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 2 of 3)

* Dual Photography, a specific example of Computational Photography

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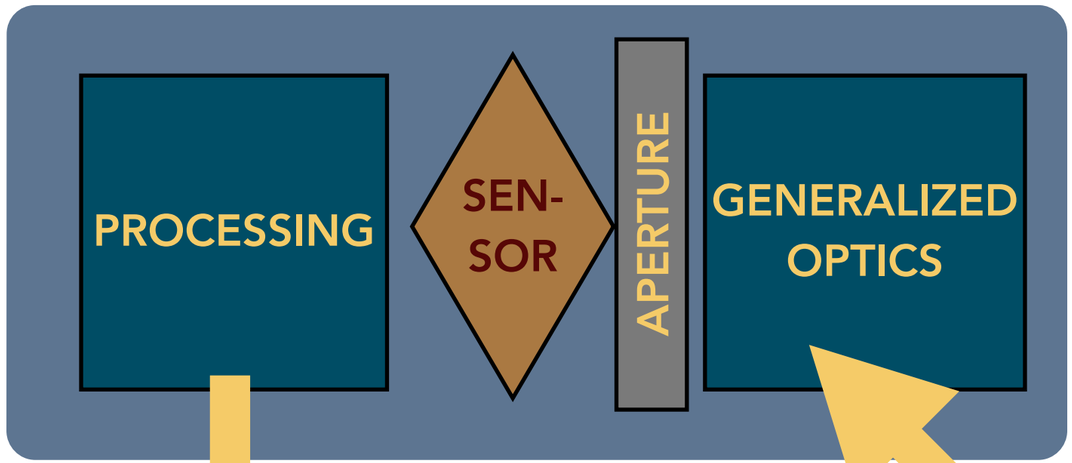
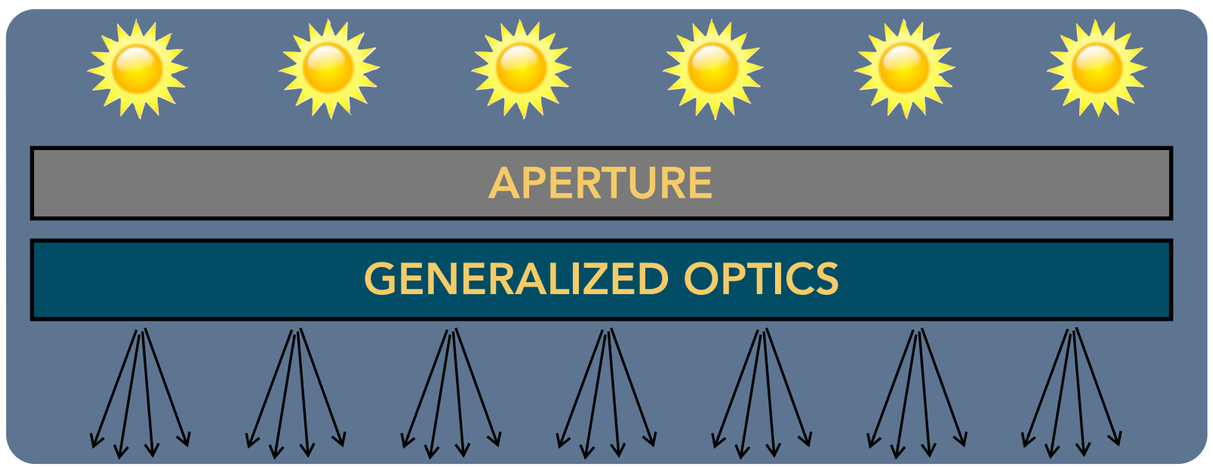
1. An example of computational photography
2. The concept of "dual photography"

Recall: Computational Photography (Rays to Pixels)

Novel Camera



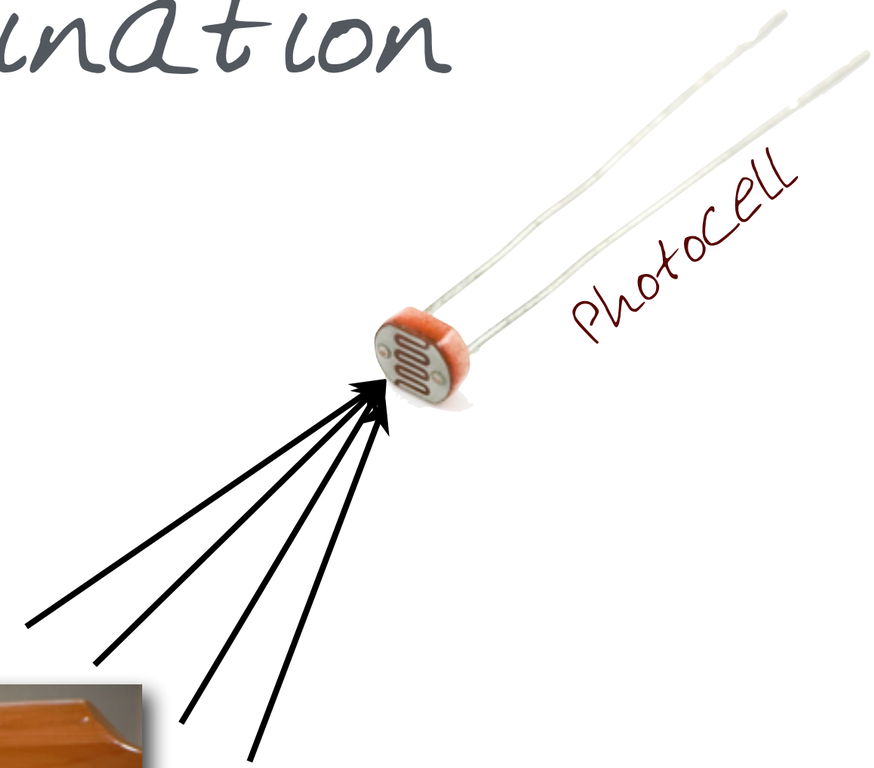
Novel Illumination



Schematic motivated by Nayar and Raskar

Novel Illumination

Modulator
(Controllable
Aperture)

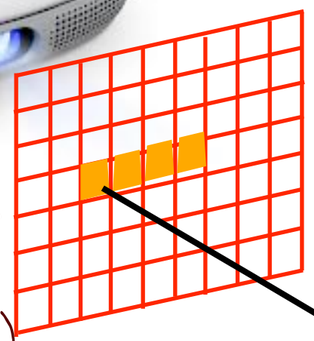


3D Scene

Schematic motivated by Shree Nayar, Ramesh Raskar, and Jack Tumblin

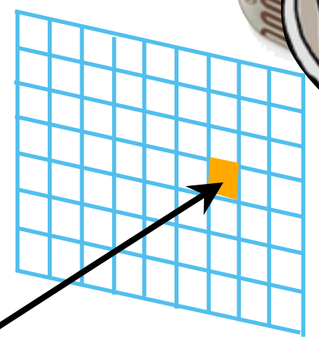
Novel Illumination

Projector
(Controllable
Light Source)



Modulator
(Controllable
Aperture)

3D Scene

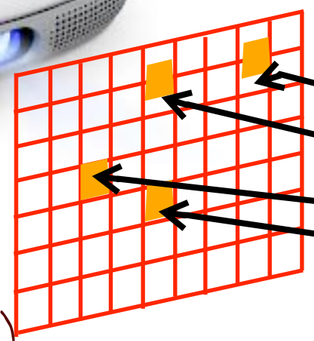


Modulator
(Controllable
Aperture)

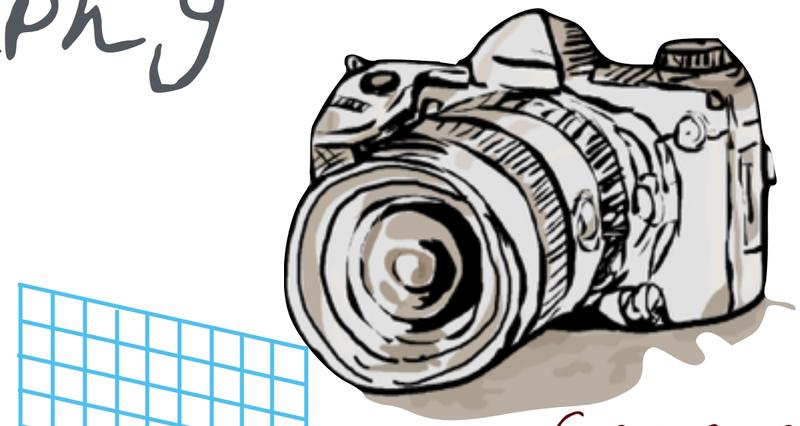
Camera

Dual Photography

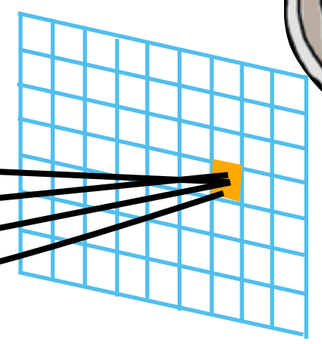
Projector
(Controllable
Light Source)



Modulator
(Controllable
Aperture)



Camera

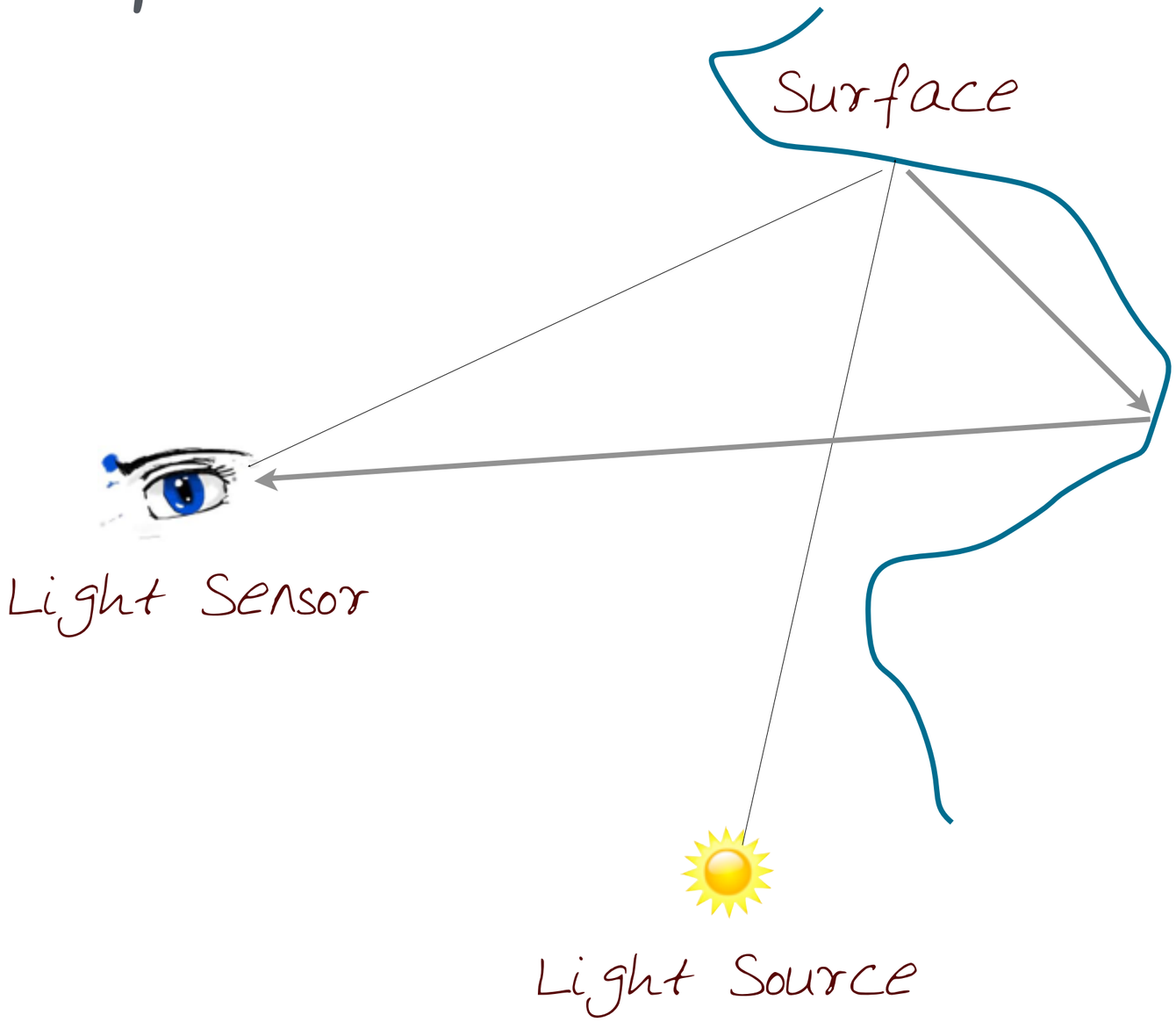


Modulator
(Controllable
Aperture)

3D Scene

Dual Photography, Sen et al. SIGGRAPH 2005

Reflective properties of ray of light



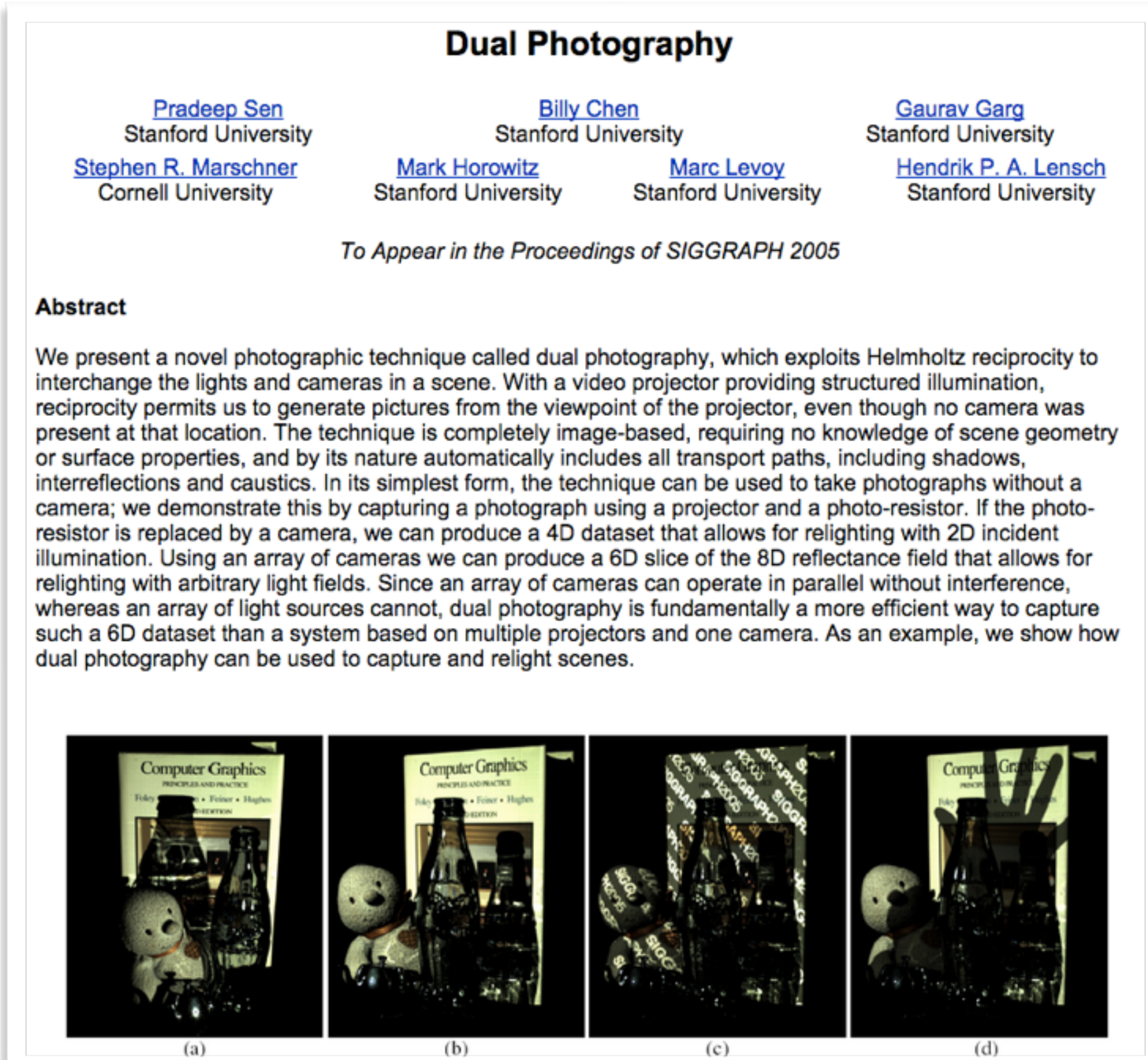
Reflection of light depends on the kind of surface:

Specular (mirror)

Diffuse (matte)

Pradeep Sen, Billy Chen, Gaurav Garg, Stephen R. Marschner, Mark Horowitz, Marc Levoy, and Hendrik P. A. Lensch. 2005. Dual photography. ACM Trans. Graph. 24, 3 (July 2005), 745-755. DOI=10.1145/1073204.1073257 http://doi.acm.org/10.1145/1073204.1073257

http://graphics.stanford.edu/papers/dual_photography/



Dual Photography

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To Appear in the Proceedings of SIGGRAPH 2005

Abstract

We present a novel photographic technique called dual photography, which exploits Helmholtz reciprocity to interchange the lights and cameras in a scene. With a video projector providing structured illumination, reciprocity permits us to generate pictures from the viewpoint of the projector, even though no camera was present at that location. The technique is completely image-based, requiring no knowledge of scene geometry or surface properties, and by its nature automatically includes all transport paths, including shadows, interreflections and caustics. In its simplest form, the technique can be used to take photographs without a camera; we demonstrate this by capturing a photograph using a projector and a photo-resistor. If the photo-resistor is replaced by a camera, we can produce a 4D dataset that allows for relighting with 2D incident illumination. Using an array of cameras we can produce a 6D slice of the 8D reflectance field that allows for relighting with arbitrary light fields. Since an array of cameras can operate in parallel without interference, whereas an array of light sources cannot, dual photography is fundamentally a more efficient way to capture such a 6D dataset than a system based on multiple projectors and one camera. As an example, we show how dual photography can be used to capture and relight scenes.

(a) (b) (c) (d)

Dual Photography

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Mark Horowitz* Marc Levoy* Hendrik P.A. Lensch*

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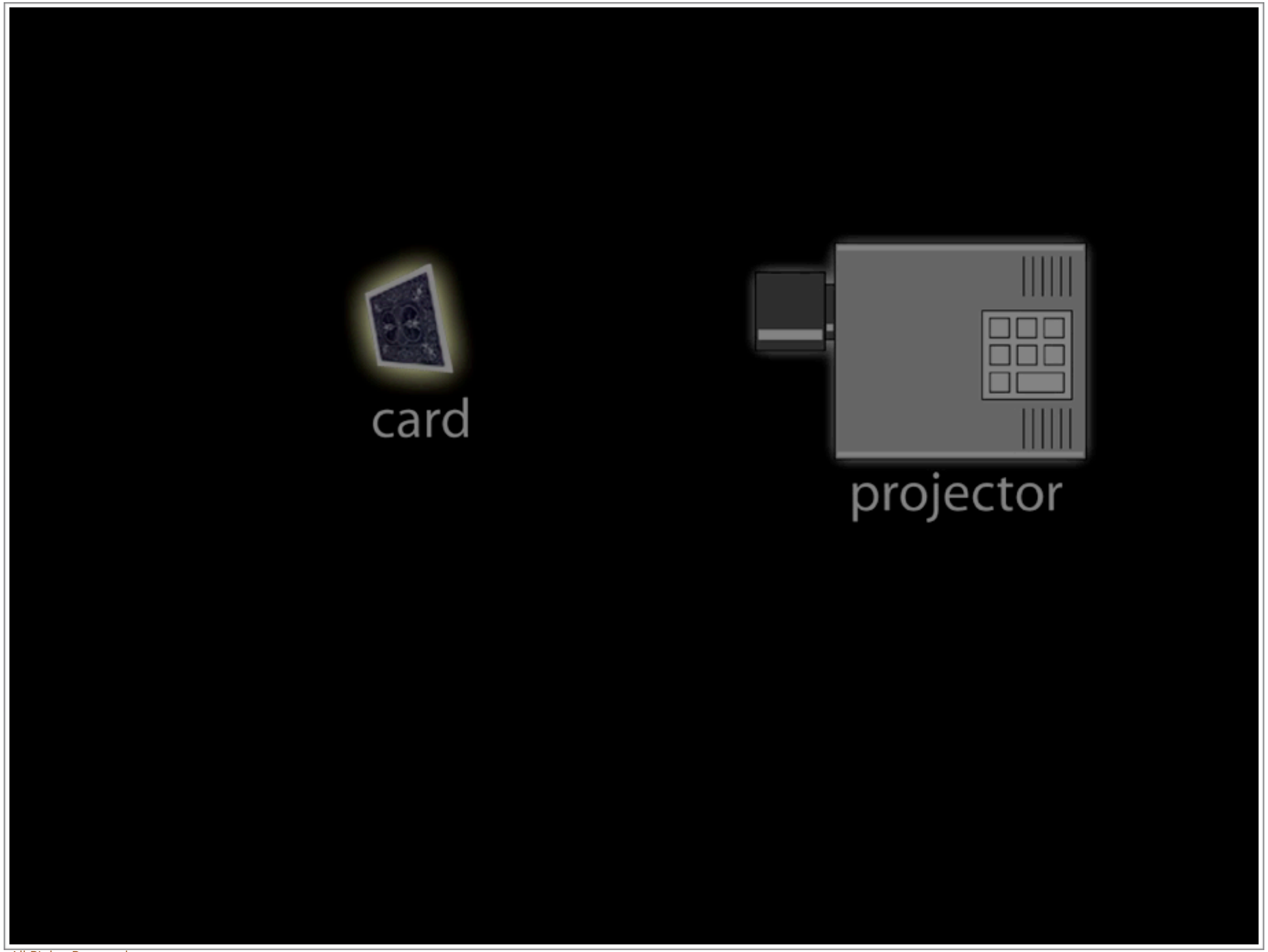
SIGGRAPH2005



Summary

* Introduced computational photography terms' novel illumination, novel cameras, generalized optics, aperture, sensors, rays, and pixels
* Studied a core computational photography example (Dual Photography)

Next Class

* Another example of Computational Photography

* Panorama

  * How to stitch multiple images to generate a "larger" image?

Credits

* References
  * Sen et al. (2005), "Dual Photography" SIGGRAPH 2005
* Some schematics adapted from Shree Nayar and Ramesh Raskar

Computational Photography

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