Lightfields and Lumigraphs

CS535
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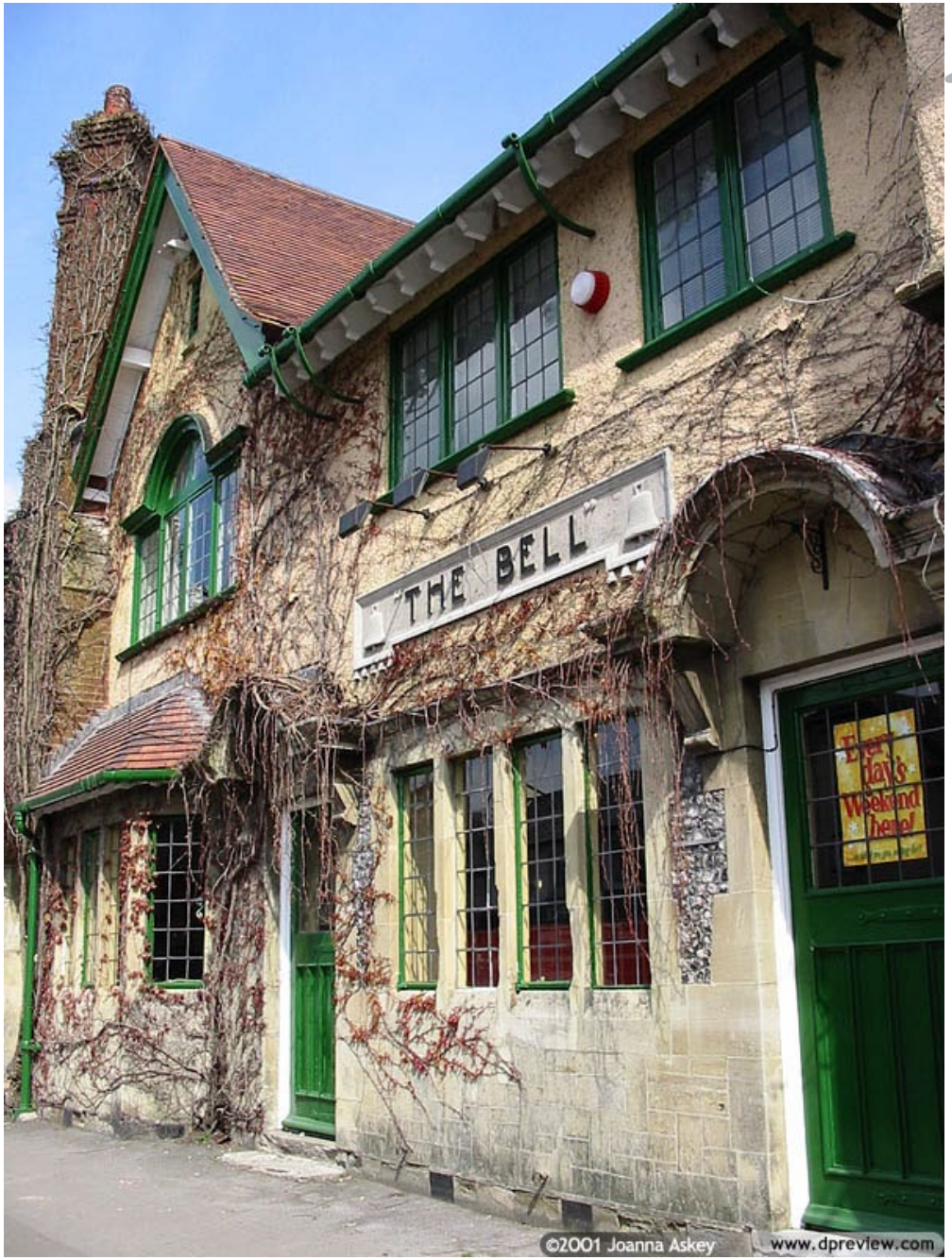
Photographs

- We have tools that acquire and tools that display photographs at a convincing quality level


THE BELL
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TIME
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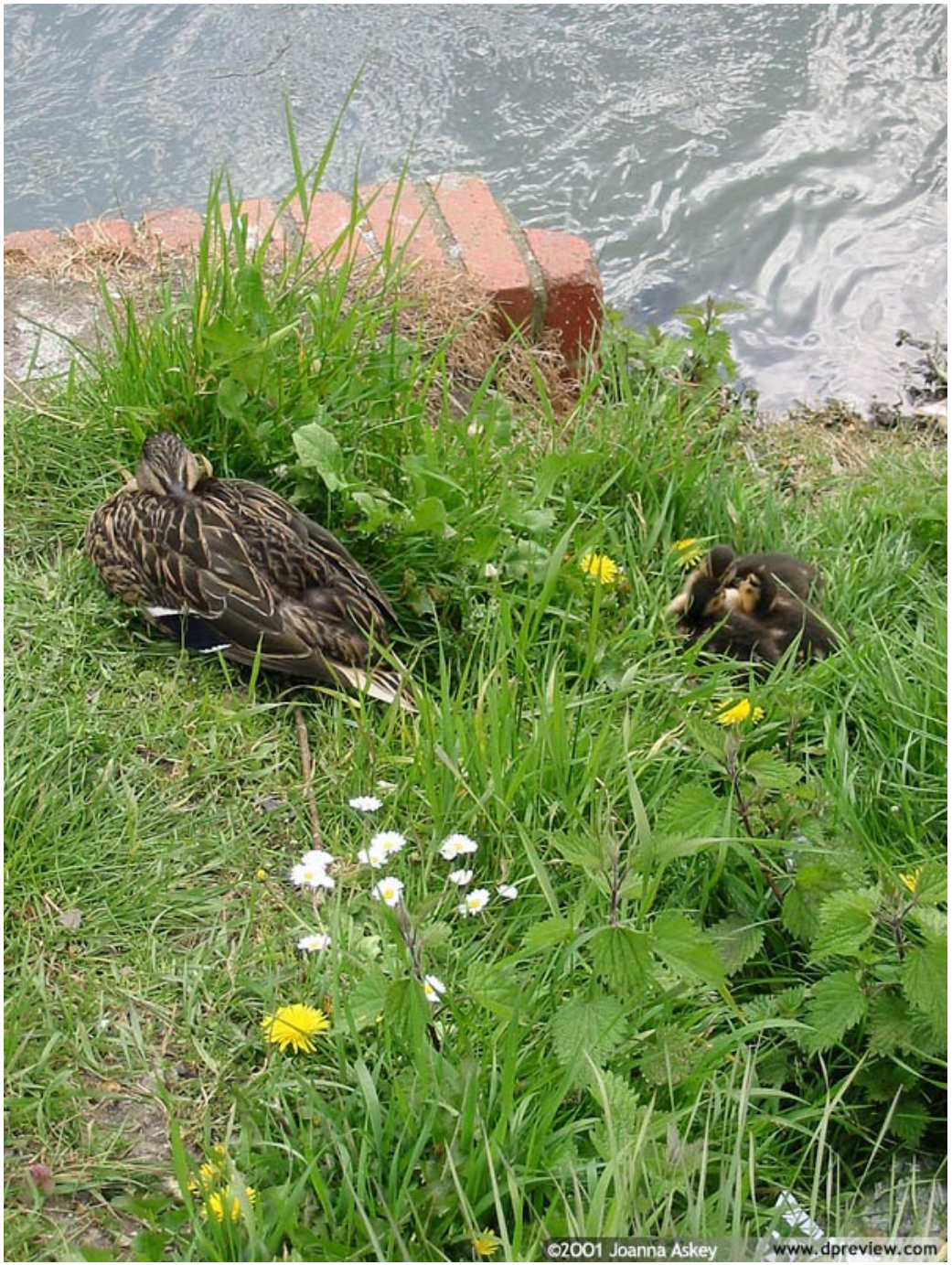
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Online

- 24 MP:
  - https://www.flickr.com/photos/markgaler/39926271622
- Gigapixel:
  - https://360gigapixels.com/360-paris-skyline-gigapixel-photo/

Plenoptic Function

- $P(x, y, z, \phi, \varphi, \lambda, t)$
  - 7D function to describe light intensity passing through every viewpoint, for every direction, for every wavelength, and for every time instant

Plenoptic Function

- “Holodeck” (Star Trek)
- Layered Depth Images
- 3D Image Warping
- View Interpolation
- (Sea of Images)
- Lightfield/Lumigraph
- (Plenoptic Stitching)
- Concentric Mosaics
- Panoramic Images

What is a “light ray through space

Lines, rays, bundles of them, line is 2D+2D, ray is 3D+2D

Light Ray Organization

- Surface-centric
- Viewpoint-centric

or

- Inside-looking-out
- Outside-looking-in

Draw different parameterizations

Reducing Dimensions of the Plenoptic Function

- Use constant frequencies
- Use static environments
- Use open spaces

End-up with two slab-like pic

Light Ray Parameterization

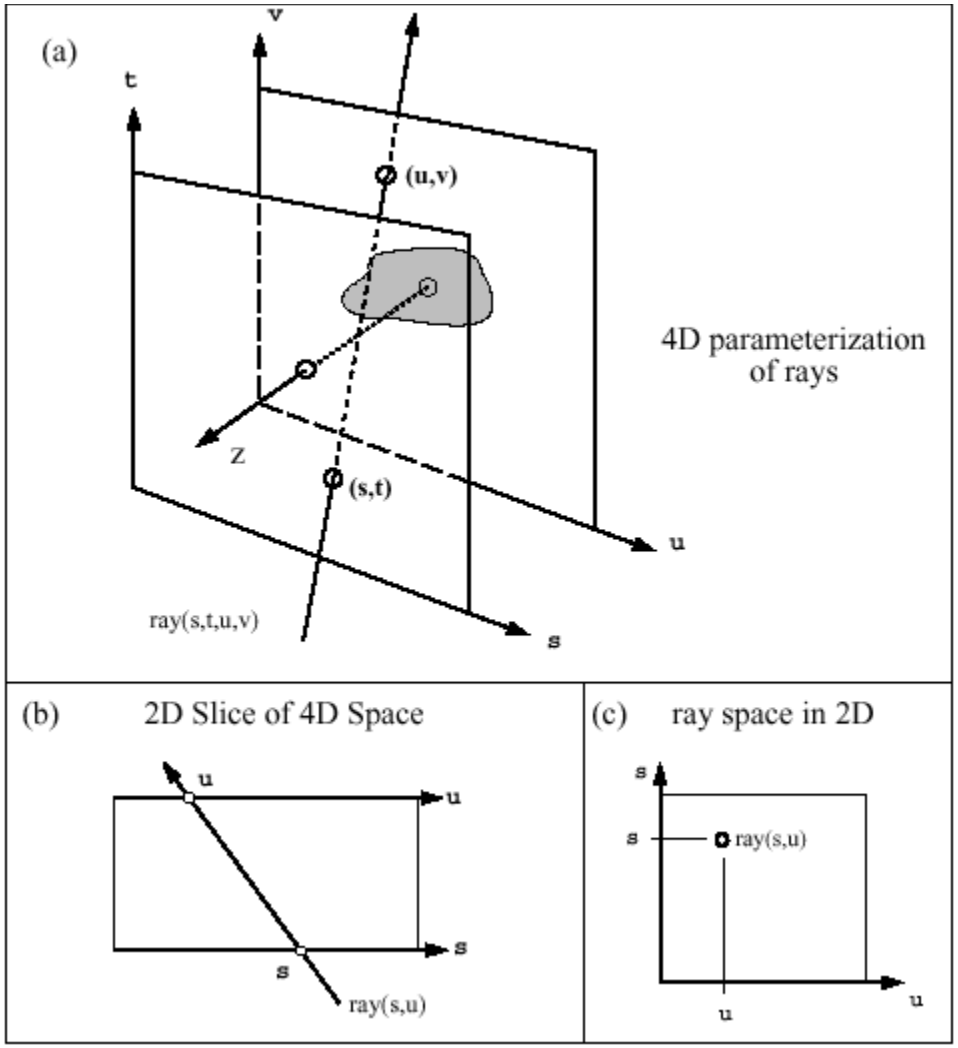
- Random collection of rays
- Two slab representation (s,t,u,v)
- Box representation

Draw each paramet.

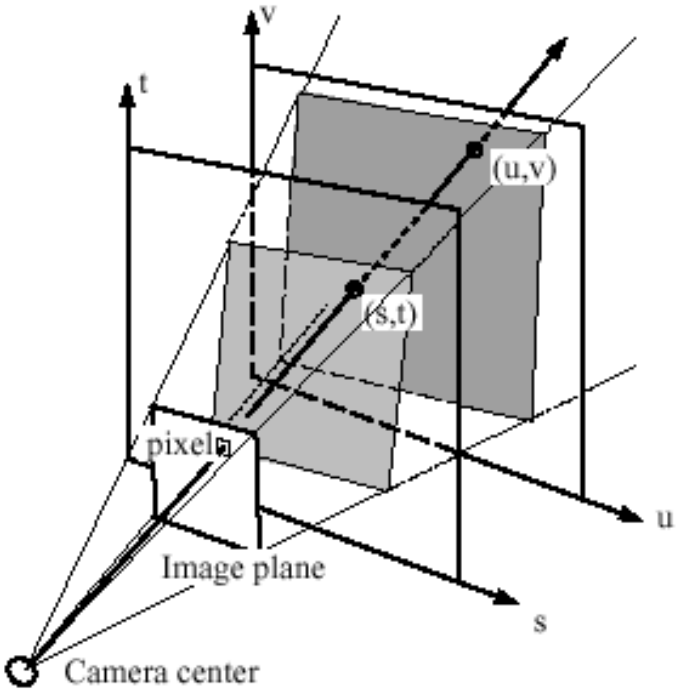
4D Lightfield / Lumigraph

- Demo

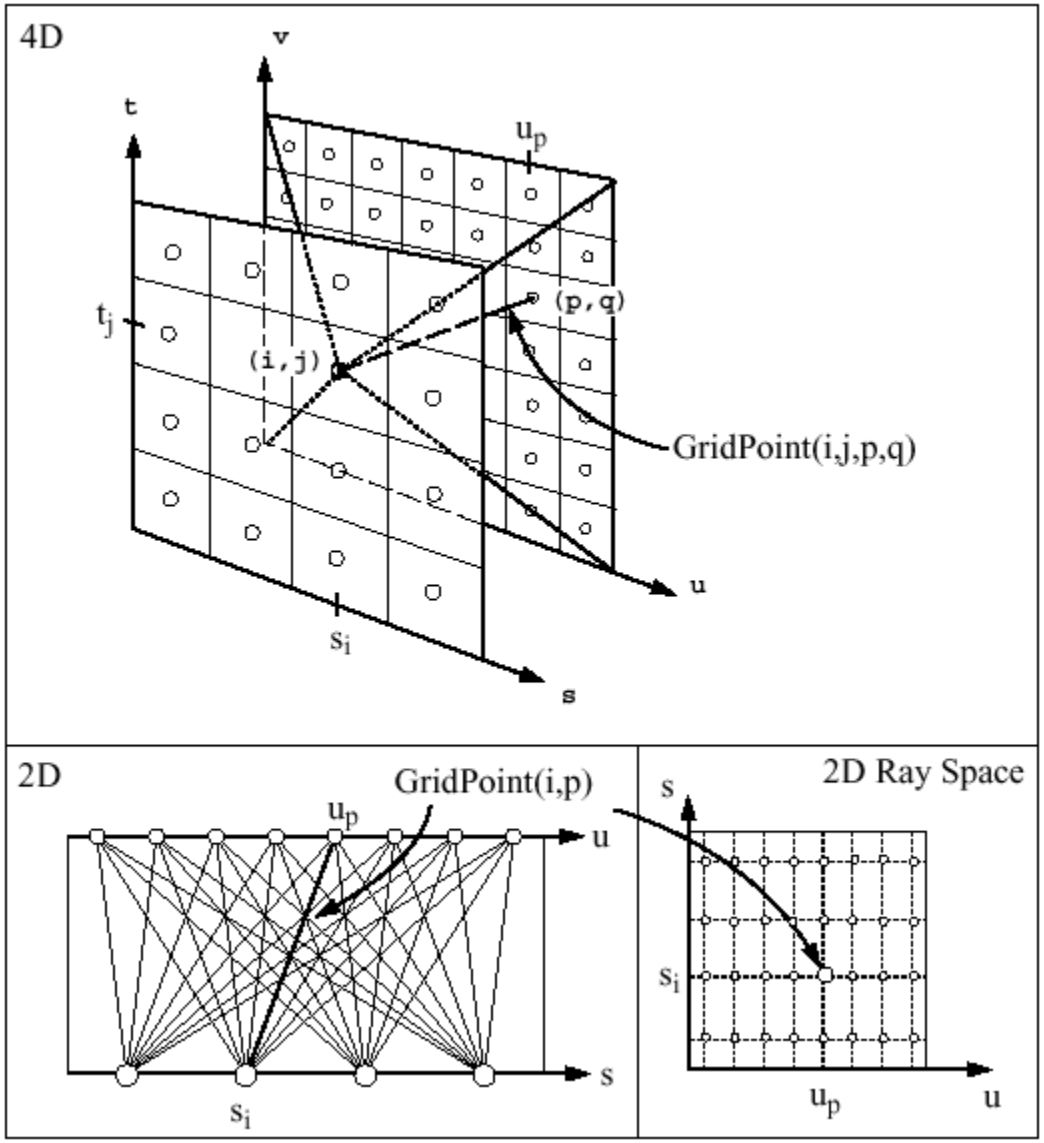
4D Lightfield / Lumigraph



4D Lightfield / Lumigraph

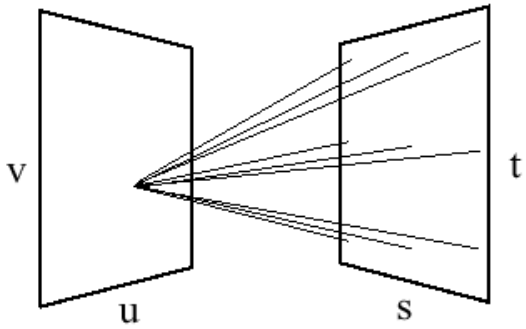


Discreet 4D Lightfield

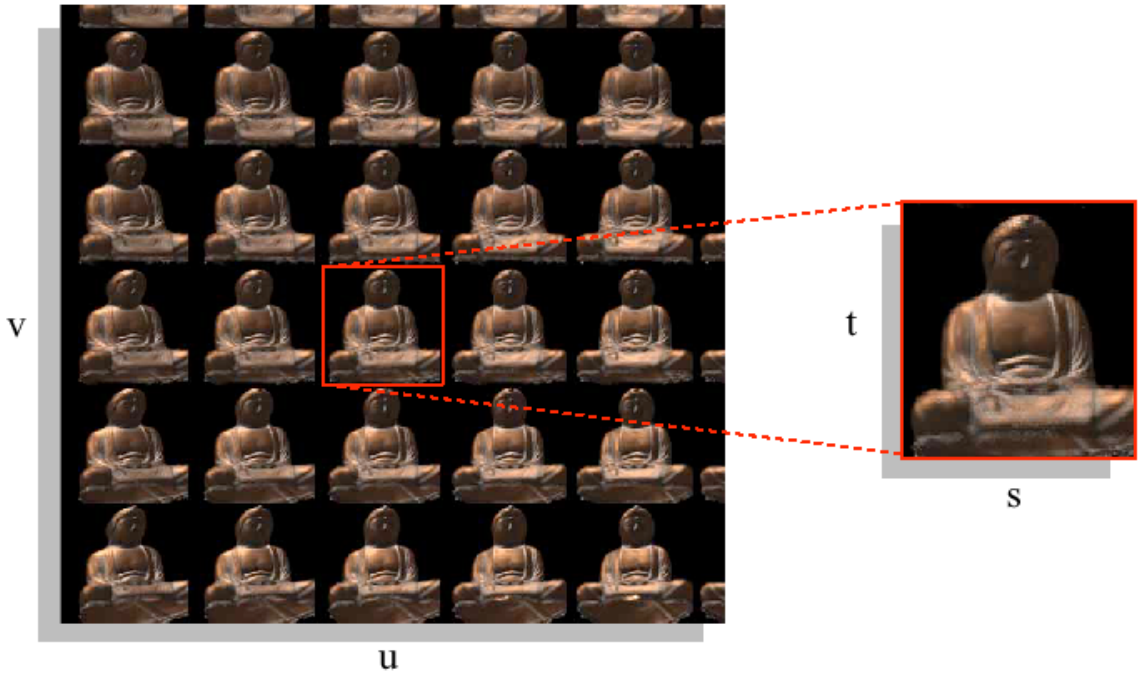


Lightfield

- Set of images with COPs on regular grid

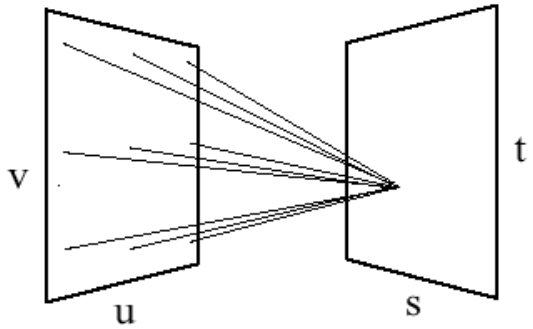


(a)

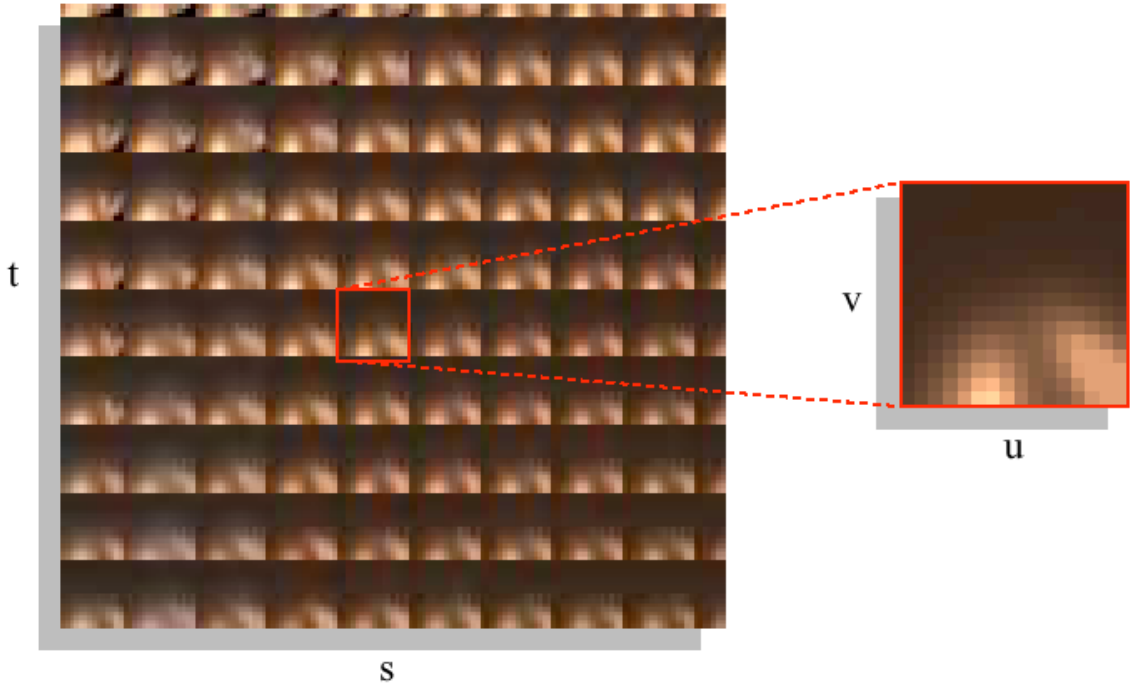


Lightfield

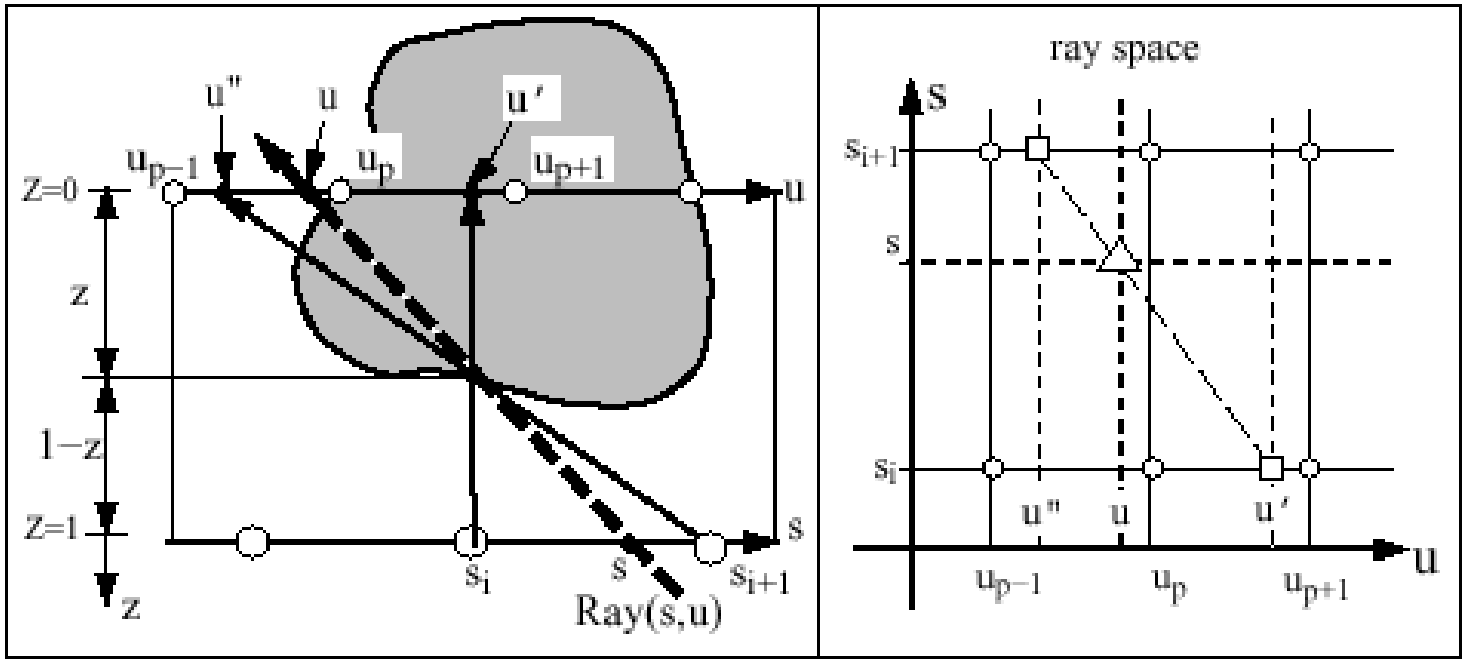
- Set of images of a point seen at various angles



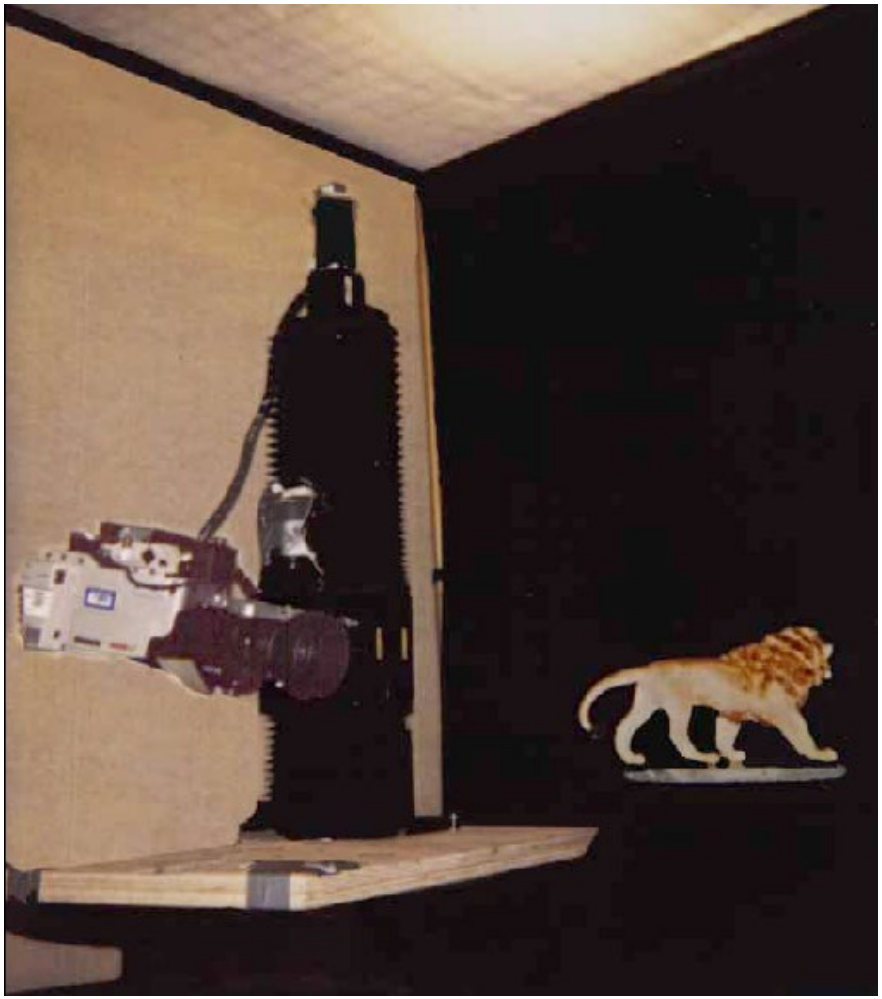
(b)

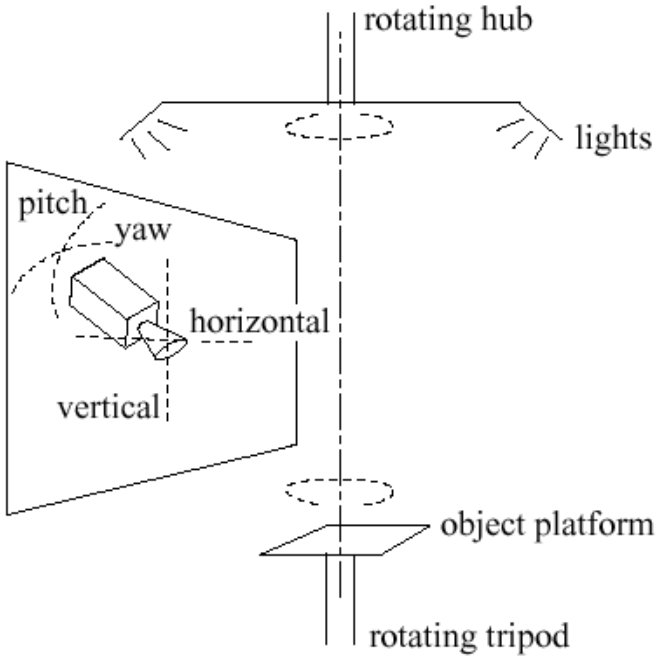


Depth Correction of Rays

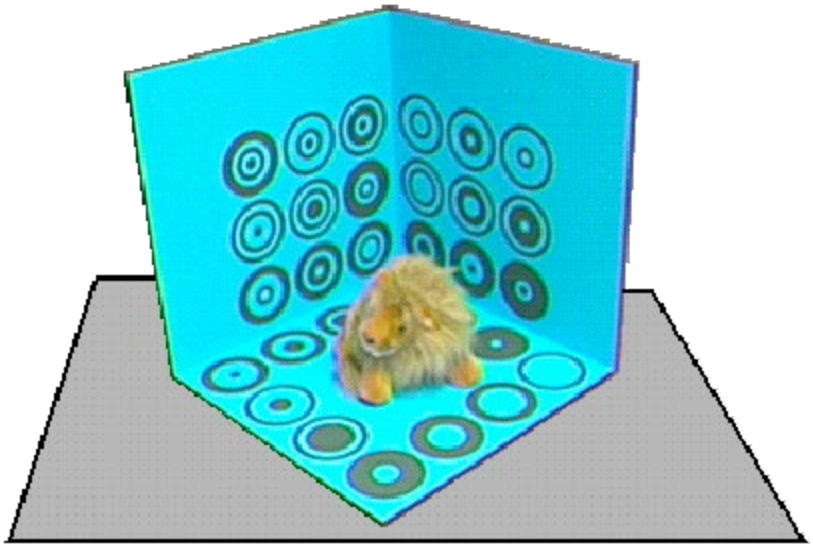


Capture a dense set of photographs



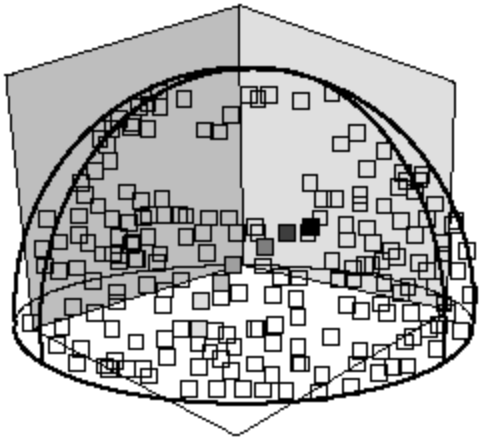


Capturing a sparse set of photographs



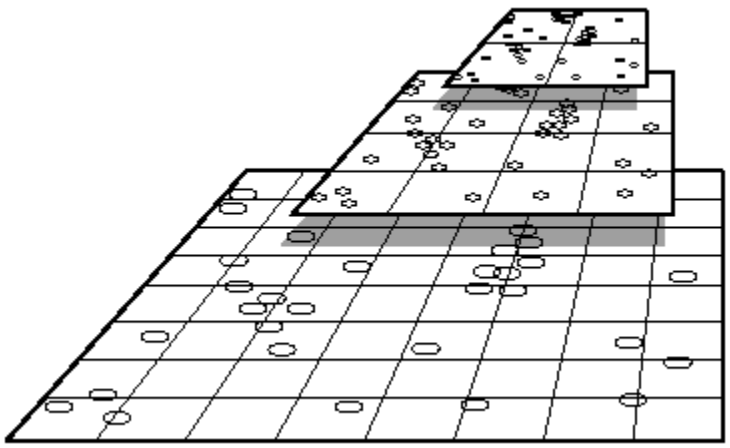
acquisition stage

camera positions



blue screening

Filling in gaps using pull-push algorithm



- Pull phase
  - low res levels are created
  - gaps are shrunk
- Push phase
  - gaps at high res levels are filled using low res levels

Acquiring a 4D Lightfield/Lumigraph

- Capture (many images)
- Organize into a (s,t,u,v) parameterization
  - Do not “need” to resample the pixels
  - Use (linear) interpolation to extract an arbitrary ray/line
  - Optionally compress/decompress data
  - Interactively extract rays/lines to create a visual representation

Limitations of a Lightfield/Lumigraph

- Resolution
- High storage requirement
- Difficult capture (?)
- No geometry
  - Cannot add new geometry and (easily) do occlusion and re-illumination

Update

- Google, AR/VR, and Lightfields:
  - https://www.youtube.com/watch?v=lRK0MtIyj0U
- Seeing through things with lightfields:
  - http://graphics.stanford.edu/papers/plane+parallax_calib/
- Microscope Lightfields
  - http://graphics.stanford.edu/projects/lfmicroscope/
- Stanford New Lightfield Archive
  - http://graphics.stanford.edu/data/LF/lfs.html
    - e.g.,"http://graphics.stanford.edu/data/LF/chess_lf/preview.zip&zoom=1"
  - Old: http://graphics.stanford.edu/software/lightpack/lifs.html

Deep Learning Lightfields

- Learning-Based View Synthesis for Light Field Cameras
  - https://www.youtube.com/watch?v=RCD2B5o1K8U
- Light Field Video Capture Using a Learning-Based Hybrid Imaging System
  - https://www.youtube.com/watch?v=TqVKcssYfAo