CS4670/5670: Computer Vision

Kavita Bala

Lecture 42: Conclusions

Announcements

- Exam review: Sunday 1-3pm, location: TBA
- Exam topics
  - Lec 18 (Cameras, Mar 9)-lec 39 (ConvNets, May 4)
- Grading: any unresolved issues drop me a note
- **Final: Sunday 2pm, May 22**
  - **BTN100WEST,** Barton Hall 100 West-Main Floor
- **Course evaluation**
  - **Replace your lowest quiz grade with your highest one**

Grading

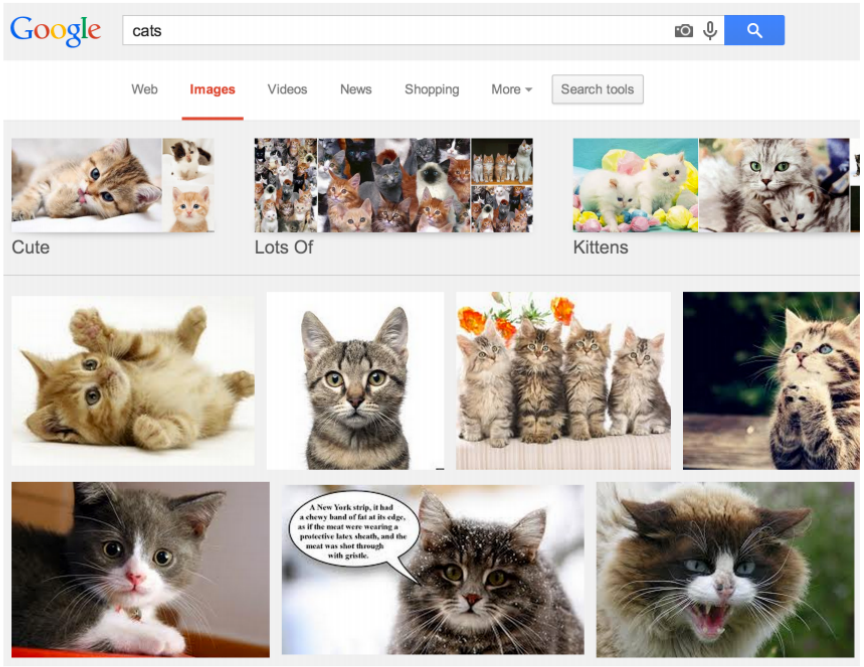
- Rough grade breakdown:
  - Quizzes + class evaluation: 5%
  - Midterm, final exam: 15% each
  - Homeworks: 10% each
  - Programming projects: 45%

ConvNets

Google

Applications

Google Image Search



Search by Image

Image size:
450 × 338

Find other sizes of this image:
All sizes - Medium

Best guess for this image: ***cats and kittens***

Funny Cats and Kittens Meowing Compilation 2013 - YouTube
www.youtube.com/watch?v=DXUAyRRkI6k
Nov 9, 2013 - **Cats** Meowing | **Cat** Meowing | **Kittens** Meowing | **Kitten** Meowing | Meowing **Cat** | Funny **Cats** | Meowing **Kittens** | **Cat** Meowing Non Stop | **Cats** ...

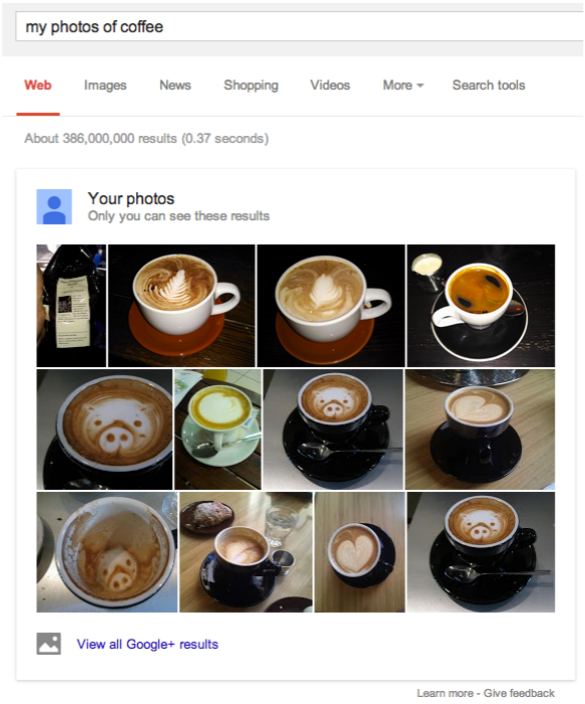
mama cat comes to rescue her little kitten - YouTube
www.youtube.com/watch?v=S5-D0f6nHSQ
Jul 7, 2007 - Pets animals **cats kittens** fun. Subscribe! http://www.youtube.com/user/Epikneverdies.

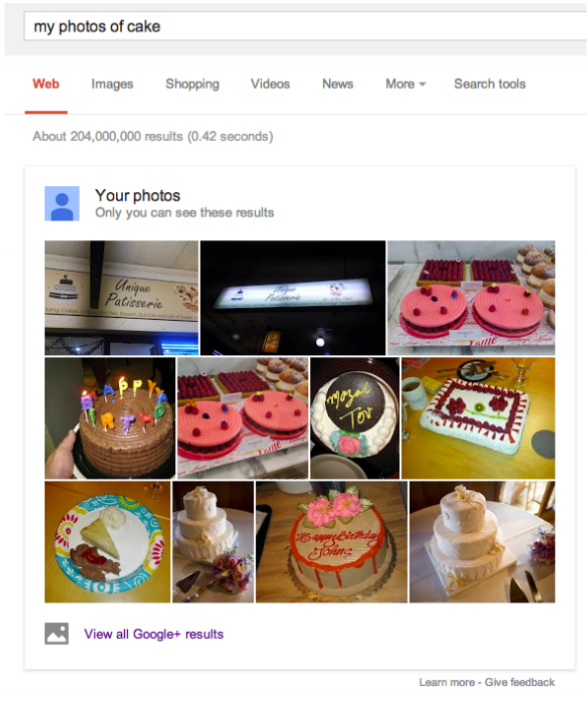
Visually similar images — Report images

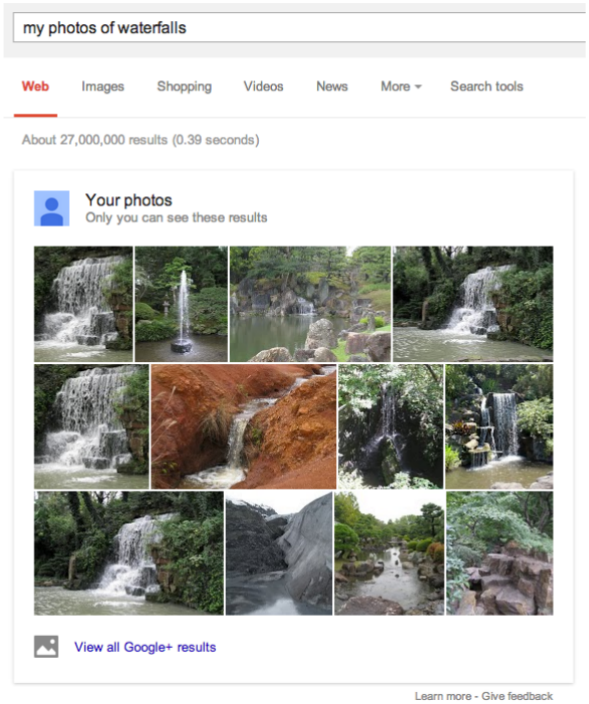
ConvNets

Google

Applications - Photo Search

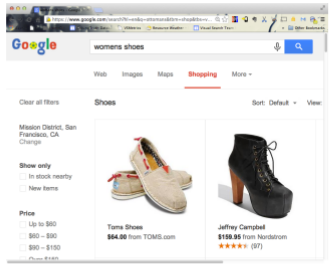




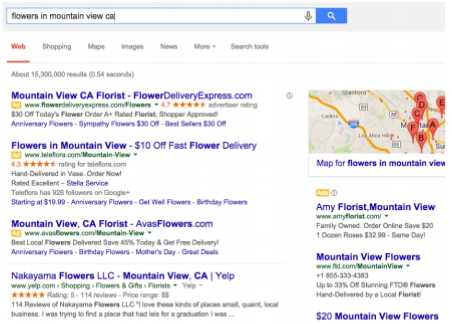


ConvNets

YouTube



Google Shopping



Advertising

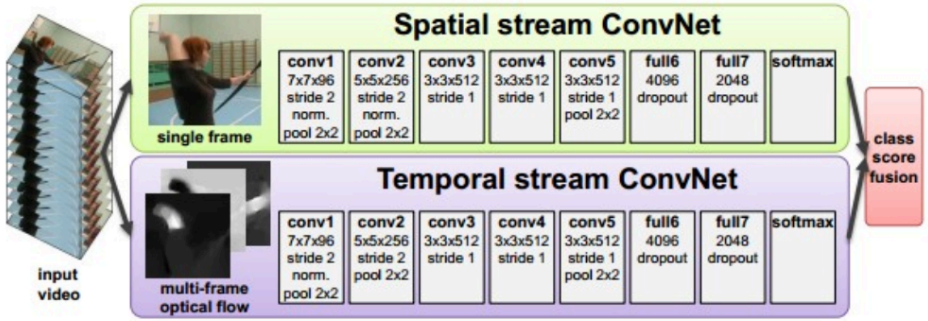
Much more...

StreetView / Maps

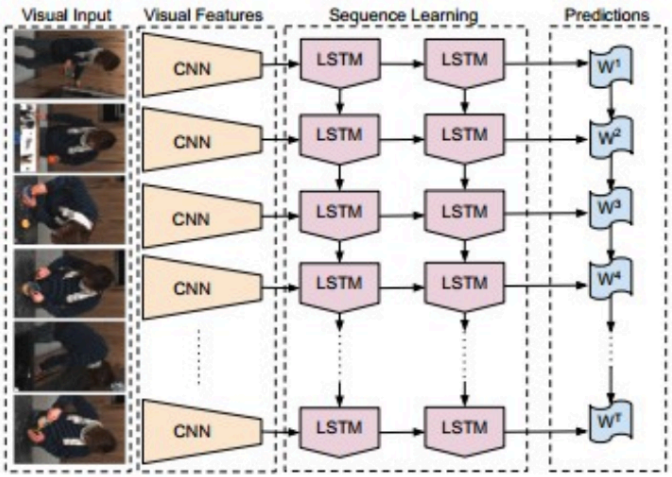
Self-Driving Cars

Robotics

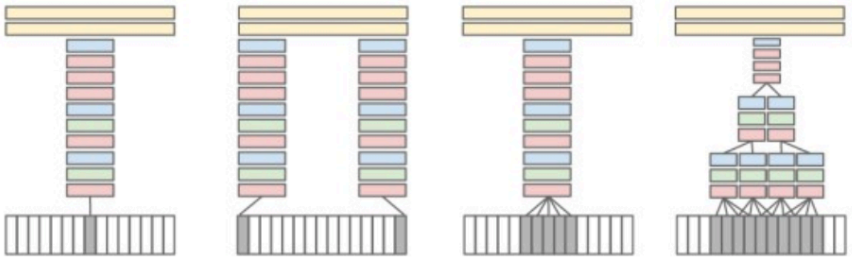
Video Classification



Two-Stream Convolutional Networks for Action Recognition in Videos *[Simonyan et al.], 2014*



Long-term Recurrent Convolutional Networks for Visual Recognition and Description
[Donahue et al.], 2014



Large-scale Video Classification with Convolutional Neural Networks
[Karpathy et al.], 2014

Image Captioning

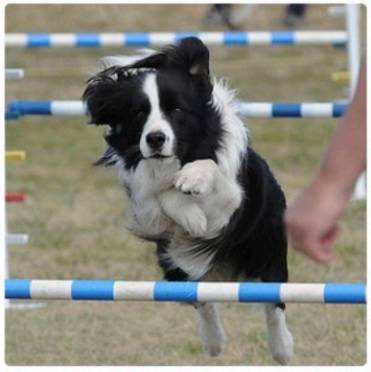
"man in black shirt is playing guitar."

"construction worker in orange safety vest is working on road."

"two young girls are playing with lego toy."

"boy is doing backflip on wakeboard."

"girl in pink dress is jumping in air."



"black and white dog jumps over bar."

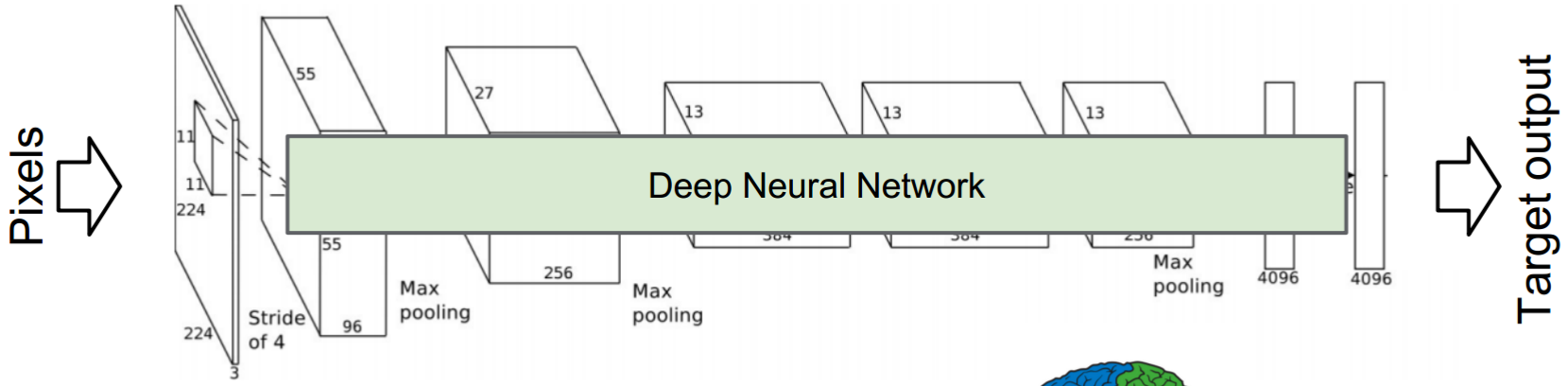
"young girl in pink shirt is swinging on swing."

"man in blue wetsuit is surfing on wave."

CNNs

Google

The Deep and now Deeper Hammer



Deep learning infrastructure by the Google Brain team

"ImageNet Classification with Deep Convolutional Neural Networks", Krizhevsky, Sutskever, Hinton, NIPS 2012

- Lightstage

Science in Art

- Joe and Pauline Degenfelder ‘60
  - Degenfelder jade collection

“Mutton” jade

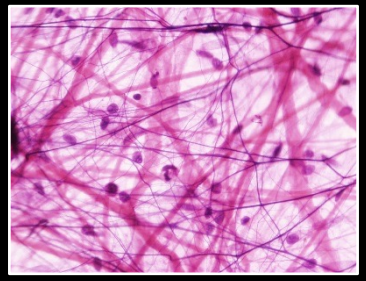
White jade inkwell

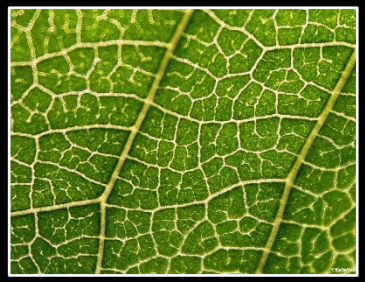
What makes
jade look like jade?

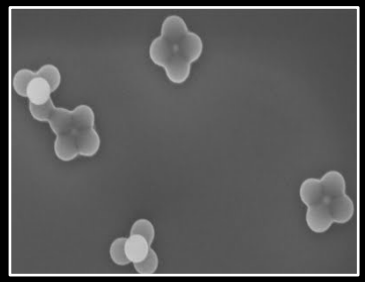
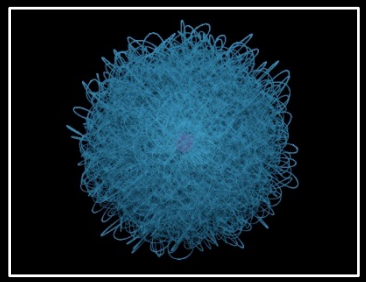
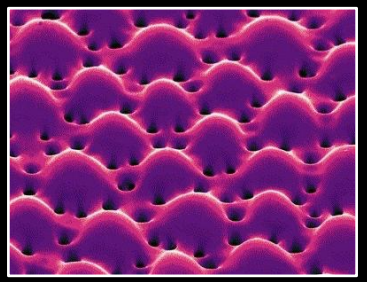
Why are translucent materials so beautiful?

shiny materials : light bounces off the surface

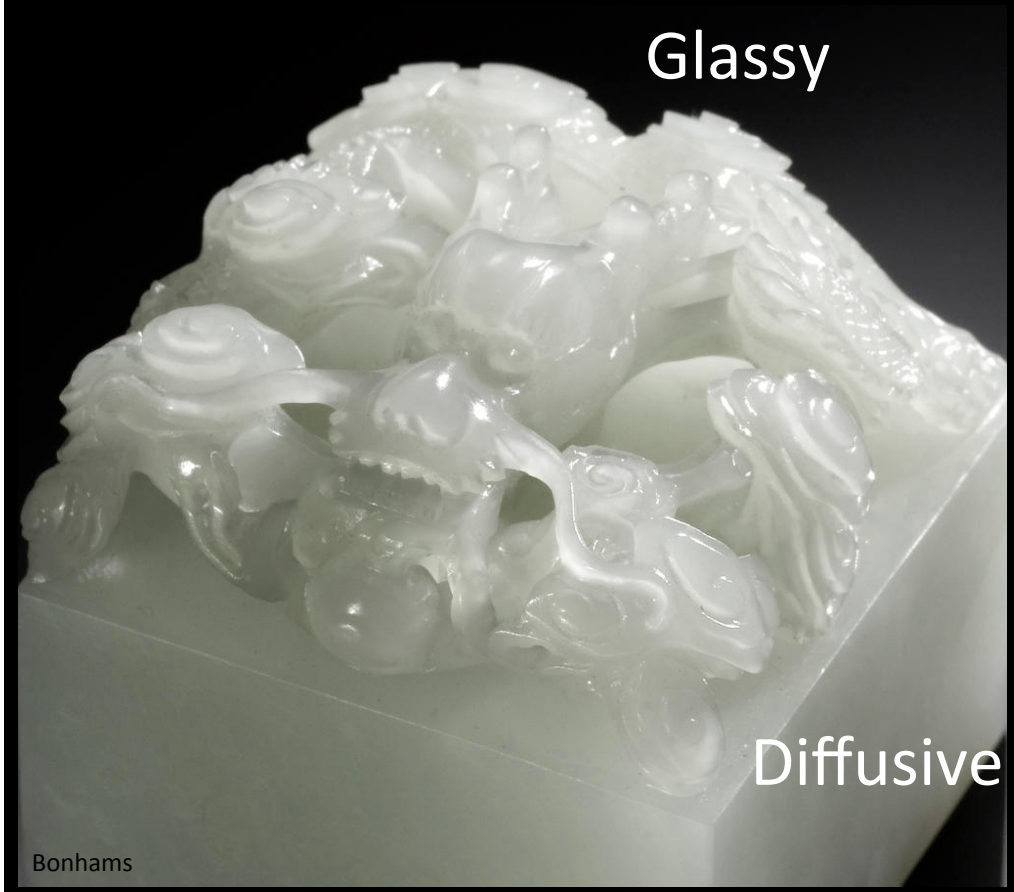
translucent materials : light goes into the surface





What makes white jade look like white jade?



Current graphics models

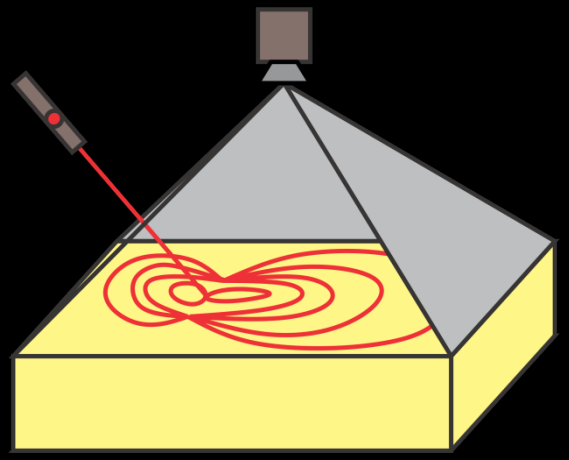
+ Diffusive

- Glassy

Answer

Phase function

Phase function: direction of light scatter

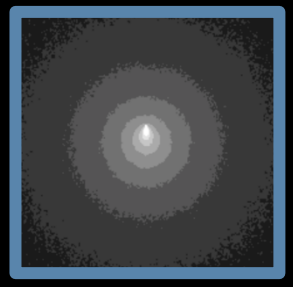


Setup

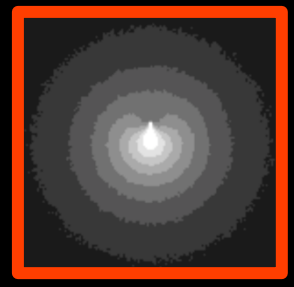
Soap

Wax

Captured



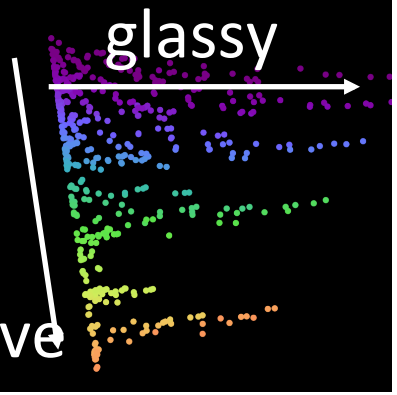
Old

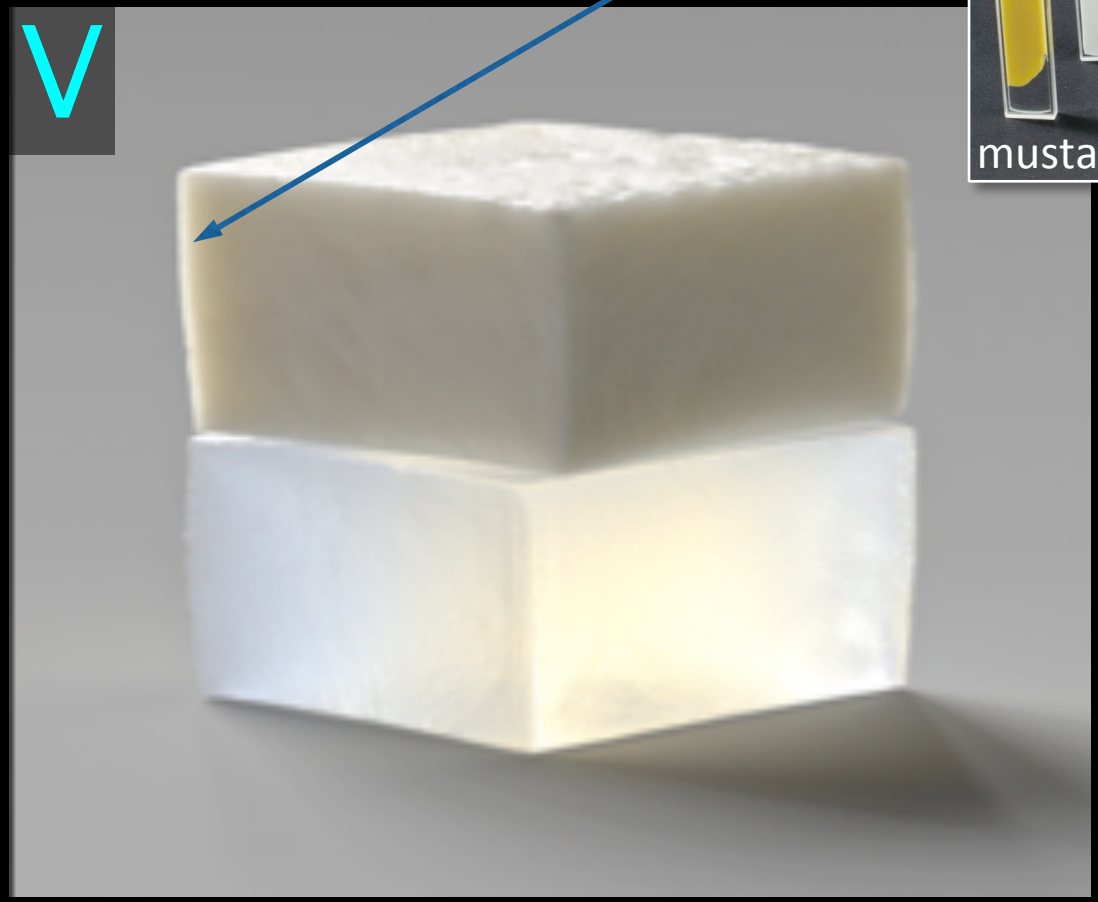


Ours

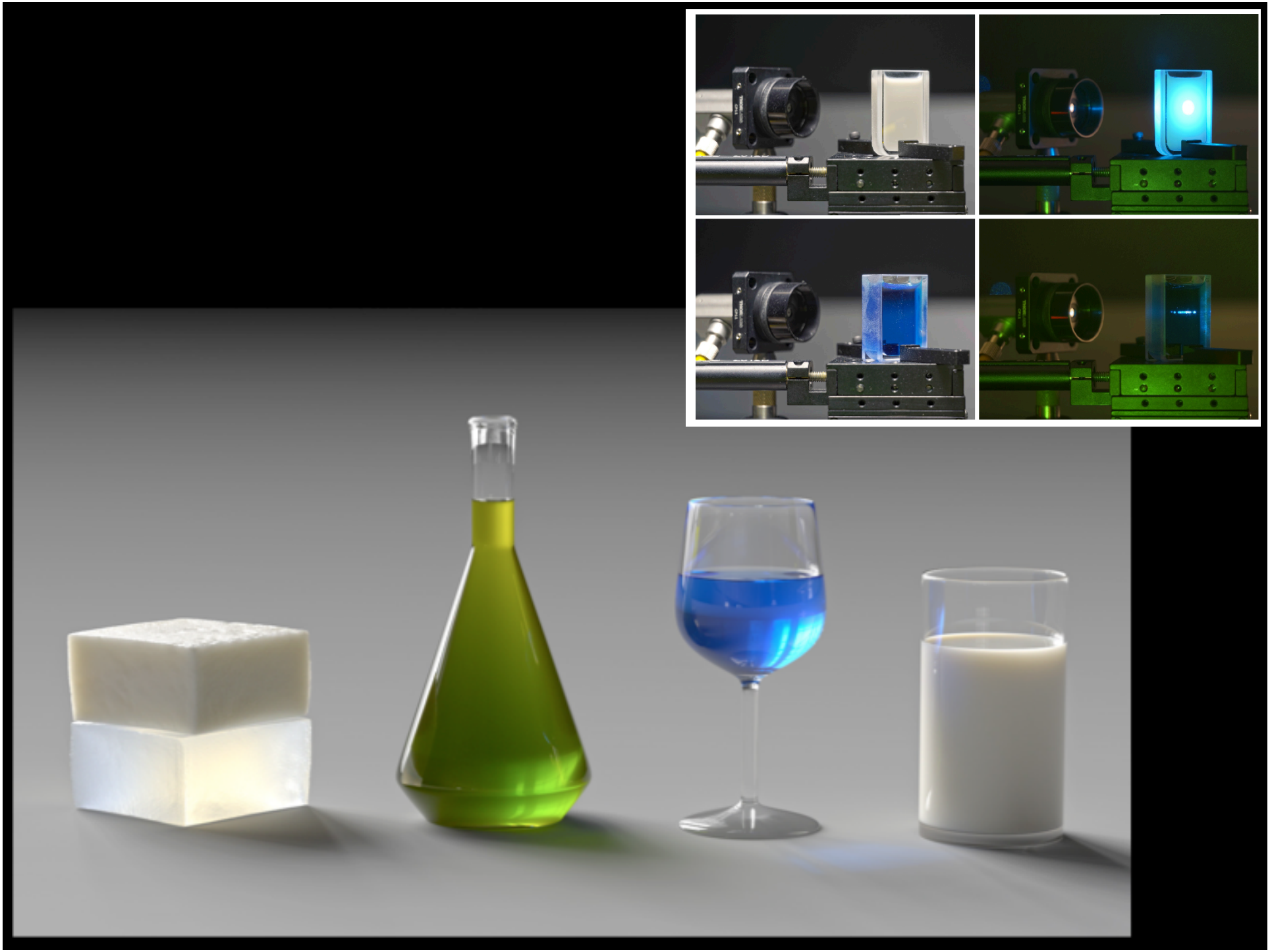
Simple models cannot produce glassy, only diffusive

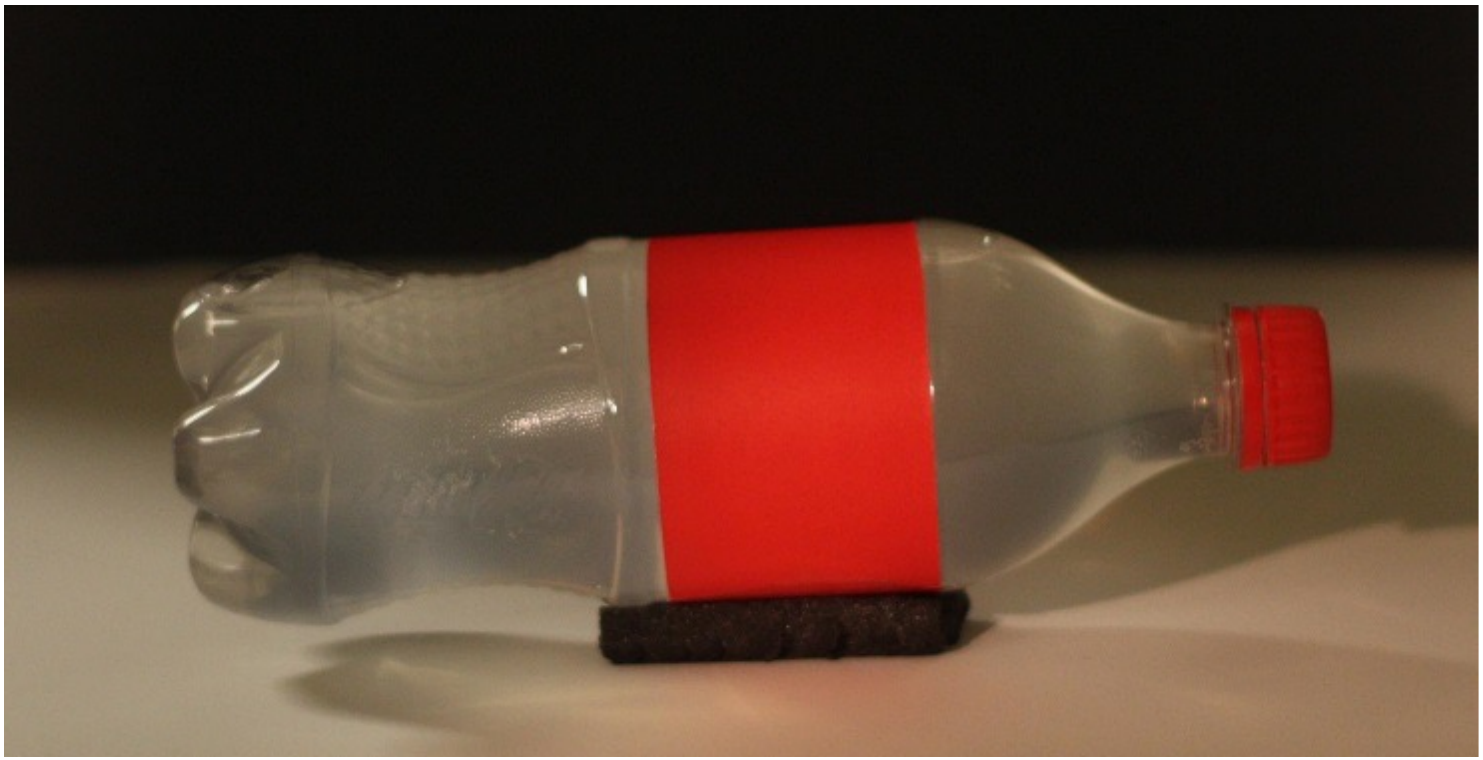
Ours: expand phase fns to 2 perceptual dimensions




V

R
hand cream
olive oil
curacao
shampoo
robitussin
mixed soa
whole milk
wine
milk soa
mustard
liquid clay
coffee
reduced milk

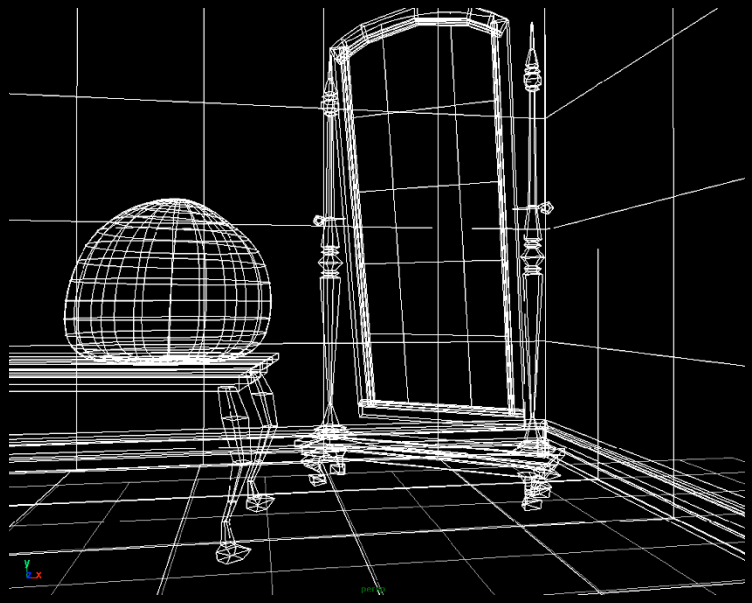




Femto photography

Project

Vision and Graphics



3D Model

2D image

- **Computer Graphics**: Models to Images
- **Computer Vision:** Images to Models
- **Comp. Photography:** Images to Images

Creating Realistic Imagery

Computer Graphics

- + great creative possibilities
- + easy to manipulate objects/ viewpoint

-Tremendous expertise and effort to obtain realism

Computational Photography

Realism
Manipulation
Ease of capture

Photography

- + instantly realistic
- + easy to aquire
- - very hard to manipulate objects/viewpoint

Aside: Image Manipulation

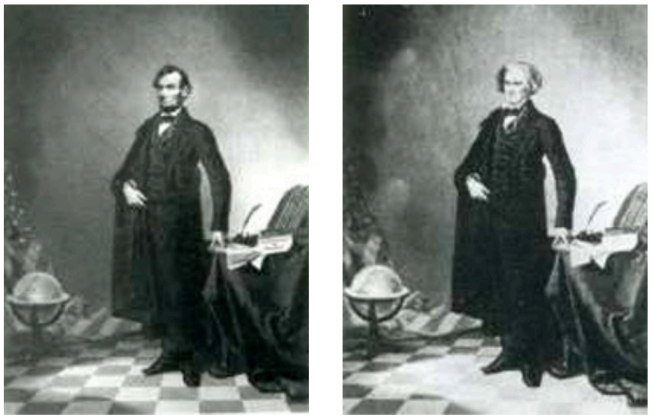
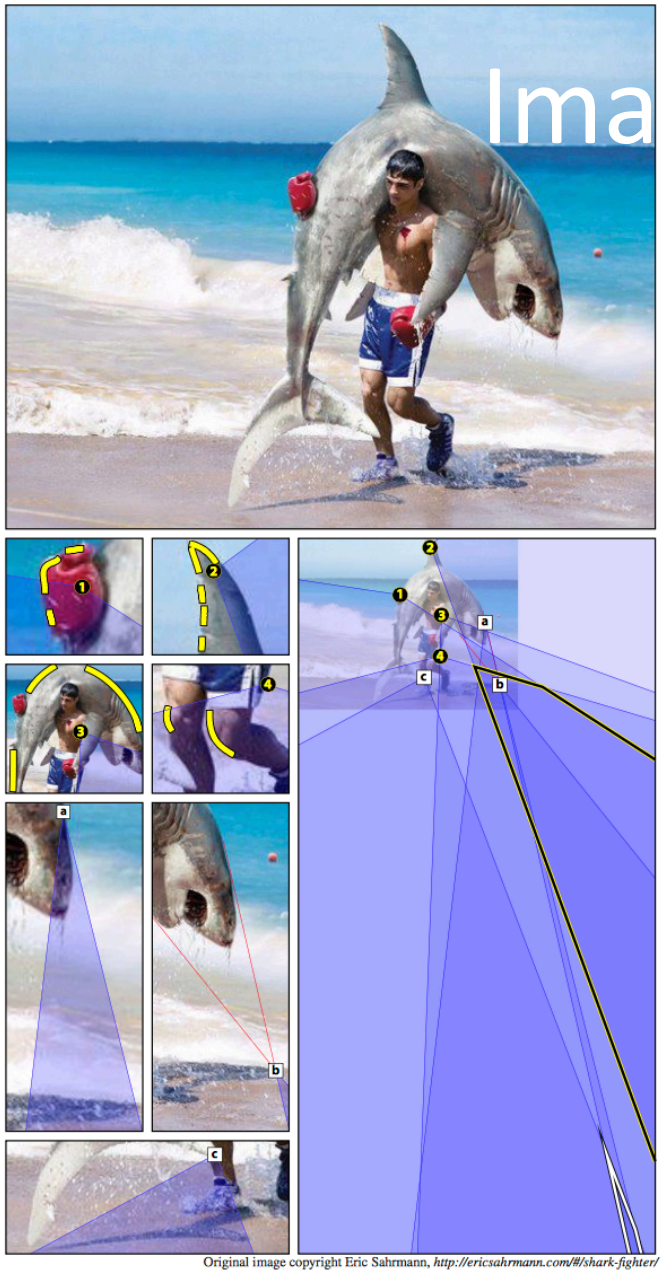


Figure 3: The 1860 portrait of President Abraham Lincoln and Southern politician John Calhoun.

Image Forensics

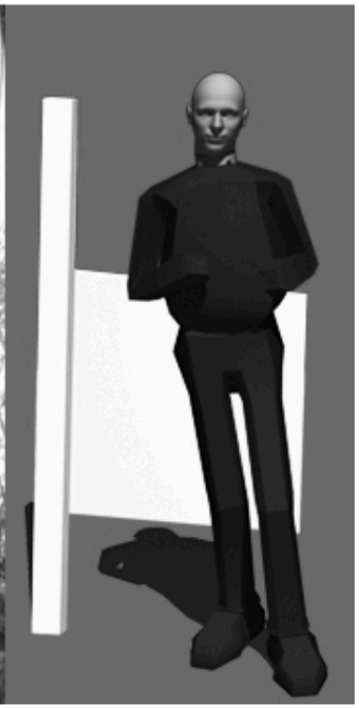


Original image copyright Eric Sahrmann, *http://ericsahrmann.com/#/shark-fighter/*

Fig. 1. The projected location of the light source is constrained by shading along occluding contours ❶ – ❹ and by cast shadows [a] – [c]. The intersection of the shading constraints (outlined in black) is inconsistent with the intersection of the shadow constraints (outlined in white), revealing this image to be a fake (not surprisingly).

Original image copyright 1969, NASA

Fig. 1. Our algorithm finds that the shadows in this 1969 moon landing photo are physically consistent with a single light source. The solid lines correspond to constraints from cast shadows and dashed lines correspond to constraints from attached shadows. The region outlined in black, which extends beyond the figure boundary, contains the projected light locations that satisfy all of these constraints.



The ultimate camera

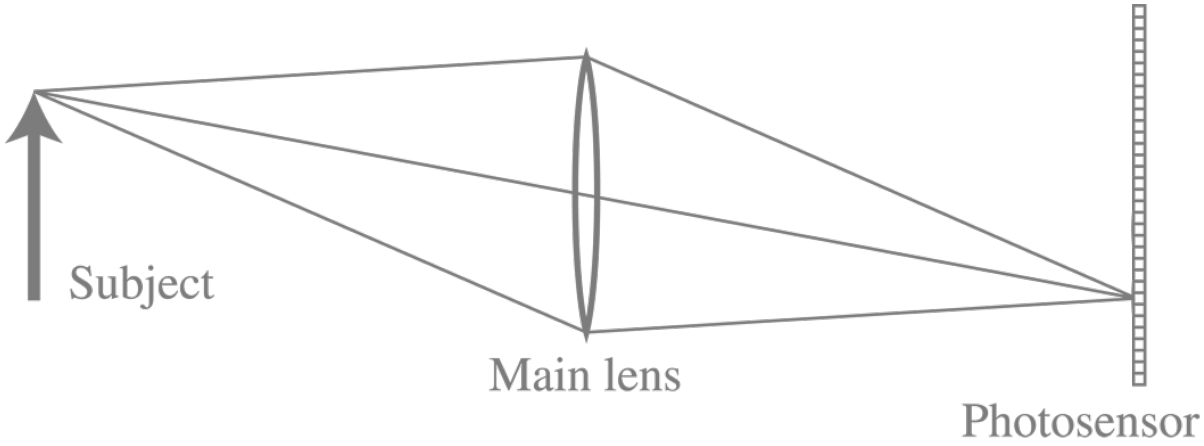
- Infinite resolution
- Infinite zoom control
- Desired object(s) are in focus
- No noise
- No motion blur
- Infinite dynamic range (can see dark and bright things)
- …

Light field camera [Ng et al., 2005]

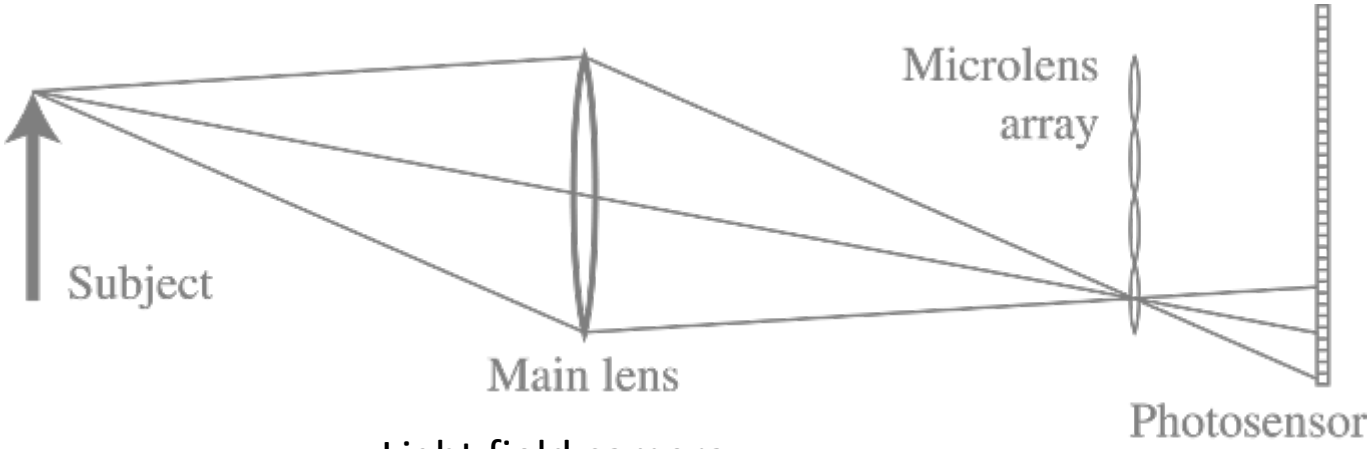
Light field camera

Refocusing images

Conventional vs. light field camera



Conventional camera



Light field camera

Inside the Lytro

The Lytro camera is the first consumer "light field camera." It uses a new technology to create photos that can have their focus changed after they have been taken. Because of this, there is no need to auto-focus, resulting in virtually no shutter delay. Here's how it works.

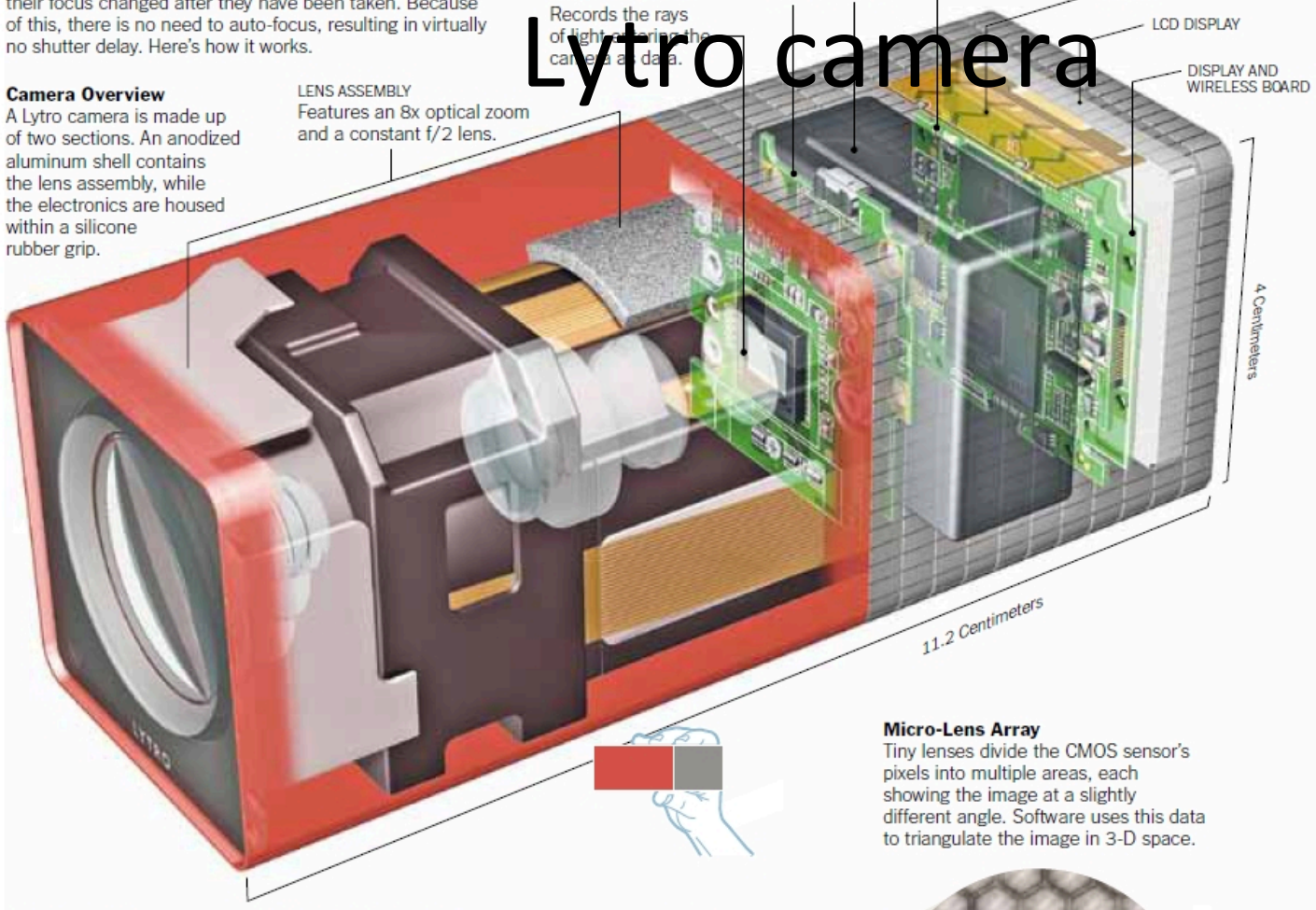
Lytro camera

Camera Overview
A Lytro camera is made up of two sections. An anodized aluminum shell contains the lens assembly, while the electronics are housed within a silicone rubber grip.

LENS ASSEMBLY
Features an 8x optical zoom and a constant f/2 lens.

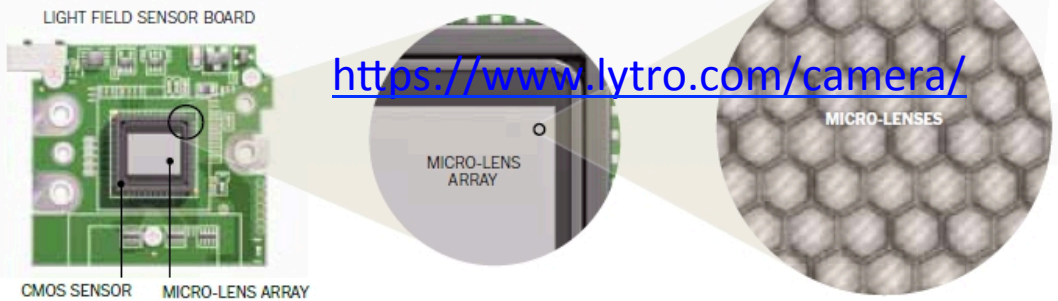
LIGHT FIELD SENSOR
Records the rays of light entering the camera at dash.

USB POWER BOARD
LITHIUM-ION BATTERY
MAIN PROCESSOR BOARD
ZOOM CONTROL SENSOR
LCD DISPLAY
DISPLAY AND WIRELESS BOARD



Micro-Lens Array
Tiny lenses divide the CMOS sensor's pixels into multiple areas, each showing the image at a slightly different angle. Software uses this data to triangulate the image in 3-D space.

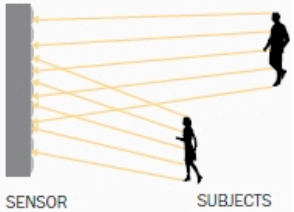
Light Field Sensor
Consists of a standard digital camera CMOS sensor coupled with a micro-lens array. The array contains thousands of miniature lenses.



https://www.lytro.com/camera/

Source: Lytro Inc.

Capturing Light
Lytro's light field sensor captures not only the color, intensity and position of the light, but also its direction, which is lost in traditional cameras.



Changing Focus
Because all the directional information of the entering light is captured, software can change the focal plane. Clicking any point on the image brings that area into focus, whether raindrops on the surface of a window or buildings beyond.

FRANK O'CONNELL/THE NEW YORK TIMES

Computational Photography

Gigapixels
Hyperlapse
Timelapse
Motion Magnification, video
Sound

LOOK RIGHT

Where to?

- Lots of companies doing vision
  - Big and small
- Robotics
- Self-driving cars
- Image applications
- Languages and images

- Masters and PhD

Questions?

- Good luck!