Computational Photography

What is Computational Photography?
Definition 1: the use of photographic imagery to create content for computer graphics

Traditional Computer Graphics

State of the Art
Amazingly real … but sterile, lifeless, futuristic

The richness of our everyday world

Beauty in complexity
Pavia, Italy
Blue Mountains, Australia
What’s so hard to model?

Urban Scenes

Nature

People

Faces / Hair

What is Computational Photography?
Definition 2: The use of computational techniques to overcome limitations of traditional photography
Traditional Photography

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

Traditional Photography

Pin-hole camera:

Traditional Photography

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

Traditional Photography

Lenses

\[ \frac{1}{D} + \frac{1}{D'} = \frac{1}{f} \]

Traditional Photography

Lenses

Slide by Freeman and Durand

Slide by Freeman and Durand

From Photography, London et al.

From Freeman, London et al.

From Photography, London et al.
**Traditional Photography**

- Lenses
  - + More light
  - + Sharp ...
  - - at one depth

**Limitations of traditional photography**

- Single depth of focus

**Limitations of traditional photography**

- Limited resolution

**Limitations of traditional photography**

- Bad color / no color

**Limitations of traditional photography**

- Limited dynamic range

**Limitations of traditional photography**

- Single viewpoint
Limitations of traditional photography

Static scene

Blur, camera shake, noise, damage

Unfortunate expressions

Unwanted objects

What is Computational Photography?

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

Computational 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
Computational Photography
Example: high-dynamic range

Debevec

Computational Photography
Example: deblurring

Debevec

Computational Photography
Example: super-resolution

Debevec

Computational Photography
Example: creating panorama

Debevec

Computational Photography
Example: gigapixel images

Kopf

Computational Photography
Example: color harmonization

Cohen-Or
Example: background replacement

Preliminary results by Sashi Kumar Penta

Example: image completion

Sun et al. (2005)

Example: image completion

Efros

Example: tour into the picture

Horry

Example: photo tourism

Snavely

Next...

Texture synthesis