COS526: Advanced Computer Graphics

Tom Funkhouser
Fall 2012

Slides from Durand, Efros, Finkelstein, Freeman, Lazebnik, Rusinkiewicz, Seitz

Background

Image Processing
- Basic signal processing
- Filtering, resampling, warping, ...

Rendering
- Polygon rendering pipeline
- Basic ray tracing

Modeling
- Basic 3D object representations
- Polygonal meshes

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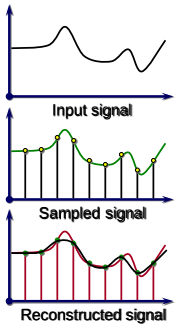

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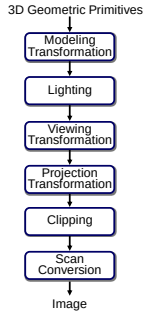

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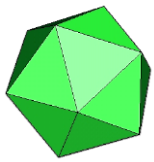

CS526 Syllabus

Computational Photography
- Image composition
- Texture synthesis
- Image-based rendering

Geometric Representations
- Multiresolution meshes
- Laplacian meshes
- Point representations

Global illumination
- Photon mapping
- Monte Carlo path tracing
- Reflectance

Other advanced topics
- TBA

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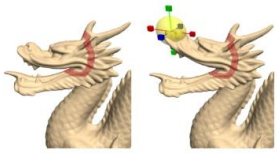

Sorkine

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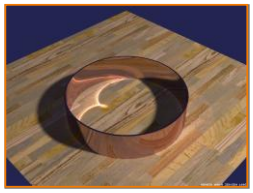

Jensen

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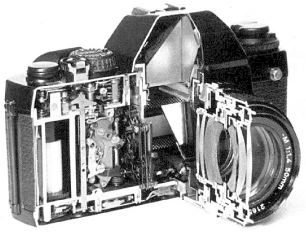
Coursework

4 Short written exercises

3 Programming assignments

Final project

Computational Photography



What is Computational Photography?

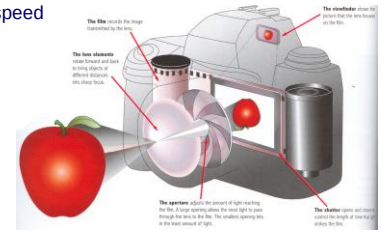
Definition 1: The use of computational techniques to overcome limitations of traditional photography

Slide by Lazebnik

Traditional Photography

Camera controls:

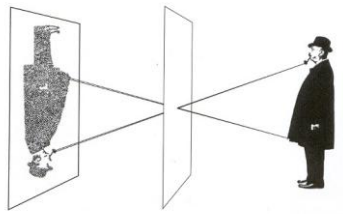
- Viewpoint
- Lens
- Shutter speed
- Aperture
- Sensor
- Flash



Slide by Freeman and Durand

Traditional Photography

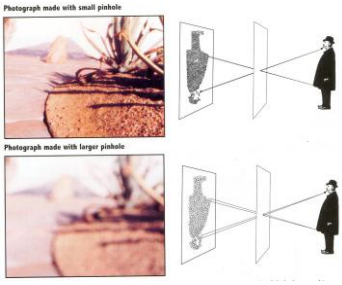
Pin-hole camera:



From Photography, London et al.

Traditional Photography

Pin-hole size?

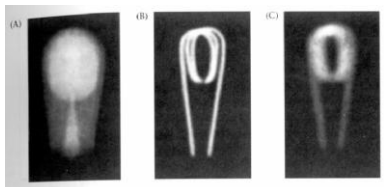


From Photography, London et al.

Traditional Photography

Pin-hole size?

- Smaller produces sharper image (up to limits of diffraction)
- Larger lets in more light

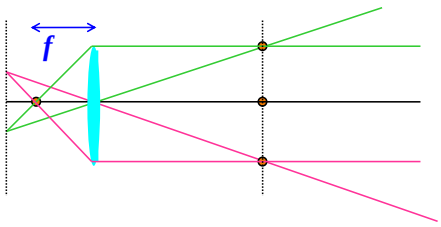


2.18 DIFFRACTION LIMITS THE QUALITY OF PINHOLE OPTICS. These three images of a bulb filament were made using pinholes with decreasing size. (A) When the pinhole is relatively large, the image rays are not properly converged, and the image is blurred. (B) Reducing the size of the pinhole improves the focus. (C) Reducing the size of the pinhole further worsens the focus, due to diffraction. From Ruechardt, 1958.

From Wandell

Traditional Photography

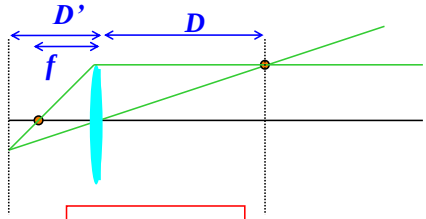
Lenses



Slide by Freeman and Durand

Traditional Photography

Lenses

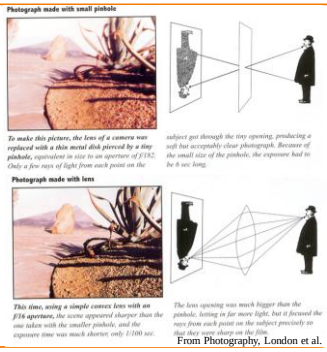


$$\frac{1}{D'} + \frac{1}{D} = \frac{1}{f}$$

Slide by Freeman and Durand

Traditional Photography

Lenses
+ More light
+ Sharp …
- at one depth



From Photography, London et al.

Limitations of traditional photography

Single depth of focus

Slide by Lazebnik

Limitations of traditional photography

Limited resolution

Slide by Lazebnik

Limitations of traditional photography

Bad color / no color

Slide by Lazebnik

Limitations of traditional photography

Limited dynamic range

Slide by Lazebnik

Limitations of traditional photography

Single viewpoint

NFL

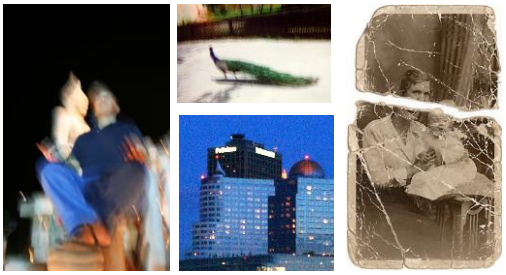
Limitations of traditional photography

Static scene

Slide by Lazebnik

Limitations of traditional photography

Blur, camera shake, noise, damage



Slide by Lazebnik

Limitations of traditional photography

Unfortunate expressions

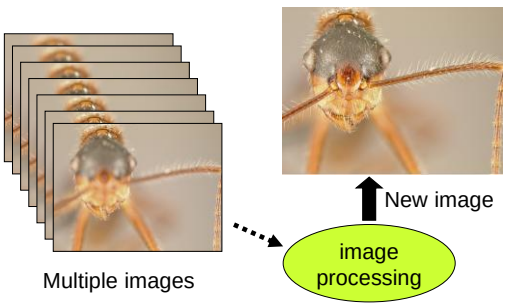
Slide by Lazebnik

Limitations of traditional photography

Unwanted objects

Slide by Lazebnik

Computational Photography



Hasinoff et al. 2009

Computational Photography

Example: high-dynamic range

Debevec

Computational Photography

Example: deblurring

Fergus

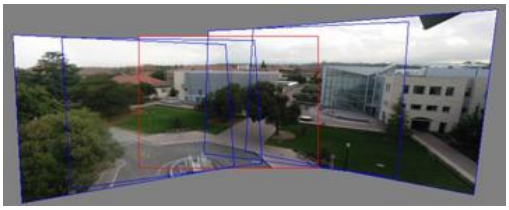
Computational Photography

Example: super-resolution

Hertzmann

Computational Photography

Example: creating panorama



Computational Photography

Example: gigapixel images

Kopf

Computational Photography

Example: color harmonization

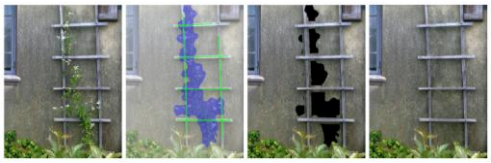
Cohen-Or

Computational Photography

Example: background replacement

Computational Photography

Example: image completion



Sun

Computational Photography

Example: image completion

Efros

Computational Photography

Example: tour into the picture

Horry

Computational Photography

Example: photo tourism

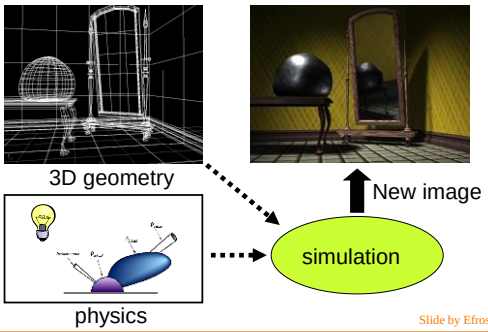
Snavely

What is Computational Photography?

Definition 2: the use of photographic imagery to overcome the limitations of computer graphics

Slide by Lazebnik

Traditional Computer Graphics



Slide by Efros

Limitations of Computer Graphics

Amazingly real … but sterile, lifeless, *futuristic*

Slide by Efros

Limitations of Computer Graphics

Pavia, Italy

Slide by Efros

Limitations of Computer Graphics

River Cherwell, Oxford

Slide by Efros

Limitations of Computer Graphics

"Final Fantasy"

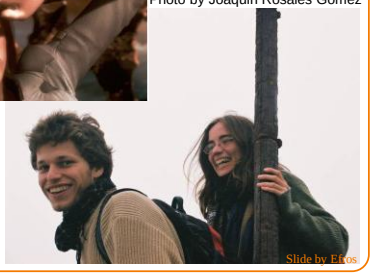
On the Tube, London

Slide by Efros

Limitations of Computer Graphics

"Final Fantasy"

Photo by Joaquin Rosales Gomez

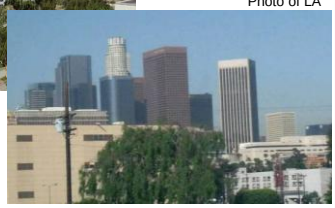


Slide by Efros

Limitations of Computer Graphics

Virtual LA (SGI)

Photo of LA



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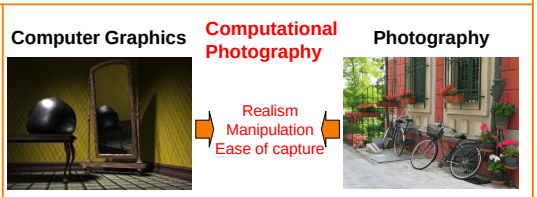

+ easy to manipulate objects/viewpoint
- hard to acquire/create
- hard to make realistic

- hard to manipulate objects/viewpoint
+ easy to acquire
+ instantly realistic

Slide by Efros

Next Time

Texture synthesis