Image or Object?

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Is this real?

Photo by Patrick Jennings (patrick@synaptic.bc.ca), Copyright 1995, 96, 97 Whistler B. C. Canada
A mental model

Sue Vision
Is this real?

Bob Graphics
Computer Graphics Meets Computer Vision
But, vision technology falls short
… and so does graphics.

Image Based Rendering

Output
Image

Synthetic Camera

Model

Real Scene

Real Cameras

Images + Model

Real Scene

Real Cameras

-or-

Expensive Image Synthesis
Ray

- Constant radiance
  - time is fixed

- 5D
  - 3D position
  - 2D direction

All Rays

- Plenoptic Function
  - all possible images
  - too much stuff!
Line

- Infinite line

Ray

- Discretize

- Distance between 2 rays
  - Which is closer together?

- 4D
  - 2D direction
  - 2D position
What is an image?

- All rays through a point
  - Panorama?

- 2D
  - position of rays has been fixed
  - direction remains
Object

- Light leaving towards “eye”

- 2D
  - just dual of image

Object

- All light leaving object
Object

θ 4D
- 2D position
- 2D direction

Object

θ All images
Object

Too Hard

Plenoptic Function

5D
Rays
Lumigraph

- How to
  - organize
  - capture
  - render

Lumigraph - Organization

- 2D position
- 2D direction

\[ \theta \]
Lumigraph - Organization

- 2D position
- 2D position
- 2 plane parameterization
Lumigraph - Organization

- Hold $s,t$ constant
- Let $u,v$ vary
- An image

Lumigraph - Organization

- Discretization
  - higher res near object
    - if diffuse
    - captures texture
  - lower res away
    - captures directions
Lumigraph - Capture

Idea 1
- Move camera carefully over s,t plane
- Gantry
  - see Lightfield paper

Lumigraph - Capture

Idea 2
- Move camera anywhere
- Rebinning
  - see Lumigraph paper
Lumigraph - Rendering

- For each output pixel
  - determine $s,t,u,v$
  - either
    - find closest discrete RGB
    - interpolate near values
Lumigraph - Rendering

- Nearest
  - closest s
  - closest u
  - draw it

- Blend 16 nearest
  - quadrilinear interpolation

Lumigraph - Rendering

- Depth Correction
  - closest s
  - intersection with “object”
  - best u
  - closest u
Lumigraph - Rendering

- Depth Correction
  - quadralinear interpolation
  - new “closest”
  - like focus

- Fast s,t,u,v finding
  - scanline interpolate
  - texture mapping
  - shear warp
Lumigraph - Rendering

- Fast s,t,u,v finding
  - scanline interpolate
  - texture mapping
  - shear warp

{s1,u1, s2,u2}
Lumigraph - Rendering

- Fast s,t,u,v finding
  - scanline interpolate
  - texture mapping
  - shear warp

Lumigraph - Demo

- Lumigraph
  - Lion, Fruit Bowl, Visible Woman, Path Tracing
Lightfield - Demo

- Digital Michelangelo Project
  - Marc Levoy, Stanford University
  - Lightfield (“night”) assembled by Jon Shade

3D Representations

- Image is 2D
- Lumigraph is 4D
- What happened to 3D?
  - 3D Lumigraph subset
  - Concentric mosaics
### 3D Lumigraph

- **One row of s,t plane**
  - i.e., hold t constant

- Thus s,u,v
- A "row of images"
Concentric Mosaics

- Replace “row” with “circle” of images
Concentric Mosaics

- From above

Concentric Mosaics

- From above
Concentric Mosaics

- Panorama

2.5D Representations

- Image is 2D
- Lumigraph is 4D
- 3D
  - 3D Lumigraph subset
  - Concentric mosaics
- 2.5D
  - Layered Depth Images
  - View Dependent Surfaces
Layered Depth Image

2.5 D?

Layered Depth Image

Layered Depth Image

Rendering from LDI

- Incremental in LDI X and Y
- Guaranteed to be in back-to-front order
Layered Depth Image

- Rendering from LDI
  - Incremental in LDI X and Y
  - Guaranteed to be in back-to-front order
Layered Depth Image

From multiple input images:
- determine geometry
- with user’s help
- view dependent texture

View Dependent Surfaces
View Dependent Surfaces

Summary

- 5D: Plenoptic Function (Ray)
- 4D: Lumigraph / Lightfield
- 3D: Lumigraph Subset
- 3D: Concentric Mosaics
- 2.5D: Layered Depth Image
- 2.5D: View Dependent Models
- 2D: Image
Thanks

- Peter-Pike Sloan (Lumigraph)
- Jonathan Shade (Lightfield, LDI)
- Marc Levoy, Stanford University
  - Michaelangelo data set