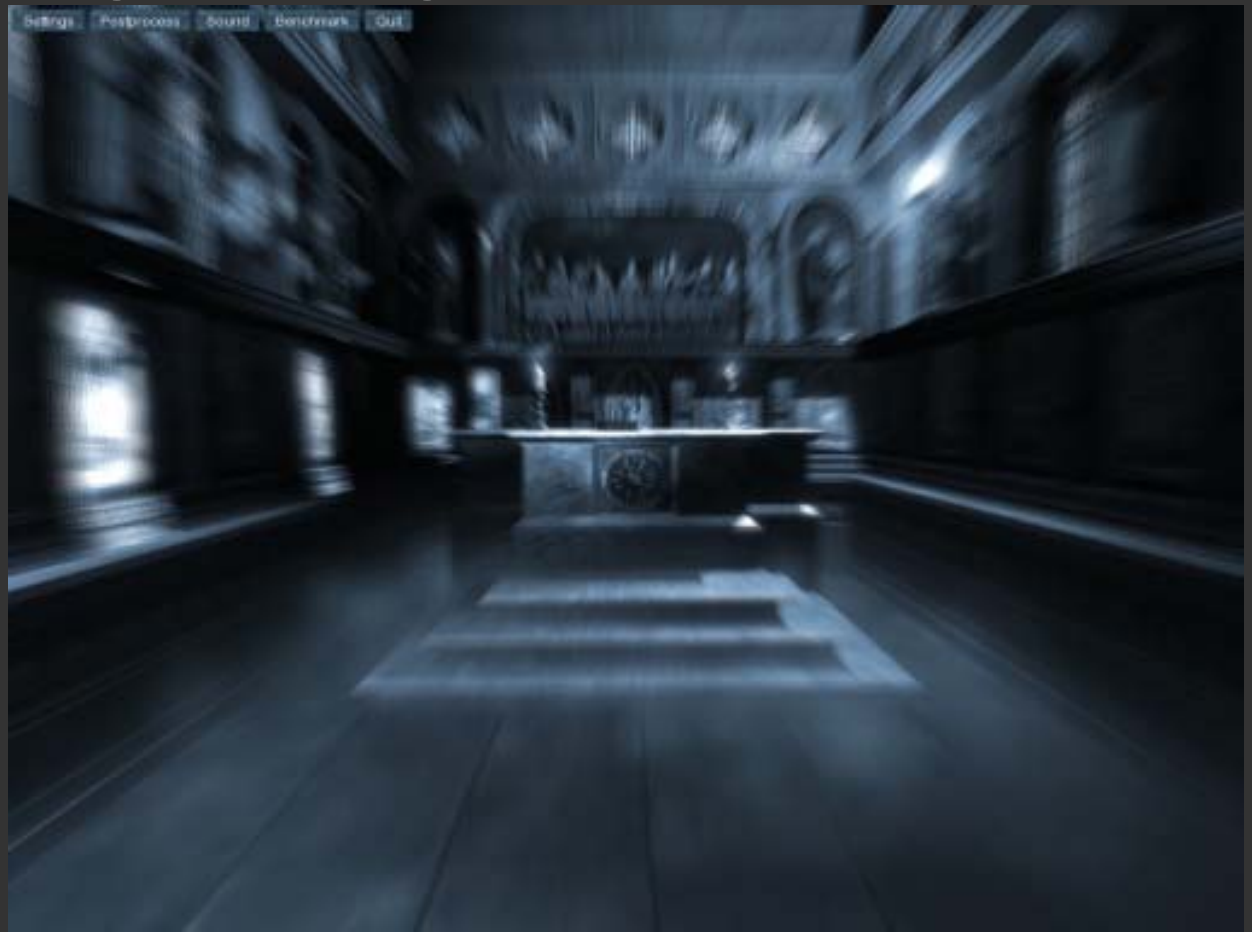
Depth of Field in OpenGL

- Render an image at each jittered location
- Then average the images



Motion Blur

- Ray trace a moving scene at different time instance and average the images



Motion Blur in OpenGL

- Render a moving scene at different time instance
- Average the images (using Accumulation buffer)

Ray tracing examples

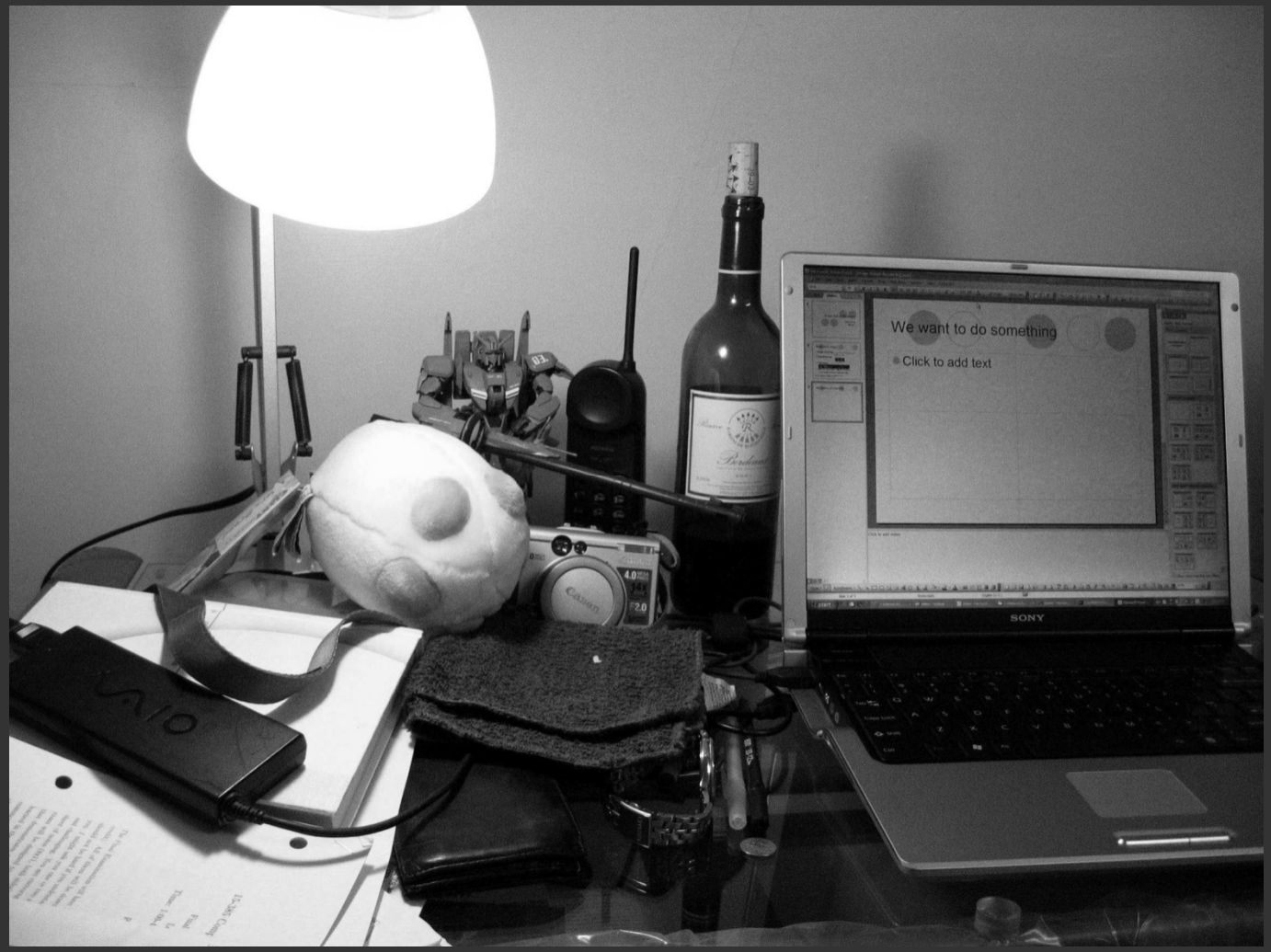
Ray tracing examples

Ray tracing examples

Image Based Rendering

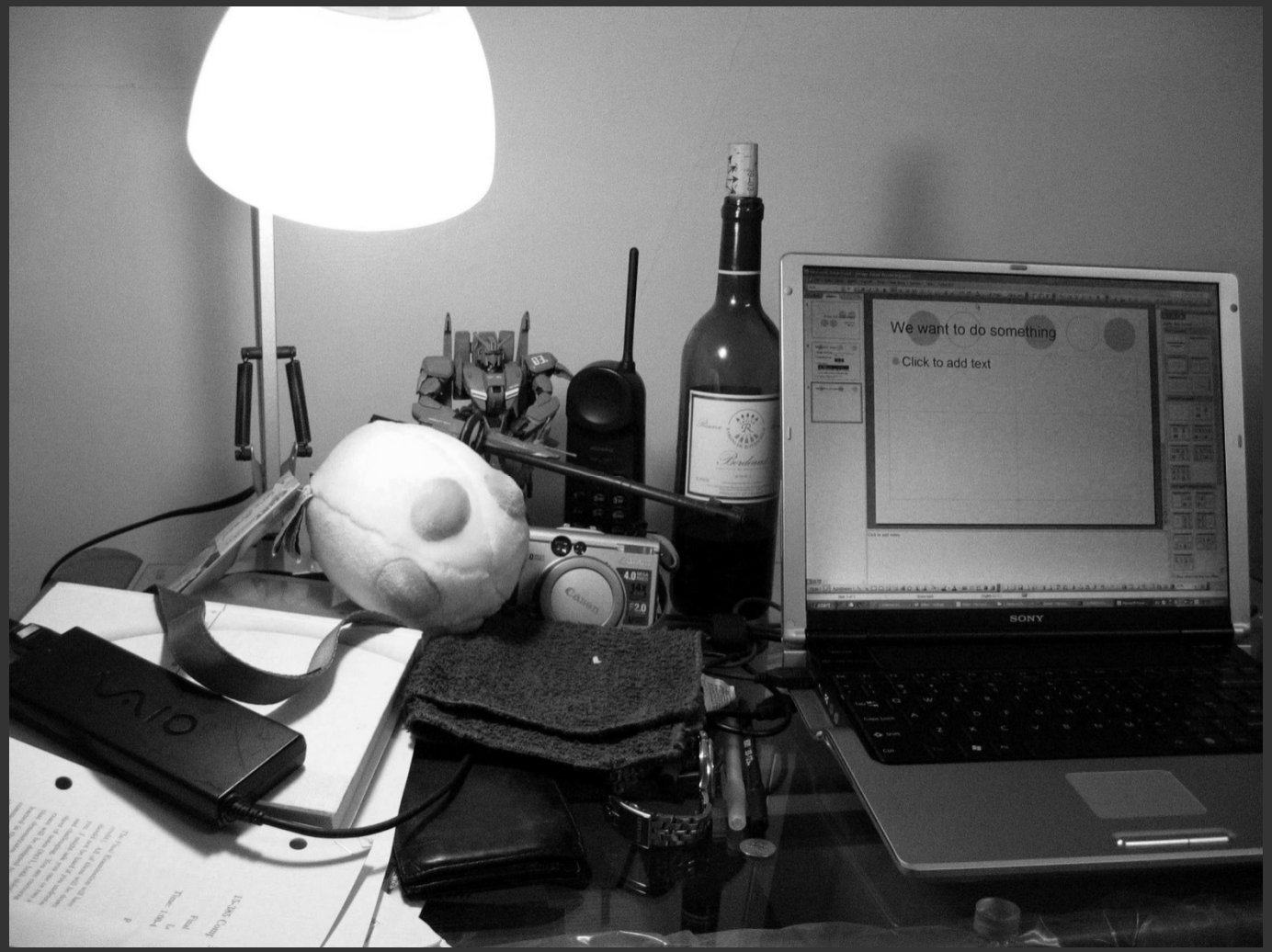
- Motivation
  - Realistic Rendering requires
    - realistic 3D models
    - realistic material models
    - takes time

Rendering a desktop




Bordeaux
2001

Rendering a desktop



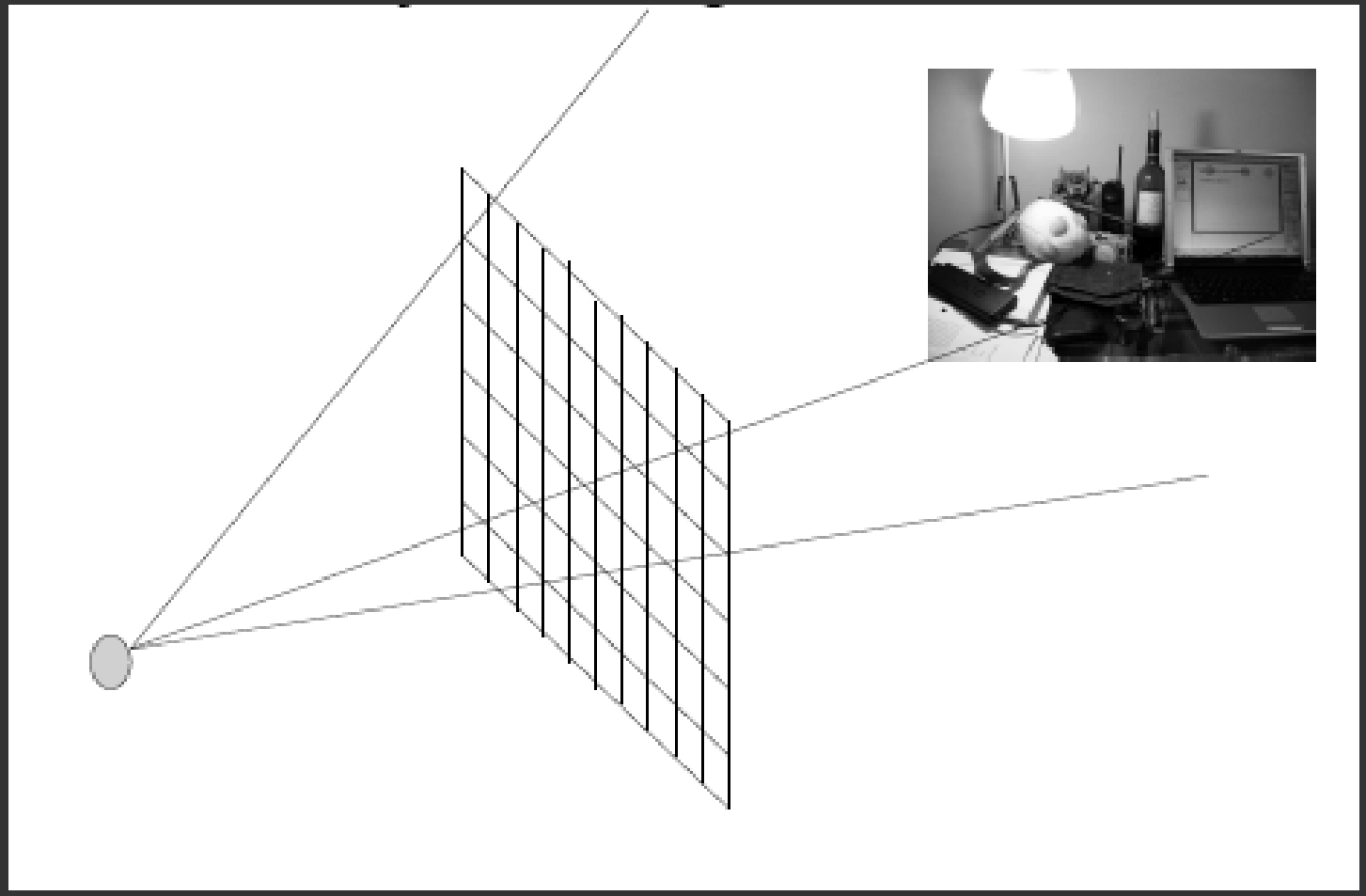
Rendering in real-time, with global illumination effect (e.g. inter-reflection)

Image Based Rendering

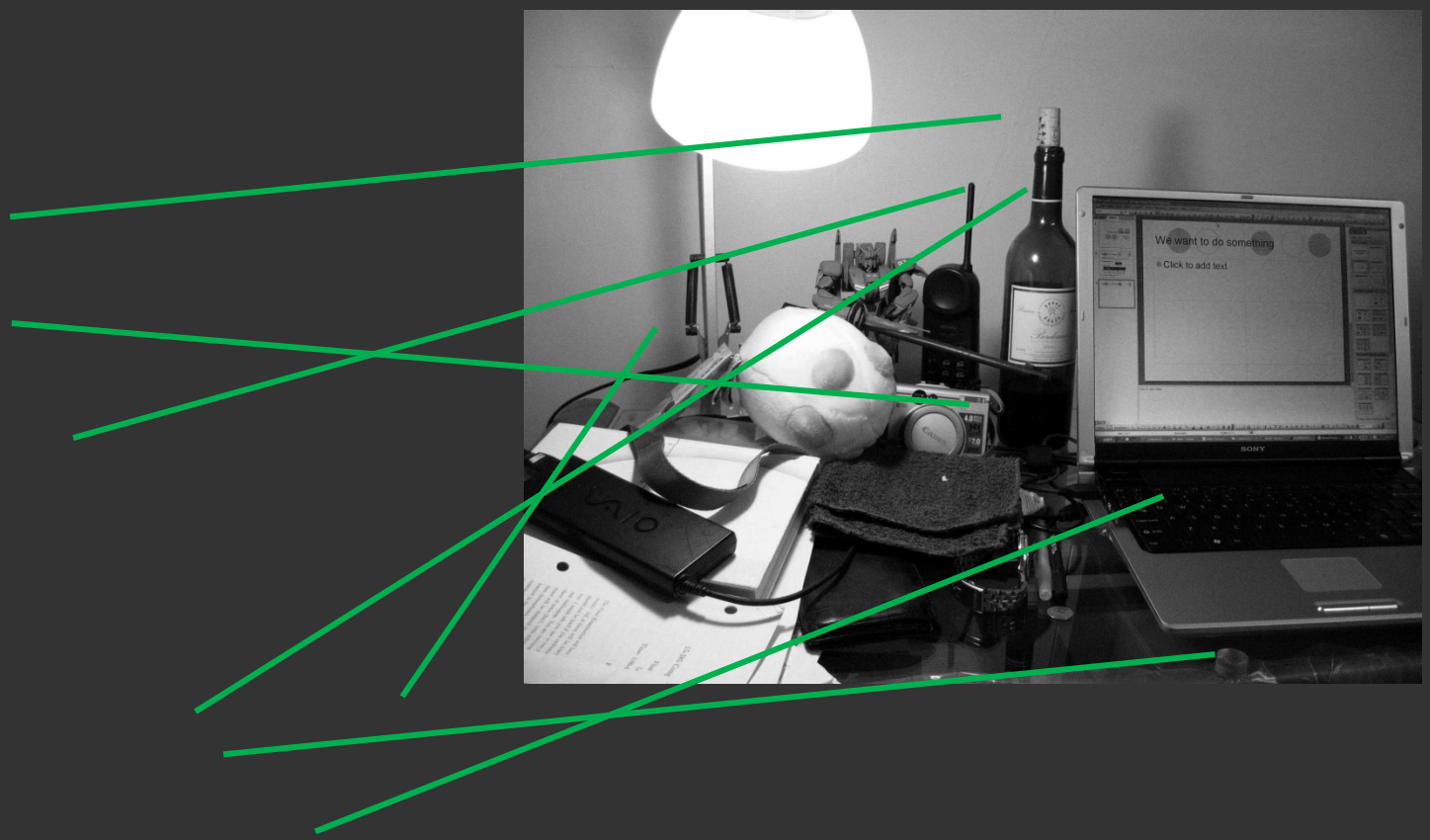
- Fast Realistic Rendering without 3D models

Start from Ray Tracing

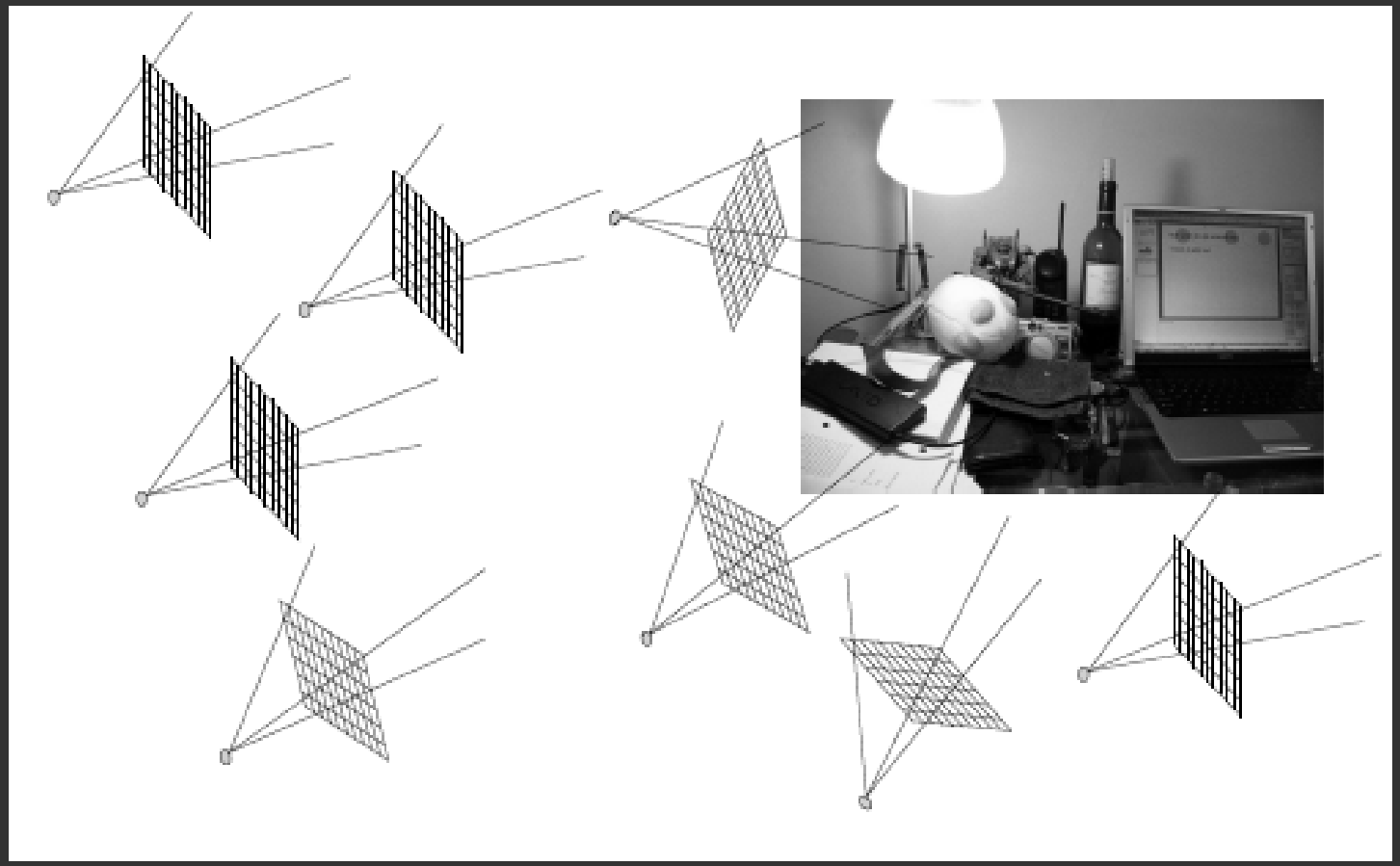
- Rendering is about computing color along each ray



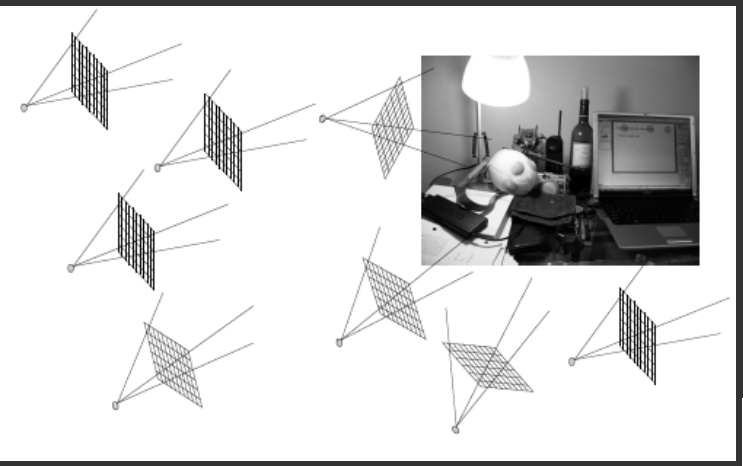
Sampling Rays

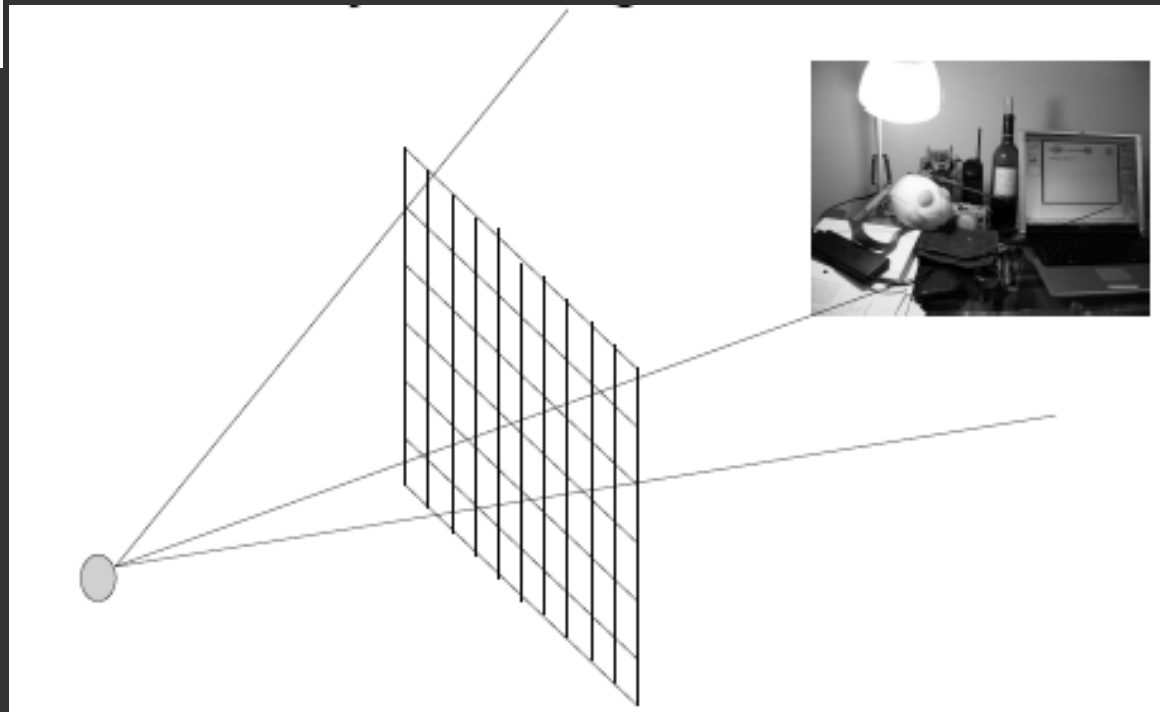


Sampling Rays by Taking Pictures



Rendering as Ray Resampling

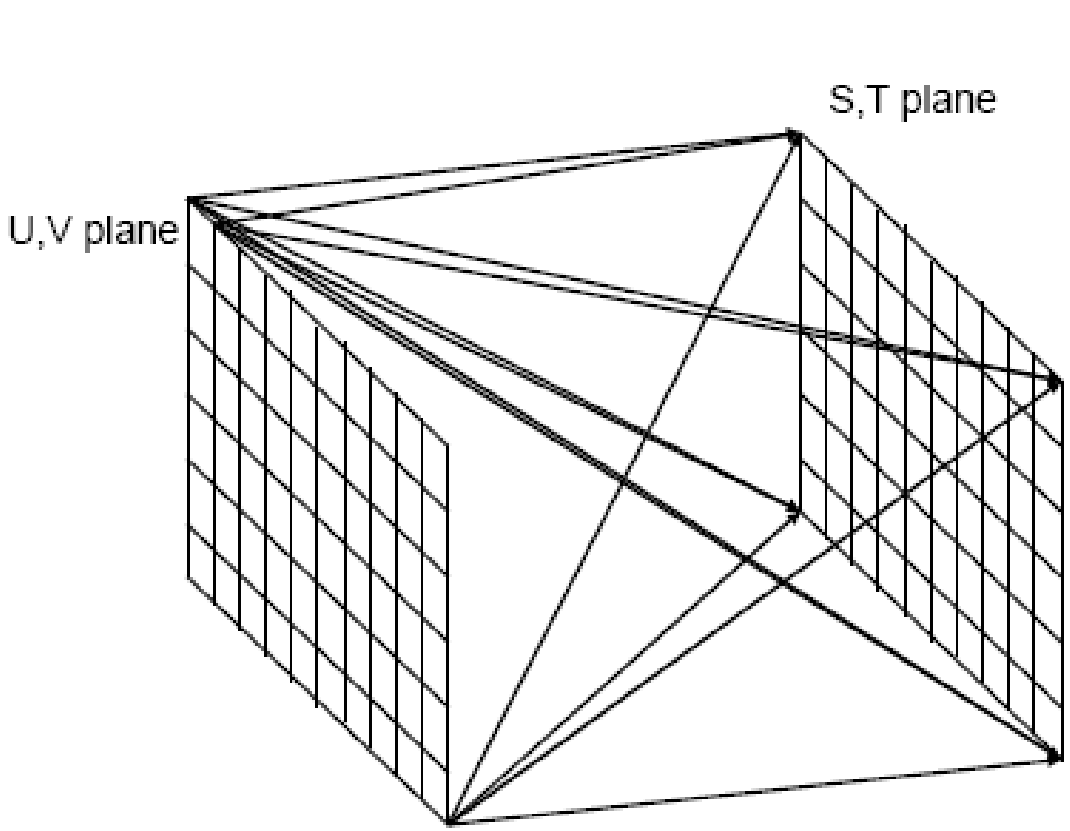


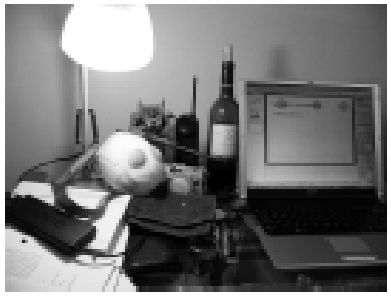


Ray space

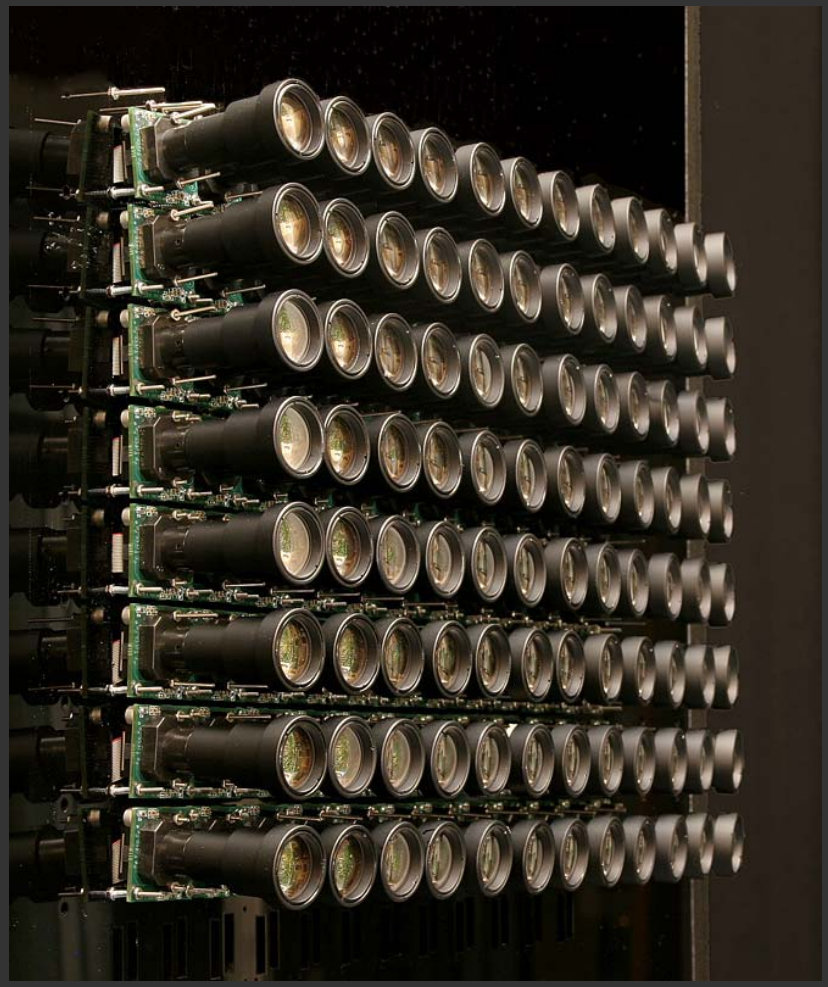
- How to parameterize the ray space
- How to sample and resample rays

Two Plane Parameterization



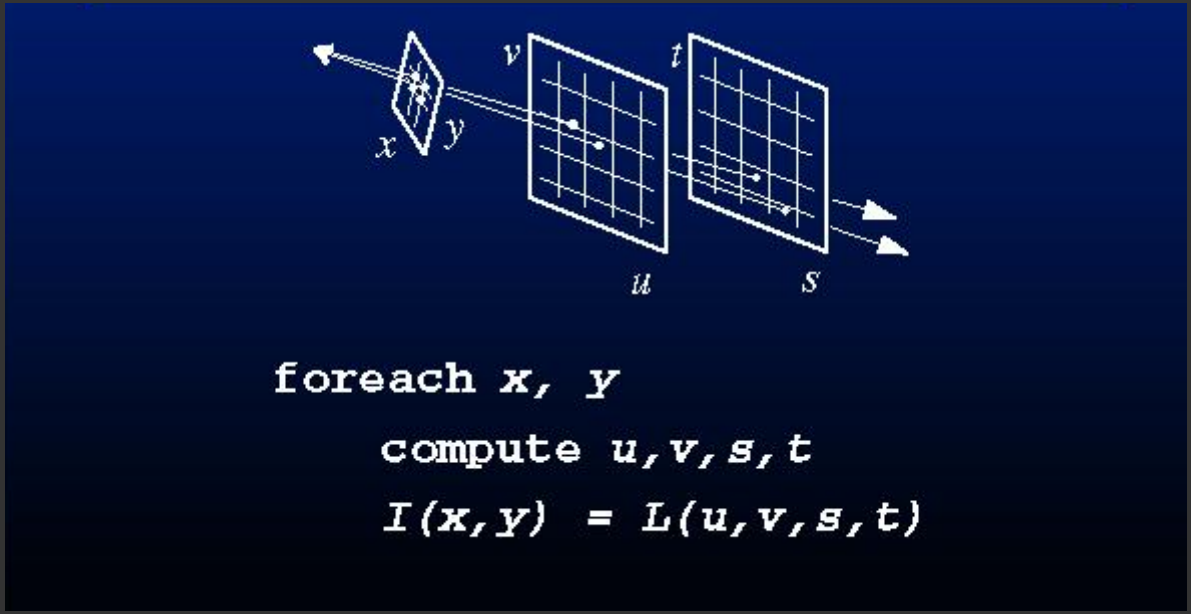


Stanford Camera Array



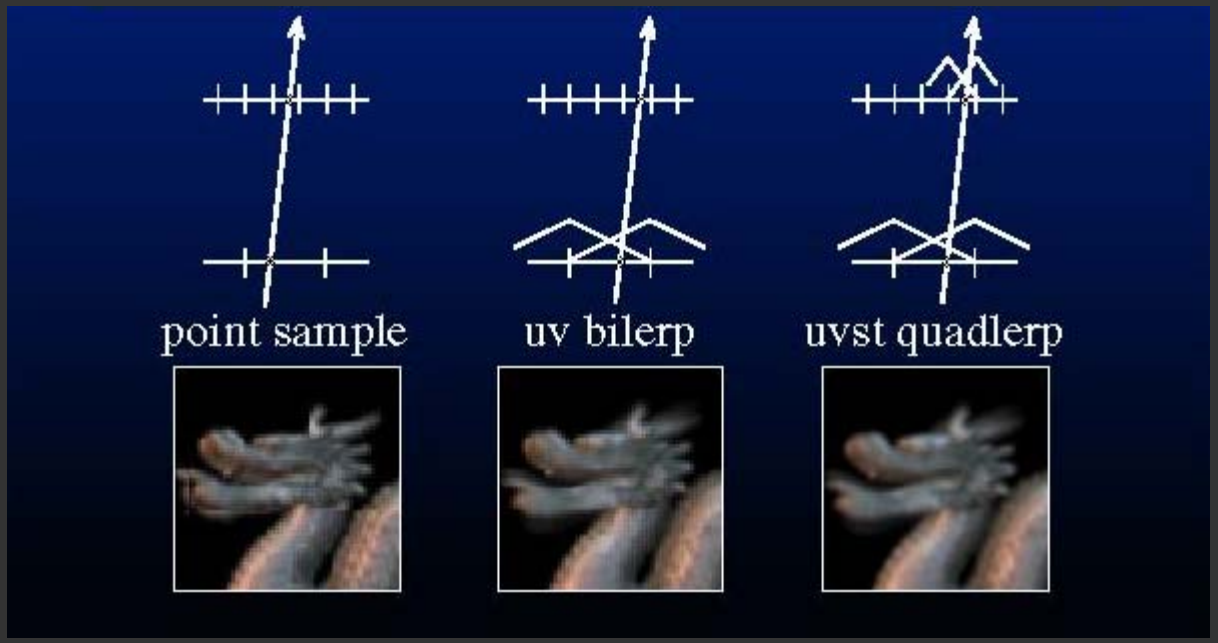
Light Field Rendering

- Very Fast



Light Field Rendering

- 4D interpolation



Light Field Rendering

- Don’t need to model anything:
  - surface model,
  - volumetric model,
  - lighting model,
  - surface property model…
- NOTHING but sampling and resampling rays.

Application in Movies

Capture scene with a camera array

Bullet time in Games

Max Payne (2001)

Discussion

- Limitation
  - Sampling density must be high
  - Fixed Illumination, static scene

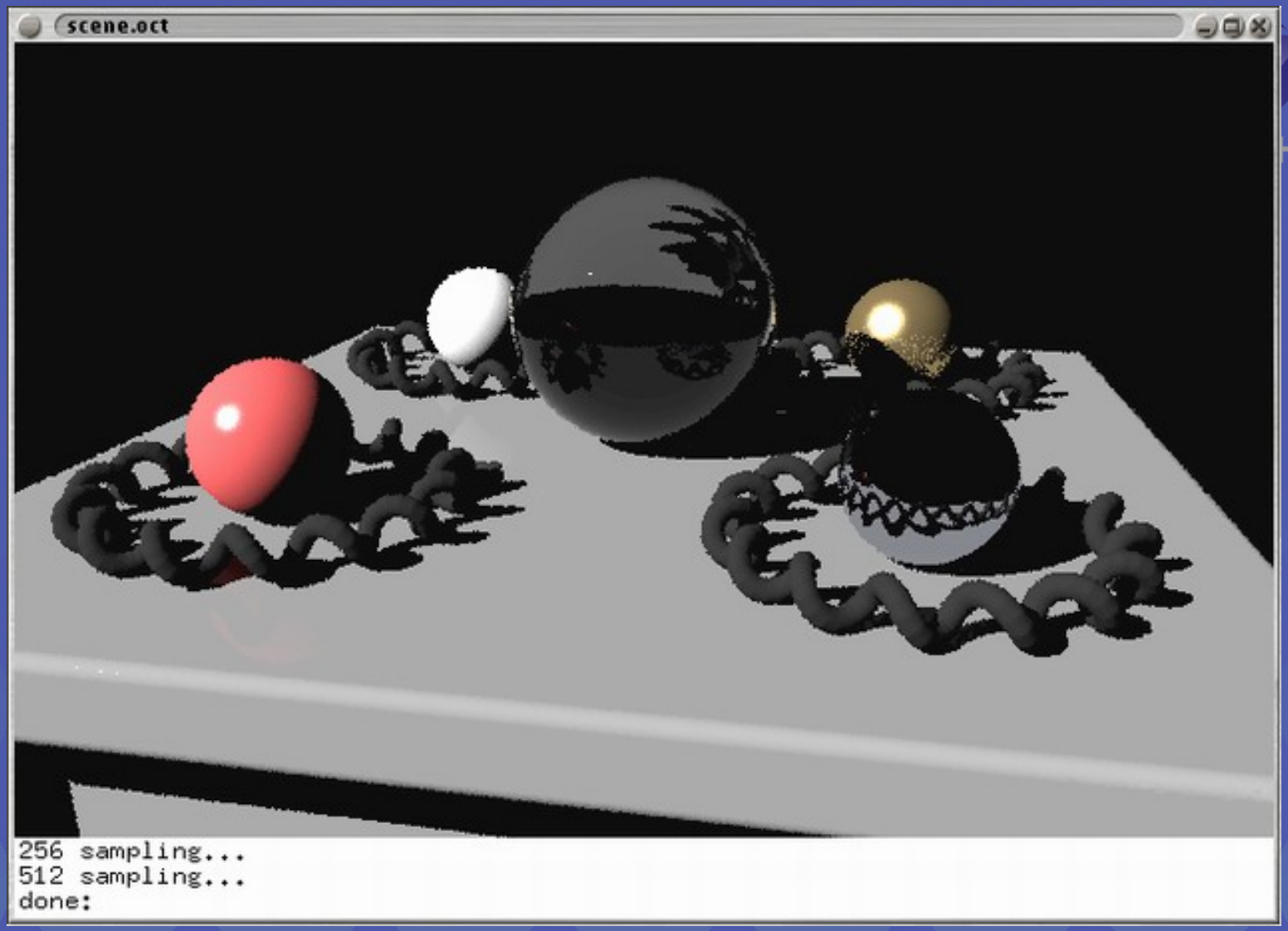
Methods using Fewer Cameras

- High-quality video view interpolation using a layered representation. C. L. Zitnick, S.B. Kang, M. Uyttendaele, S. Winder, and R. Szeliski, *SIGGRAPH* 2004

  http://research.microsoft.com/~larryz/videoviewinterpolation.htm

Image Based Lighting

- http://www.debevec.org/IBL2001/



CG Objects Illuminated by a Traditional CG Light Source

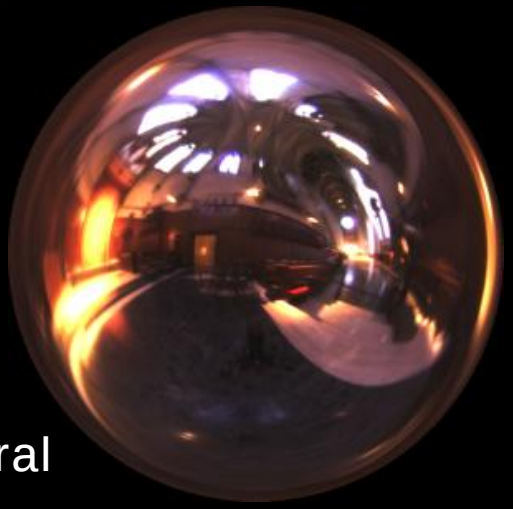
Real-World HDR Lighting Environments

Funston Beach

Eucalyptus Grove

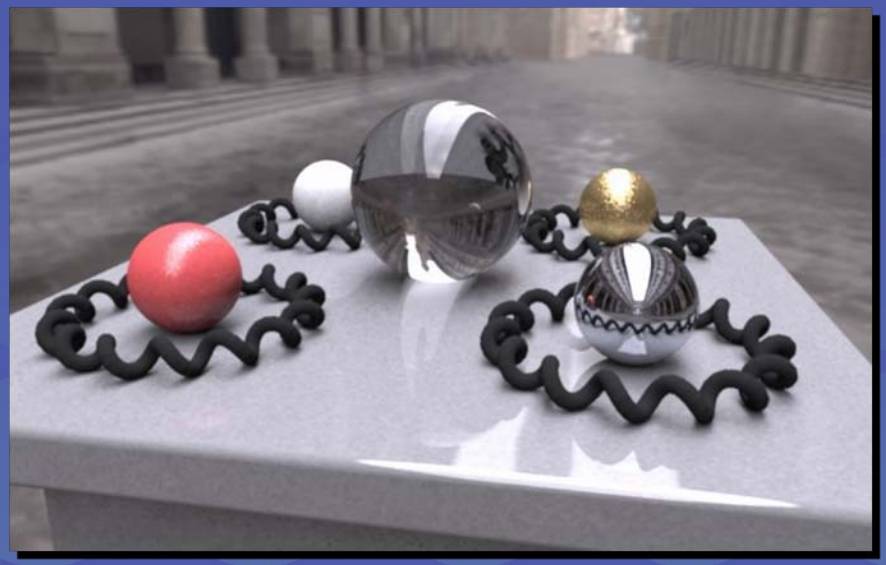
Uffizi Gallery

Grace Cathedral

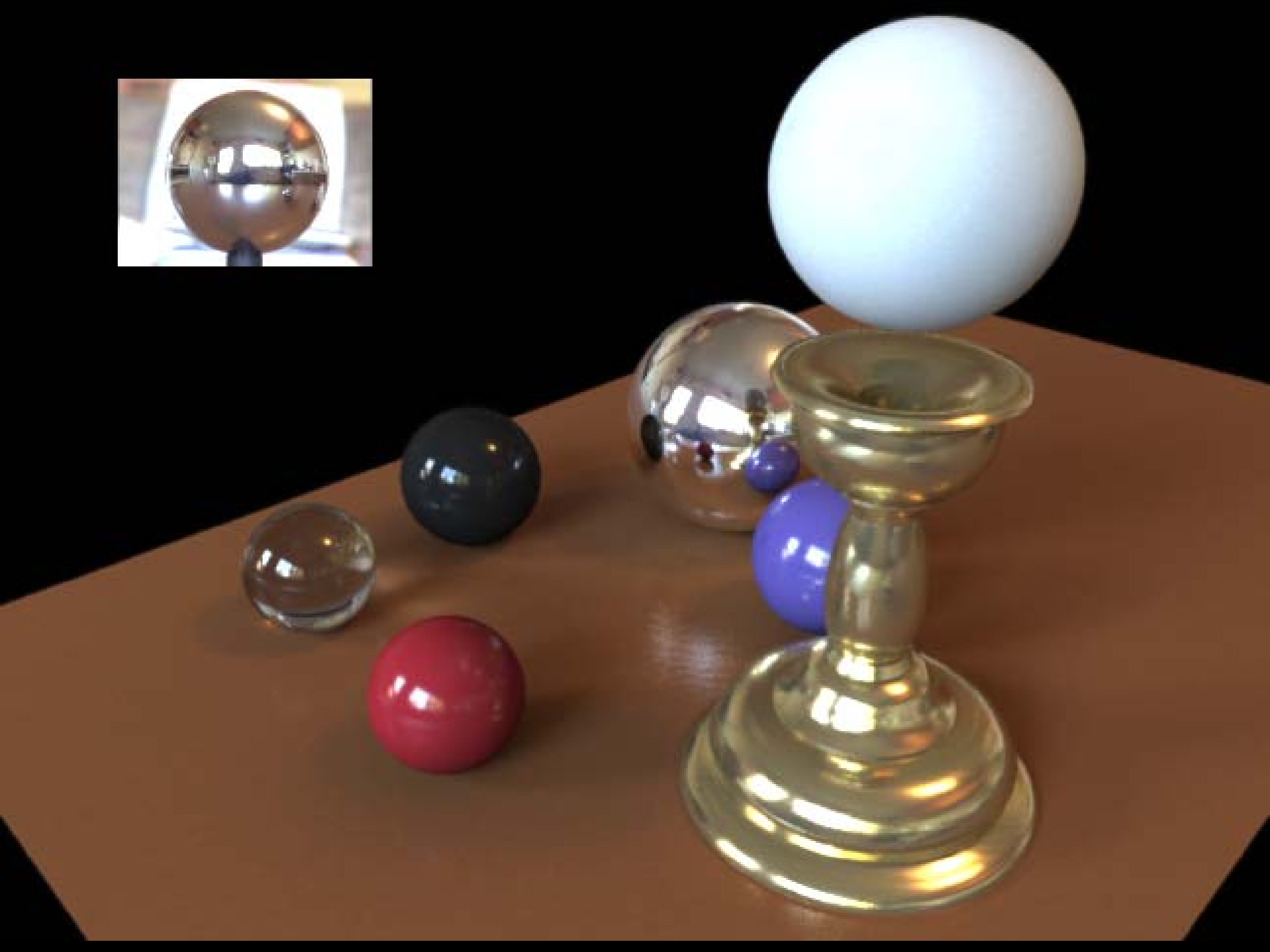


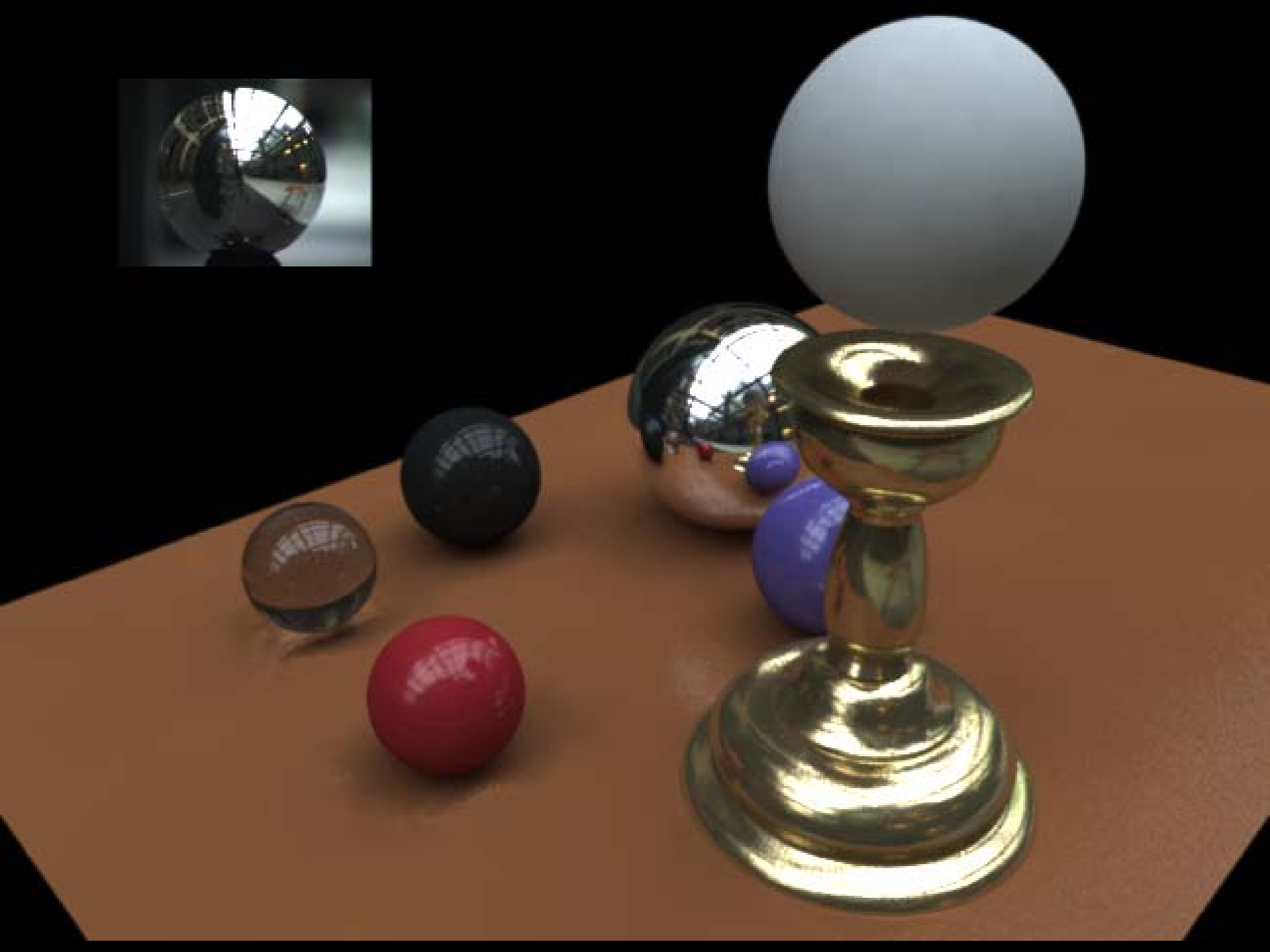
Lighting Environments from the Light Probe Image Gallery:
http://www.debevec.org/Probes/






Paul Debevec. A Tutorial on Image-Based Lighting. IEEE Computer Graphics and Applications, Jan/Feb 2002.





Rendering with Natural Light

SIGGRAPH 98 Electronic Theater

IMAGE-BASED LIGHTING IN *FIAT LUX*

Paul Debevec, Tim Hawkins, Westley Sarokin, H. P. Duiker, Christine Cheng, Tal Garfinkel, Jenny Huang

SIGGRAPH 99 Electronic Theater

Capturing a Spatially-Varying Lighting Environment

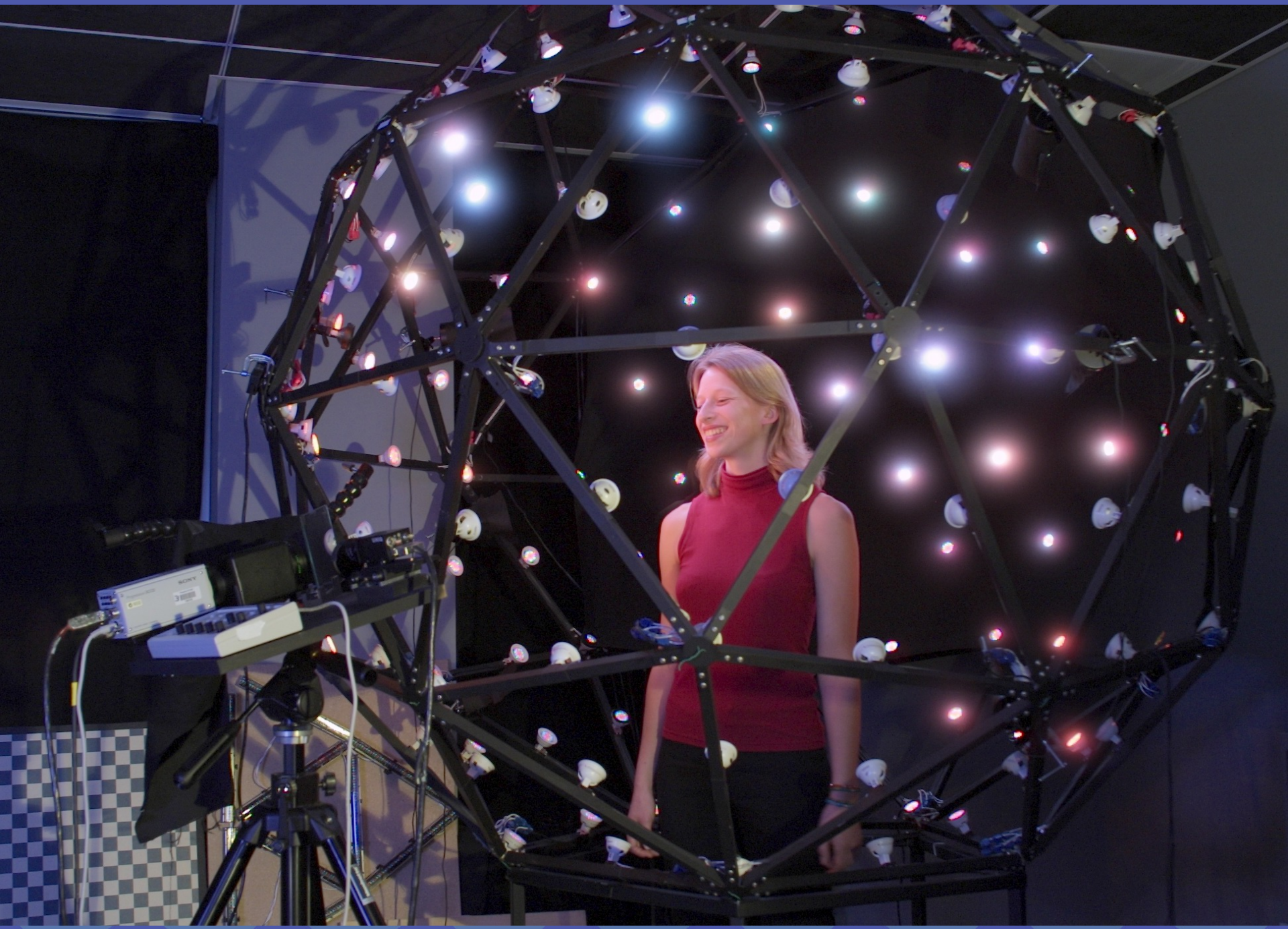
The Movie

So far

- Put synthetic objects in real natual lighting

- How to put real actors in synthetic environment?

Rendering Light Probes as Light Sources



A Lighting Reproduction Approach

Composited Results