Computational Photography

* Study the basics of computation and its impact on the entire workflow of photography, from capturing, manipulating and collaborating on, and sharing photographs.

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What is Computational Photography? (Part 1 of 3)

* Computational Photography and its comparison to traditional photography and digital photography.

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1. What is Computational Photography?

2. Fundamental elements of computational photography

What is Photography?

Photography is the science, art and practice of creating durable images by recording light or other electromagnetic radiation, either electronically by means of an image sensor, or chemically by means of a light-sensitive material such as photographic film.[1]

Typically, a lens is used to focus the light reflected or emitted from objects into a real image on the light-sensitive surface inside a camera during a timed exposure. With an electronic image sensor, this produces an electrical charge at each pixel, which is electronically processed and stored in a digital image file for subsequent display or processing. The result with photographic emulsion is an invisible latent image, which is later chemically "developed" into a visible image, either negative or positive depending on the purpose of the photographic material and the method of processing. A negative image on film is traditionally used to photographically create a positive image on a paper base, known as a print, either by using an enlarger or by contact printing.

Lens and mounting of a large-format camera

Photography is employed in many fields of science, manufacturing (e.g. photolithography) and business, as well as its more direct uses for art, recreational purposes, and mass communication.

http://en.wikipedia.org/wiki/Photography?

(Accessed, December 2014)

What is Computational Photography?

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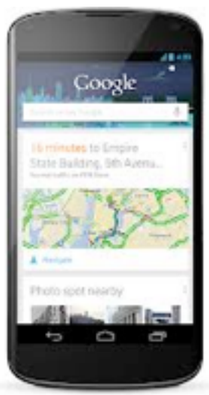
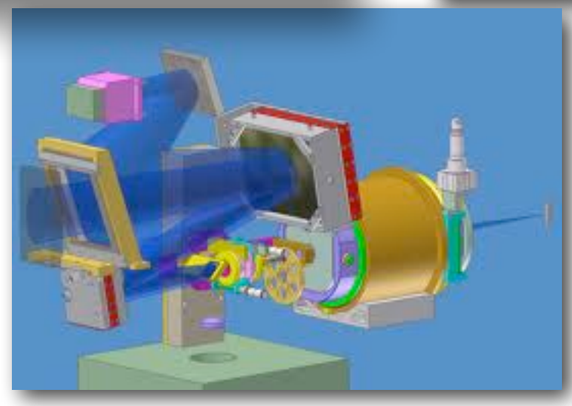
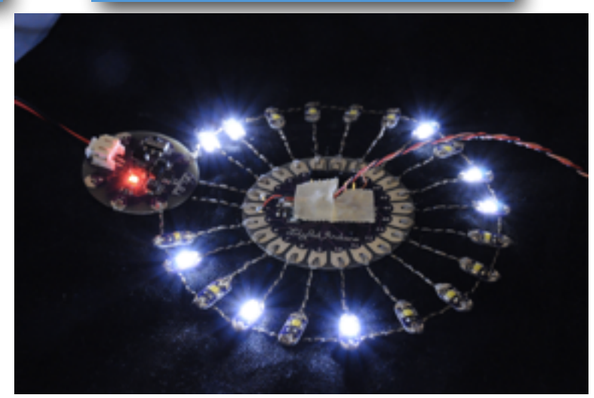
Camera 2.0
(Frankencamera)
Adams et al., 2010



Computational Photography Combines

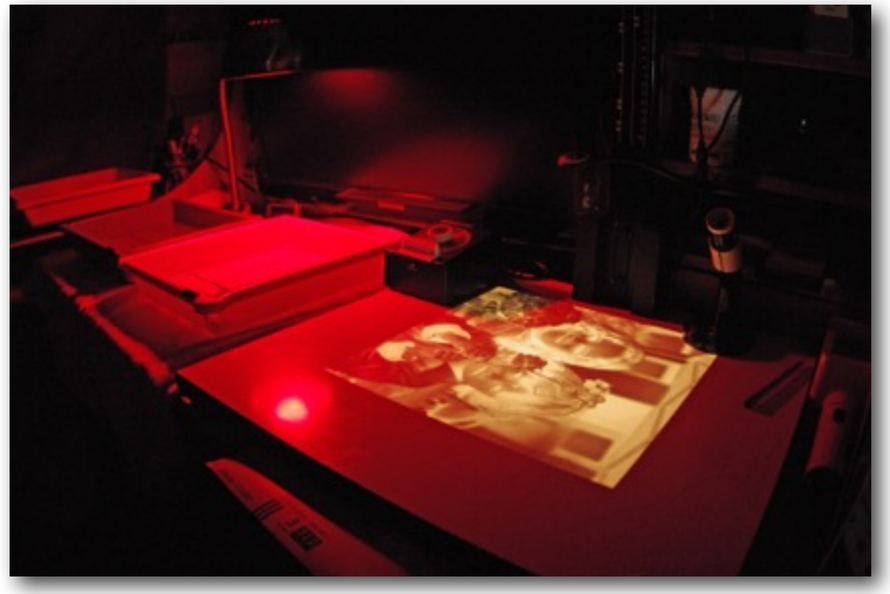
- Computing
- Digital Sensors
- Modern Optics
- Actuators
- Smart Lights
- To "escape" the limitations of traditional film cameras





Limitations of Traditional Film Cameras

* Debatable, but . . .
  * Chemicals / Darkroom
* 12-24-36 pictures / roll
* No instant gratification
* Sensitivity of film



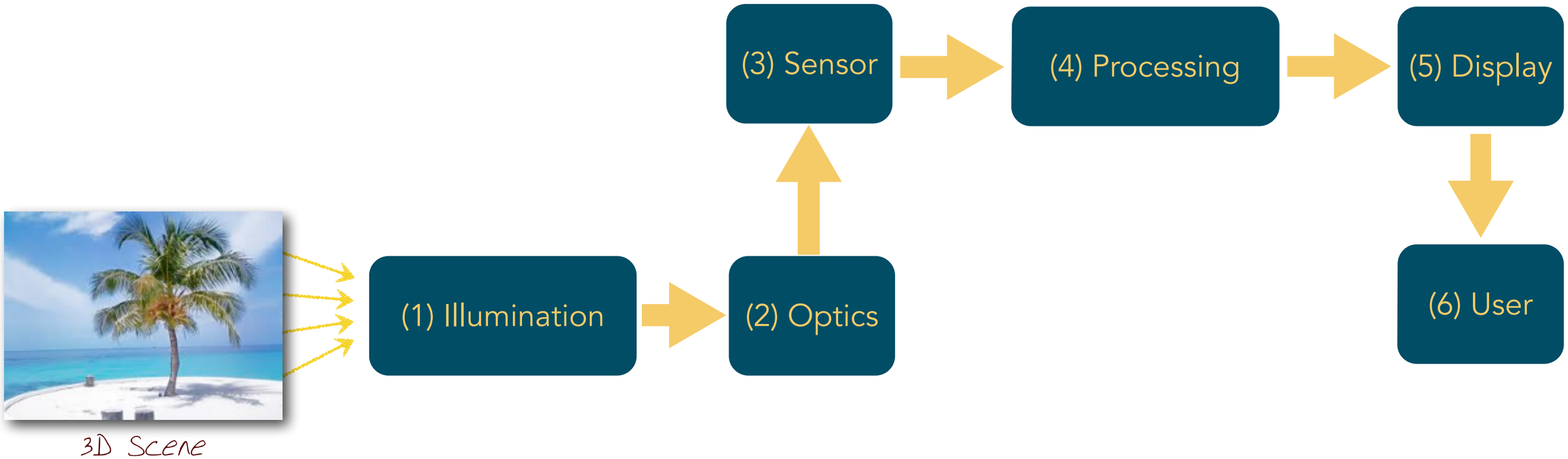
Computational Photography Enables Imaging

* Unbounded Dynamic Range
* Variable
  * Focus
  * Depth of Field
  * Resolution
  * Lighting
  * Reflectance

* Supports and Enhances the Medium of Photography

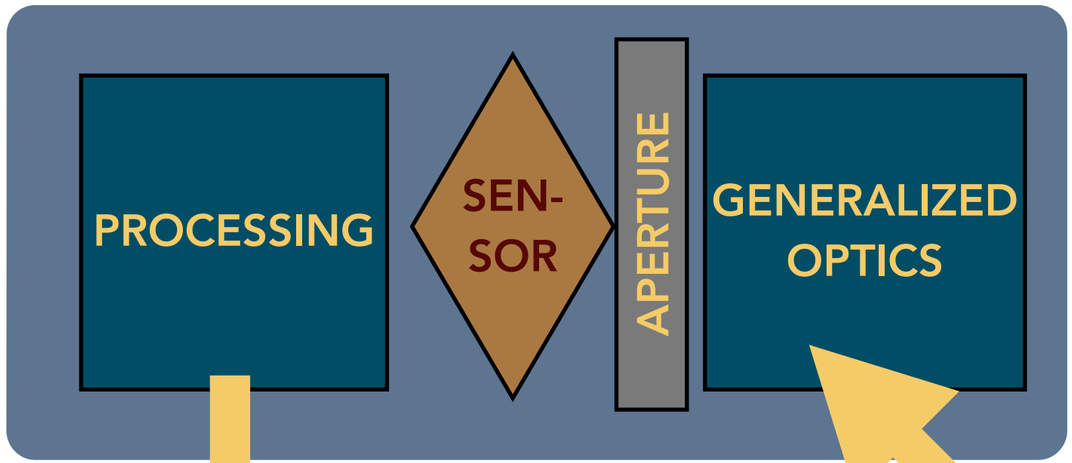
Elements of Computational Photography

Computation can be embedded in all aspects of these elements to support photography



Computational Photography (Rays to Pixels)

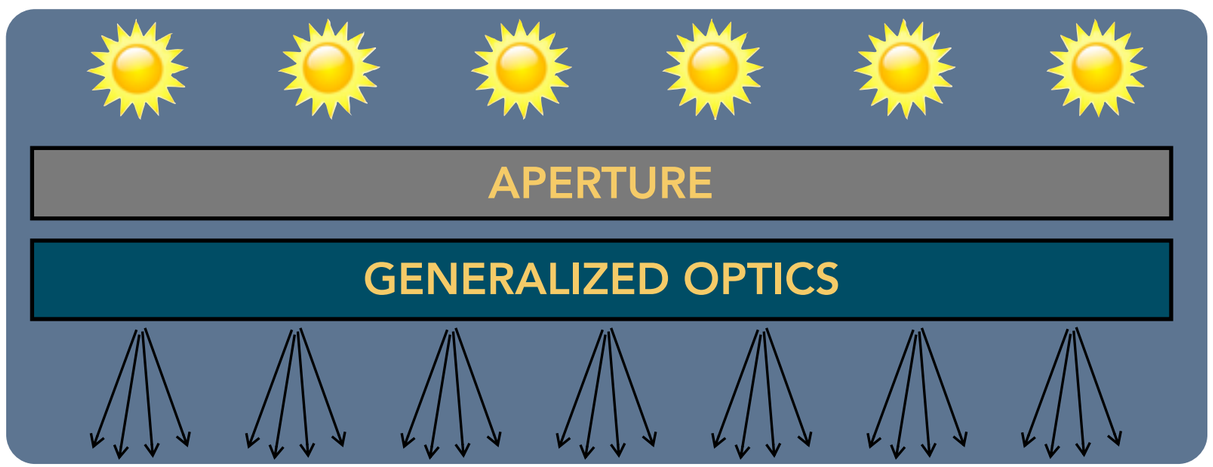
Novel Camera



Pixels

Rays

Novel Illumination



Rays

3D Scene

Schematic motivated by Nayar and Raskar

Summary

1. Computational Photography "computationalizes" the entire workflow of photography
2. Rays to pixels
3. Generalizing control (actuation) of elements: illumination, optics/aperture, sensor, processing, display, and sharing
4. "Enhances" the photographic process

Next Class

* Look at a specific example of Computational Photography
* A deeper dive, with brief details about how "computationalizing" the different elements of Computational Photography can generate novel images

Credits

* Adams, Talvala, Park, Jacobs, Ajdin, Gelfand, Dolson, Vaquero, Baek, Tico, Lensch, Matusik, Pulli, Horowitz, Levoy (2010) "The Frankencamera: An Experimental Platform for Computational Photography", In SIGGRAPH 2010
* Some schematics motivated by Shree Nayar, Ramesh Raskar, and Jack Tumblin

Computational Photography

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