Georgia Institute of Technology

Computational Photography

Dr. Irfan Essa
Professor
School of Interactive Computing

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 2)

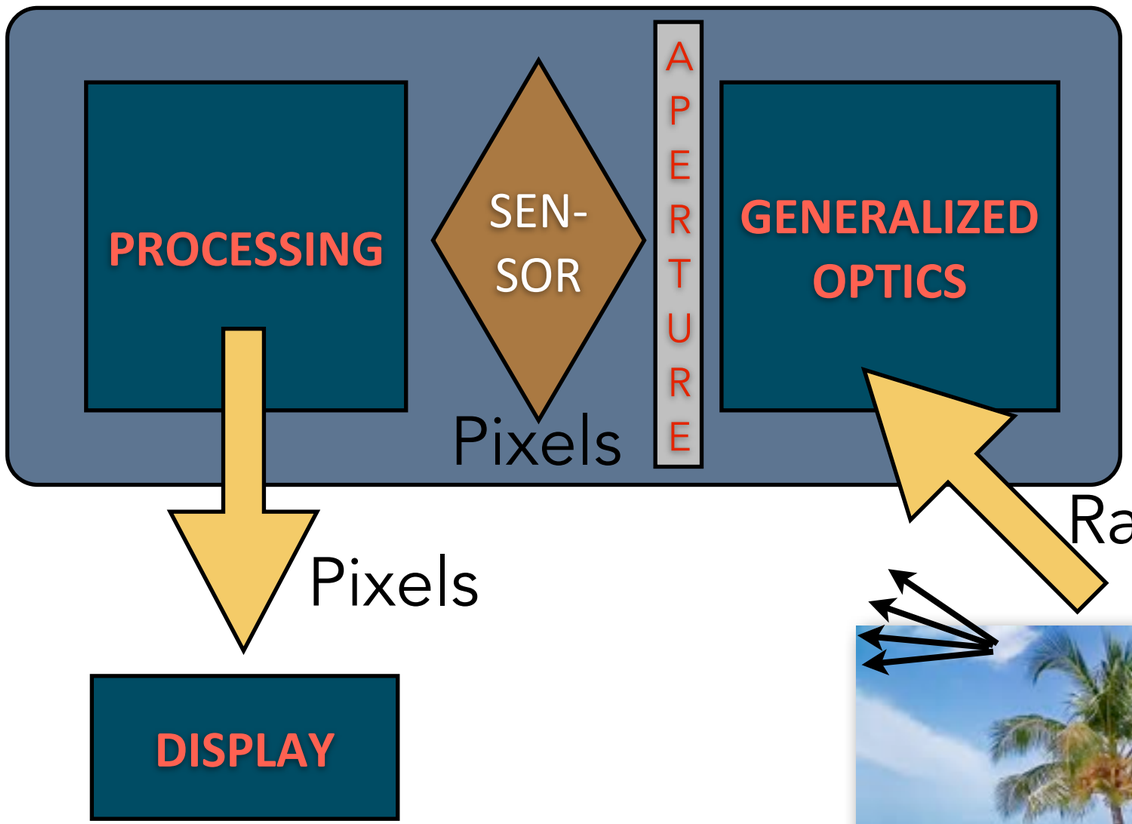
Dual Photography, a specific example of the Computational Photography

Lesson Objectives

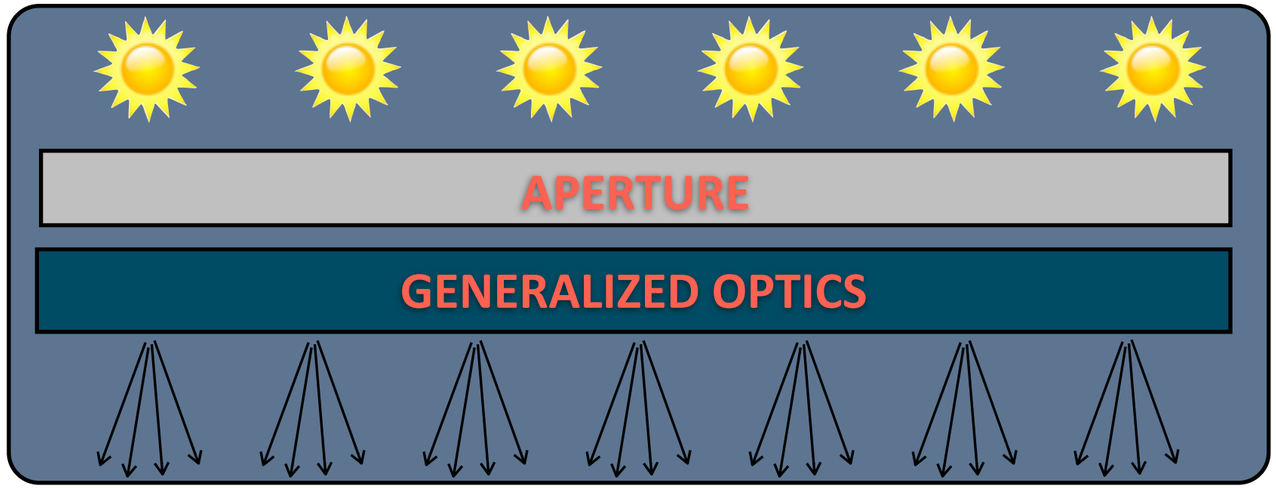
- ★ Describe in your own words an example of computational photography, using terms like novel illumination, novel cameras, generalized optics, aperture, sensors, rays, and pixels.
- ★ Describe in your own words the concept of "dual photography" with respect to appropriate use of controlled lighting and sensing to make new images.

Computational Photography (Rays to Pixels)

Novel Camera



Novel Illumination



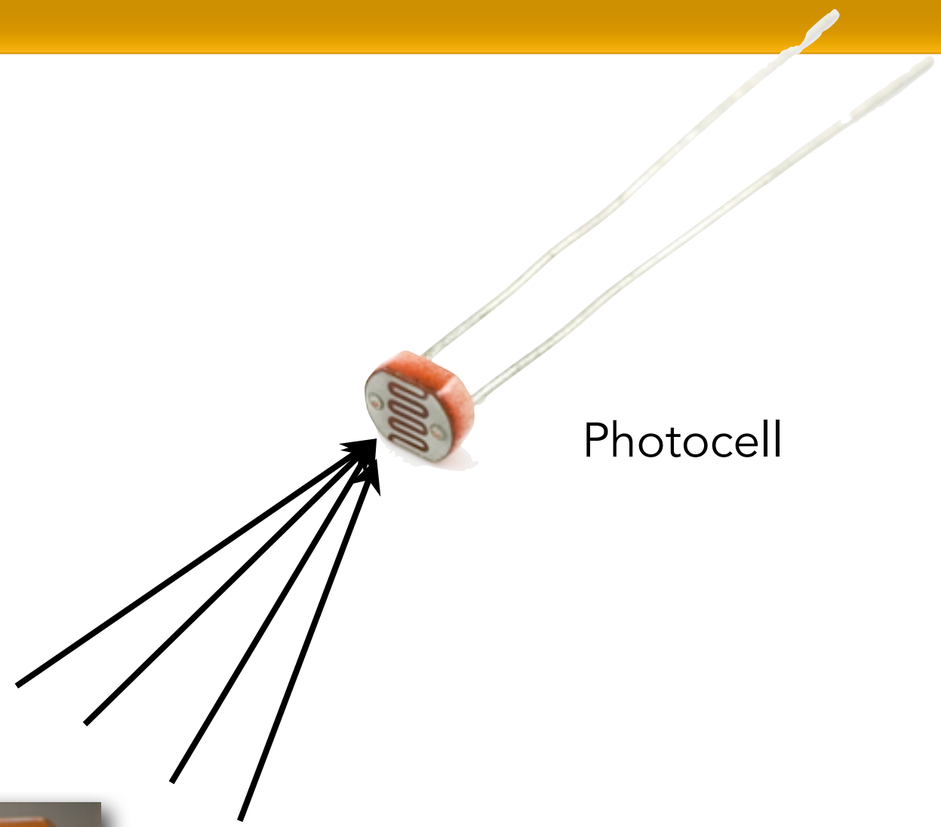
Schematic motivated by Shree Nayar and Ramesh Raskar

Novel Illumination

3D Scene

Schematic similar to one used by Shree Nayar and Ramesh Raskar

Novel Illumination



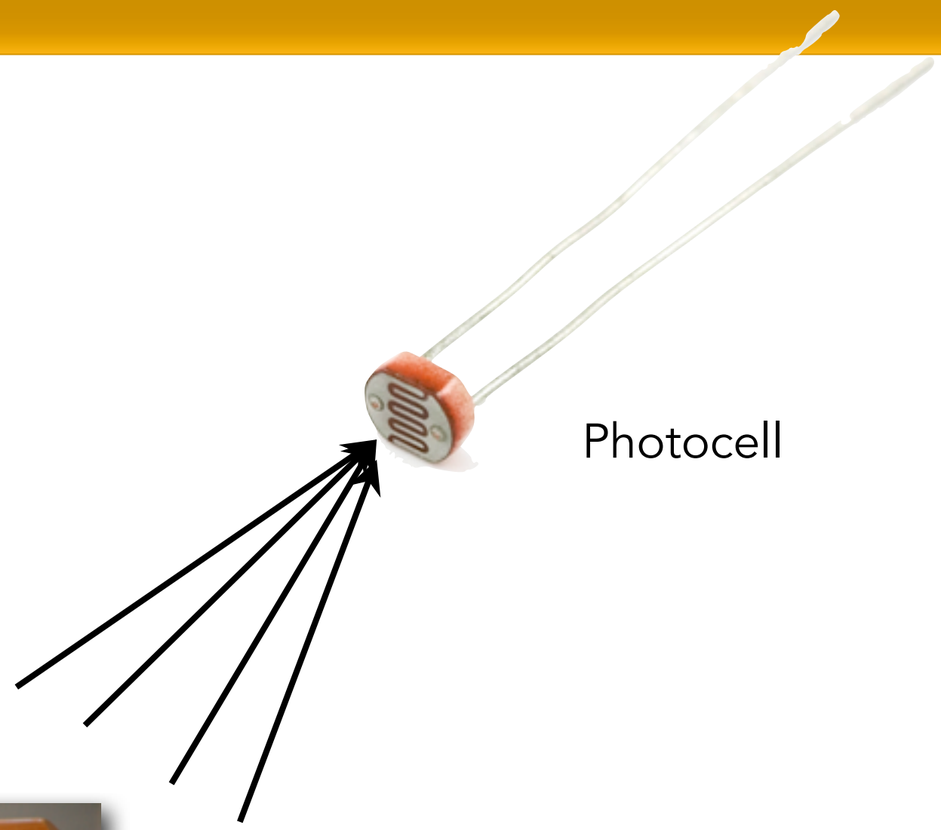
3D Scene

Schematic similar to one used by Shree Nayar and Ramesh Raskar

Novel Illumination

Projector
(Controllable
Light Source)

Modulator
(Controllable
Aperture)



Photocell

3D Scene

Schematic similar to one used by Shree Nayar and Ramesh Raskar

5

Novel Illumination

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Light Source)

Modulator
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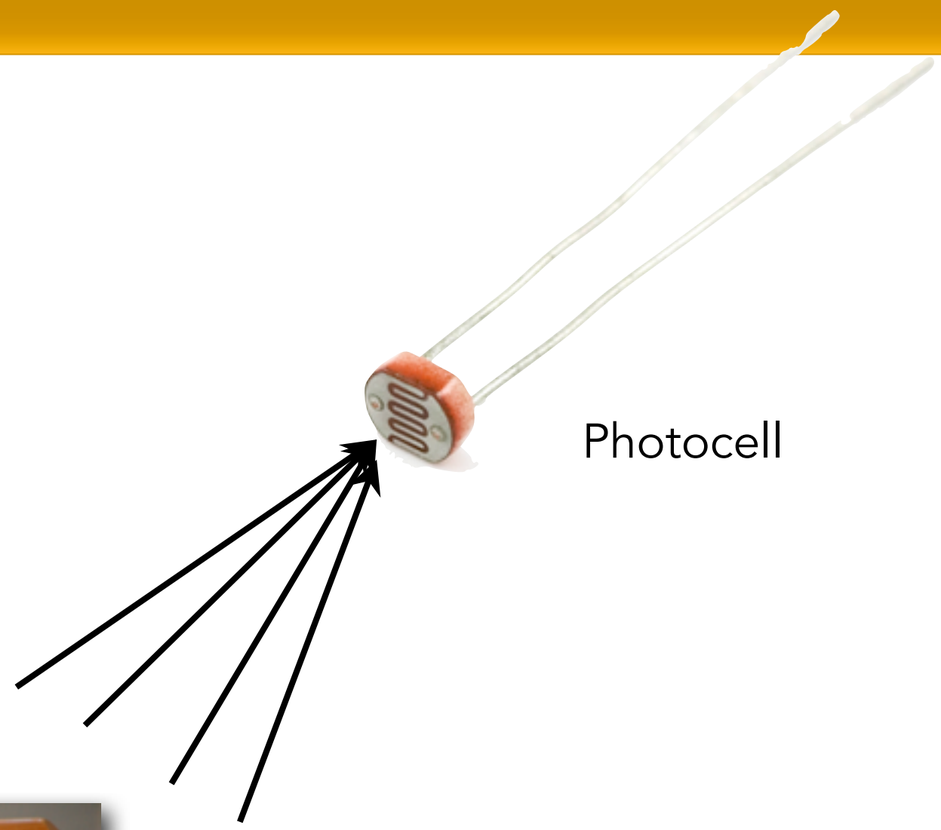
Aperture)



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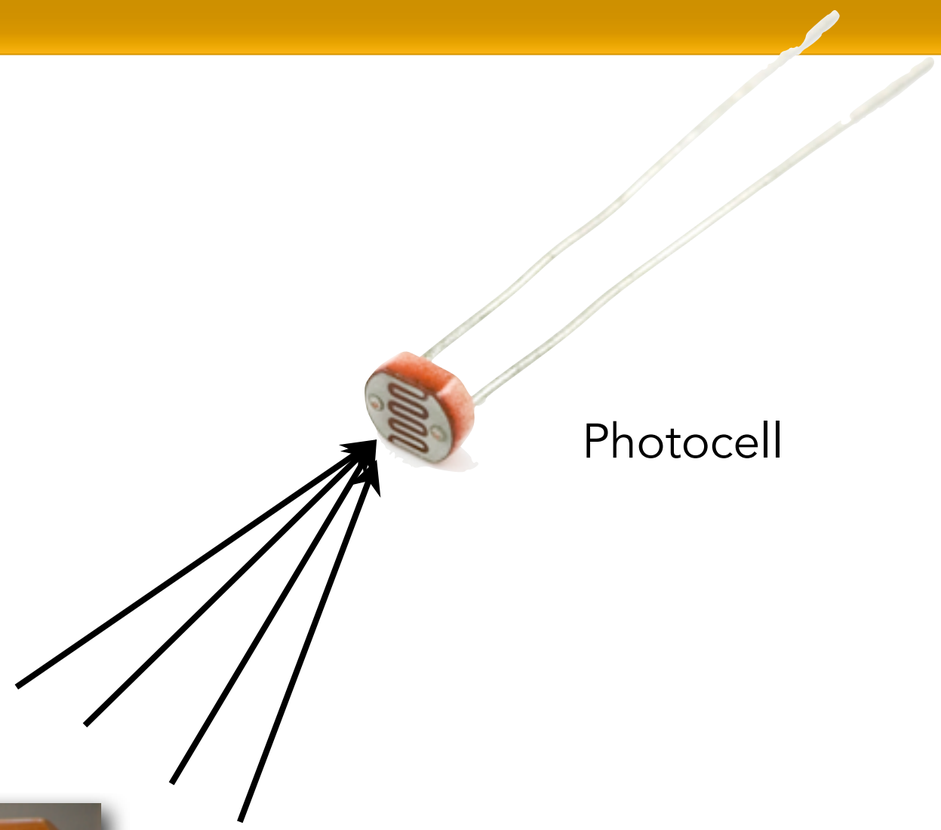

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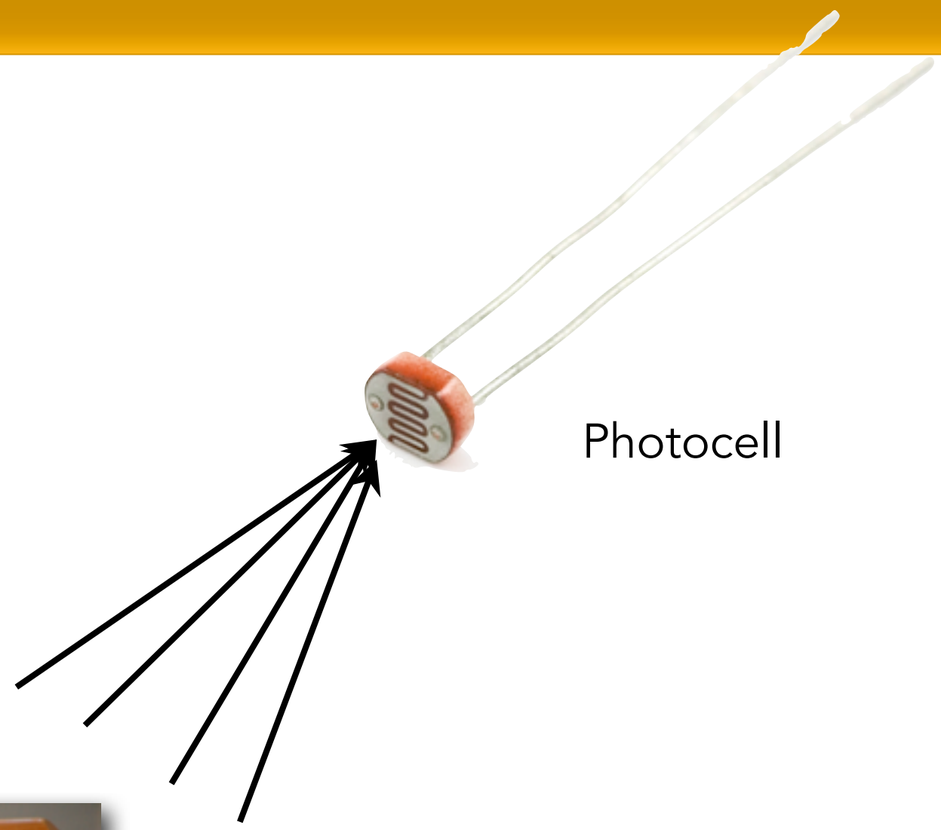

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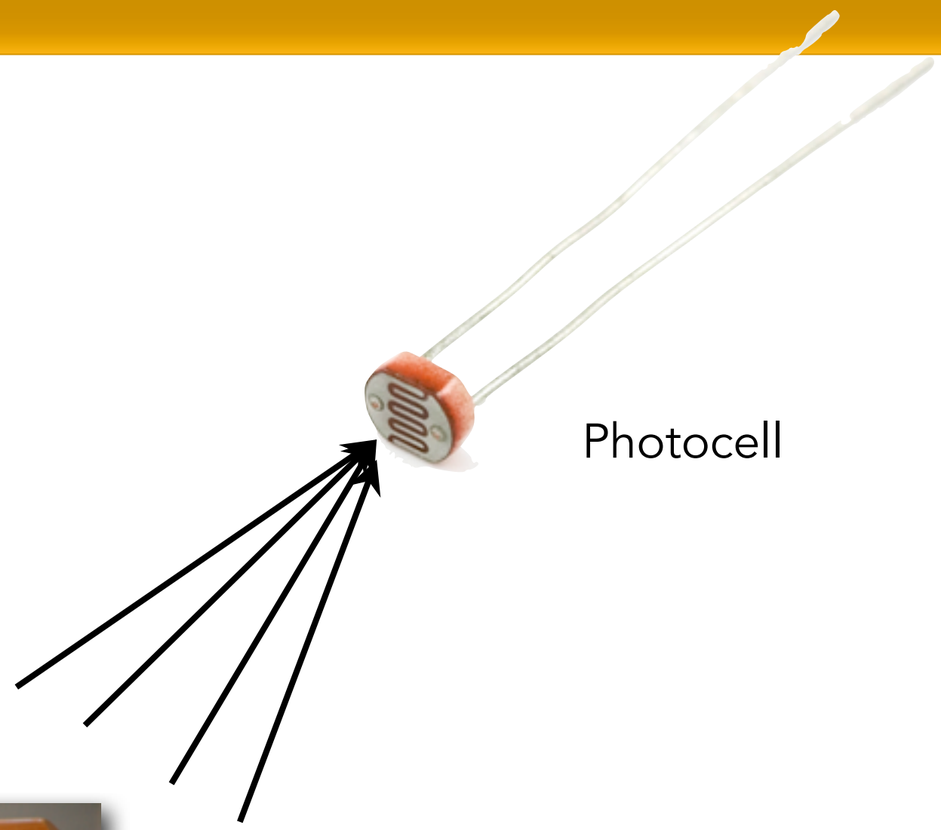

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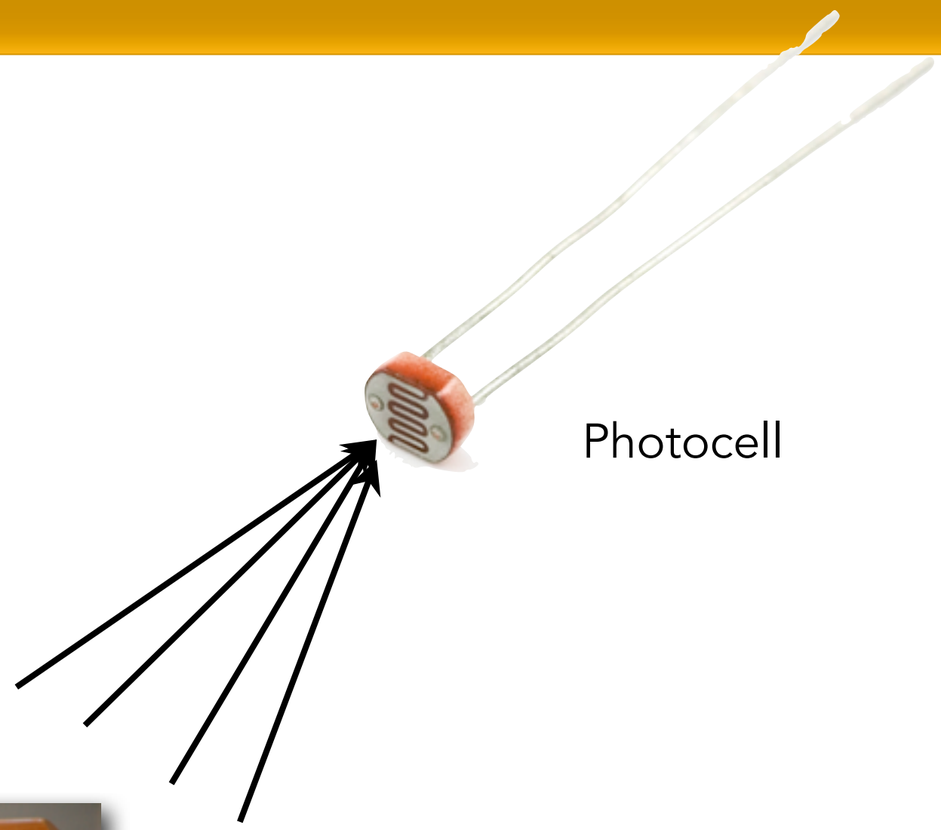

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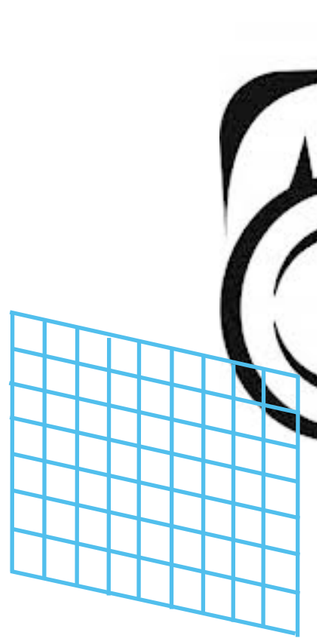

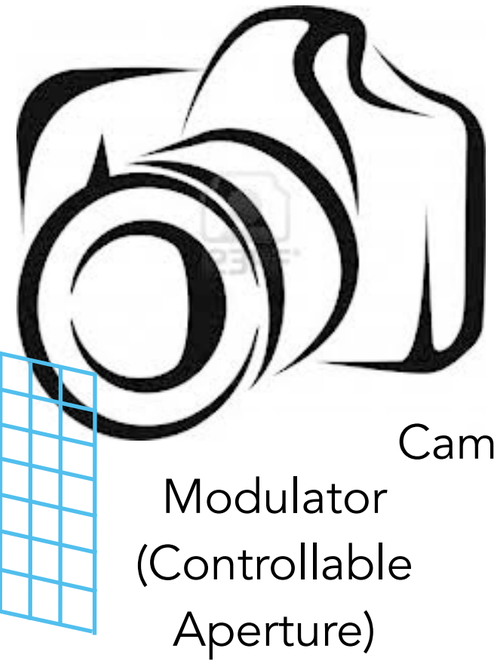

Camera

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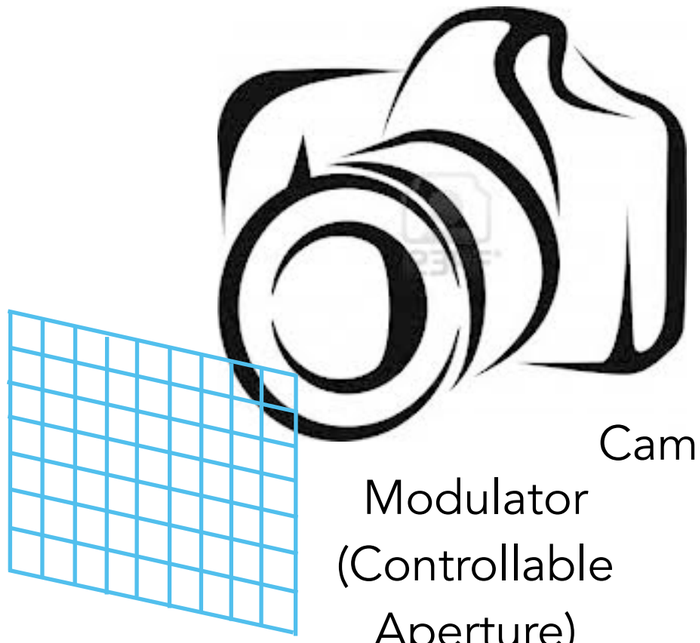

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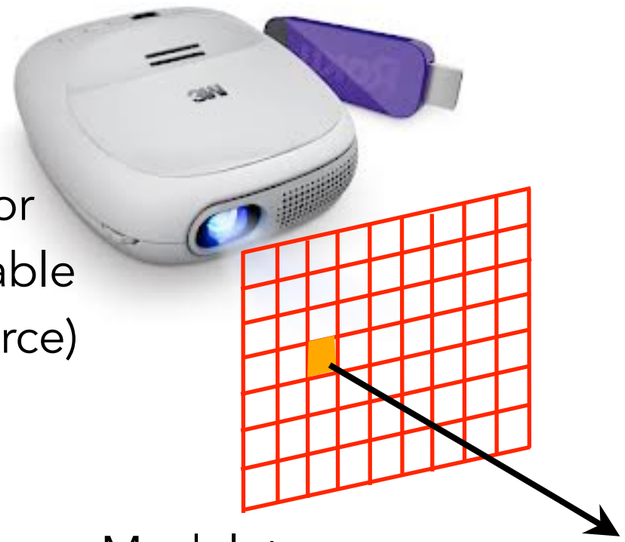

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Modulator
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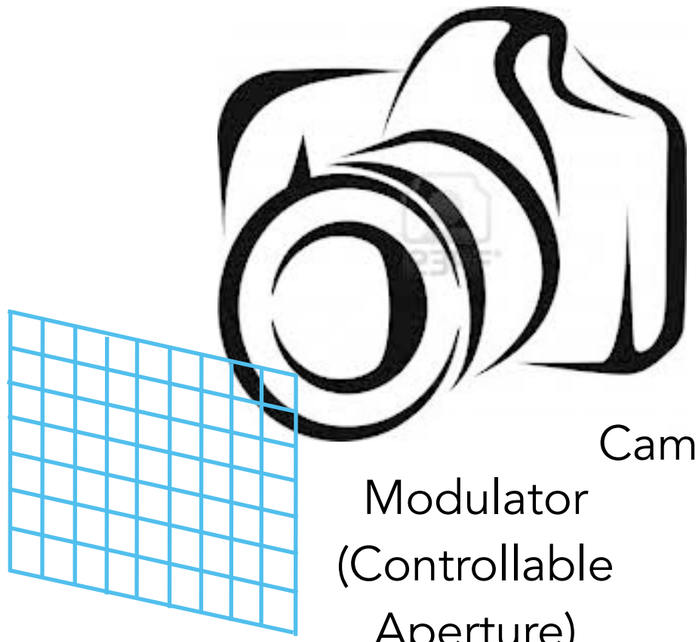
Aperture)

Scene



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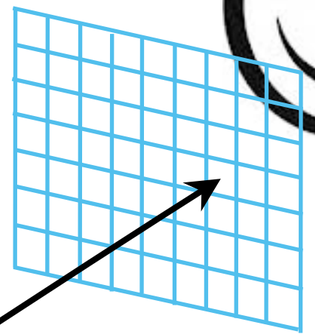

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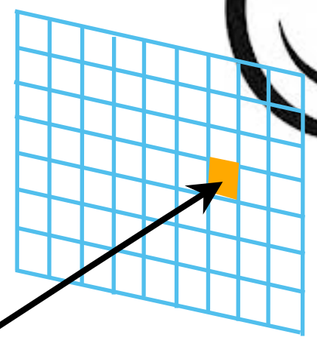

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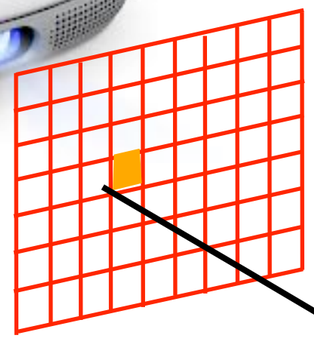

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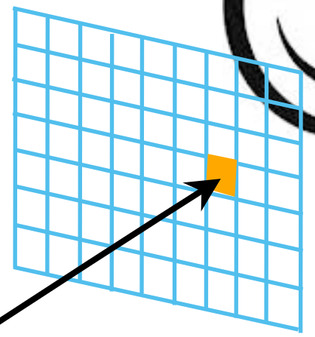
Camera



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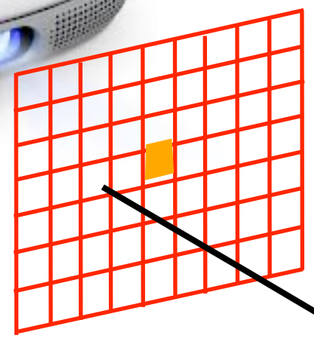

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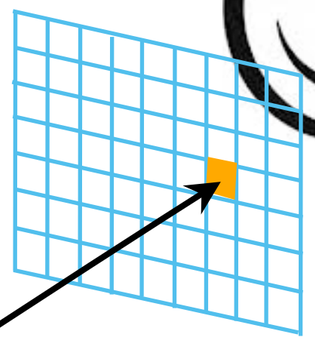
Scene



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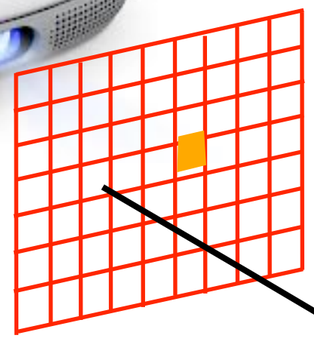

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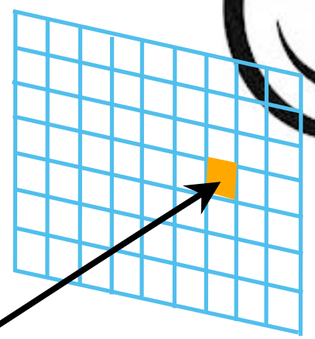

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Dual Photography

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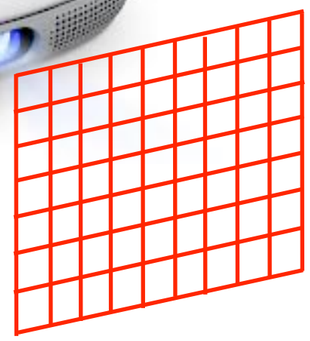

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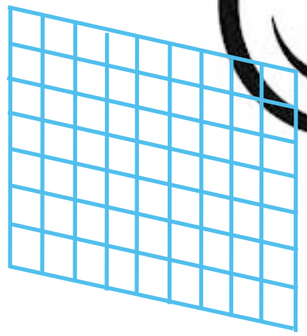
Camera



Scene

Dual Photography, Sen et al. SIGGRAPH 2005

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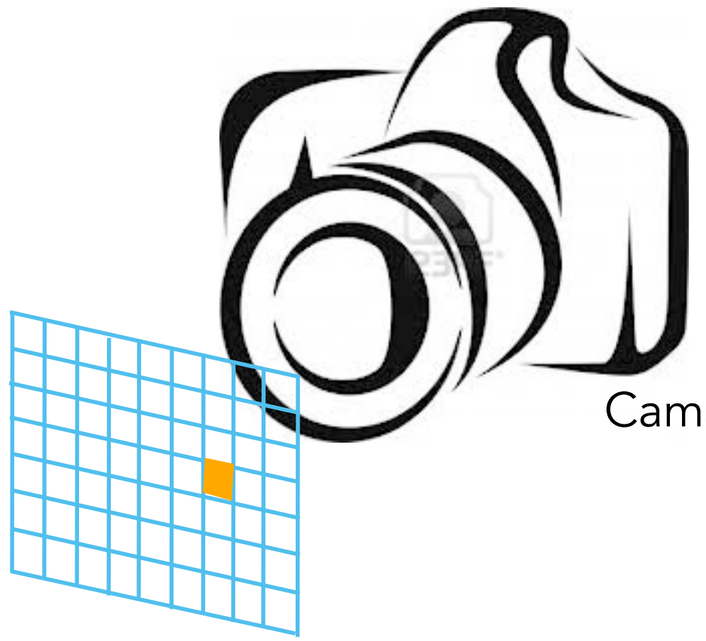

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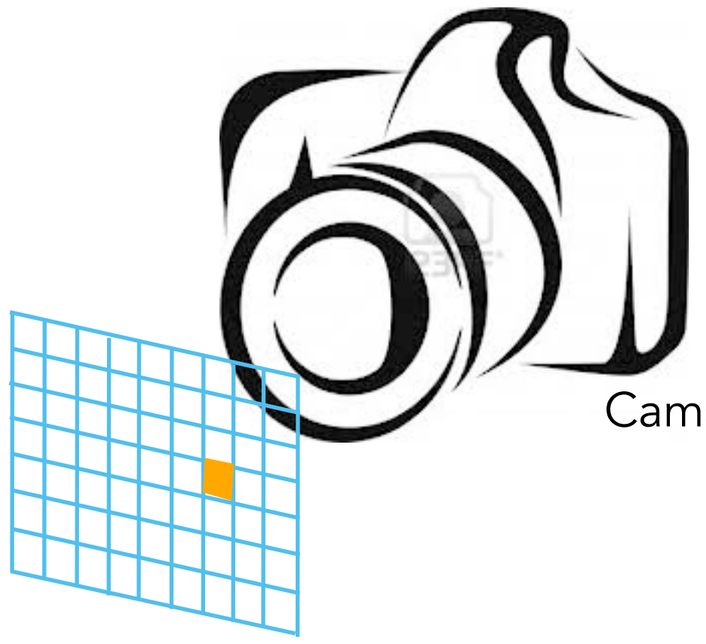

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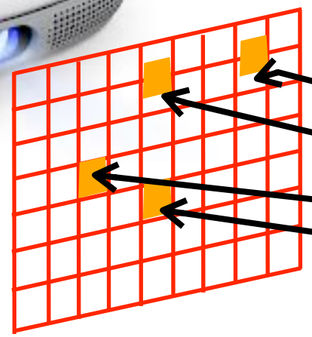

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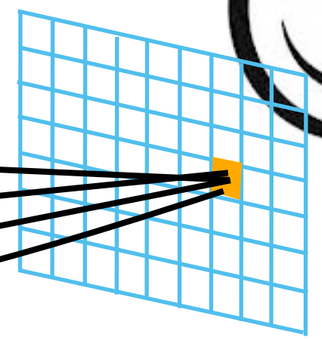

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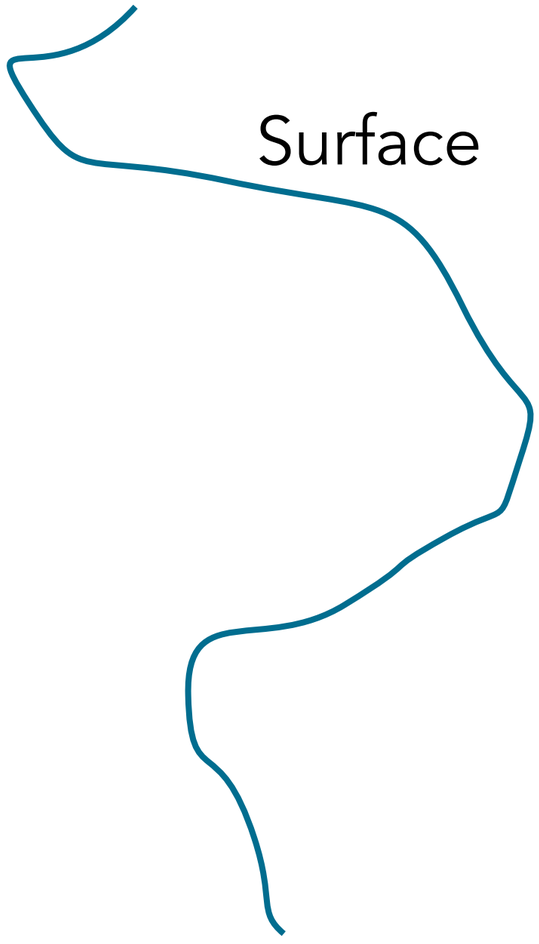
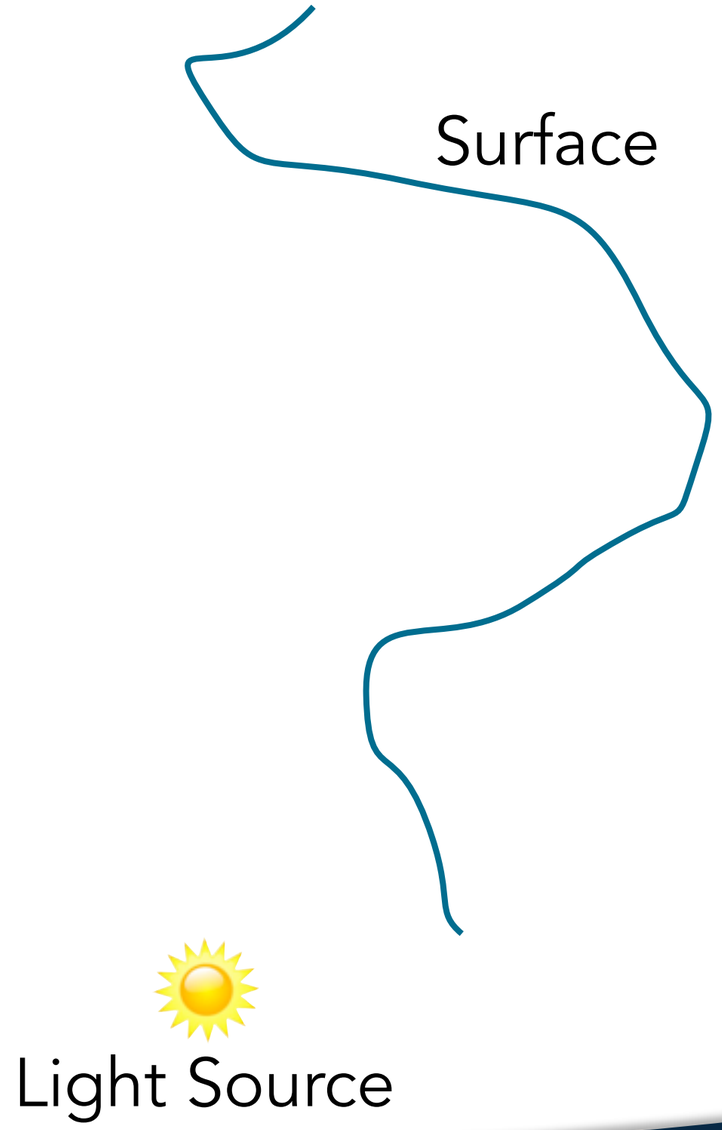
Reflective properties of ray of light



8

Reflective properties of ray of light



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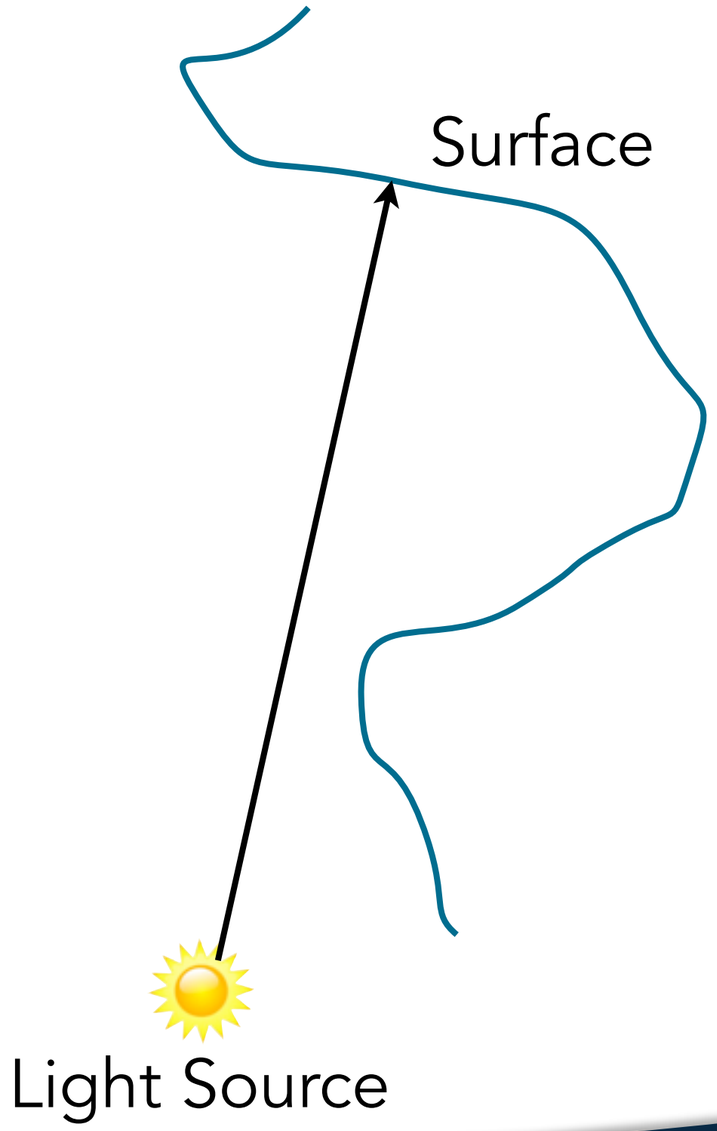

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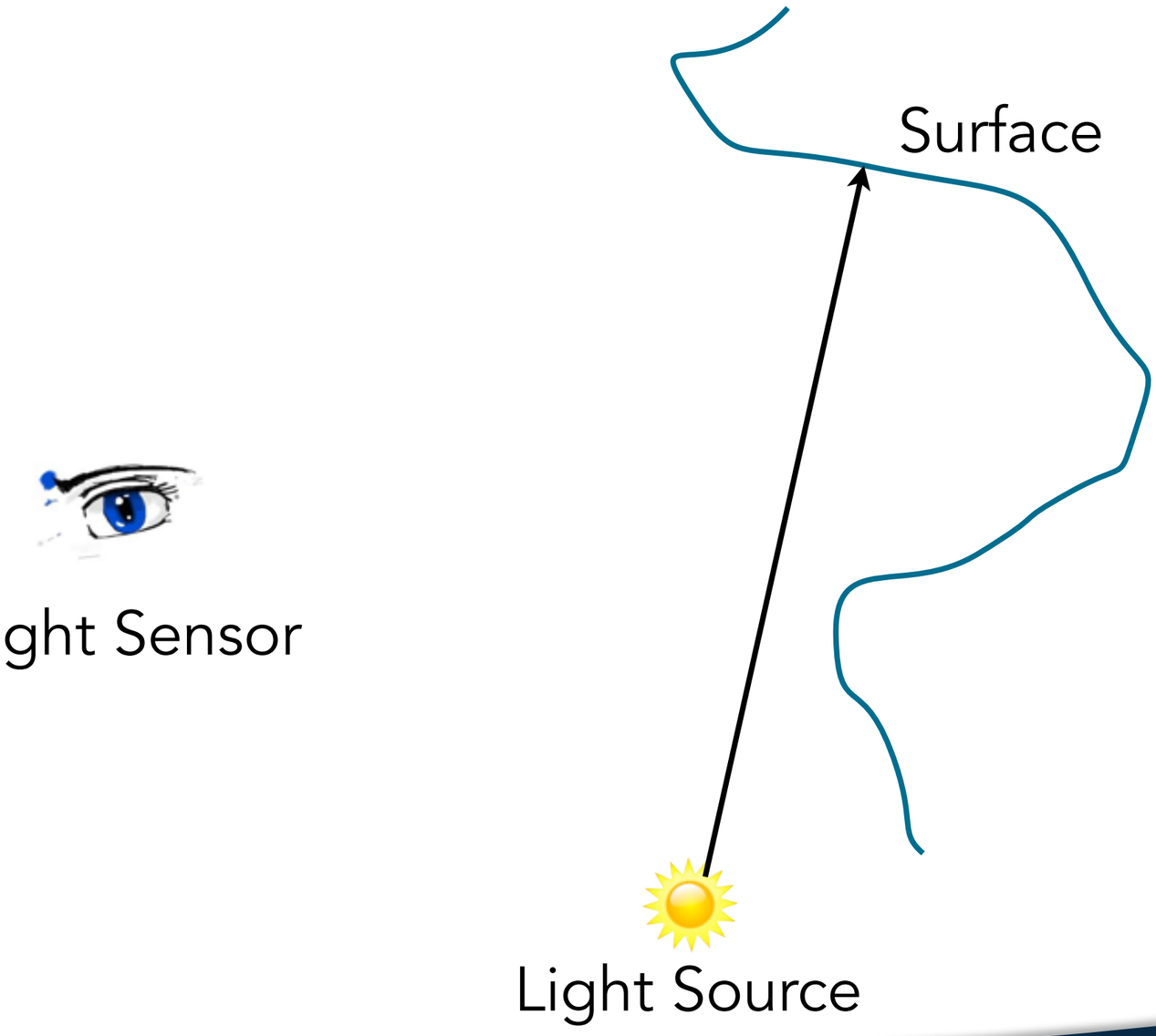

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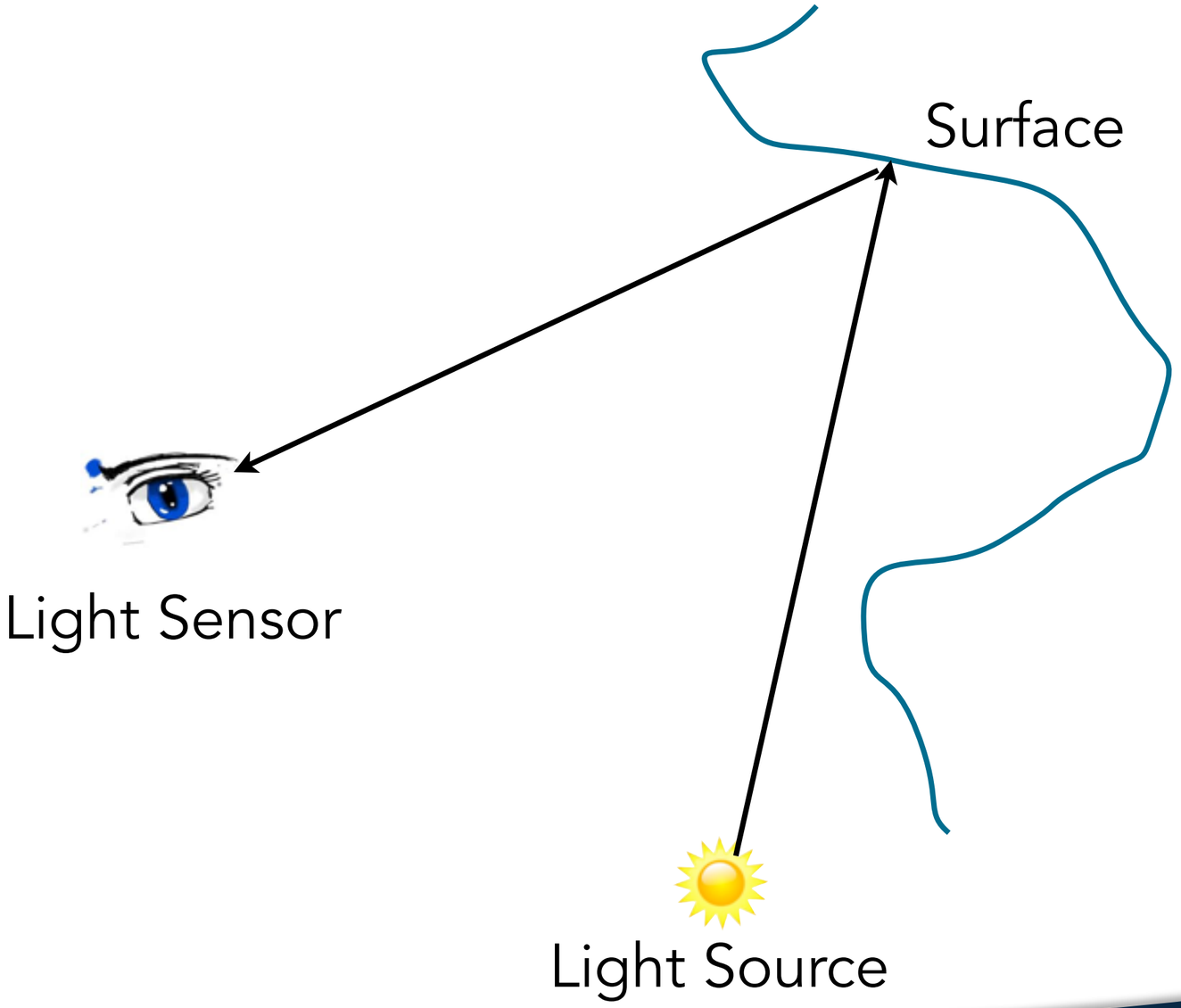

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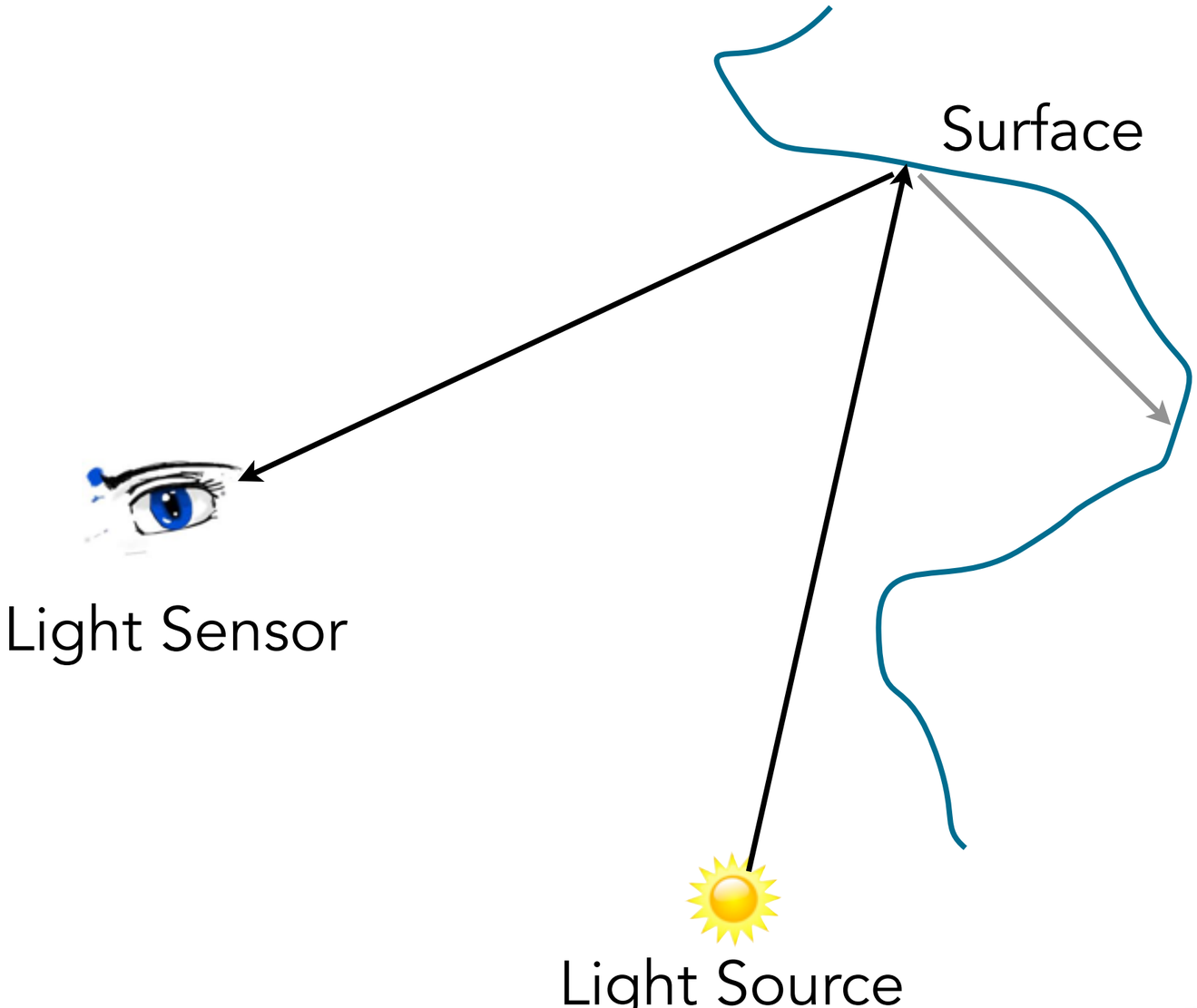

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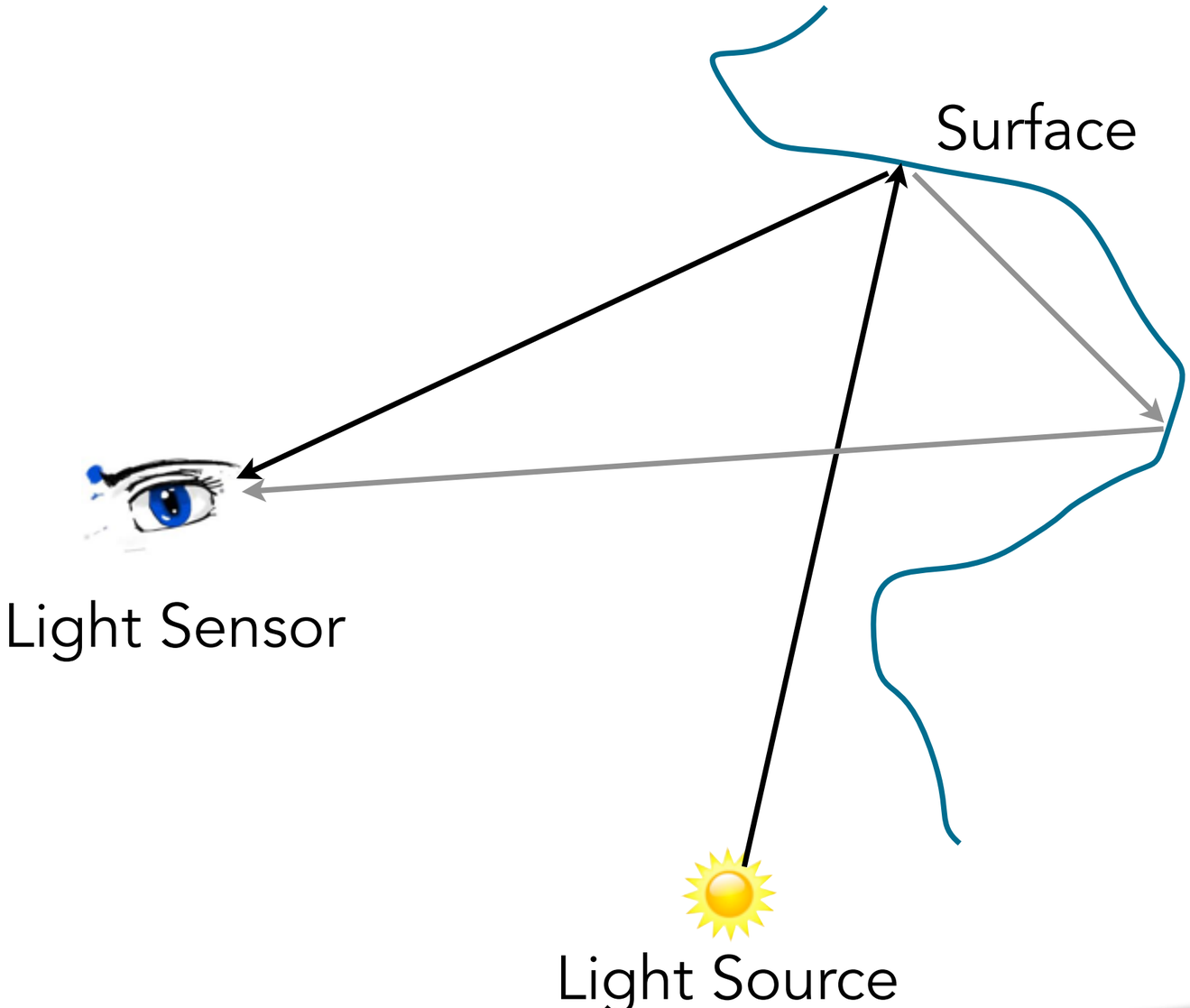

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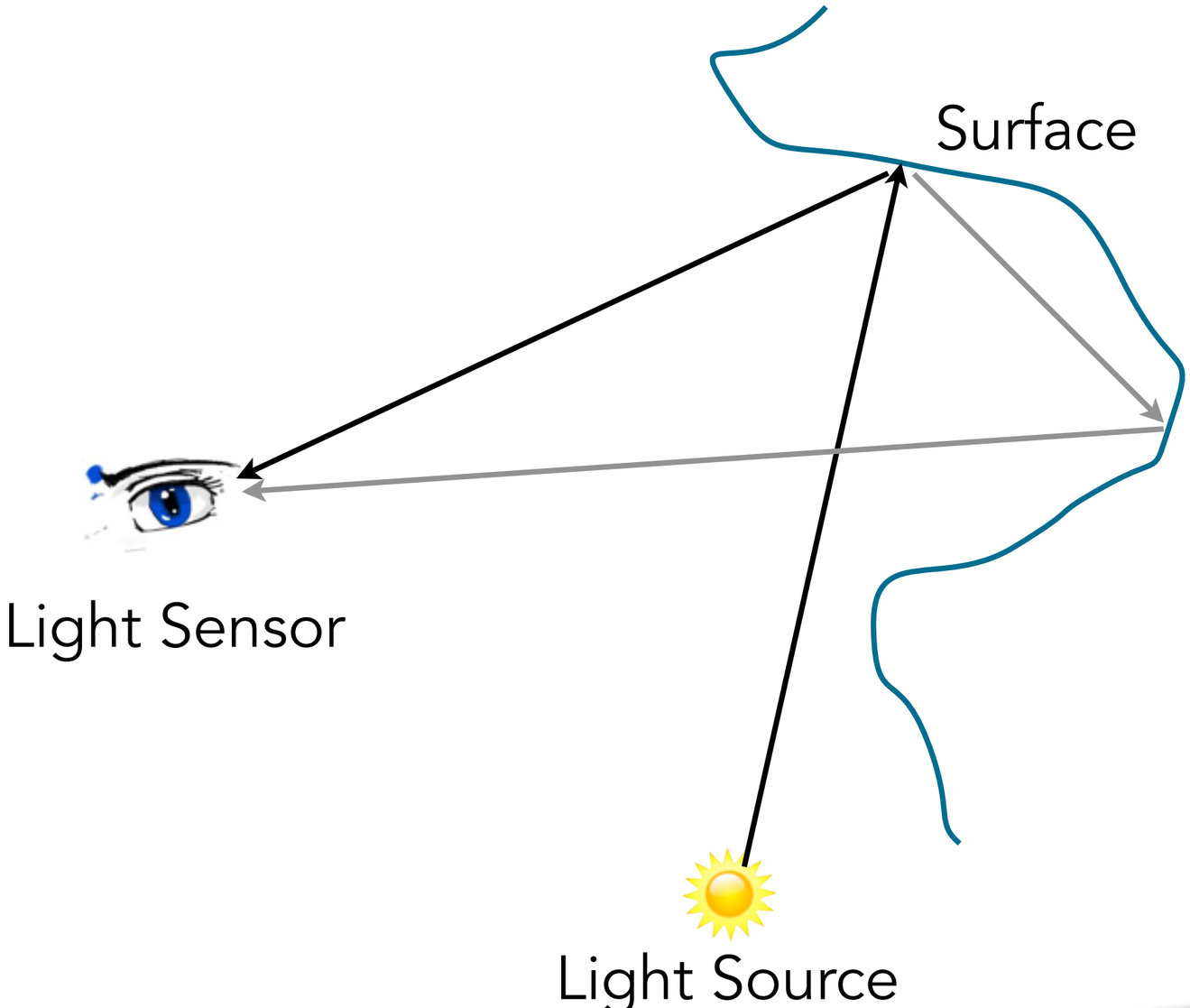
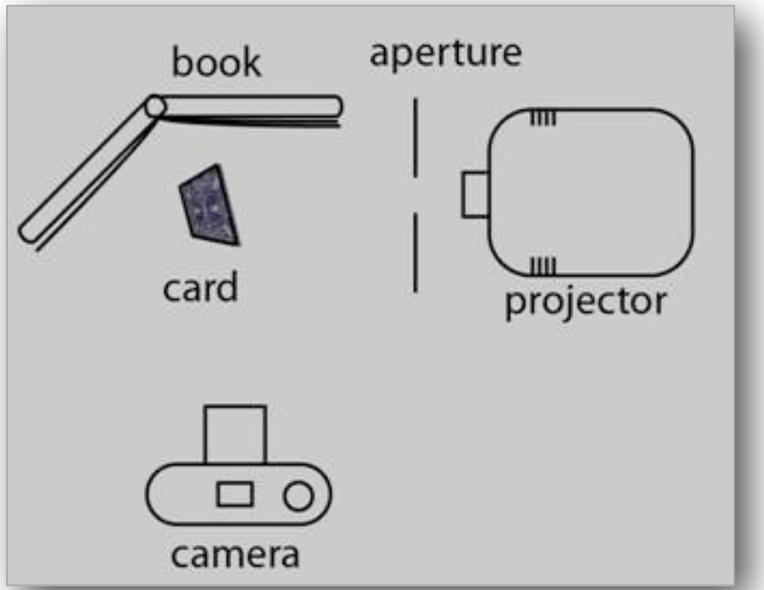


Reflection of light depends on the kind of surface

Specular (mirror),

Diffuse (matte), etc.

Dual Photography

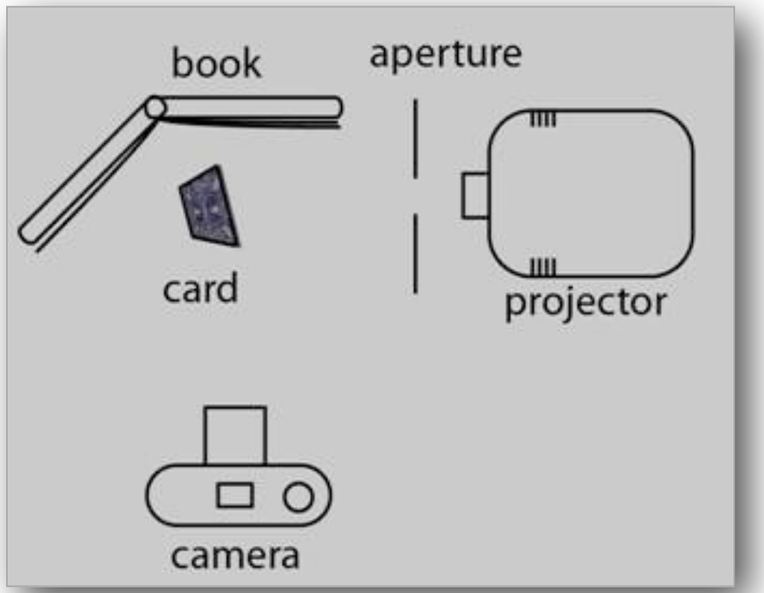


This just shows a MOCK-UP of the experiment

9

Dual Photography

This is what the camera sees



Back of the Card

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Dual Photography

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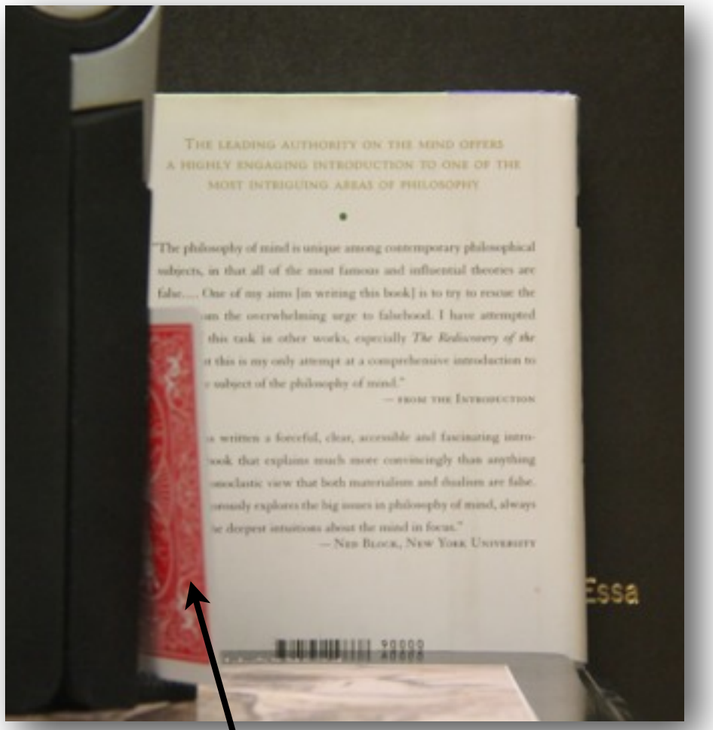
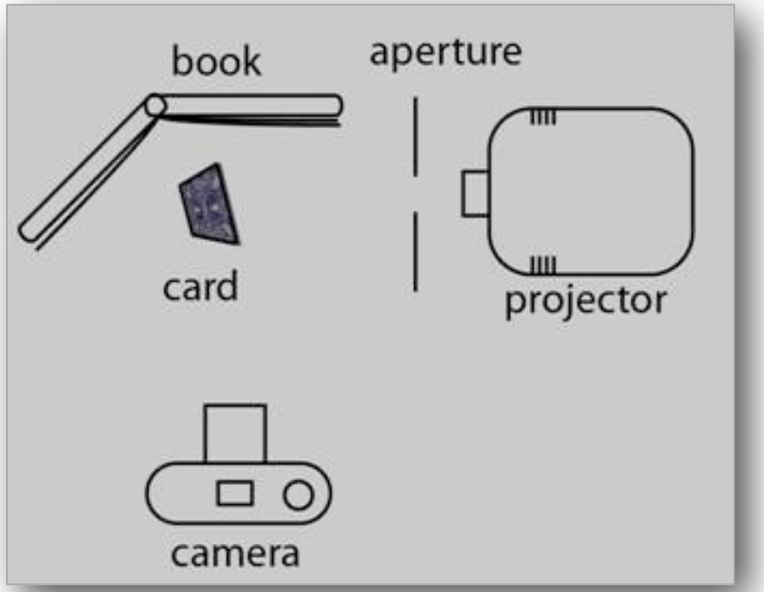


Back of the Card



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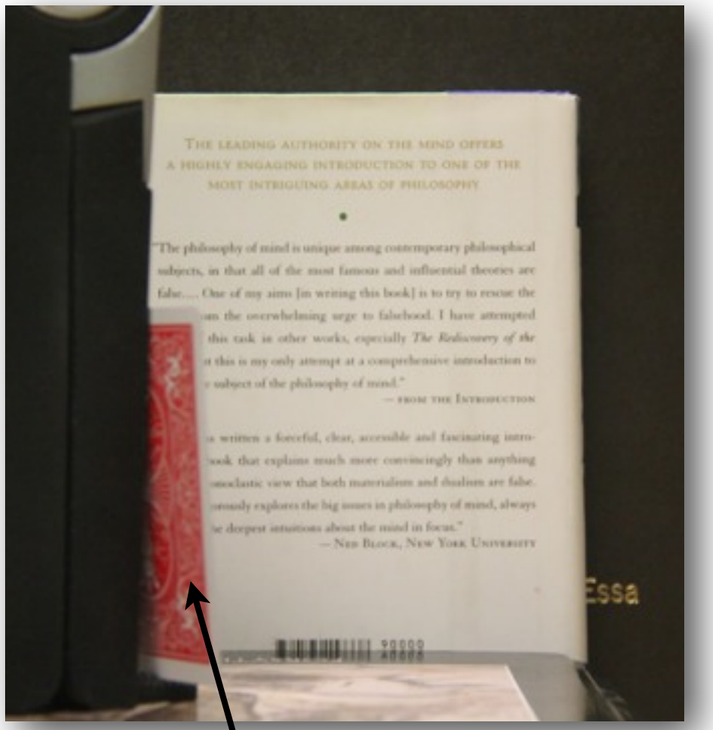

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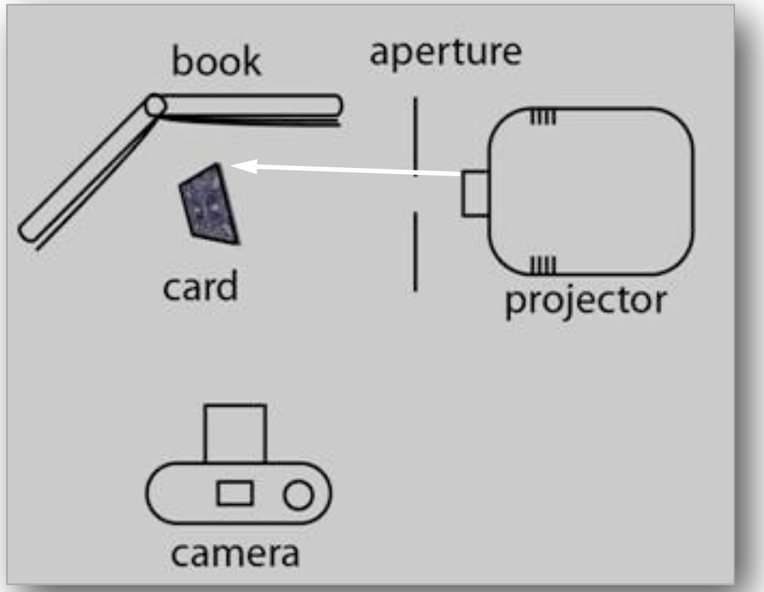

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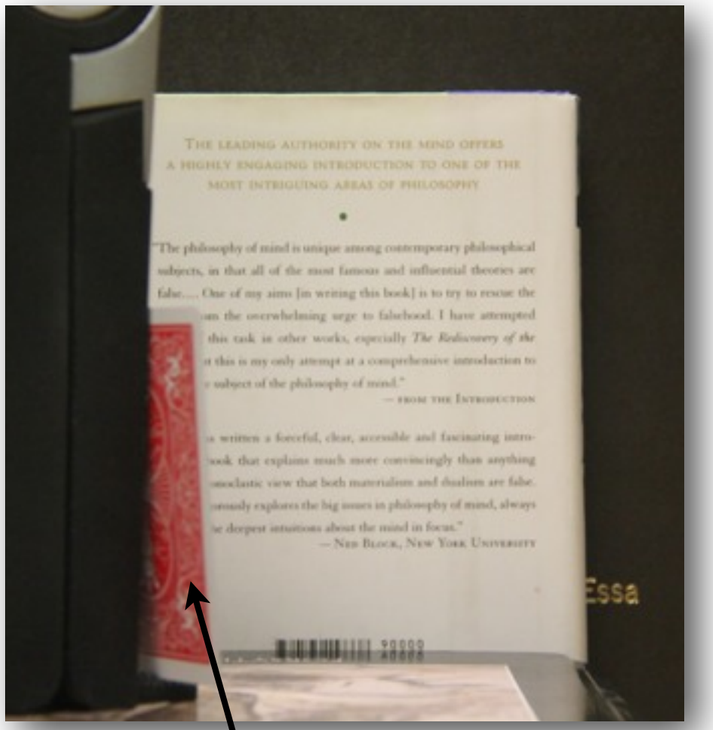

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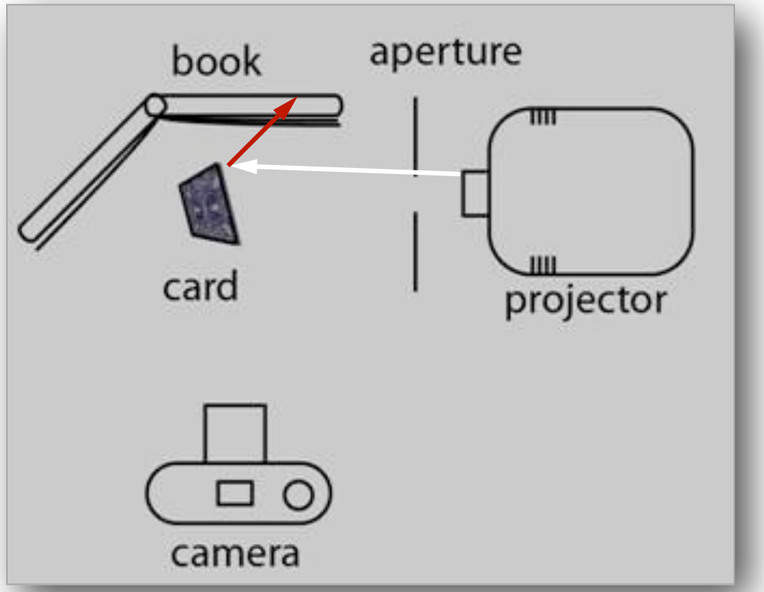

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Dual Photography

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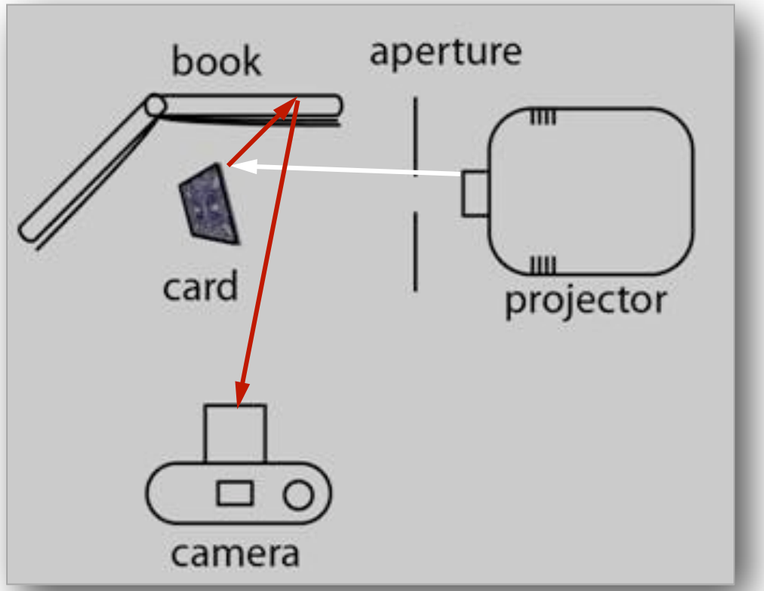
Back of the Card



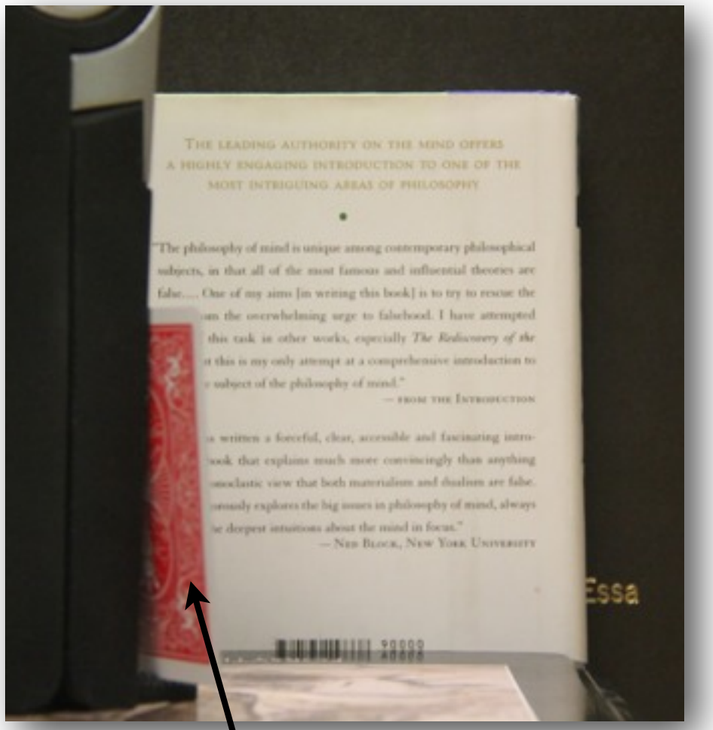
Front of the Card

Book

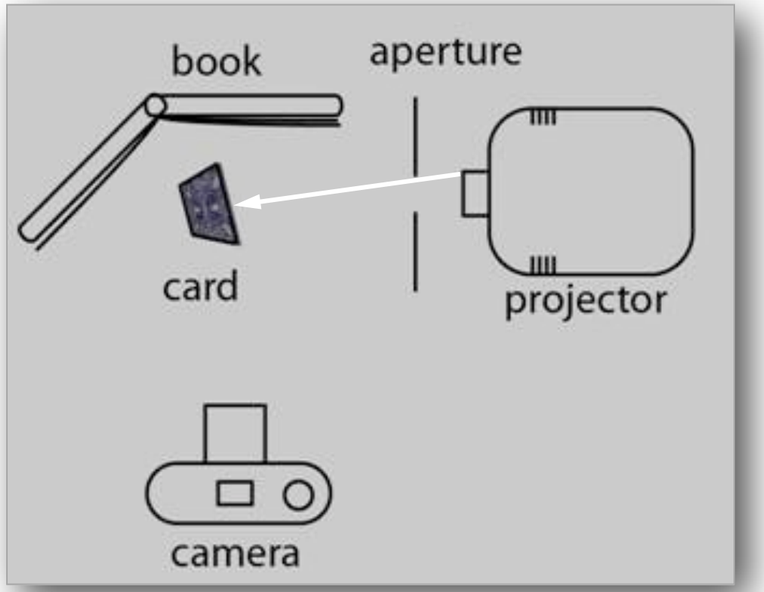
This just shows a MOCK-UP of the experiment

Dual Photography

This is what the camera sees



Back of the Card



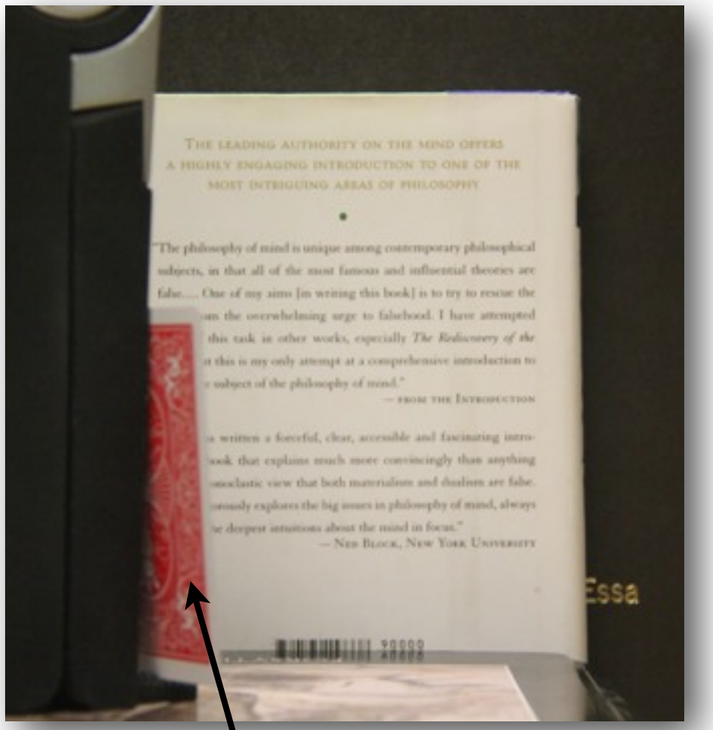
Front of the Card

Book

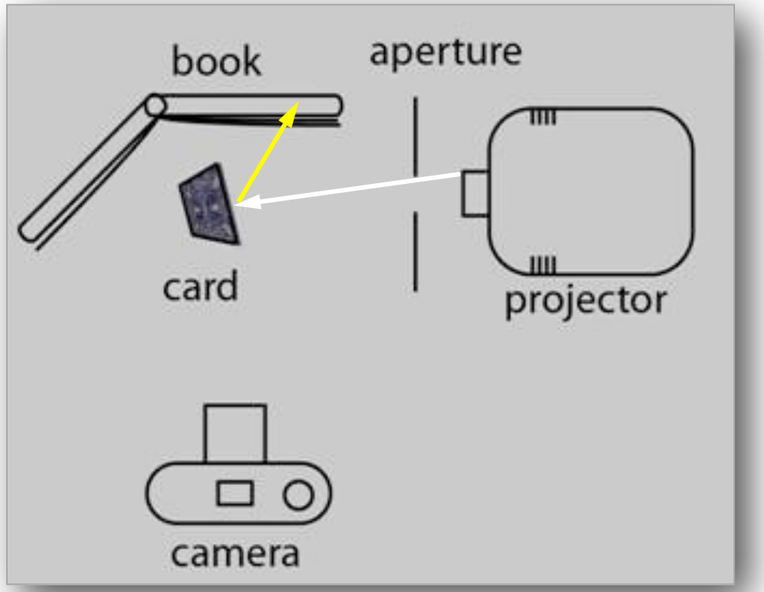
This just shows a MOCK-UP of the experiment

Dual Photography

This is what the camera sees



Back of the Card

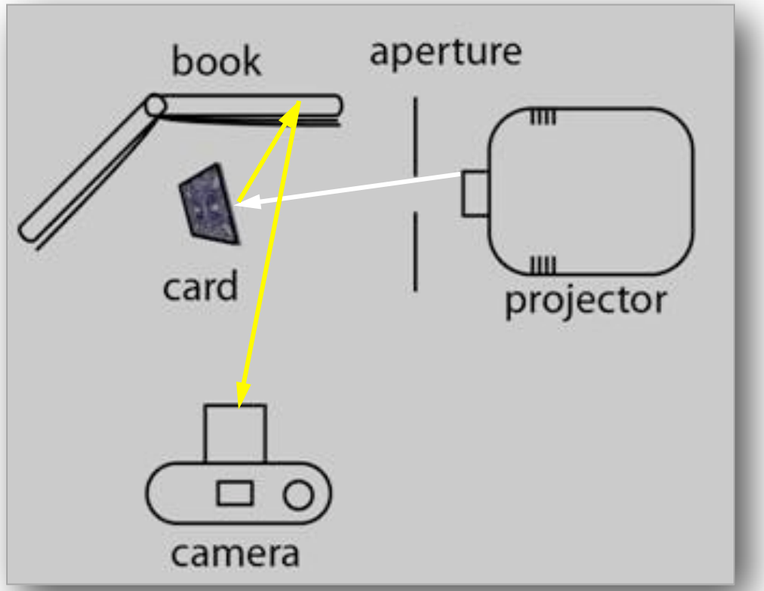


This just shows a MOCK-UP of the experiment

Dual Photography

This is what the camera sees

Back of the Card



Front of the Card

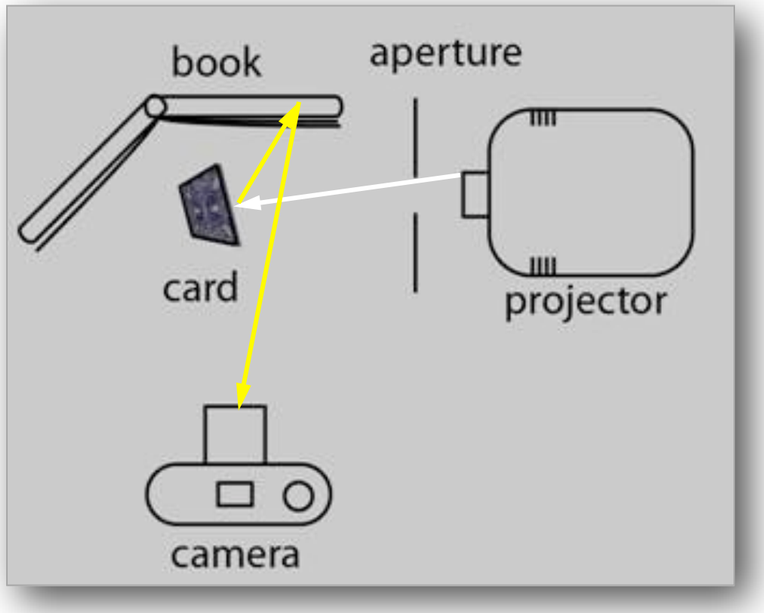
Book

This just shows a MOCK-UP of the experiment

Dual Photography

This is what the camera sees

Back of the Card



Dual Photography, Sen et al. SIGGRAPH 2005
see the video at
http://www.youtube.com/watch?v=p5_tpq5ejFQ

This just shows a MOCK-UP of the experiment

Summary

- Introduced to previously used and new computational photography terms: *novel illumination*, *novel cameras*, *generalized optics*, *aperture*, *sensors*, *rays*, and *pixels*.
- Studied a core computational photography example (Dual Photography)
  - The effects of *controlling* the *illumination* and *aperture* on the camera to generate *novel images* (in this case, see a card by just measuring the reflections!)

Next Class

- ★ Another example of Computational Photography
- ★ Panorama
  - How to stitch multiple images to generate a "larger" image?

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Credits

- References
  - Sen et al. (2005), “Dual Photography” SIGGRAPH 2005
  - Some schematics adapted from Shree Nayar and Ramesh Raskar
- Creative Commons Images
  - http://farm1.staticflickr.com/48/132530501_14b56e7796_z.jpg?zz=1
  - http://commons.wikimedia.org/wiki/File:Fruitbowl.jpg
  - http://www.ipernity.com/doc/lauge65/11487272
  - http://www.flickr.com/photos/herebedragons/2479043774/

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Georgia Institute of Technology

Computational Photography

Dr. Irfan Essa
Professor
School of Interactive Computing

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