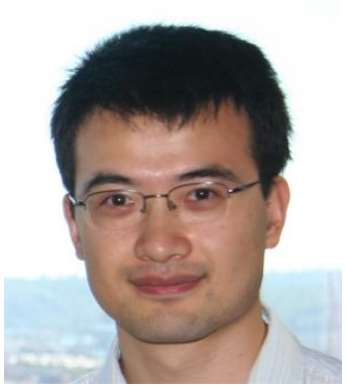
Computer Vision, CS766

Staff



Instructor: Li Zhang
lizhang@cs.wisc.edu

TA: Jake Rosin
rosin@cs.wisc.edu

Today

Introduction

Administrative Stuff

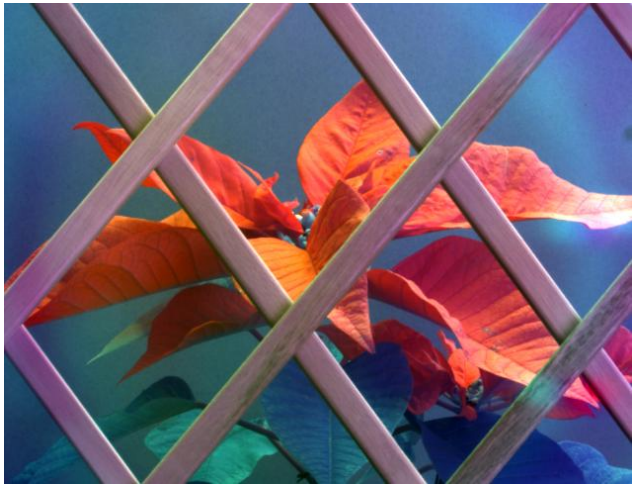
Overview of the Course

About Me

- Li Zhang (张力)
  - Last name pronounced as Jung
  - www.cs.wisc.edu/~lizhang
- Research
  - Computer Vision
  - Computer Graphics
- Teaching
  - CS766 Computer Vision
  - CS559 Computer Graphics

Previous Research Focus

- 3D shape reconstruction



Scene

3D Model

Depth Map

Previous Research Focus

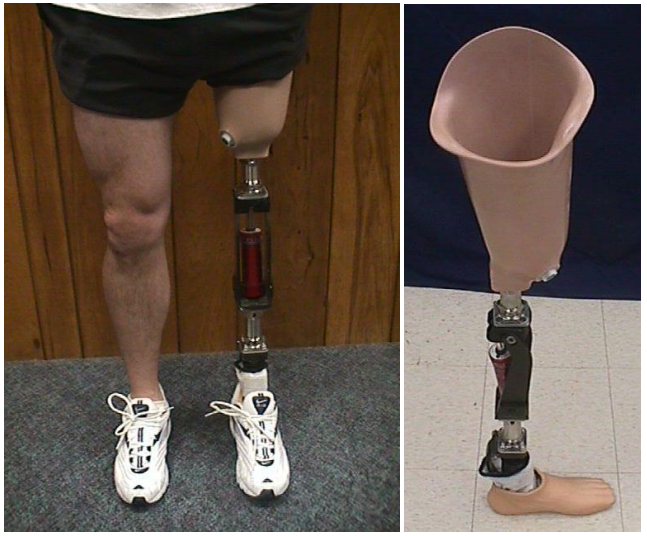
- 3D shape reconstruction

Four examples of recovered 3D shapes
of a moving face from six video streams

Previous Research Focus

- 3D shape reconstruction
- Application

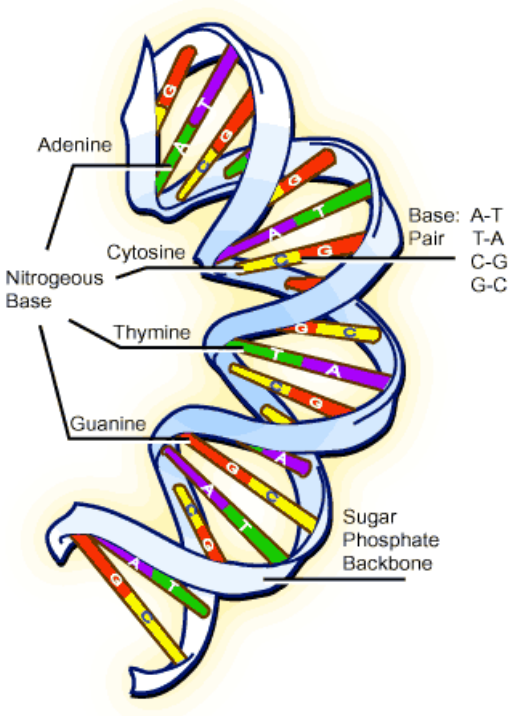
Entertainment:
Games & Movies



Medical Practice:
Prosthetics

Previous Research Focus

- 3D shape reconstruction
- Application



Biology: genotype ⇔ phenotype

Please tell me about you

Who you are?
Why you are taking this class?
What do you want to learn?

Name	Honors Type	Honors Y/N	Units Taken	Audit	Program	Current Level	Proj Level
Barnard,Aubrey Francis			3.00		G229	GR	GR
Bechle,Adam Jon			3.00		G175	GR	GR
Chen,Xiyang			3.00		BS	40	40
Deshpande,Alok Shridhar			3.00		G382	GR	GR
Field,Blayne Alan			3.00		G229	GR	GR
Hopman,Christopher John			3.00		BS	30	30
Huang,Yancan			3.00		G229	GR	GR
Jin,Guoliang			3.00		G229	GR	GR
Maheshwari,Mayank			3.00		G229	GR	GR
Nassif,Houssam G			3.00		G229	GR	GR
Pan,Yi			3.00		G229	GR	GR
Song,Jiasi			3.00		G229	GR	GR
Vaddadi,Sundeep			3.00		G382	GR	GR
Vuong,Ba-Quy			3.00		G229	GR	GR
Wang,Tuo			3.00		G229	GR	GR
Wayner,Elisabeth Laura			3.00		G229	GR	GR
Xie,Chao			3.00		G229	GR	GR
Yang,Kong			3.00		G229	GR	GR
Zhang,Yupu			3.00		G229	GR	GR
Zhu,Shengqi			3.00		G229	GR	GR

Prerequisites

- Prerequisites—*these are essential*!
  - Data structures
  - A good working knowledge of C++/Java programming
    - (or willingness/time to pick it up quickly!)
  - Linear algebra
  - Vector calculus

- Course does ***not*** assume prior imaging experience
  - no image processing, graphics, etc.

Administrative Stuff

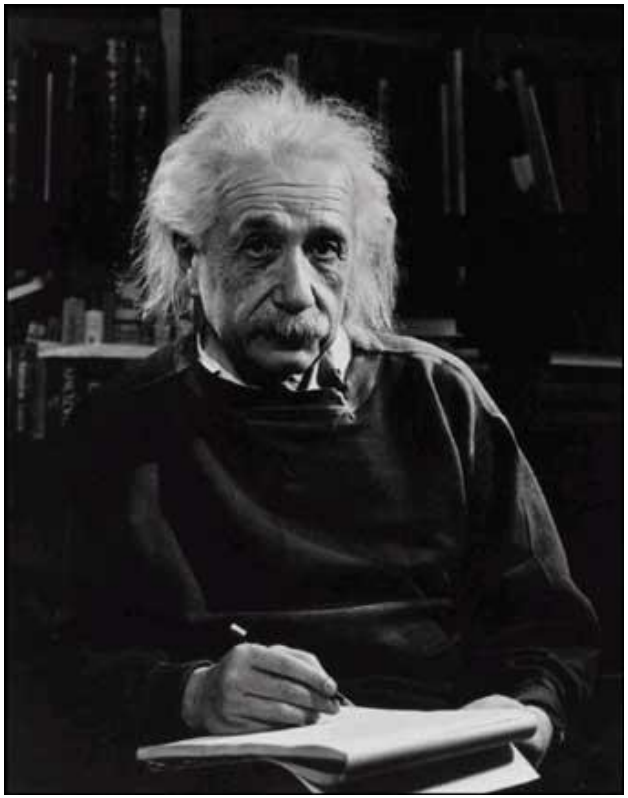
- **1 written assignment**
  - 5% (this week)
- **3 programming projects**
  - 15%, 2-3 weeks each
- **Paper presentation**
  - 15%, over a month
- **1 final project**
  - 35%, 5 weeks, open ended of your choice, but needs
  - project proposal after 1 week
  - progress report after 3 weeks
  - Final presentation after 5 weeks

Administrative Stuff

- **Computer account**:
  - Everyone registered in this class will get a Computer Systems Lab account to do project assignments.
- **Email list**:
  - compsci766-1-f08@lists.wisc.edu

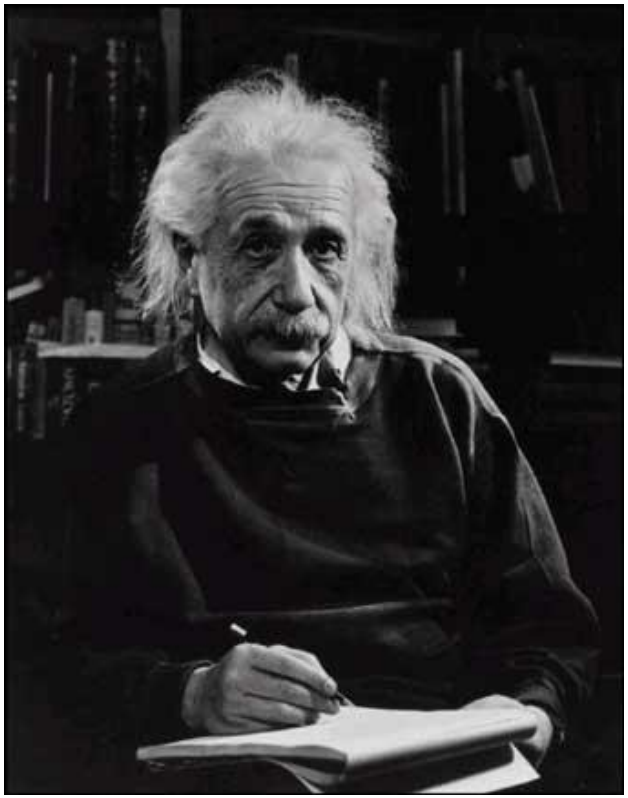
Questions?

Every picture tells a story



Goal of computer vision is to write computer programs that can interpret images

Can computer match human perception?



- Yes and no (but mostly no!)
  - computers can be better at “easy” things

Can computer match human perception?

- Yes and no (but mostly no!)
  - computers can be better at “easy” things
  - humans are much better at “hard” things

Computer Vision vs Human Vision

- Can do amazing things like:
  - Recognize people and objects
  - Navigate through obstacles
  - Understand mood in the scene
  - Imagine stories
- But still is not perfect:
  - Suffers from Illusions
  - Ignores many details
  - Doesn’t care about accuracy of world

Srinivasa Narasimhan’s slide

Computer vision vs Human Vision

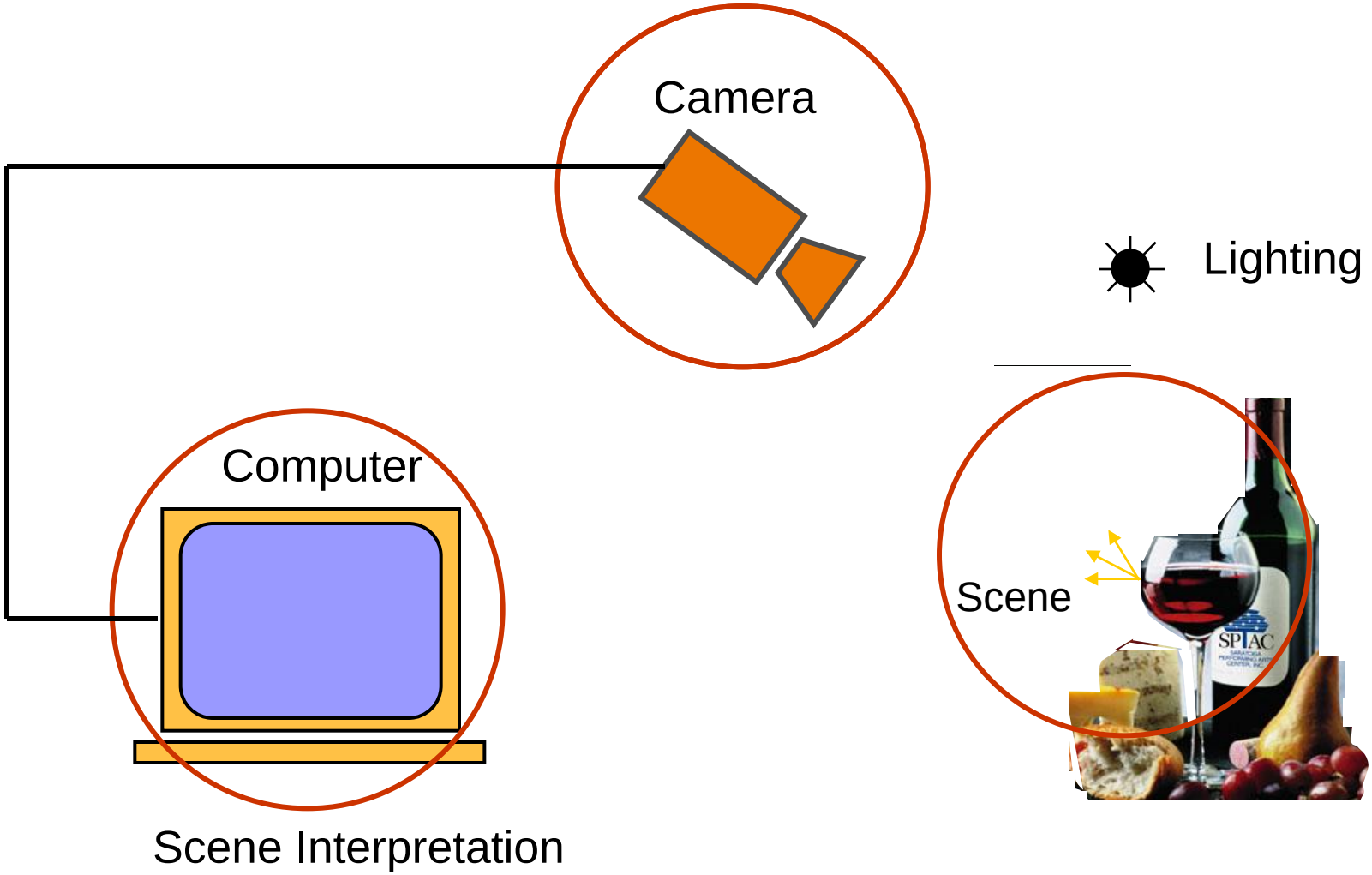
What we see

0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

Srinivasa Narasimhan's slide

Components of a computer vision system

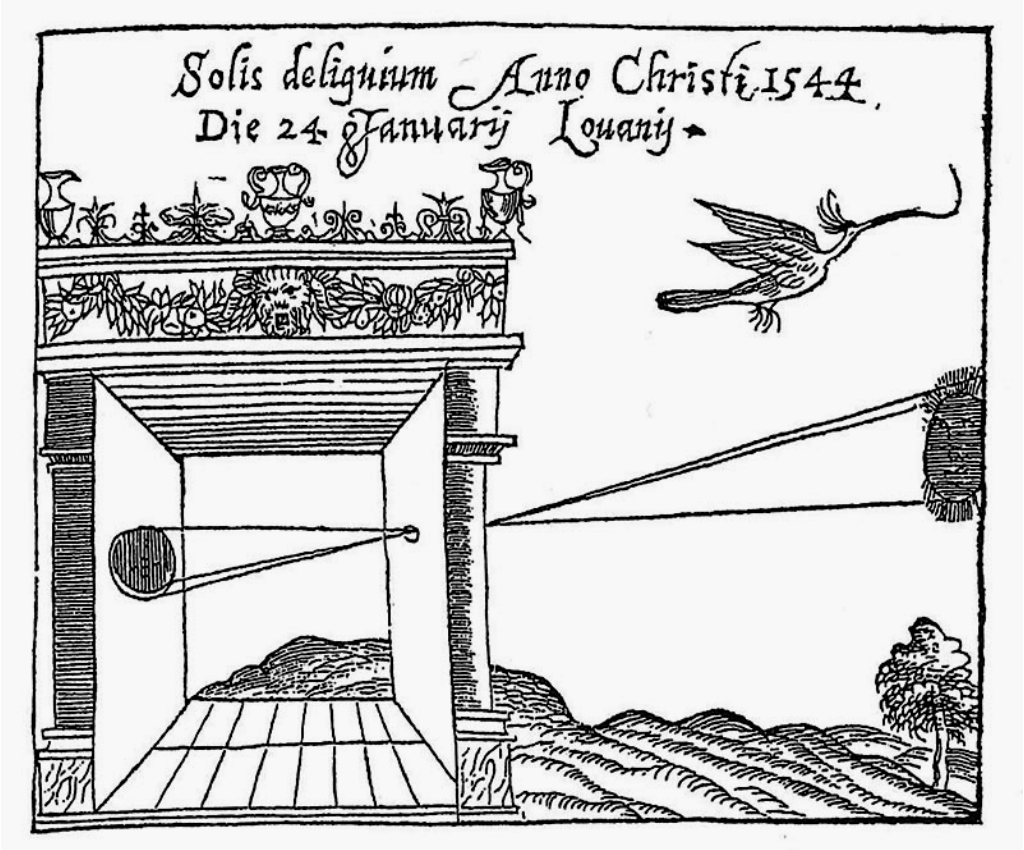


Srinivasa Narasimhan's slide

Topics Covered

Cameras and their optics

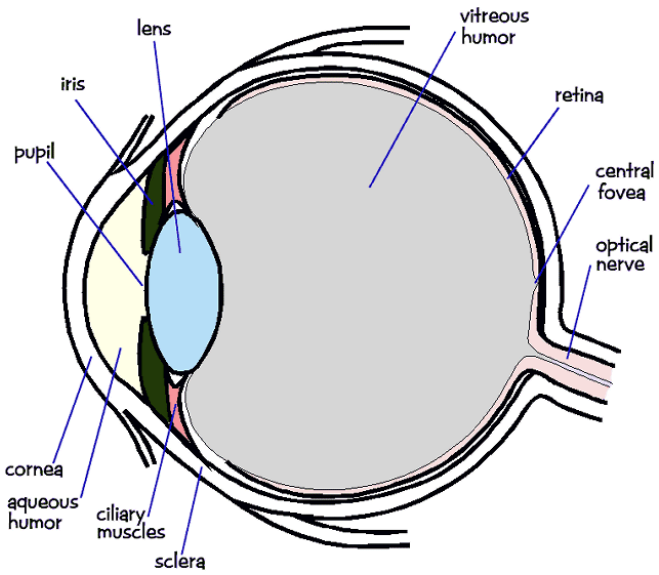
Today's Digital Cameras



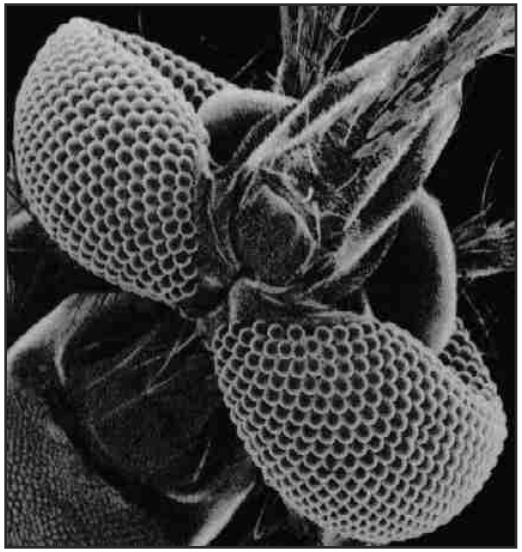
The *Camera Obscura*

Srinivasa Narasimhan's slide

Biological vision



Human Eye



Mosquito Eye

Srinivasa Narasimhan's slide

A tiny camera

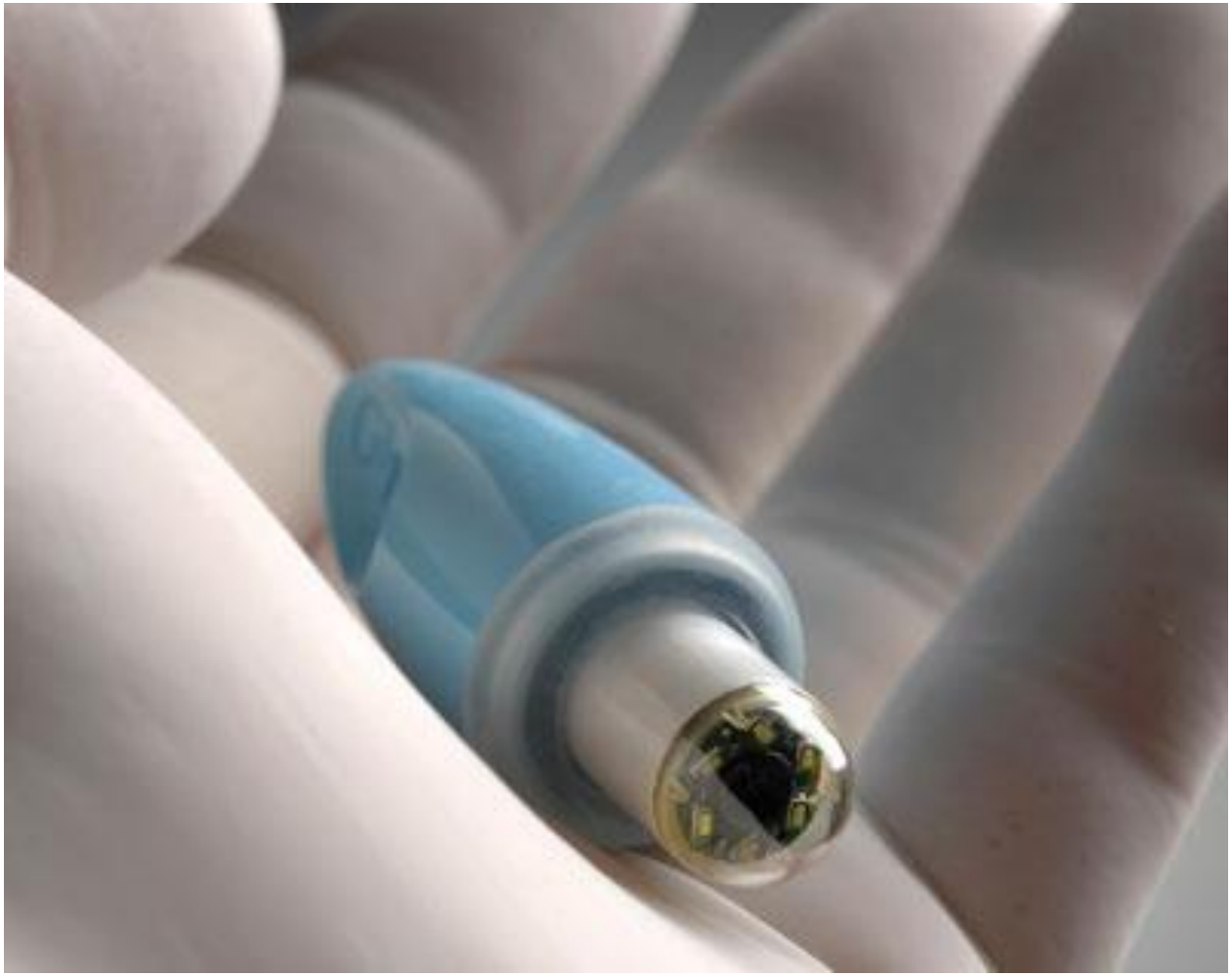
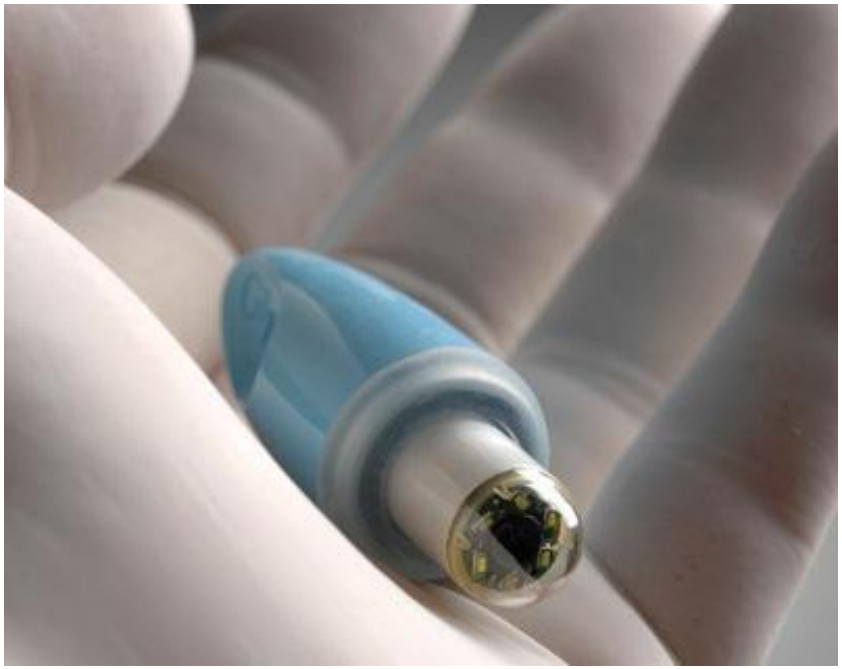


PHOTO: FRAUNHOFER INSTITUTE FOR BIOMEDICAL ENGINEERING

A tiny camera



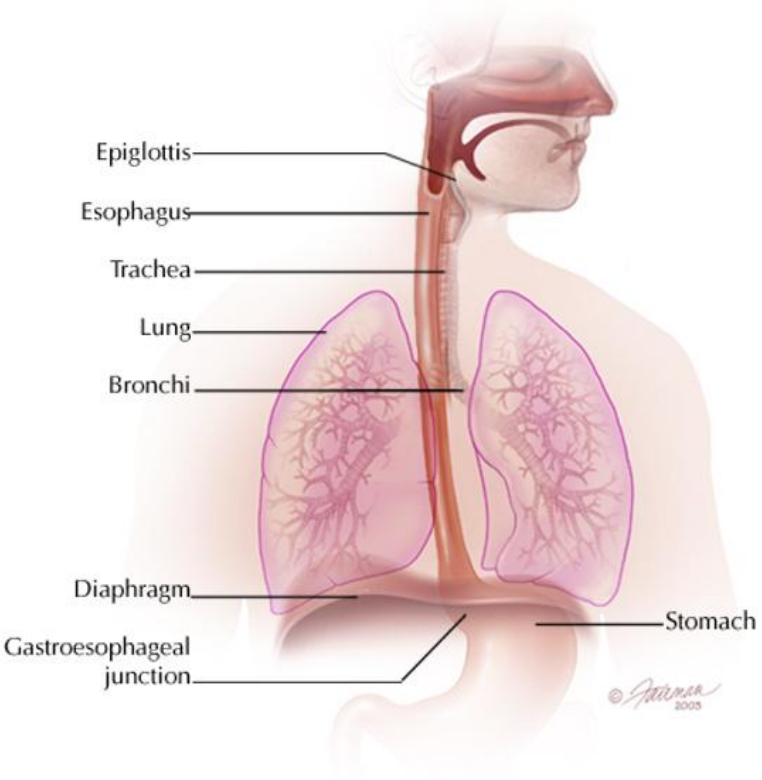


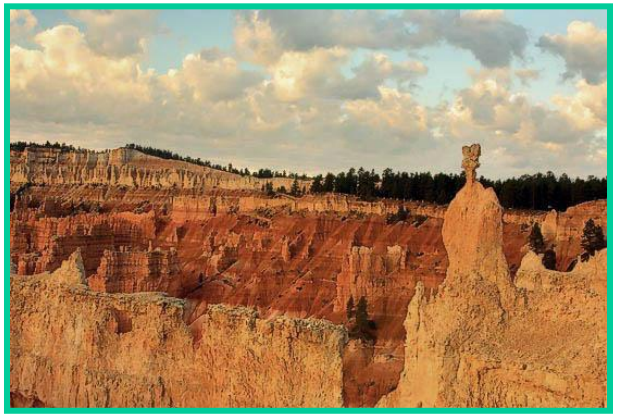
PHOTO: FRAUNHOFER INSTITUTE FOR BIOMEDICAL ENGINEERING

Project 1: High Dynamic Range Imaging

- Cameras have limited dynamic range

Short Exposure

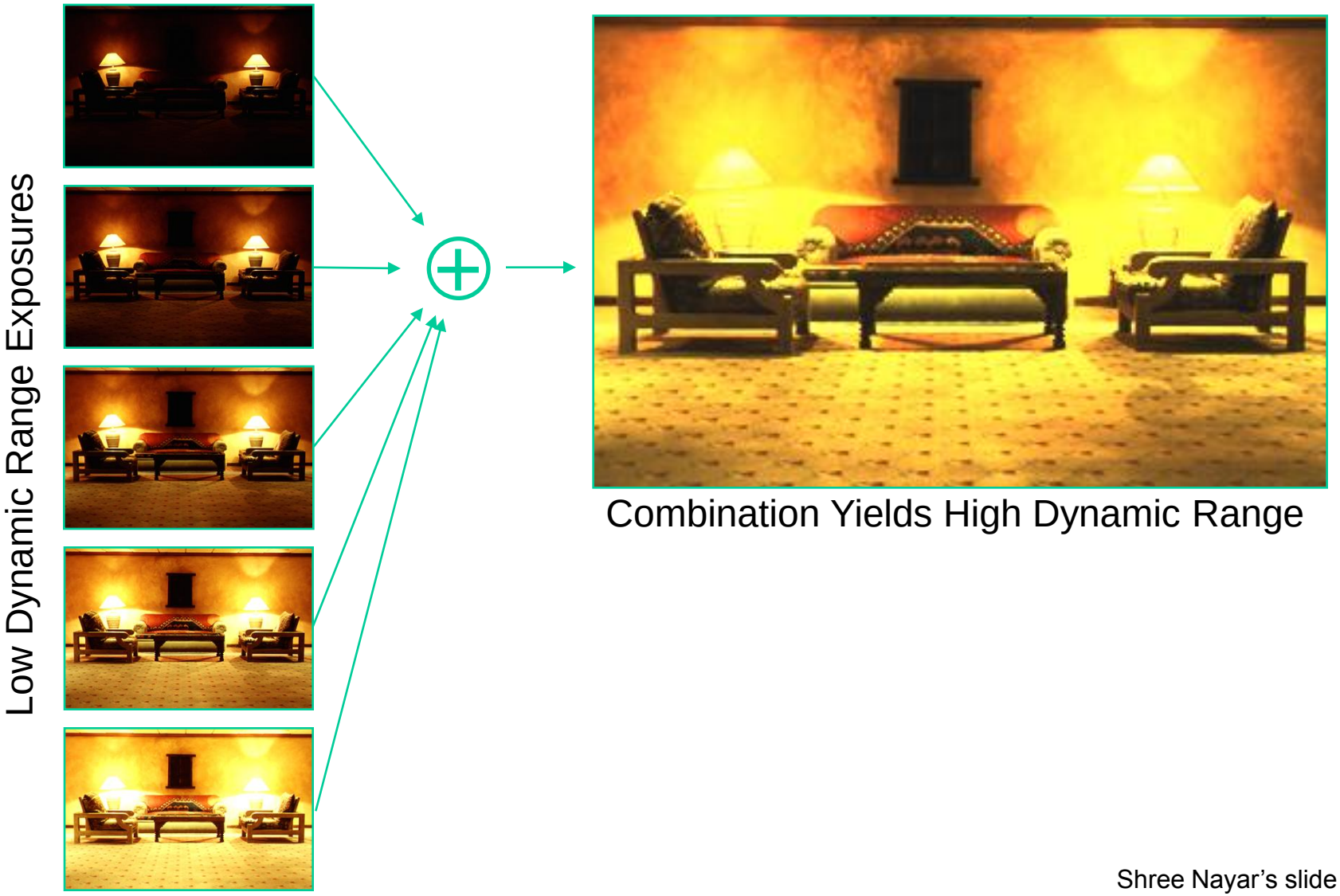
Long Exposure



Desired Image

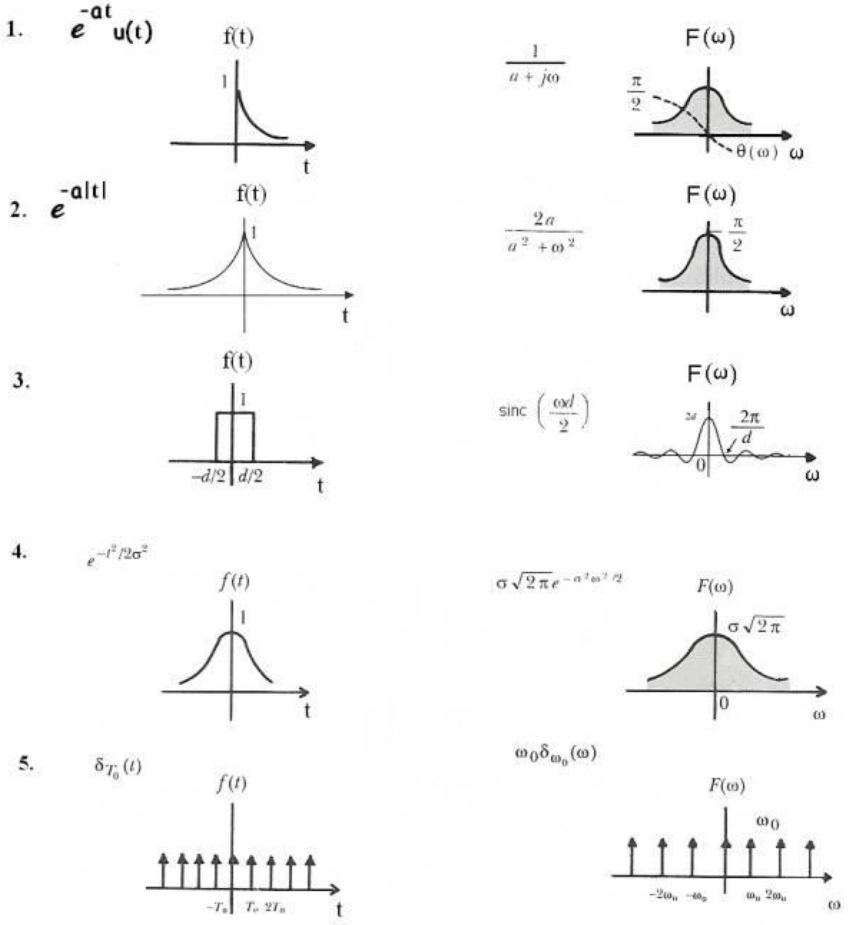
Shree Nayar's slide

Project 1: High Dynamic Range Imaging



Shree Nayar's slide

Image Processing



Fourier Transform
Sampling, Convolution

Image enhancement
Feature detection

Srinivasa Narasimhan's slide

Camera Projection

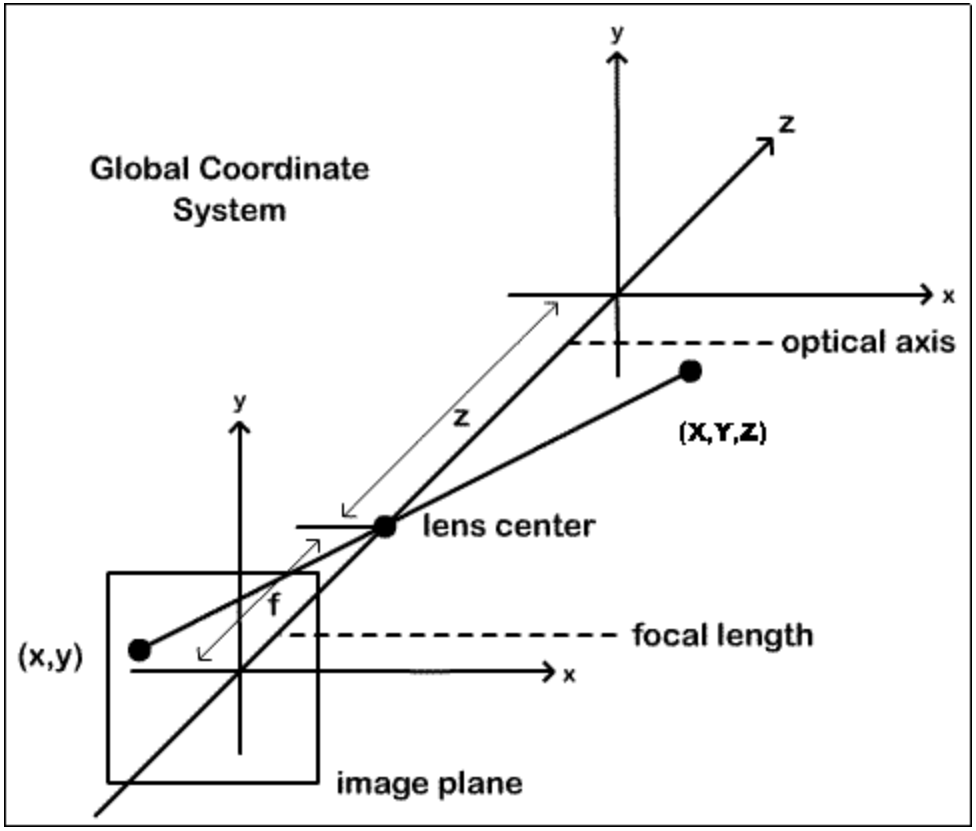
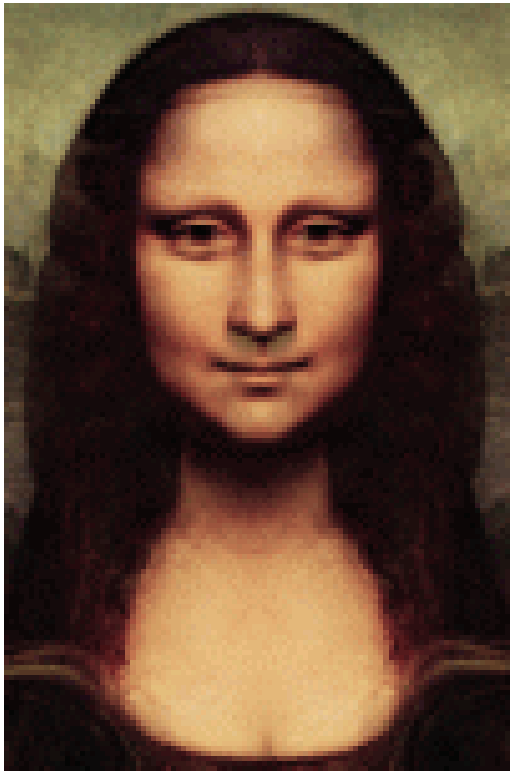


Image Transformation



Steve Seitz and Chuck Dyer, View Morphing, SIGGRAPH 1996

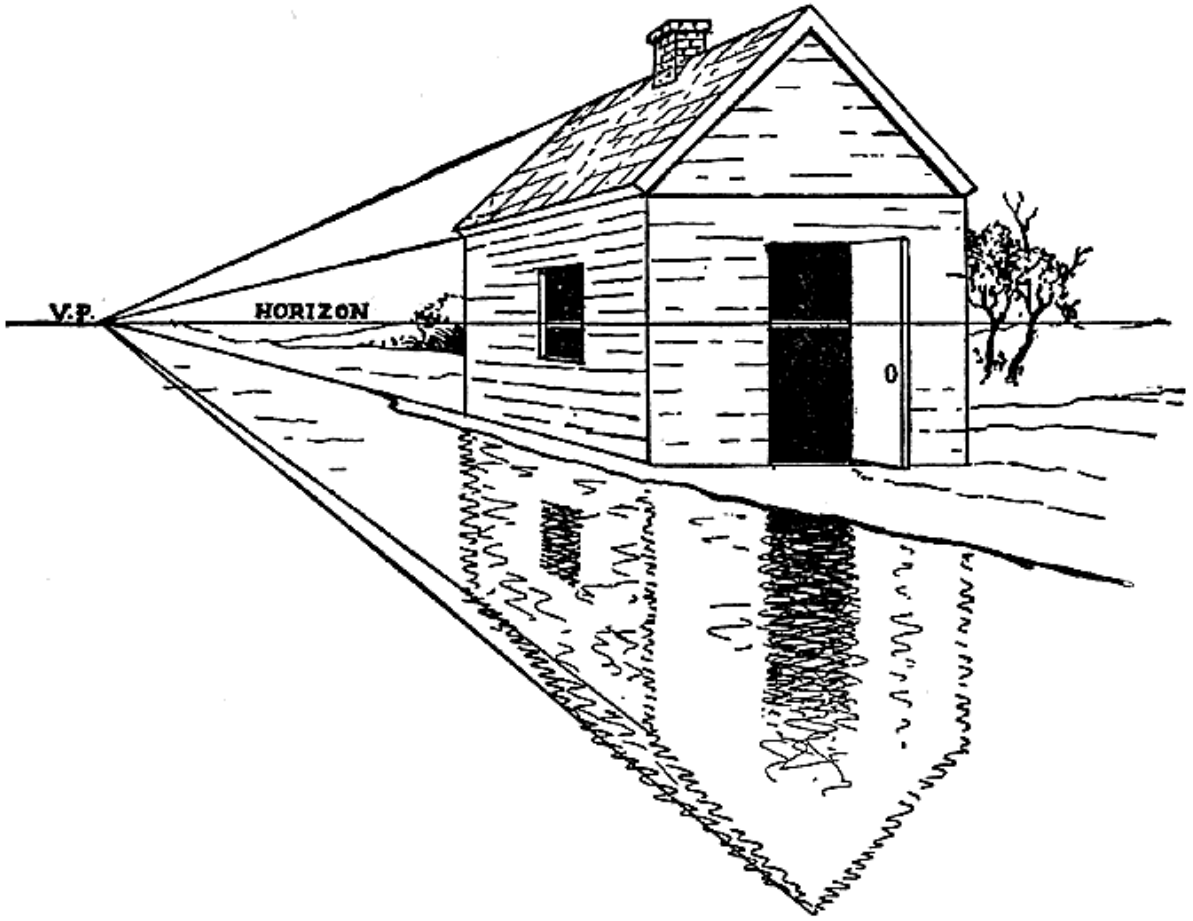
Project 2: Panoramic Imaging

Input images:

Output Image:

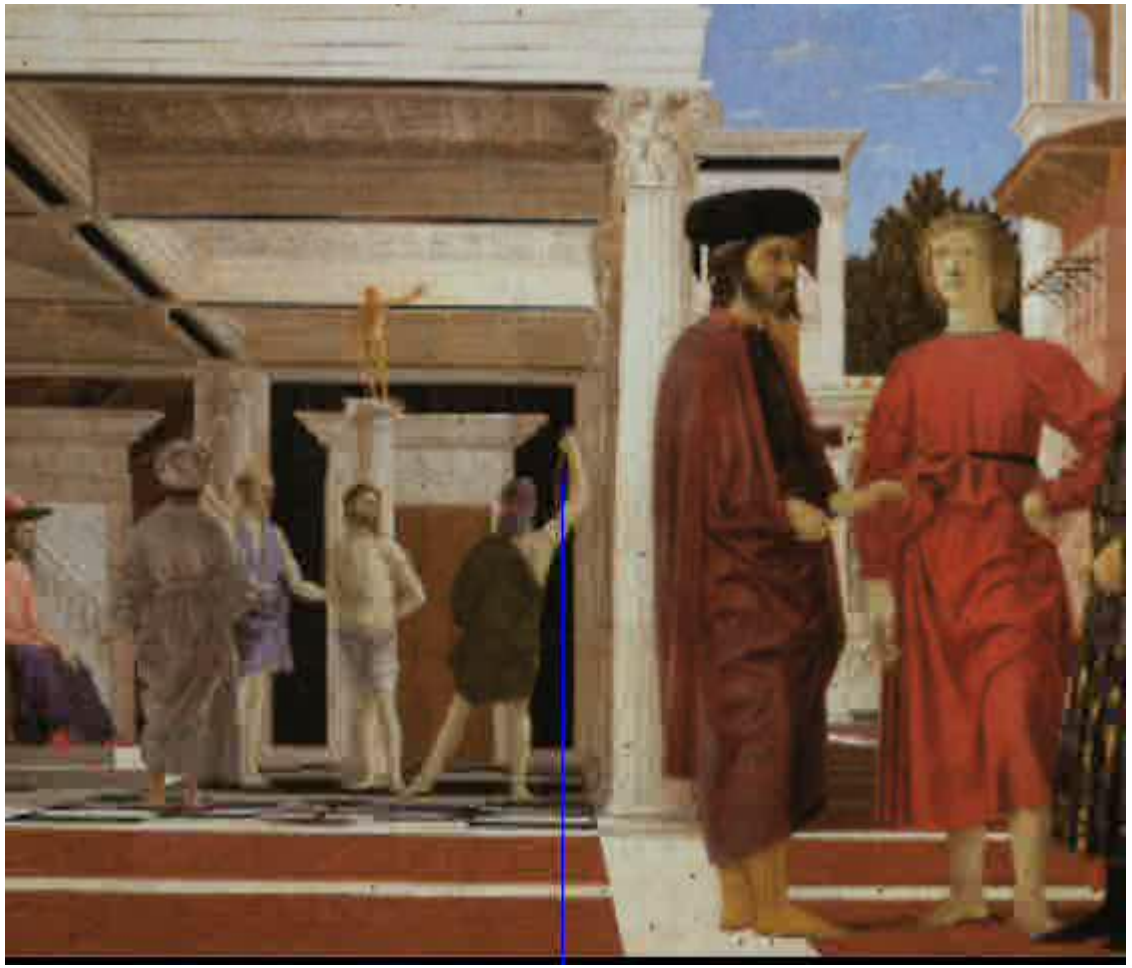
Steve Seitz's slide

Projective Geometry



Single View Metrology

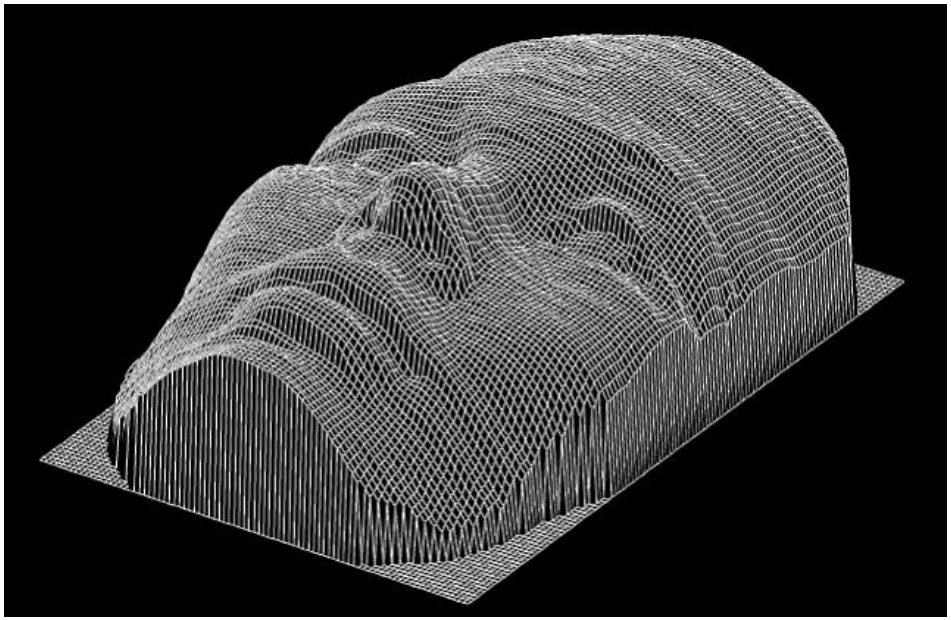
- http://research.microsoft.com/vision/cambridge/3d/default.htm



Single View Metrology

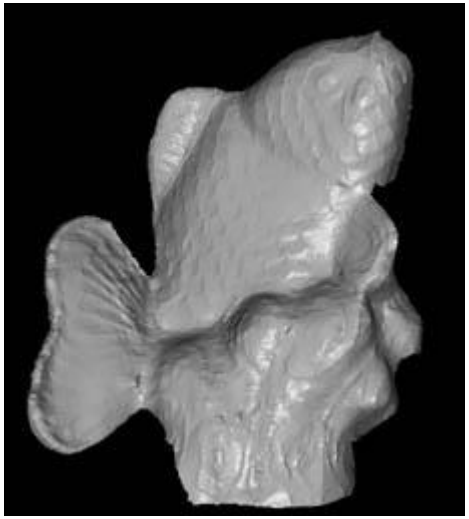
- http://research.microsoft.com/vision/cambridge/3d/default.htm

Shading and Photometric Stereo

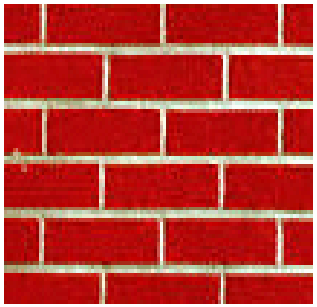


http://www.eecs.harvard.edu/~zickler/helmholtz.html

Project 3: photometric stereo

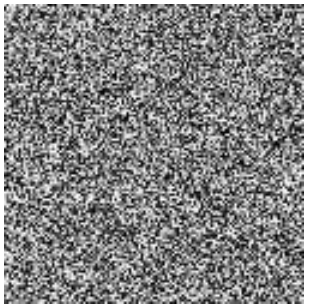


Texture Modeling



repeated

radishes rocks yogurt



stochastic

“Semi-stochastic” structures

Alexei Efros’ slide

Texture Synthesis

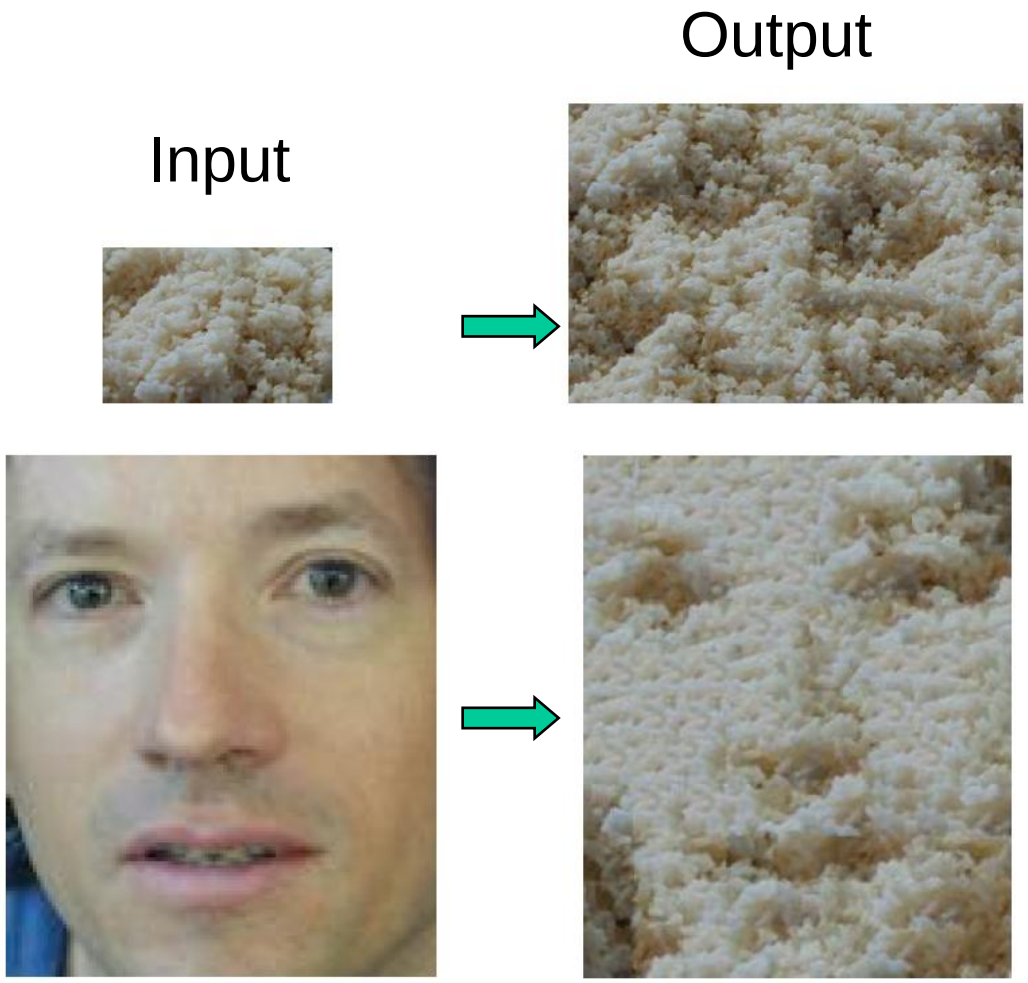


Image Quilting, Efros and Freeman., SIGGRAPH 2002.

Texture Synthesis

Input images:

Output Image:

Graphcut Textures, Kwatra et al., SIGGRAPH 2003.

Multi-view Geometry

http://phototour.cs.washington.edu/

- Binocular Stereo (2 classes)
- Multiview Stereo (1 class)
- Structure from Motion (2 classes)

Applications

- http://photosynth.net/default.aspx

Face Detection and Recognition

Motion Estimation

Hidden Dragon Crouching Tiger

Motion Estimation

Application

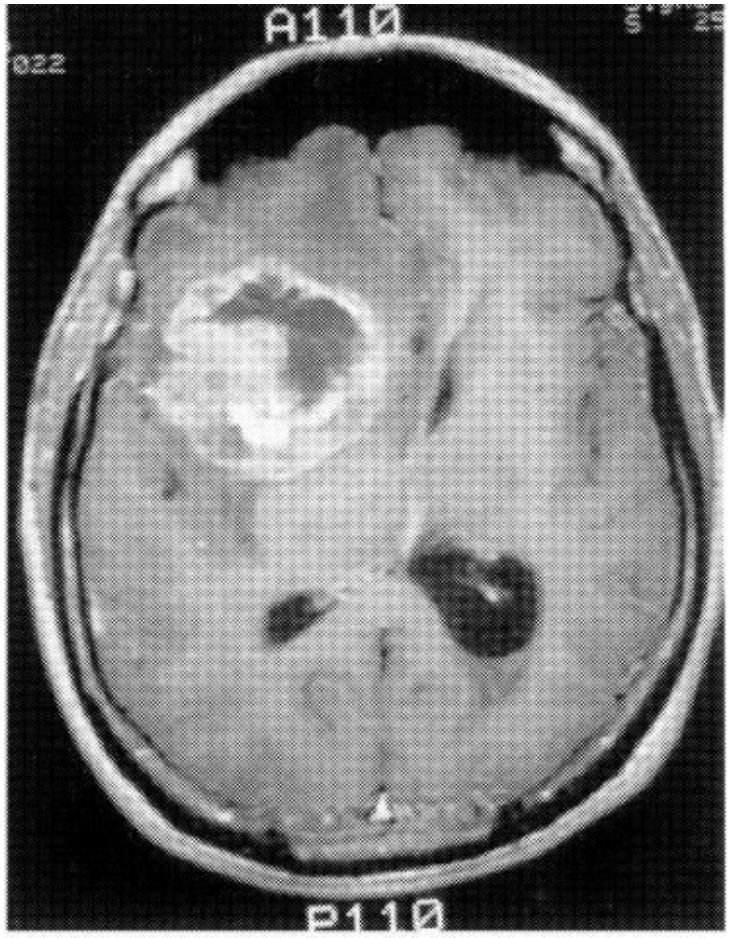
Andy Serkis, Gollum, Lord of the Rings

Segmentation

http://www.eecs.berkeley.edu/Research/Projects/CS/vision/bsds/

Segmentation

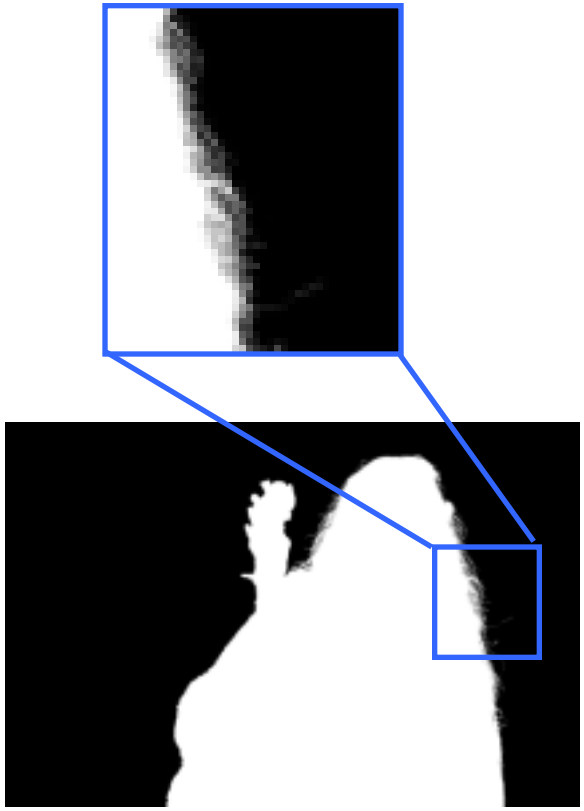
Application



Medical Image Processing

Matting

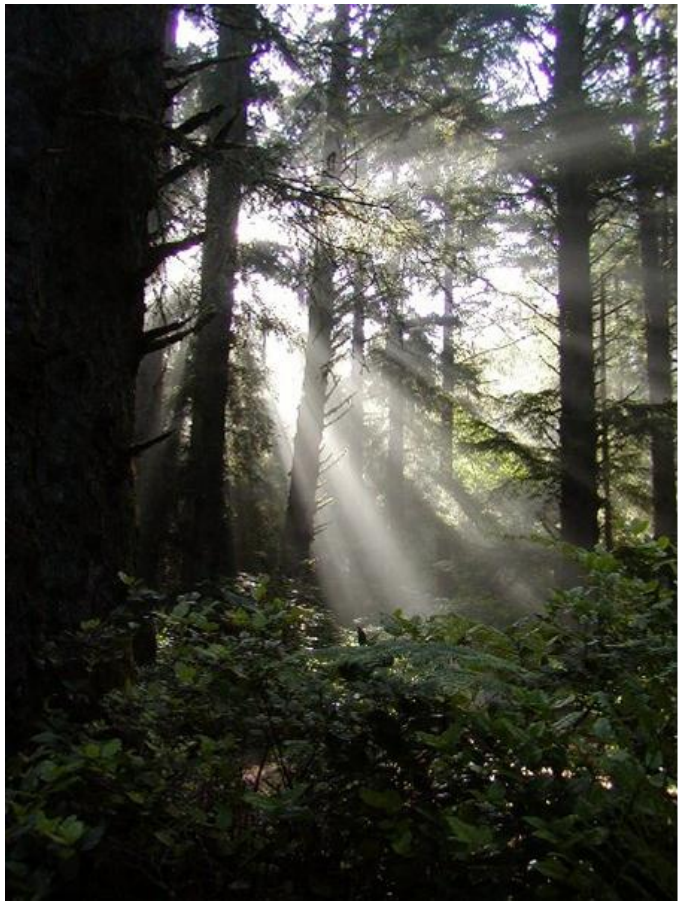
Input

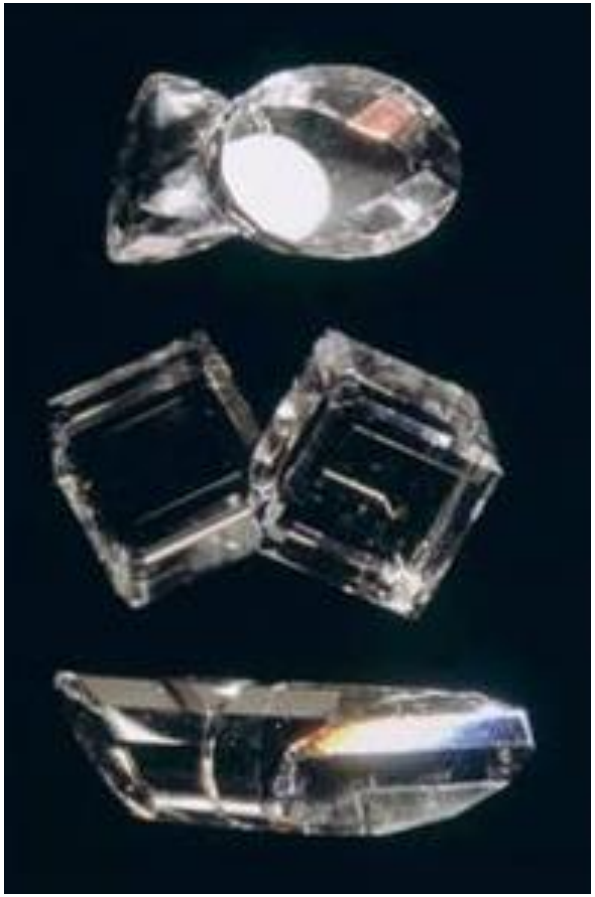


Matting

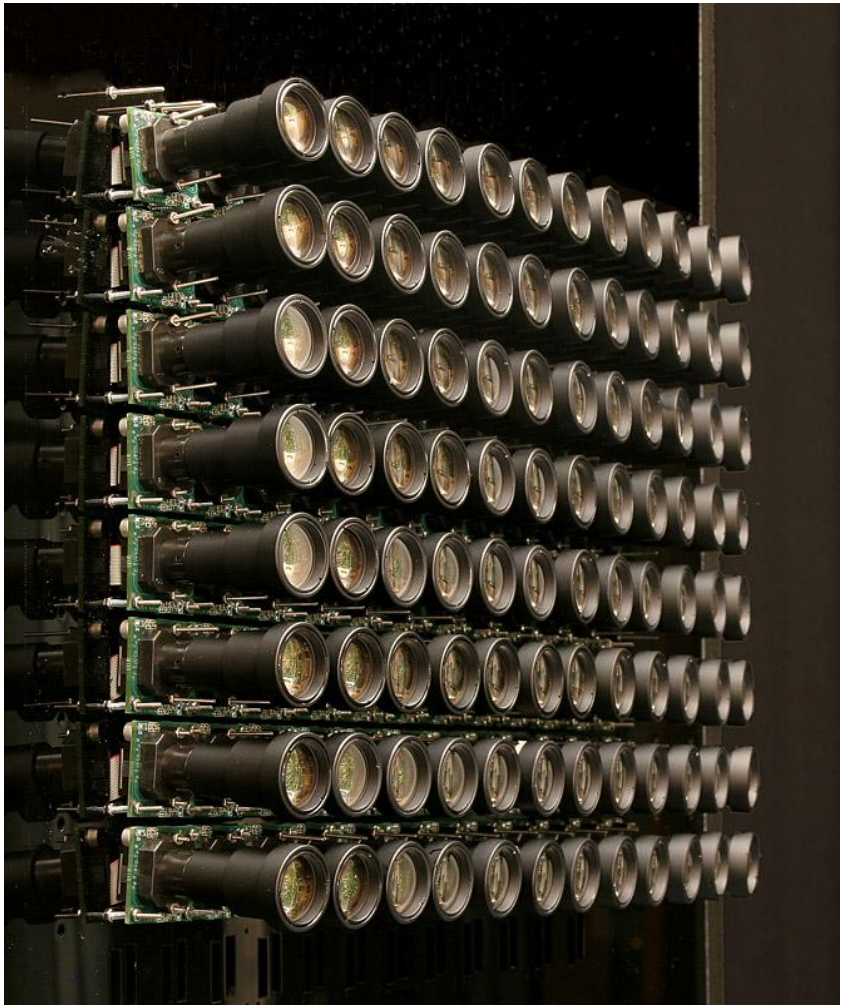
Composition

Light, Color, and Reflection





Capturing Light Field



Camera Arrays, Graphics Lab, Stanford University

Capturing Light Field

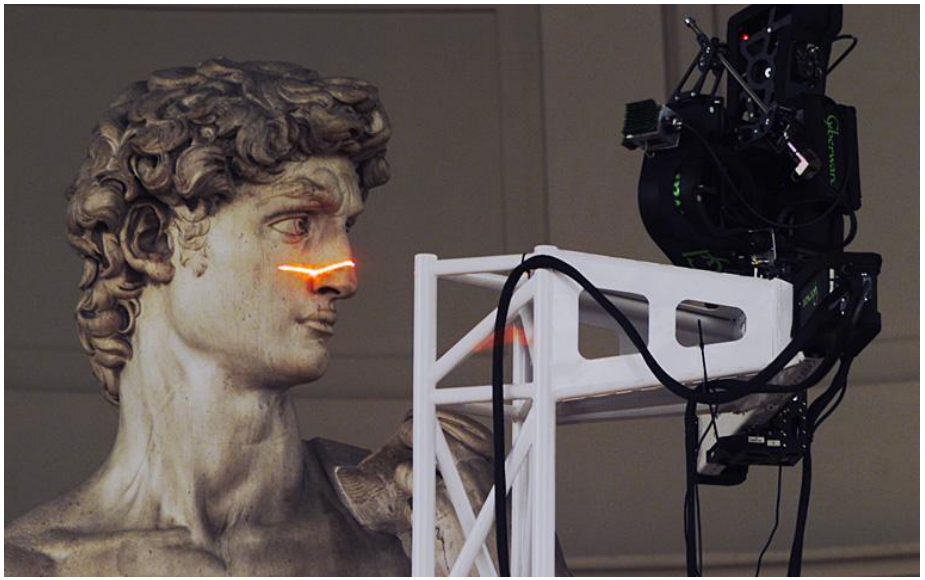
Applications: synthetic aperture imaging

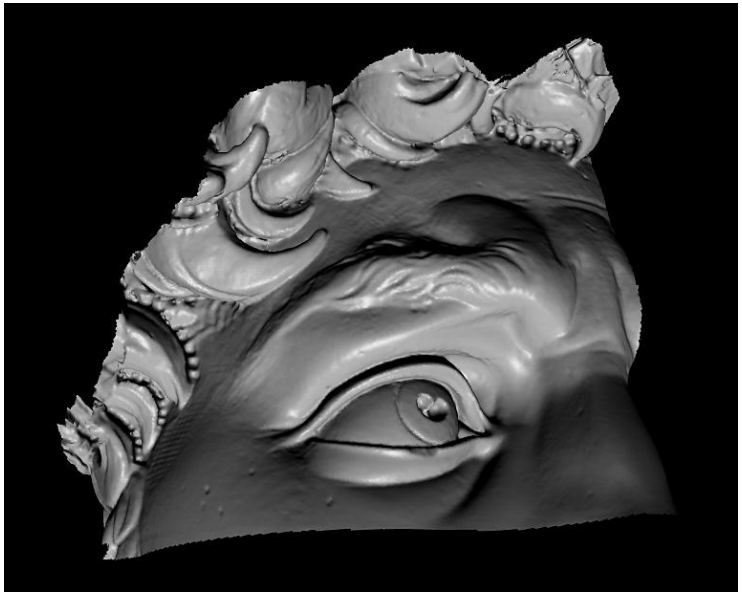
crowd0-parallax.mov

bike-sap.mov

Camera Arrays, Graphics Lab, Stanford University

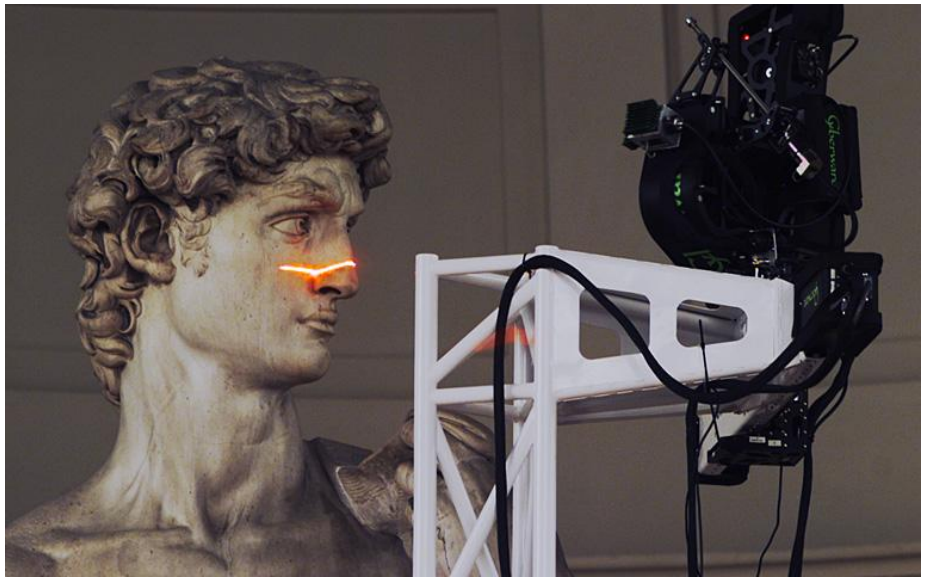
Structured Light and Ranging Scanning

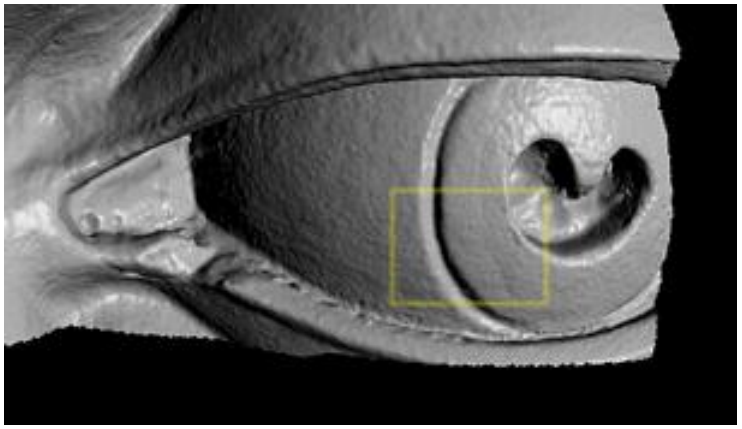




http://graphics.stanford.edu/projects/mich/

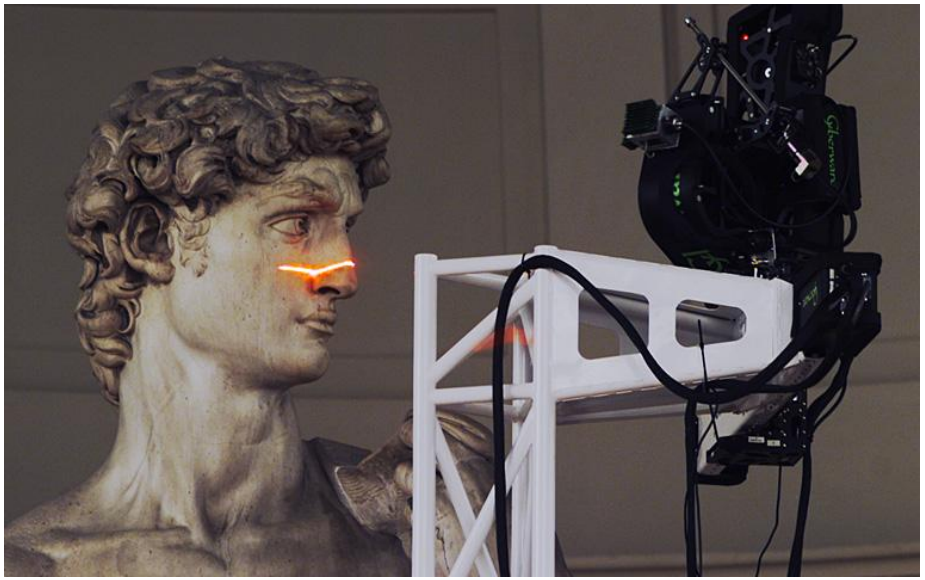
Structured Light and Ranging Scanning

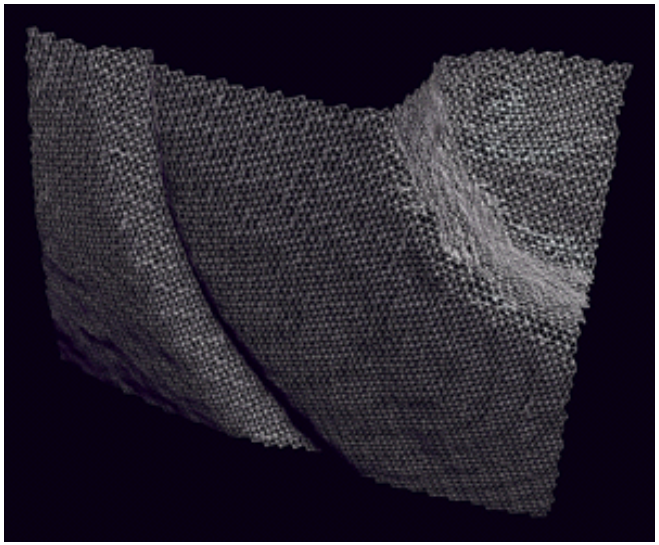




http://graphics.stanford.edu/projects/mich/

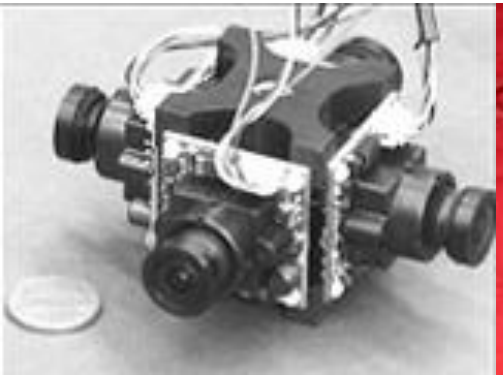
Structured Light and Ranging Scanning

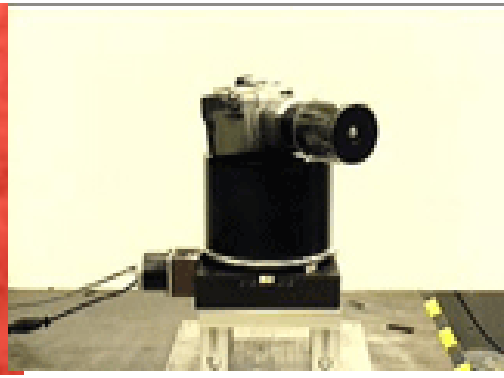




http://graphics.stanford.edu/projects/mich/

Novel Cameras and Displays





http://www1.cs.columbia.edu/CAVE/projects/cc.htm

Assignment 0, Imagination

- Due next Tuesday
- Give FIVE interesting things that you may wish to do with images
  - Better Image Capture
  - Making use of images
  - Design imaging systems

Course Info

http://www.cs.wisc.edu/~cs766-1/