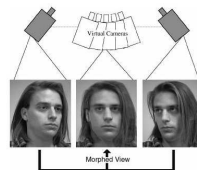# Image Based Rendering

Hua Zhong
2004/11
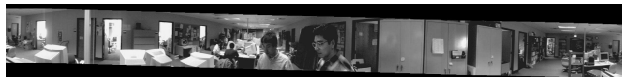

Render from images

- Image Morphing (has nothing to do with the real physical world)

- View Morphing

- Panorama

- Even in your roller coaster project:
  Your world is a box with texture!

*"View Morphing" image is from Steve Seitz's SIGGRAPH 96 paper
**Panorama image is from Jianbo Shi's website.

But what is image based rendering?

- What is the fundamental idea of image based rendering?
- Why we want to do that?
- Why it works? (in some cases)
- How to do that?
- …

A Rendering task: A Programmer's Desk

A Rendering task: A Programmer's Desk

A Phone.
Black, Plastic,
Solid and
Opaque
Surface

A Rendering task: A Programmer's Desk

A Robot!
Well model this
could be a little bit
complex, but still
doable, there is
only one, right?

A Rendering task: A Programmer's Desk

A transparent cube with a statue of liberty inside it!
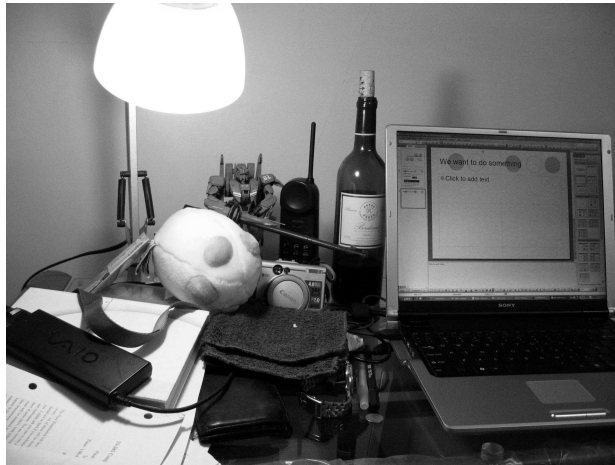
A Rendering task: A Programmer's Desk

Half transparent objects, non-regular shape, different materials (labels) on the object.

A Rendering task: A Programmer's Desk

A fuzzy toy full of fur all over it and a piece of cloth. Special materials.

A Rendering task: A Programmer's Desk

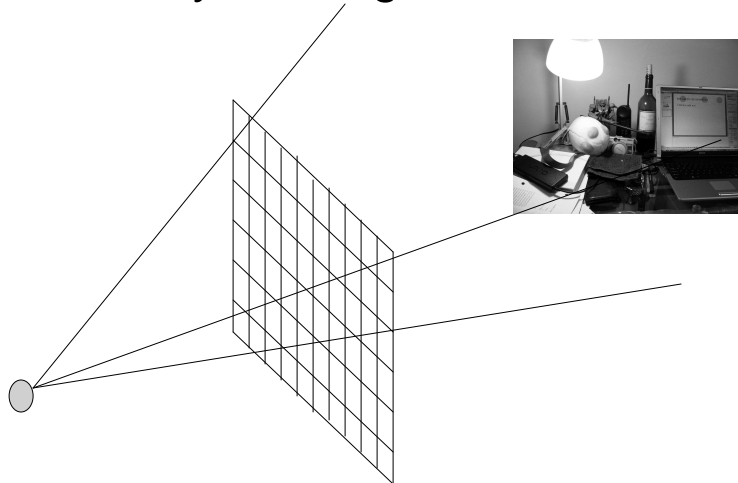With a lot of other things together, and we need global illuminations!!

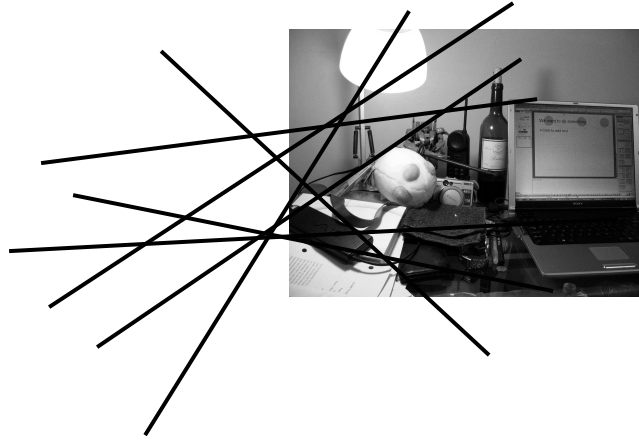## A Rendering task: A Programmer's Desk

Render it in Real-time!!

With a lot of other things together, and we need global illuminations!!
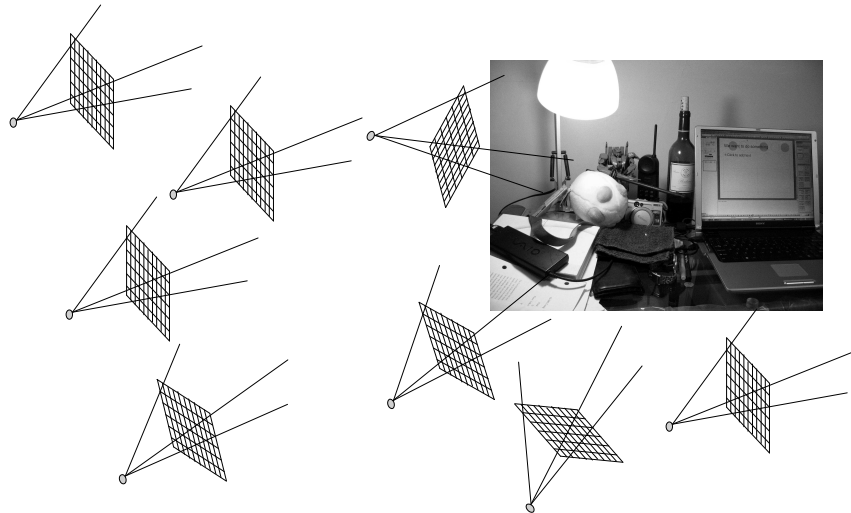
Start from Ray Tracing

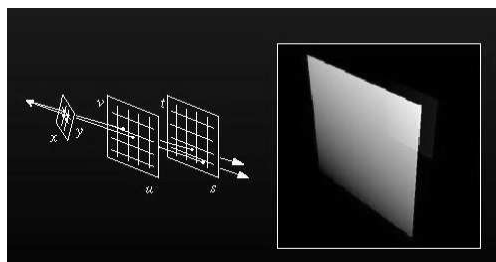# Sample the ray space

Sample Rays by Taking Pictures!

Ray Space

- Dimension?
- How to parameterize it?
- Then how to sample it?

Light Field: Ray Space Representation
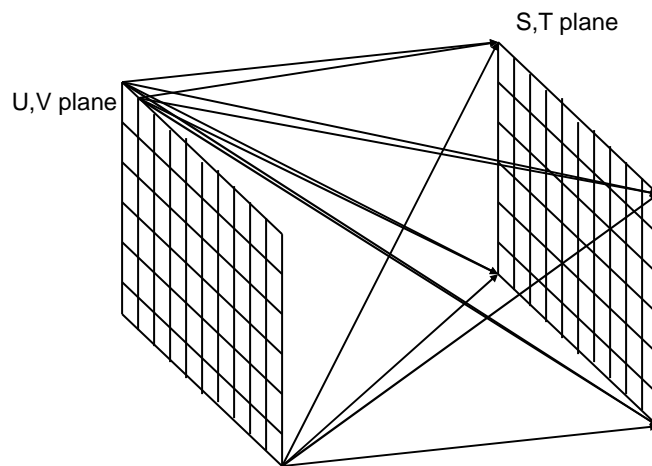
Two-plane parameterization of ray space

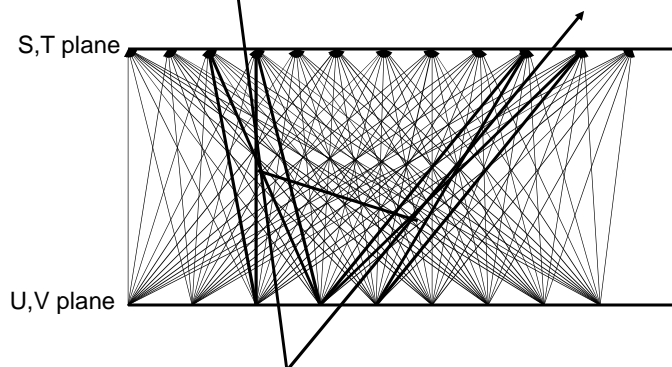Marc Levoy and Pat Hanrahan. Light field rendering. In Proceedings of SIGGRAPH '96

Image is from Marc Levoy and Pat Hanrahan's Siggraph 96 slides.

Light Field: Sampling Scheme

S,T plane

U,V plane

Light Field: Render

S,T plane

U,V plane

A Simple Demo

- I wrote this simple LF demo.
- Samples on ST plane: 200x200
- Samples on UV plane: 21x21
- Rendering is in 200x200

Overview of the whole Light Field

- Two-plane ray space parameterization
- Sample scheme for UV,ST
- Interpolating rays to render novel views

- Don't need to model anything: surface model, volumetric model, lighting model, surface property model… NOTHING but ray space model.

Difference from conventional graphics pipeline

- No model
- Sampling and Synthesis (render) approach
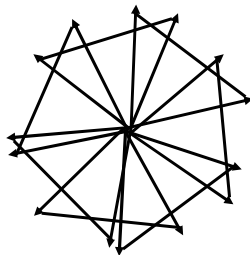
And is it perfect?

- No

Light Field is one basic IBR technique

- There are a lot of more others
- They all share the "sampling-rendering" scheme
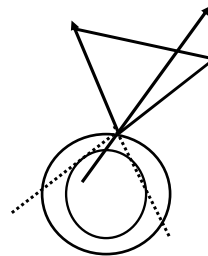- They only differ in how to sample, and how to render.
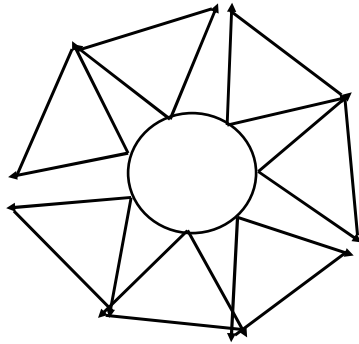

Panorama

- S. E. Chen. Quicktime VR --- An image-based approach to virtual environment navigation. In Proc. SIGGRAPH 95

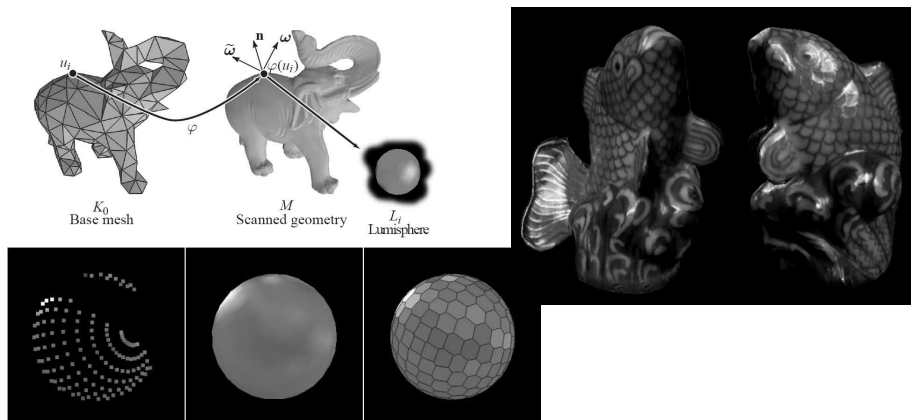http://www.worldserver.com/turk/quicktimevr/SanctusFrancisco1.html
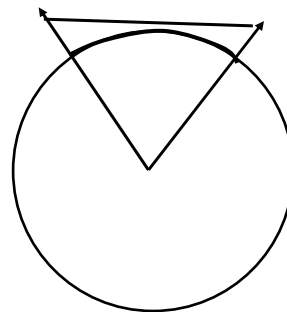
Concentric Mosaic

- H.-Y. Shum and L.-W. He. Rendering with concentric mosaics. SIGGRAPH, pages 299--306, August 1999

Surface Lightfield

- D. Wood, D. Azuma, K. Aldinger, B. Curless, T. Duchamp, D. Salesin, and W. Stuetzle. Surface Light Fields for 3D Photography. In Proc. SIGGRAPH, pages 287--296, July 2000

Plenoptic Sampling
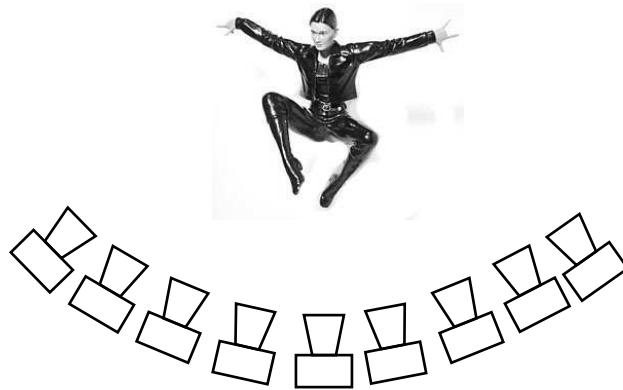
- J. X. Chai, X. Tong, S. C. Chan, and H. Y. Shum, "Plenoptic Sampling," in SIGGRAPH Conf. Proc., 2000, pp. 307--318

Motion Pictures, Animations!

- All those techniques are only good for static objects. 3D
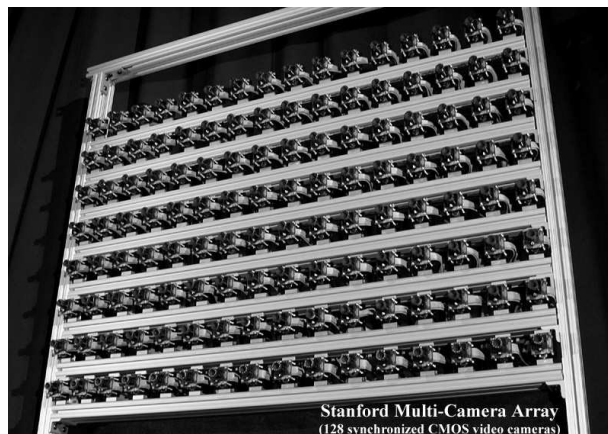- 3D+time = 4D motion pictures
- Remember Matrix?

Effects in Matrix

New Light Field Hardware

- Stanford people built this recently

Stanford Multi-Camera Array
(128 synchronized CMOS video cameras)

Similar hardware

- CMU people built this a long time ago: Virtualized Reality
- EyeVision demo in Superbowl 2001

sb_2_13_p.avi

sb_3_3_p.avi

What can be done in the future?

- Better compression
- Combine IBR with geometry
- Cheaper hardware

Conclusion

- A different approach to render scenes: sample and synthesis.
- Can deal with very complex scenes without modeling it, super realistic, because it is real.
- Have to save a lot of samples, but for movies, that's ok. For games, maybe not.