COS526: Advanced Computer Graphics

Tom Funkhouser Fall 2010

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

Background

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

Rendering
- Polygon rendering pipeline
- Ray tracing

Modeling
- Basic 3D object representations
- Polygonal meshes

Background

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Rendering
- Polygon rendering pipeline
- OpenGL

Modeling
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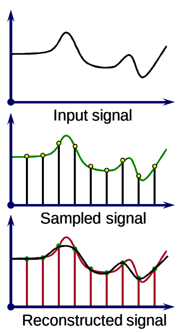
- Polygonal meshes



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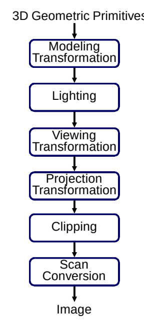

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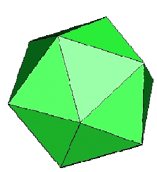

CS526 Syllabus

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

Geometric Representations
- Laplacian meshes
- Multiresolution meshes
- Point representations

Shape Analysis
- Matching
- Segmentation
- Deformation

Global illumination
- Reflectance
- Simulating light transport

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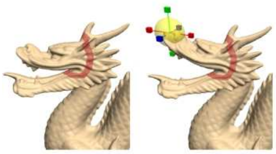

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Sorkine

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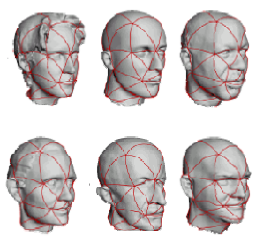

Shape Analysis
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Praun

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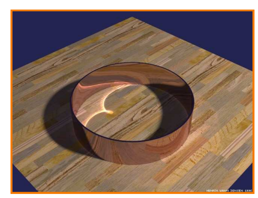

Shape Analysis
- Matching
- Segmentation
- Deformation

Global illumination
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- Simulating light transport

Jensen

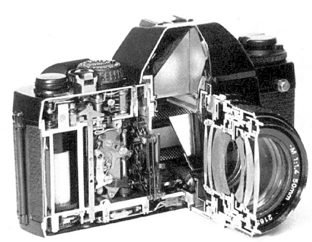
Coursework

4 Short written exercises

3 Programming assignments

Final project

Computational Photography

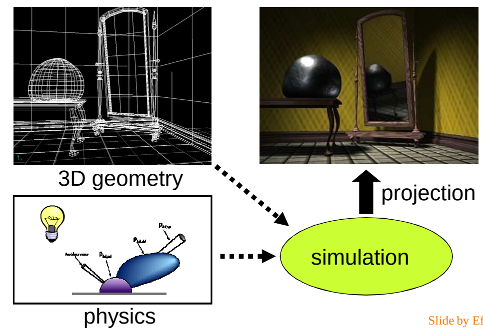


What is Computational Photography?

Definition 1: the use of photographic imagery to create content for computer graphics

Slide by Lazebnik

Traditional Computer Graphics



Slide by Efros

State of the Art

Amazingly real … but sterile, lifeless, *futuristic*

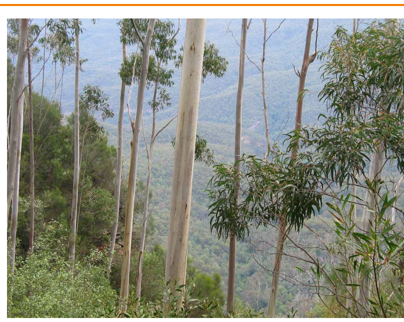
Slide by Efros

The richness of our everyday world

Pavia, Italy

Slide by Efros

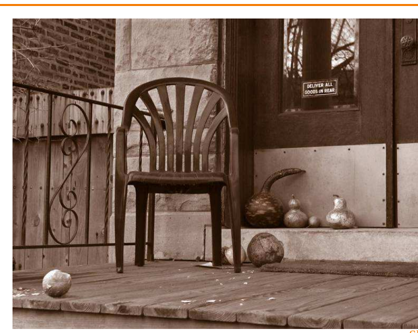
Beauty in complexity



Blue Mountains, Australia

Slide by Efros

Which parts are hard to model?



Slide by Efros

People

"Final Fantasy"

On the Tube, London

Slide by Efros

Faces / Hair

"Final Fantasy"

Photo by Joaquin Rosales Gomez

Slide by Efros

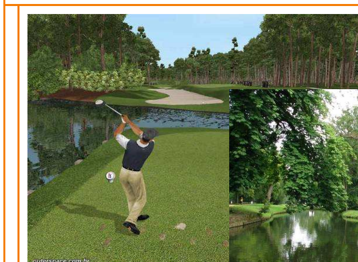
Urban Scenes

Virtual LA (SGI)

Photo of LA

Slide by Efros

Nature

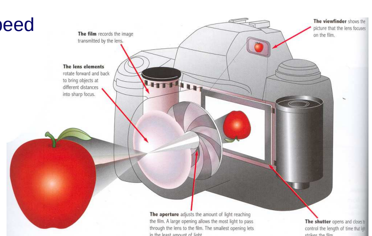


River Cherwell, Oxford

Slide by Efros

Traditional Photography

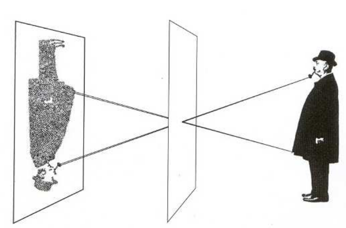
Camera controls:
- Viewpoint
- Lens
- Shutter speed
- Aperture
- Sensor



Slide by Freeman and Durand

Traditional Photography

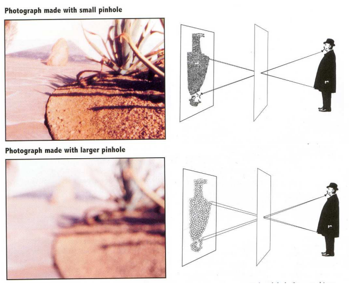
Pin-hole camera:



From Photography, London et al.

Traditional Photography

Pin-hole size?

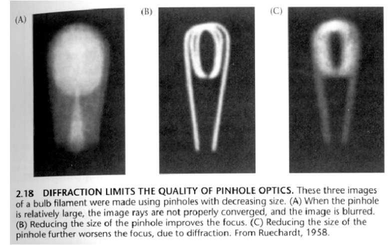


From Photography, London et al.

Traditional Photography

Pin-hole size?

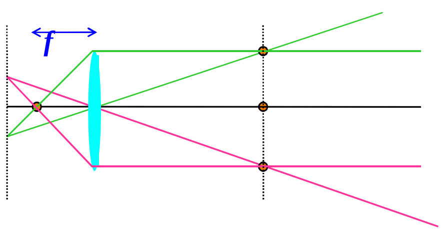
- Smaller produces sharper image (up to limits of diffraction)
- Larger lets in more light



From Wandell

Traditional Photography

Lenses



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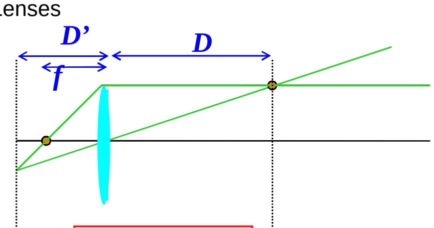


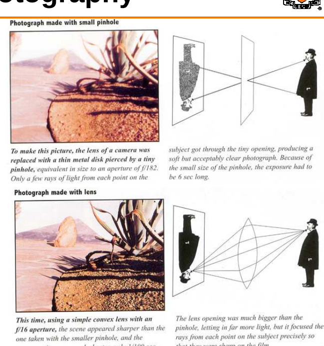
$$\frac{1}{D'} + \frac{1}{D} = \frac{1}{f}$$

Slide by Freeman and Durand

Traditional Photography

Lenses

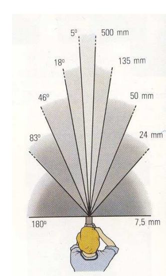
- \+ More light
- \+ Sharp …
- \- at one depth



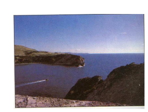
From Photography, London et al.

Traditional Photography

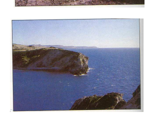
Effect of different focal lengths



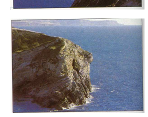
24mm



50mm

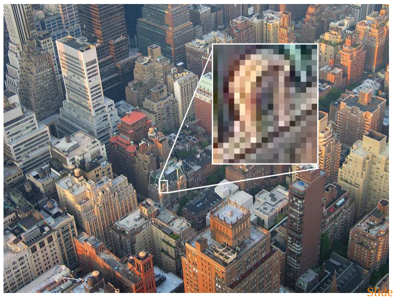


135mm



Limitations of traditional photography

Limited resolution



Slide by Lazebnik

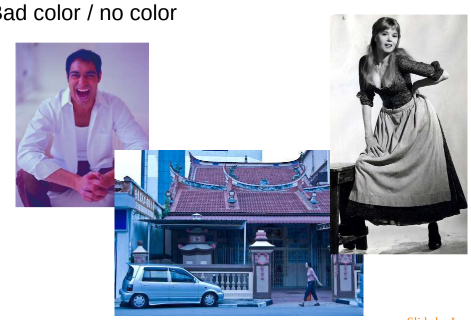
Limitations of traditional photography

Single depth of focus

Slide by Lazebnik

Limitations of traditional photography

Bad color / no color



Slide by Lazebnik

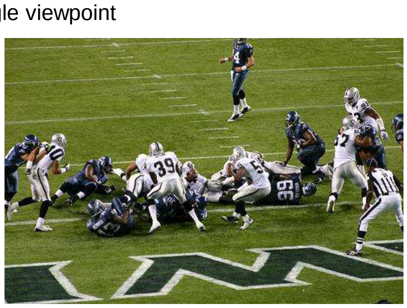
Limitations of traditional photography

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

The Realism Spectrum

Computer Graphics	Computational Photography	Photography
	Realism Manipulation Ease of capture	
+ 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

What is Computational Photography?

Definition 1: the use of photographic imagery to create graphics content

Definition 2: The use of computational techniques to overcome limitations of traditional photography

Slide by Lazebnik

Computational Photography

Example: high-dynamic range

Debevec

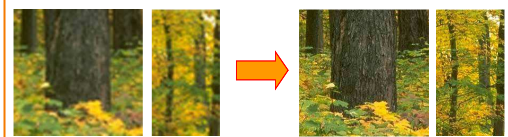
Computational Photography

Example: deblurring

Fergus

Computational Photography

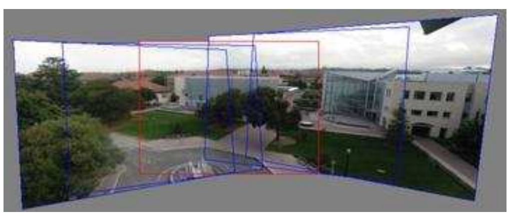
Example: super-resolution



Hertzmann

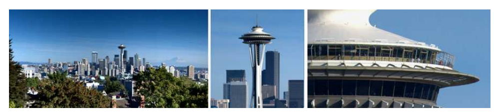
Computational Photography

Example: creating panorama



Computational Photography

Example: gigapixel images



Kopf

Computational Photography

Example: color harmonization

Cohen-Or

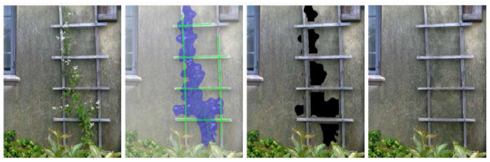
Computational Photography

Example: background replacement

(a) input (b) result 1 result 2

Computational Photography

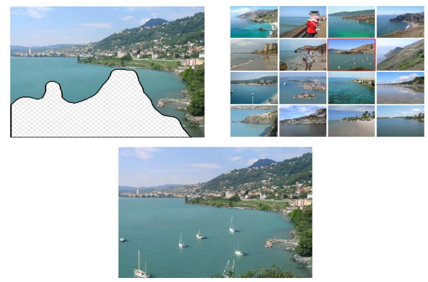
Example: image completion



Sun

Computational Photography

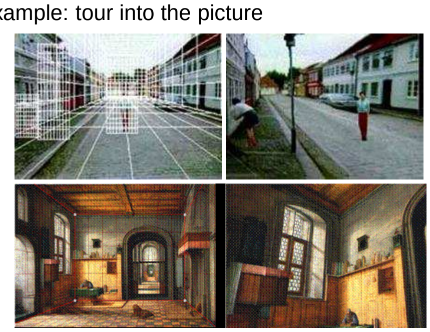
Example: image completion



Efros

Computational Photography

Example: tour into the picture



Horry

Computational Photography

Example: photo tourism

Snavely

Next Time

Texture synthesis