Rendering Synthetic Objects into Real Scenes

based on [Debevec98]

Compositing of synthetic objects

- Geometry consistency
  - *needed:* geometric model of synthetic objects
  - *needed:* (coarse) geometric model of the real scene
  - *needed:* camera calibration (extrinsics & intrinsics)
  - *procedure:* rendering of synthetic and real scene with virtual camera identical to real camera

Compositing of synthetic objects

- Lighting consistency
  - *subproblem 1:* the synthetic objects need to be lit by the natural light sources that affect the real scene
  - *subproblem 2*: the synthetic objects affect the real scene

1. Illumination of synthetic objects with real light

- *Solution 1* – modeling the real light sources
  - light source surveying
  - photographing reference object
  - analysis of photographs
- *Solution 2* – recording scene illumination
  - using high dynamic range photography

High dynamic range photography

- Natural light requires many more intensity levels than the usual 256

- More levels can be acquired by varying exposure times

- Cameras are fast enough to avoid saturation of the brightest natural light sources

2. Scene affected by synthetic objects

- Shadows
  - synthetic objects should cast shadows in the scene

- Reflections
  - synthetic objects should be reflected by shiny scene objects
  - synthetic objects should cast light in the scene

Overview

- Introduction

- Illumination of synthetic objects

- Complete method for integrating synthetic objects in natural scenes

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Recording light using radiance maps

- *Radiance:* energy of radiation per unit transverse area, in a given direction, of a source of radiation $<$W sr-1 m-2$>$

- *Radiance map:* in a point, measure radiance in all directions

- *Practical construction:*
  - panorama centered in that point or
  - using spherical or parabolic mirrors

Radiance map example

Radiance map example

Radiance map example

Inter-register exposures to obtain high range
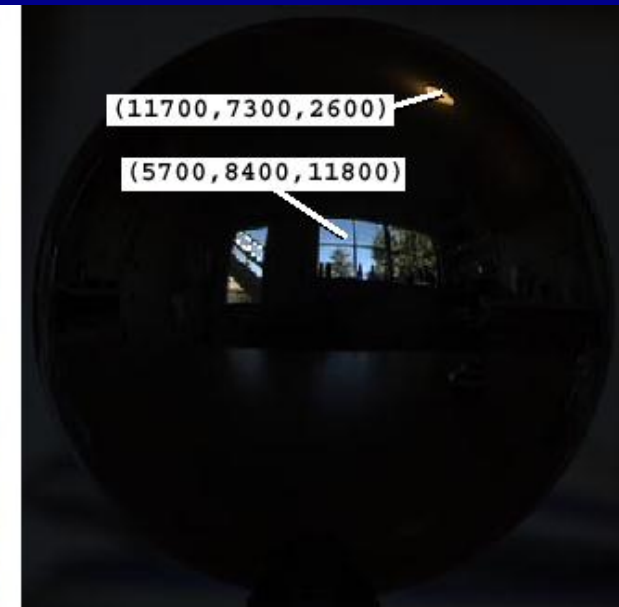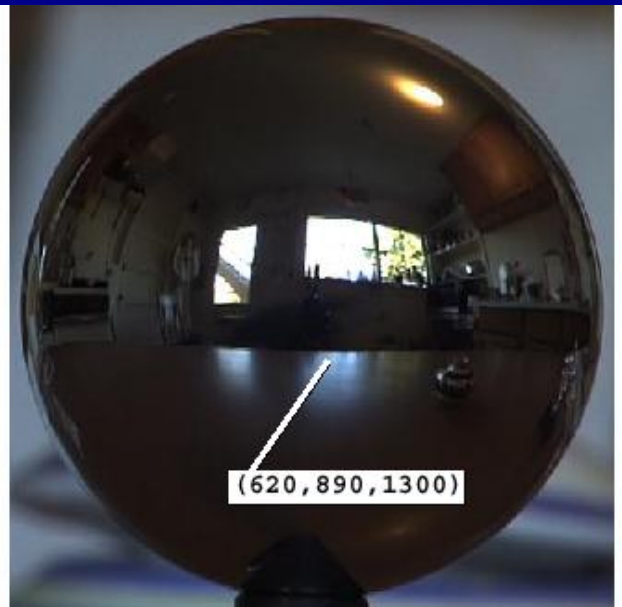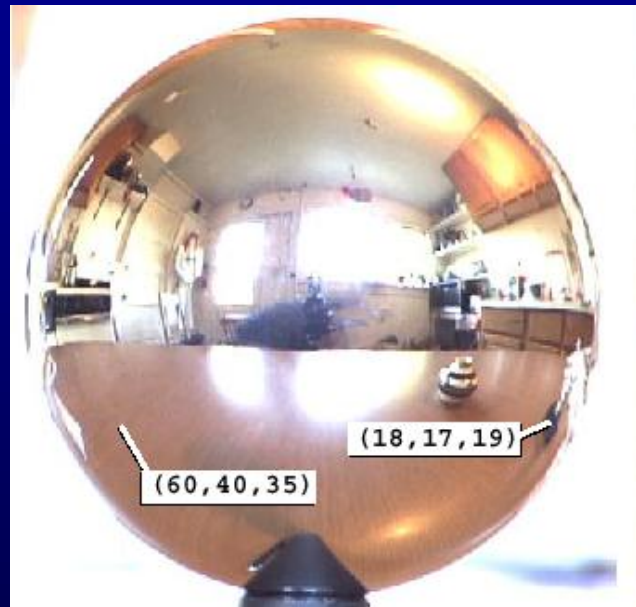
radiance map obtained by photographing polished steel sphere (light probe)

Illuminate synthetic object using a global illumination algorithm
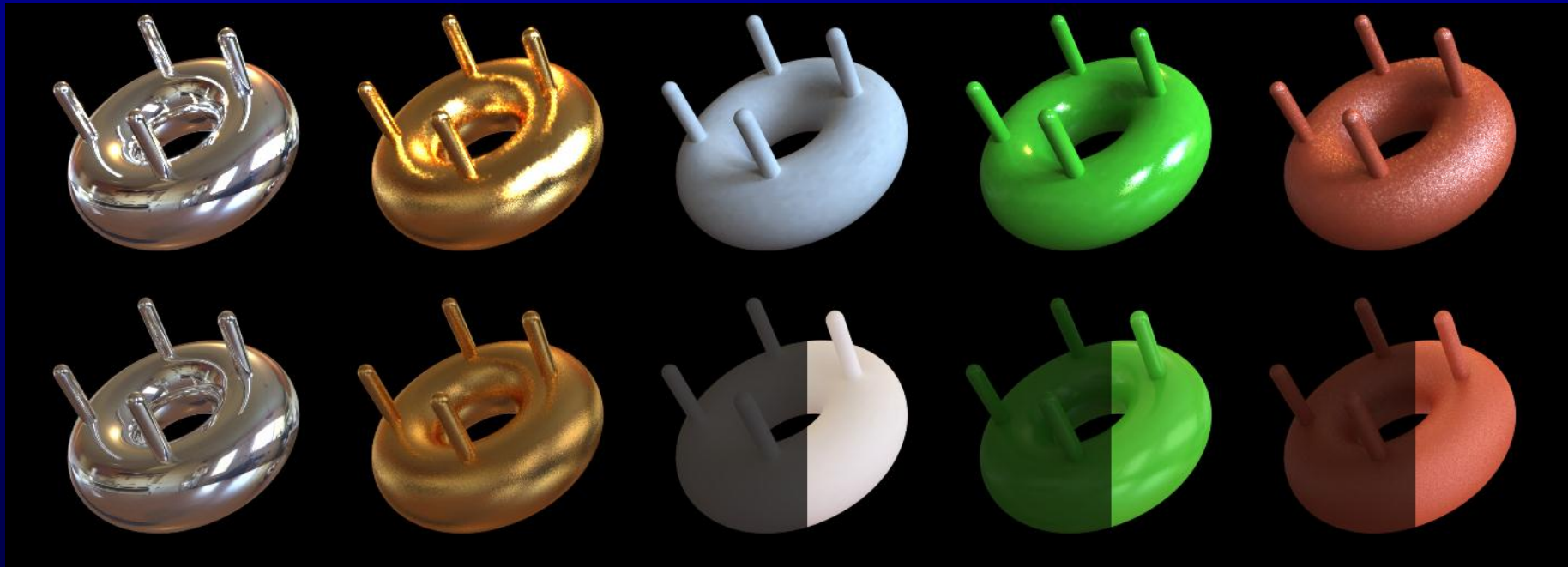
Another example
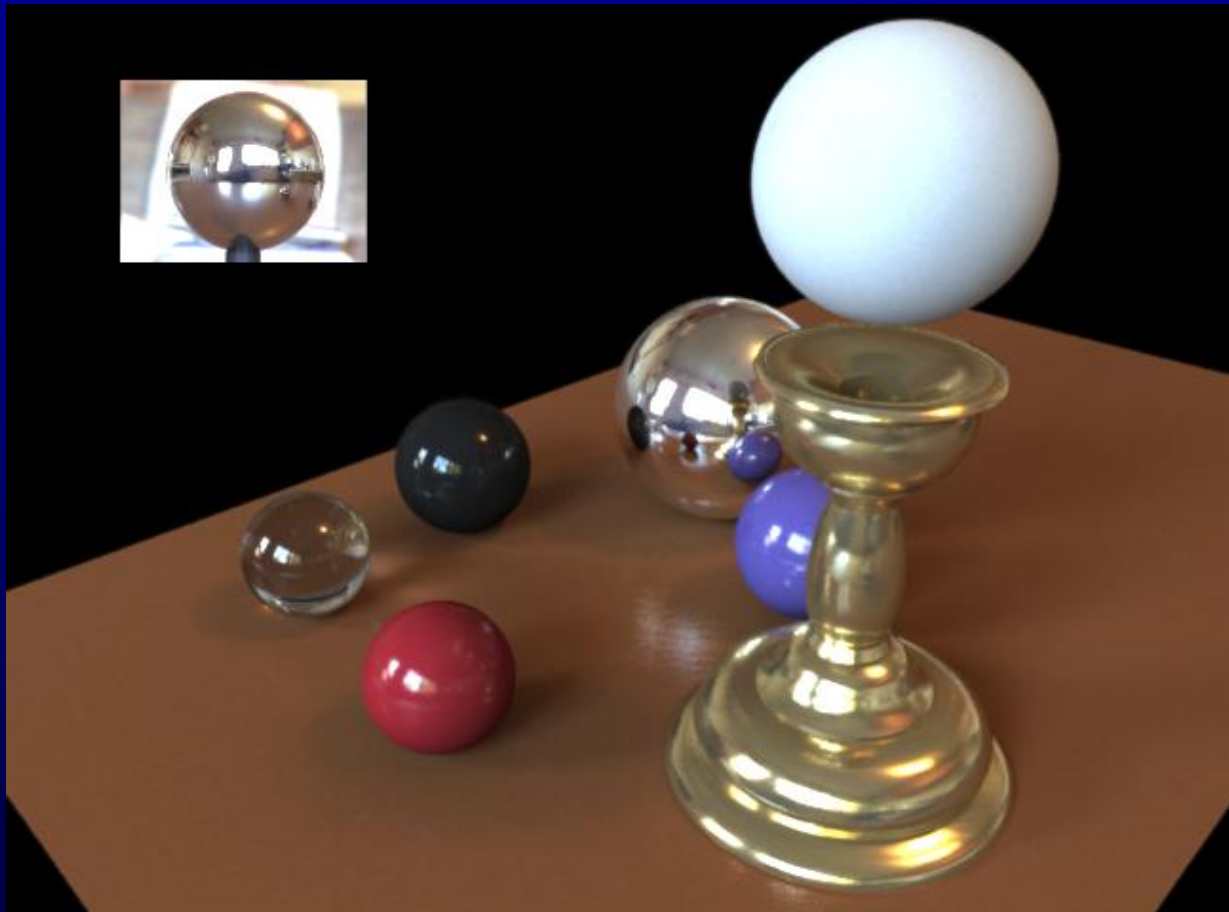
Another example
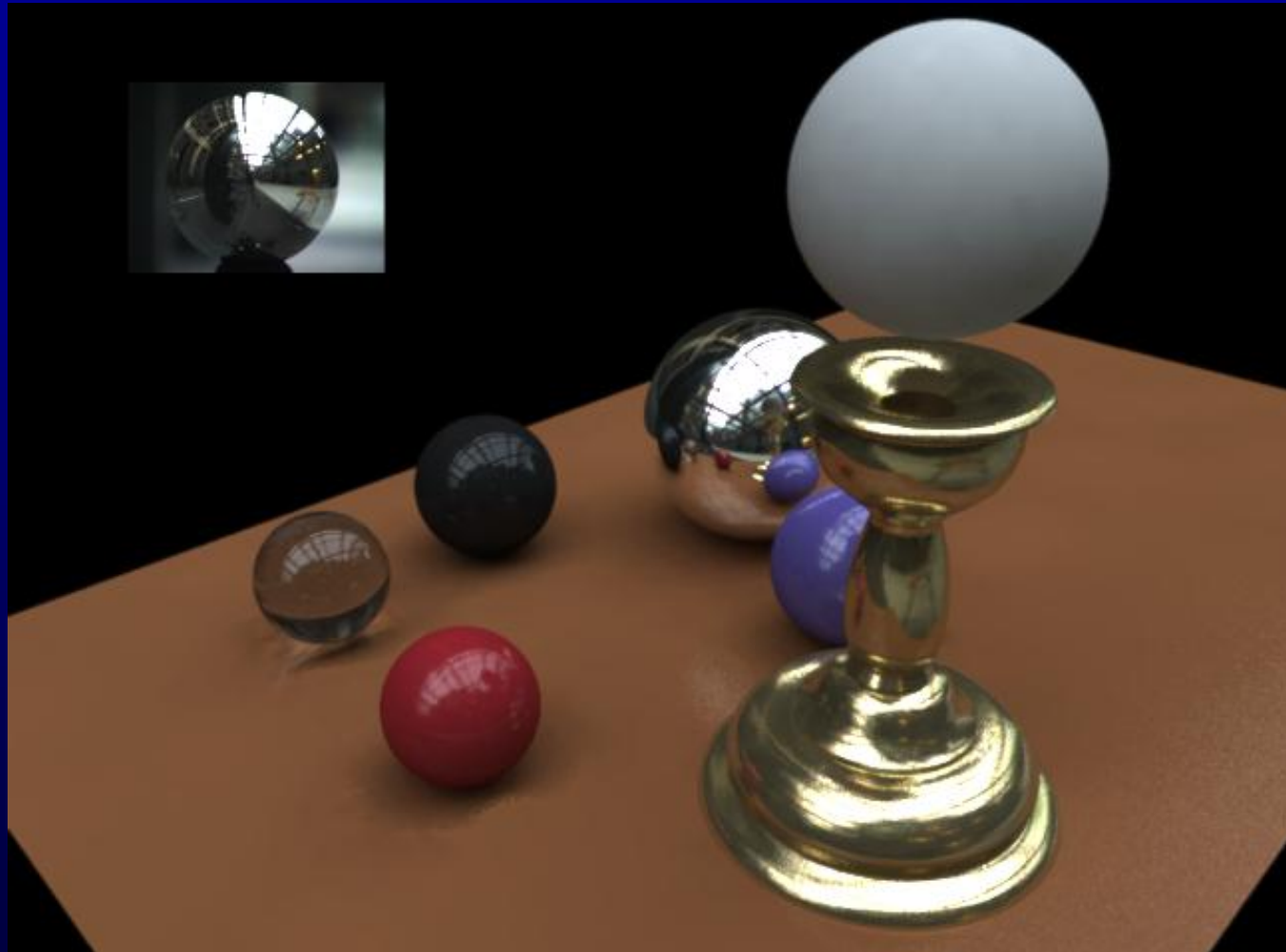
Light probe distortions

- Not all directions are treated equally
  - poor sampling close to the half-sphere edge
- Camera acquiring the light-probe image can image itself
- Solution is to take several images of the light probe
  - additional difficulty of interregistering the images
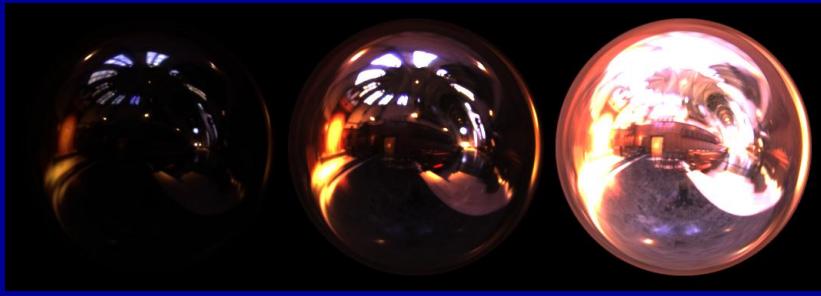
Reducing distortions using two light-probe images

Videos
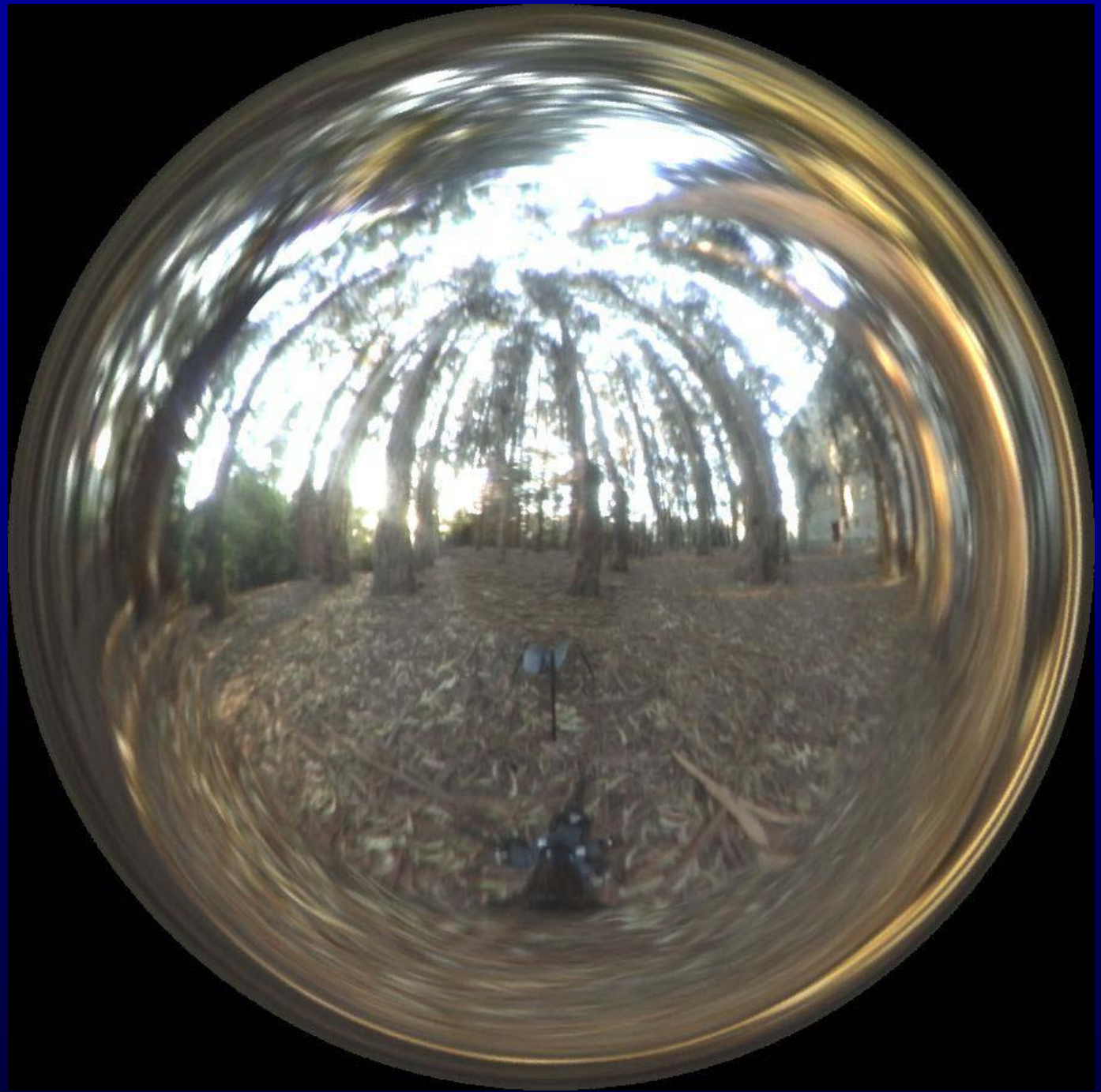
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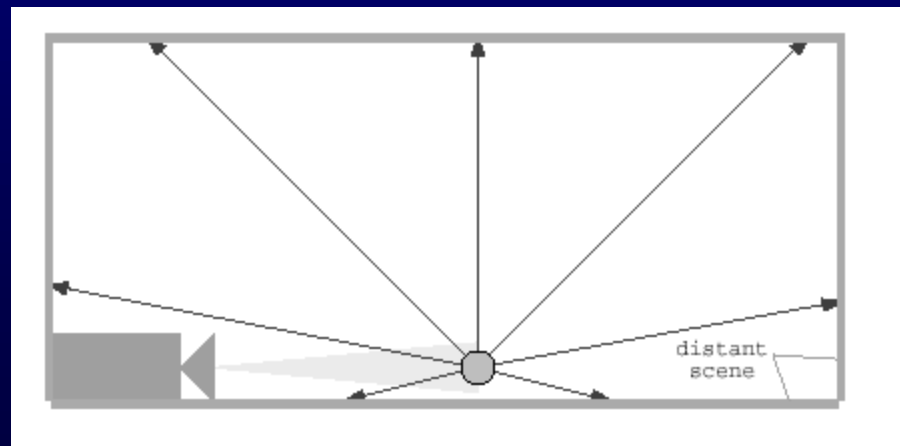
The general method
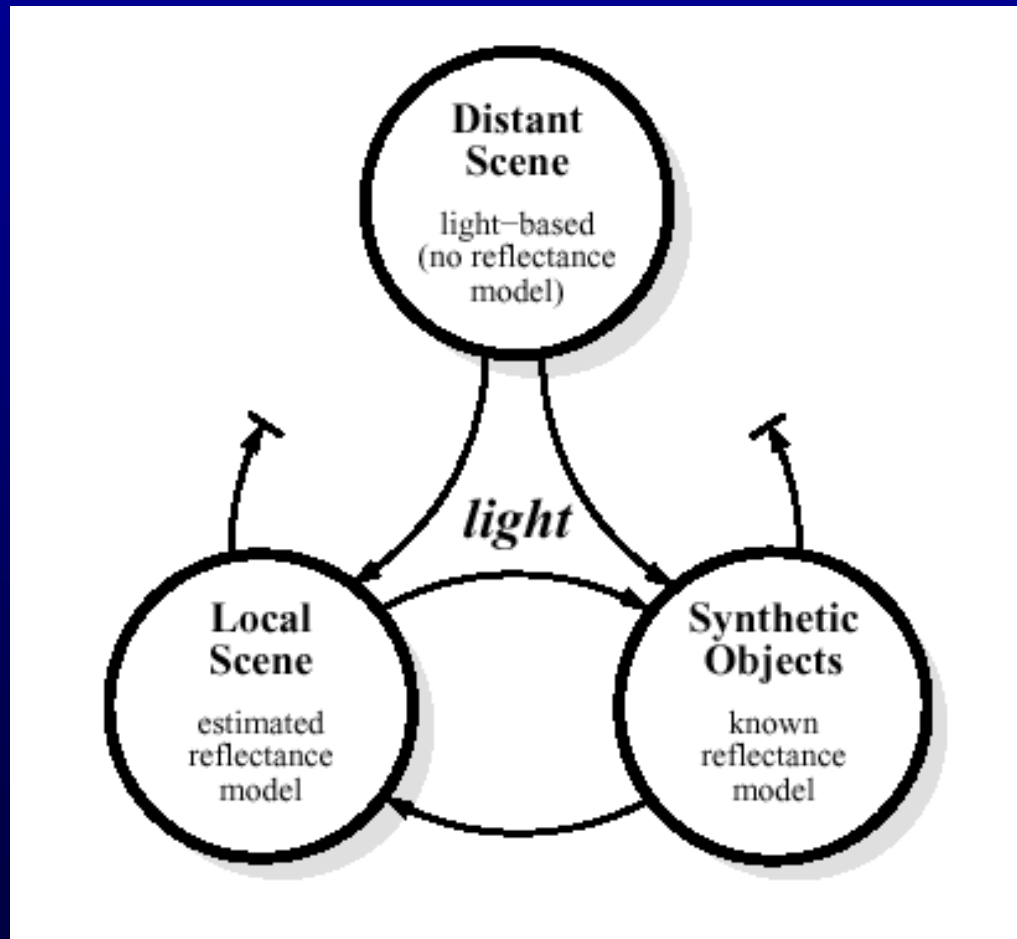
Step 1: background acquisition
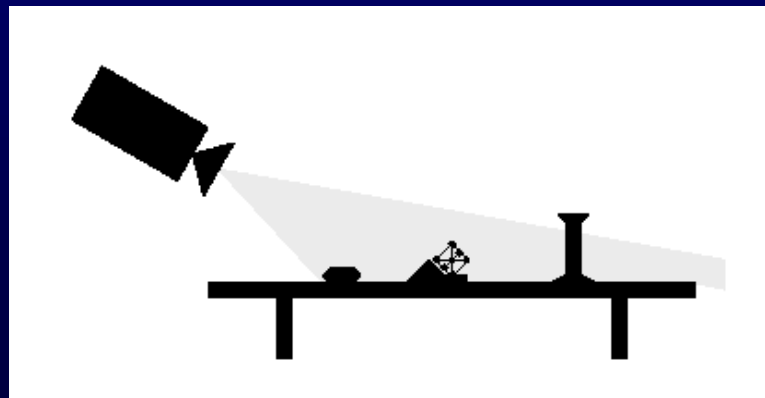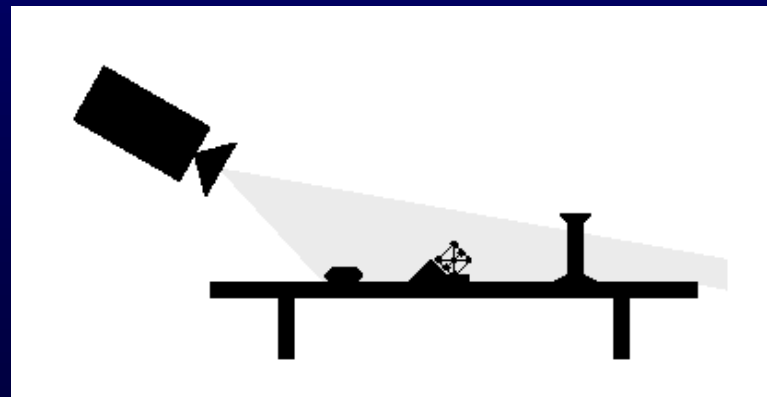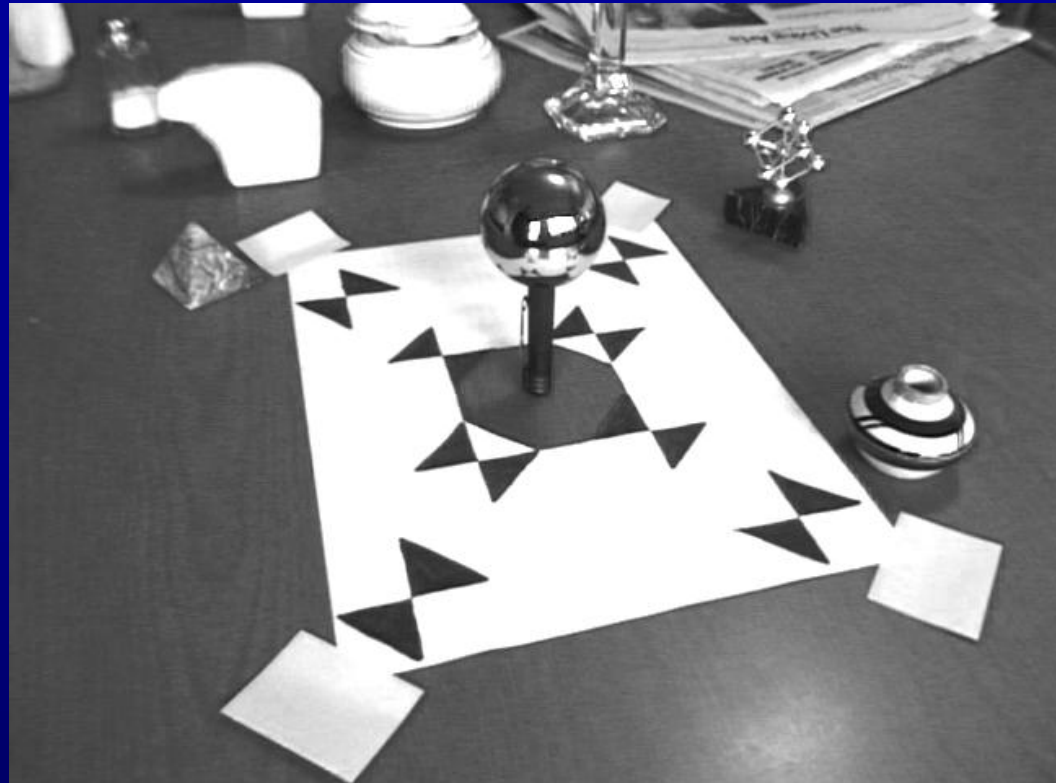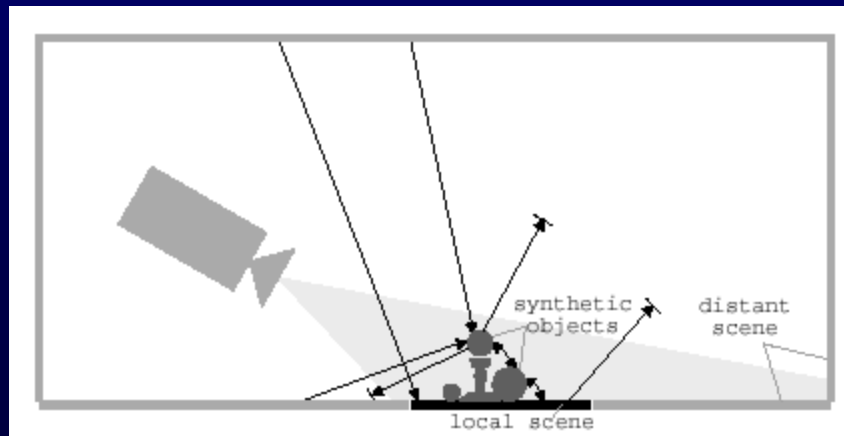
Step 2:
light probe
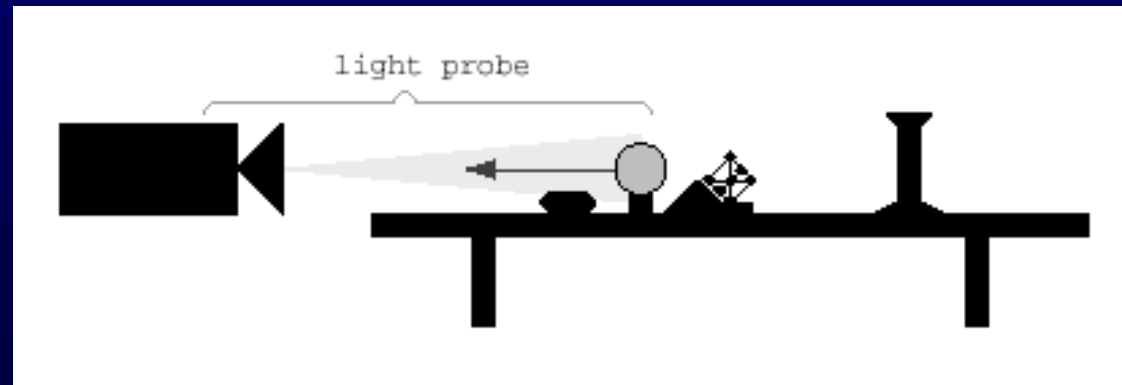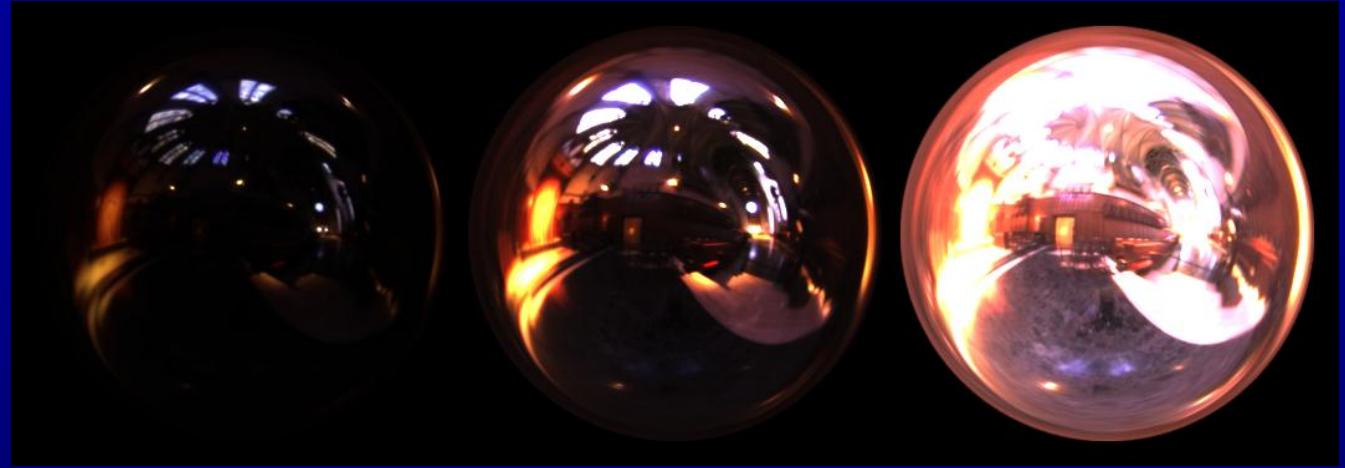
Step 3: constr. the light-based model
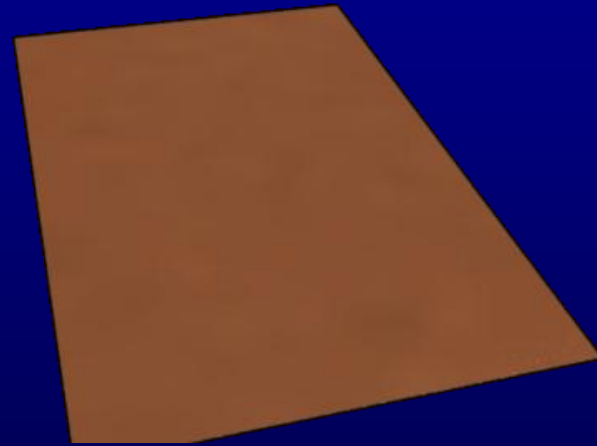

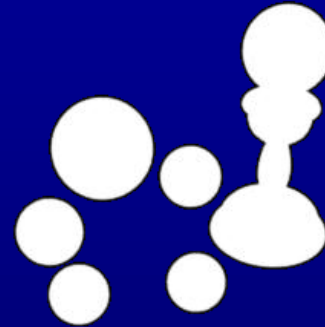distant scene

Step 4: camera calibration

Step 5: global illumination solution

Step 7: compositing
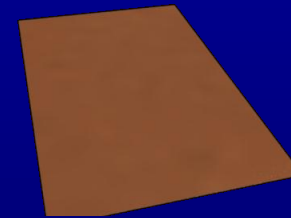## a. render local scene w/o synthetic objects

Step 7: compositing

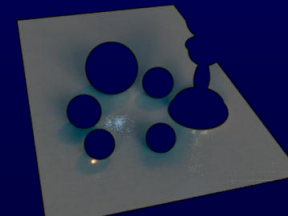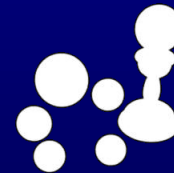b. create synthetic objects mask

Step 7: compositing

c. isolate synthetic objects contribution to local scene

subtract

apply

mask

Step 7:
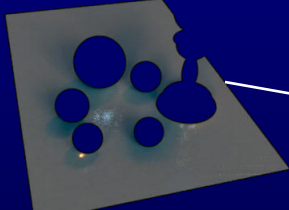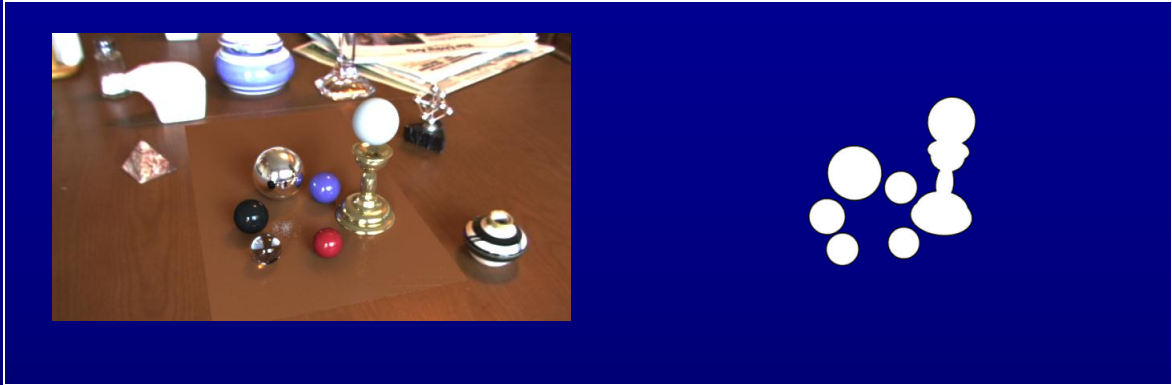## compositing

d. add to the background the synthetic objects and their contribution to the local scene

add

add

Results: before and after