Image-based Rendering

Can we model and rendering this?

What do we want to do with the model?

Image-Based Modeling

- Images (photographs, renderings) are used to determine
  - Scene Appearance
  - Scene Geometry
  - Lighting
  - Reflectance Characteristics

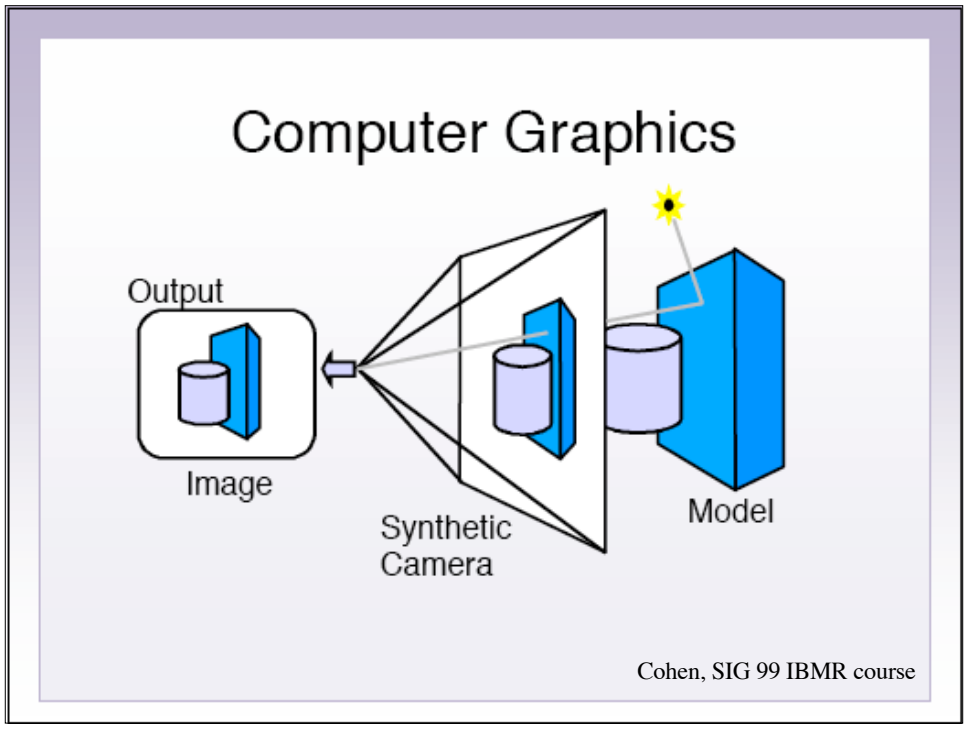
Image-Based Rendering

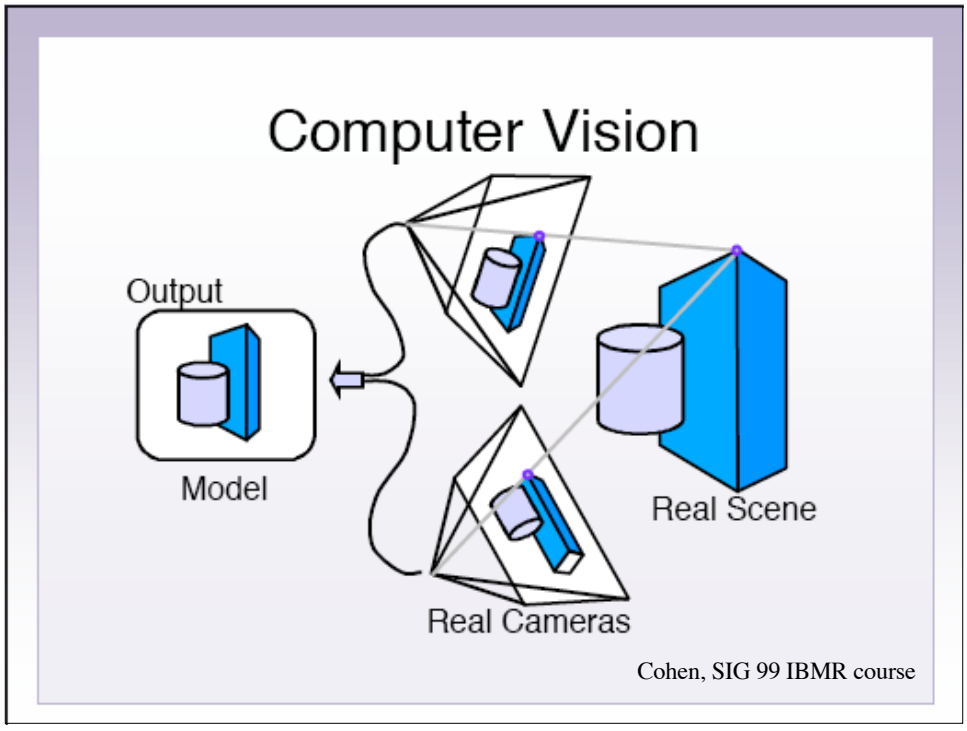
- Appearance in available views is used to determine appearance in novel views
- Don’t need to perform full illumination computations

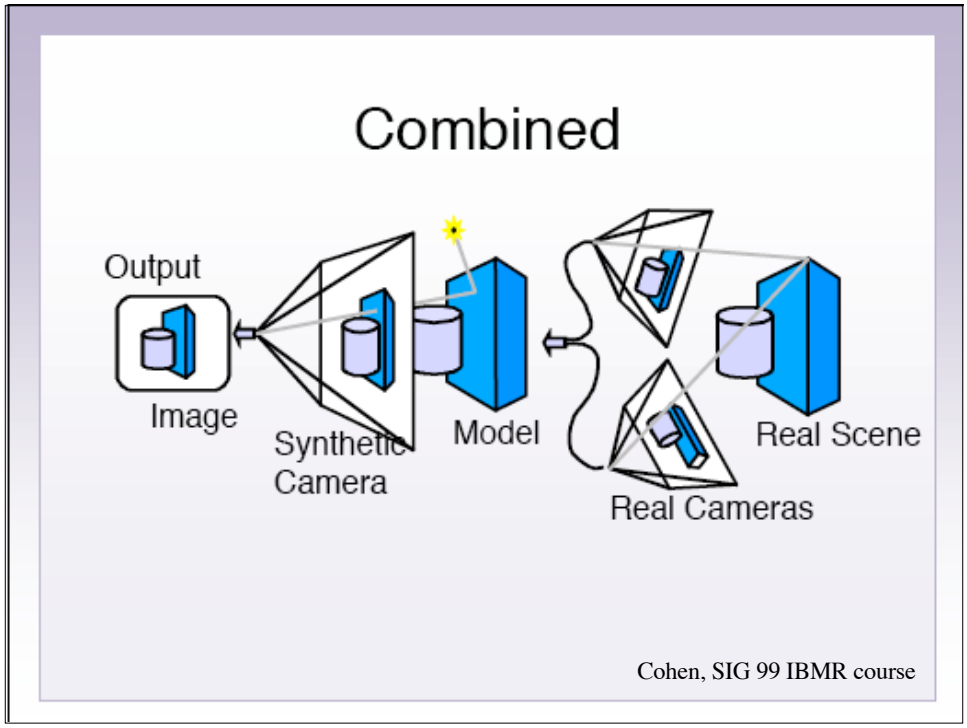
-> Rendering is faster

Image Based Rendering

- Traditions from
  - Photogrammertry (camera calibration)
  - Computer Vision (robots, image understanding)
  - Computer Graphics


Computer Graphics
Output
Image
Synthetic
Camera
Model
Cohen, SIG 99 IBMR course


Computer Vision
Output
Model
Real Scene
Real Cameras
Cohen, SIG 99 IBMR course


Combined
Output
Image
Synthetic
Camera
Model
Real Scene
Real Cameras
Cohen, SIG 99 IBMR course

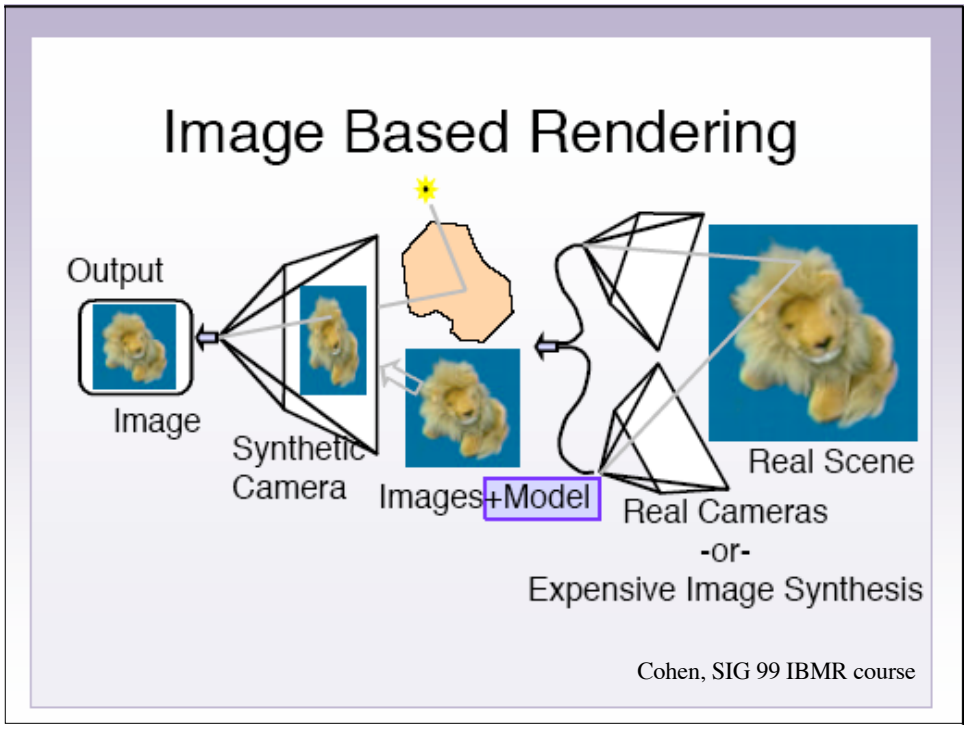
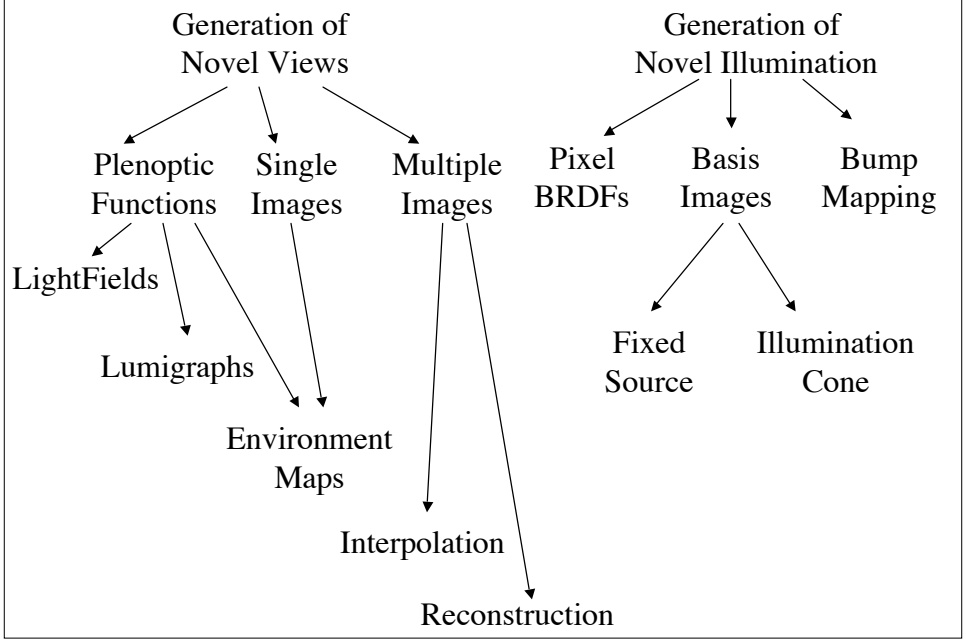


Image Based Rendering
Output
Image
Synthetic
Camera
Images+Model
Real Scene
Real Cameras
-or-
Expensive Image Synthesis
Cohen, SIG 99 IBMR course

Image-Based Rendering



Generation of Novel Views

- Start with multiple images
- Fixed illumination
- Generate new viewpoint
  - Plenoptic Function

Direction manipulation of Example Images

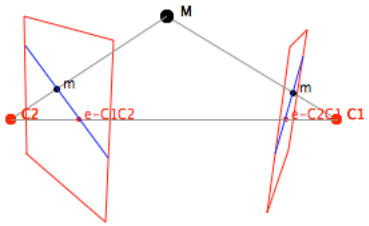
- QuickTimeVR
- Morphing
- http://www.research.microsoft.com/~cohen/SIG_97_IBR/index.htm
- http://graphics.lcs.mit.edu/~mcmillan/IBRpanel/slide10.html

Direction manipulation

- Given
  - Two views
  - Camera's internal & extern params
- Correspondence btwn image pixels in any third view can be reconstructed
- For orthographic: only need pixel correspondences
- For perspective, need pixel correspondences & epipolar geometry for two views
  - Estimated from small number of point correspondences

Definition Epipolar Geometry

- http://www-sop.inria.fr/robotvis/personnel/sbougnou/Meta3DViewer/EpipolarGeo.html

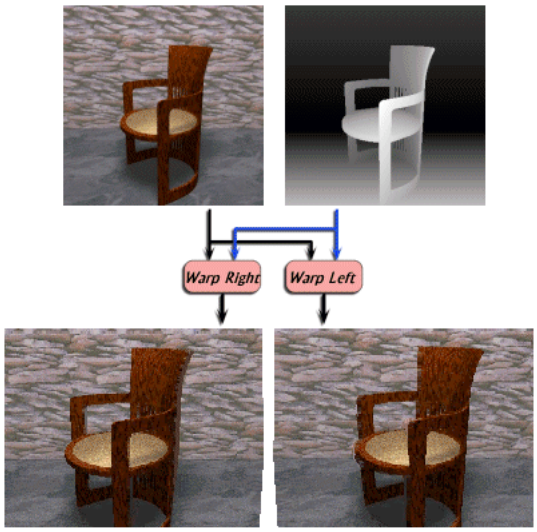


Example Cylindrical Panorama

3D Scene Capture

Fuchs et.al., UNC

UNC and UVA

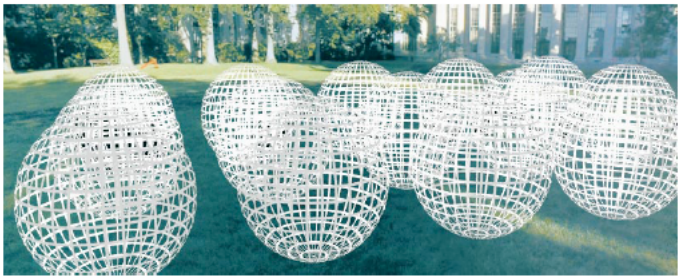


Plenoptic function

- 5D Parameterized function
- Describe everything that is visible a single point in 3D space
- Latin:
  - *plenus* = complete or full
  - *optic* = pertaining to vision

Plenoptic Function

✔The set of rays seen from all points ...



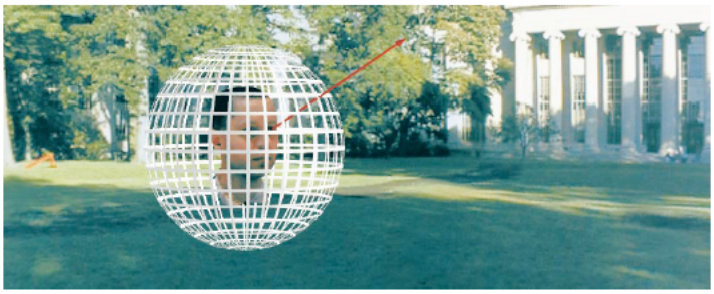
$$p = P(\theta, \phi, x, y, z, \lambda, t)$$

Azimuth, Elevation, Position, Wavelength, Time

McMillian, SIG 99 IBMR course

Plenoptic Function

- A single viewpoint --> function is reduced from 5D to 2D,
  - Azimuth and elevation angle

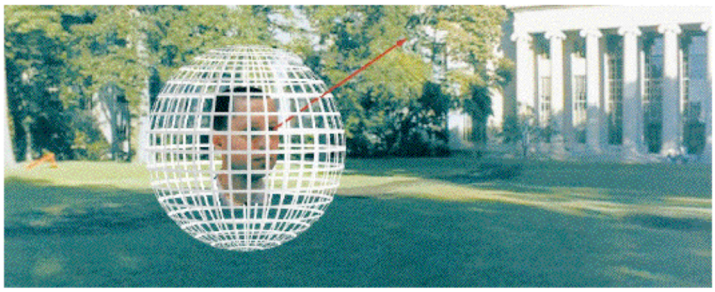


An image is a subset of the rays seen from a given point
- this "space" of rays occupies two dimensions

McMillian, SIG 99 IBMR course

Plenoptic Function

- If the view is from inside convex hull, it is reduced from 5D to 4D
  - Large amoounts of storage

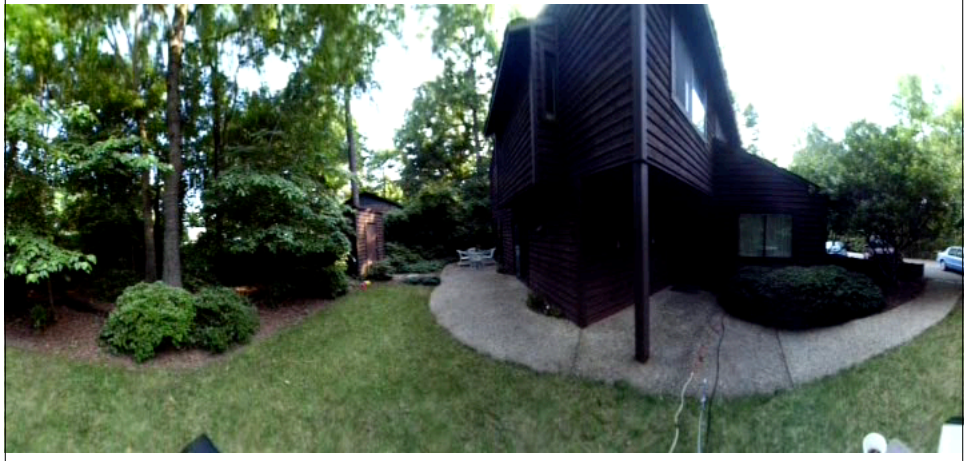


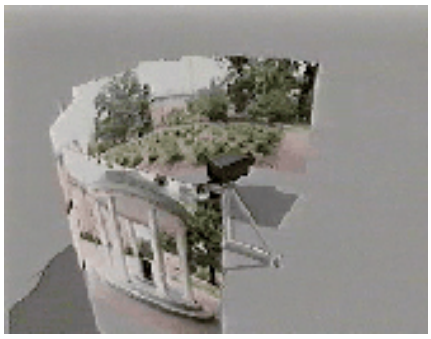
Cylindric Panoramas

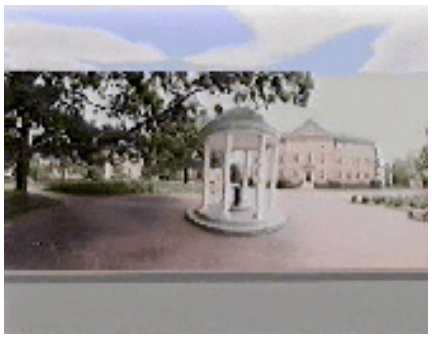
- 36 images, uncalibrated video camera 360^o

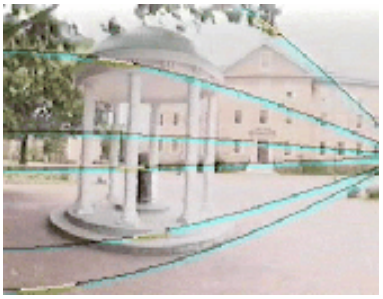
- 31 images, 60 inches from first

Arbitrary Reprojections



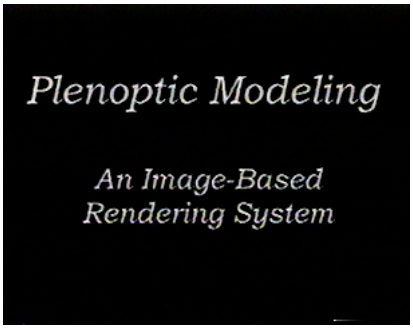






Summary

- Digitized at 5fps



This paper is cool because

- Doesn't require scene depth

Credits

- http://www.dai.ed.ac.uk/CVonline/LOCAL_COPIES/ASHBROOK1/node1.html#SECTION00010000000000000000
- http://www.research.microsoft.com/~cohen/SIG_97_IBR/index.htm
- http://graphics.lcs.mit.edu/~mcmillan/IBRpanel/slide06.html
- http://peter-oel.de/ibmr-focus/
- http://www.cs.berkeley.edu/~debevec/IBMR99/

- http://www-2.cs.cmu.edu/~ph/869/www/869.html