

# **CSCE 448/748 – Computational Photography**

## **Introduction and Overview**

**Nima Kalantari**

# Course info

- **Instructor: Nima Kalantari ([nimak@tamu.edu](mailto:nimak@tamu.edu))**
  - **Office hours: MW 4:10 – 5:10 pm**
  - **Location: Peterson 406**
- **Course website: Link on Canvas**
- **Sign up on Campuswire for discussions: Link on Canvas**
  - **All the announcements are made via Campuswire**
- **We use Canvas, but only for submitting the assignments**

# Course info

## □ TA: Libing Zeng

- Email: [libingzeng@tamu.edu](mailto:libingzeng@tamu.edu)
- Office hours: TR 2:00 – 4:00
- Location: Peterson 402



# **Outline**

- **What is computational photography?**
- **Course objective**
- **Administrative stuff**

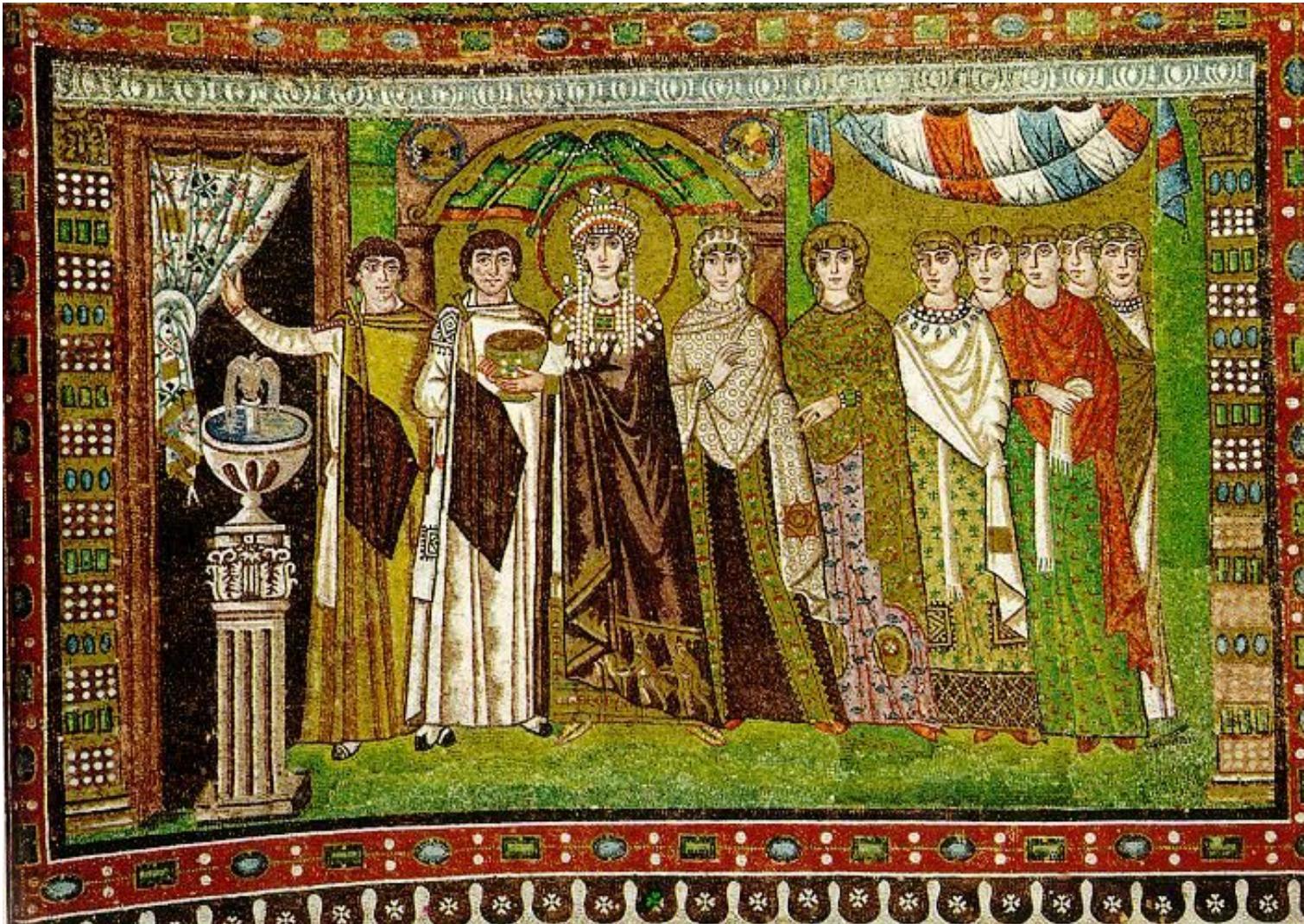
# A Brief History of Visual Media

# Depicting Our World: The Beginning



Prehistoric Painting, Lascaux Cave, France  
~ 13,000 -- 15,000 B.C.

# Depicting Our World: Middle Ages



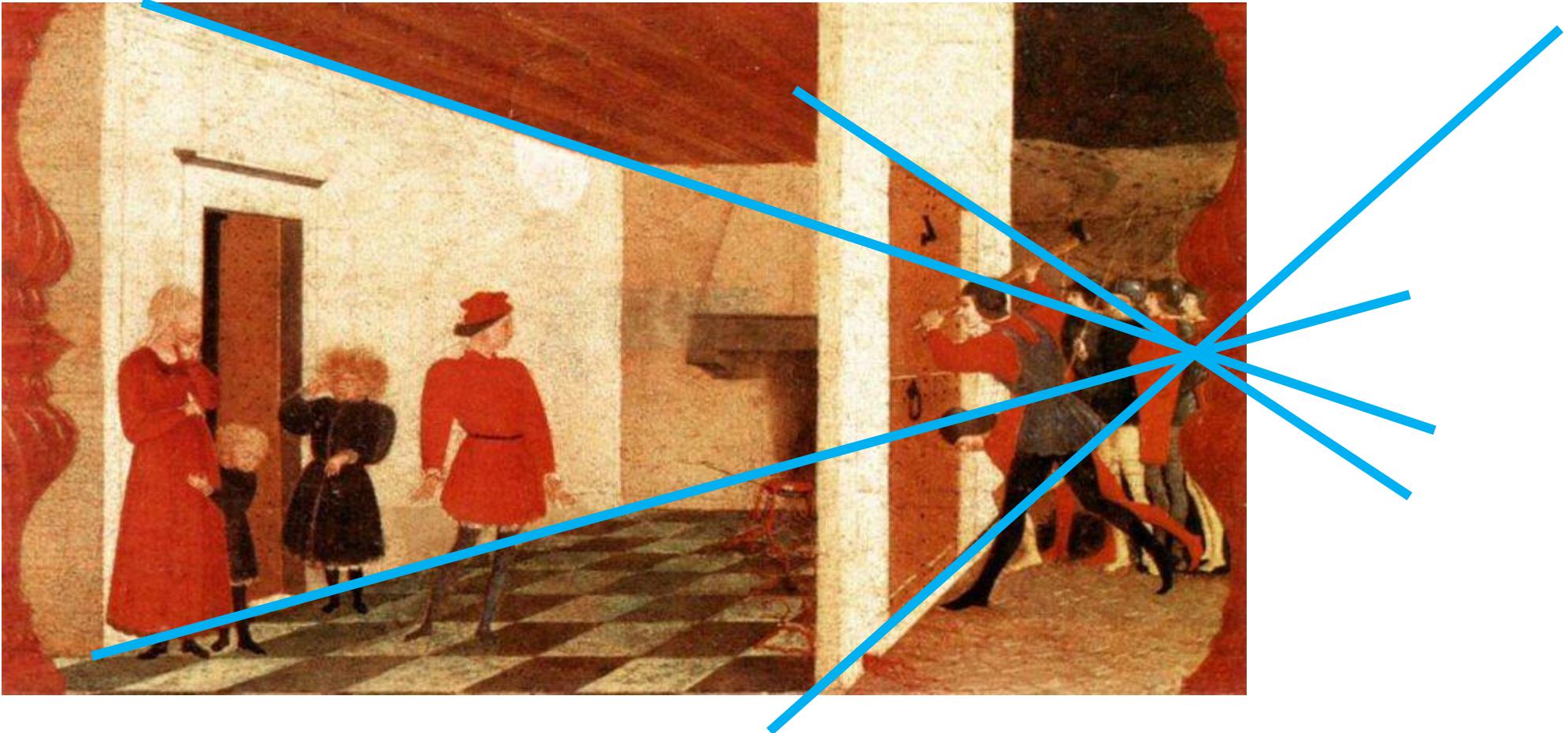
The Empress Theodora with her court. Ravenna, St. Vitale 6th c.

# Depicting Our World: Middle Ages



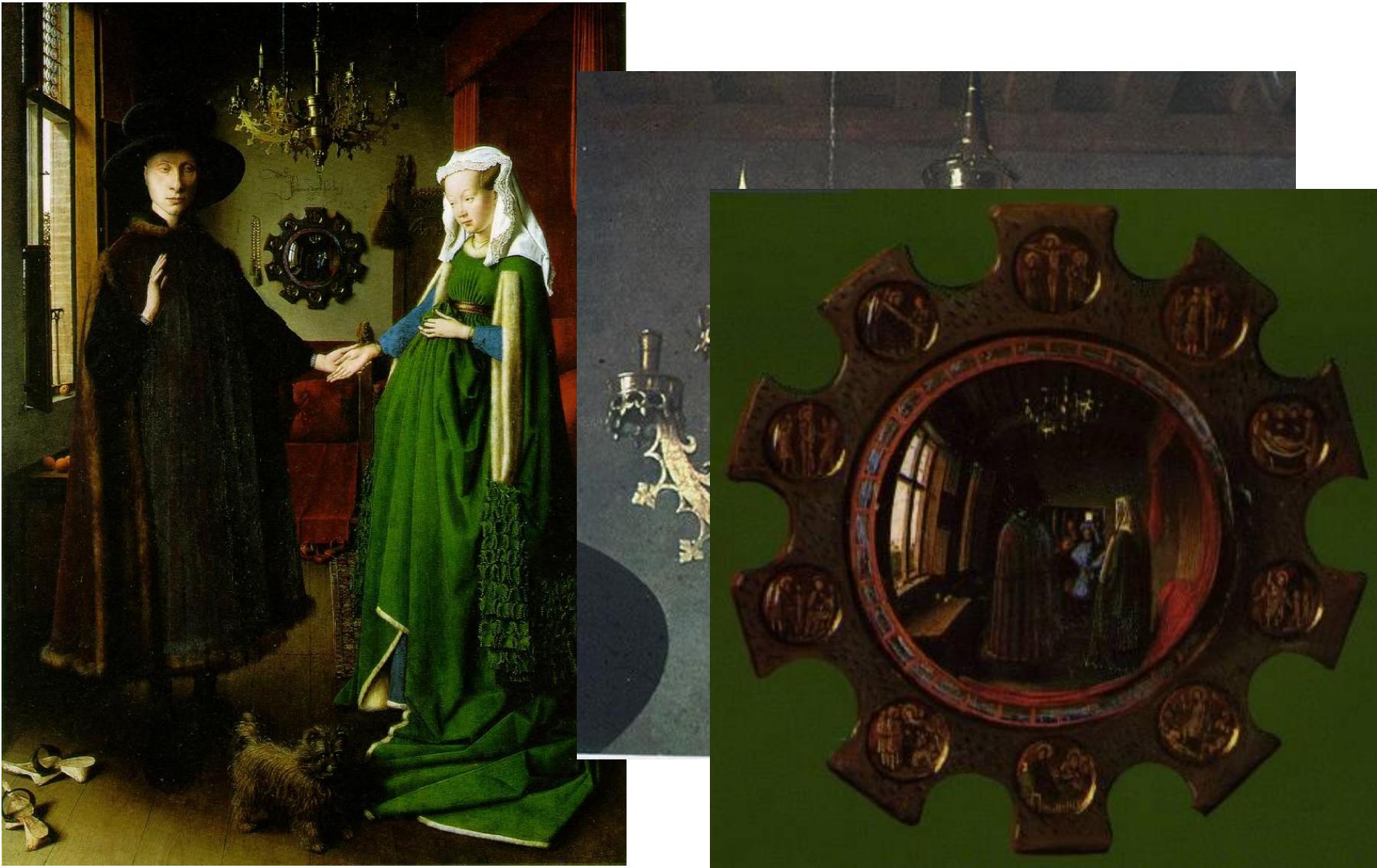
Nuns in Procession. French ms. ca. 1300.

# Depicting Our World: Renaissance



*Paolo Uccello, Miracle of the Desecrated Host (1467-9)*

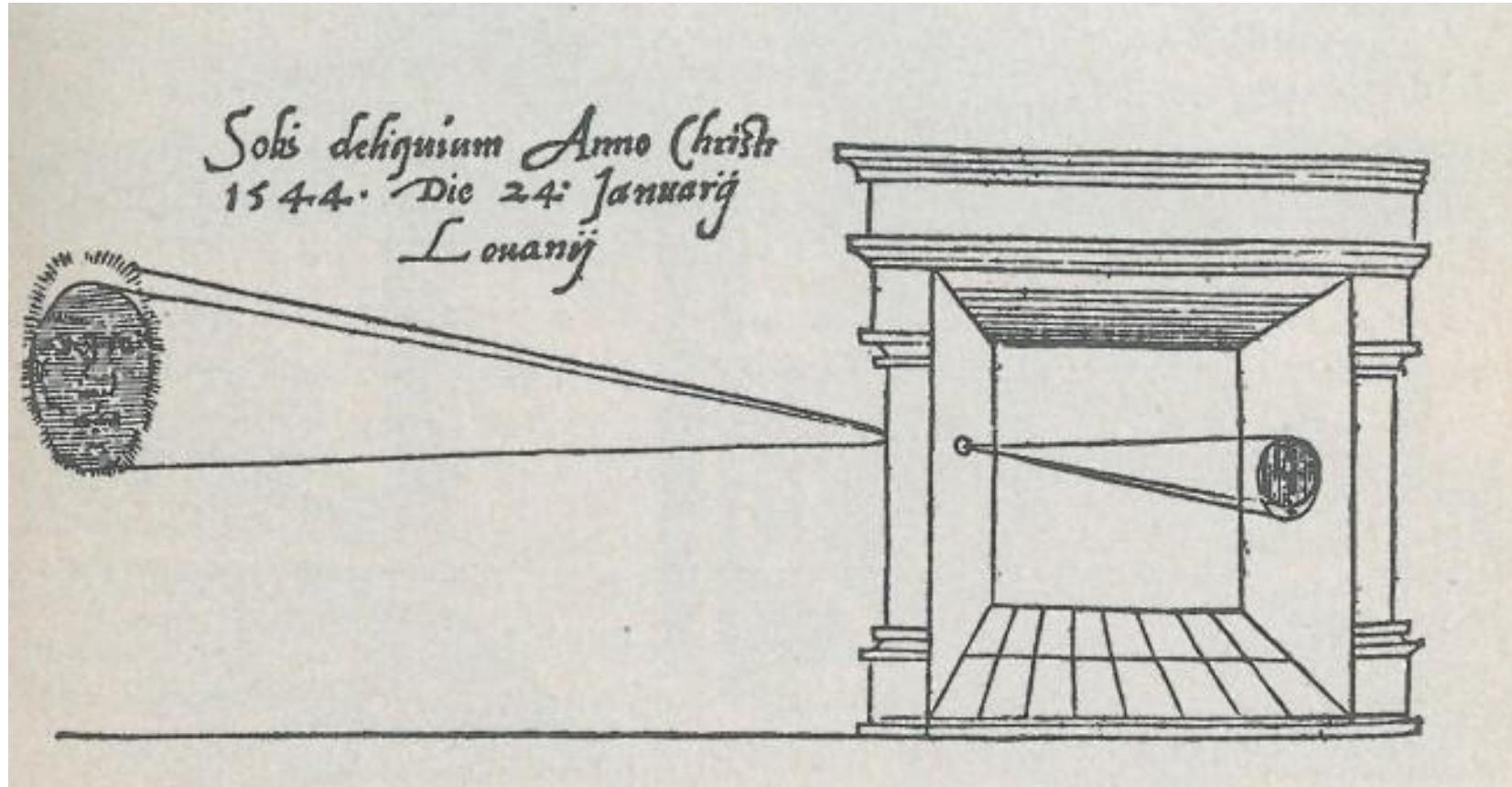
# Depicting Our World: Toward Perfection



Jan van Eyck, *The Arnolfini Marriage* (1434)

# Depicting Our World: Toward Perfection

## □ Camera obscura



First published picture of camera obscura (1545)

# Depicting Our World: Toward Perfection

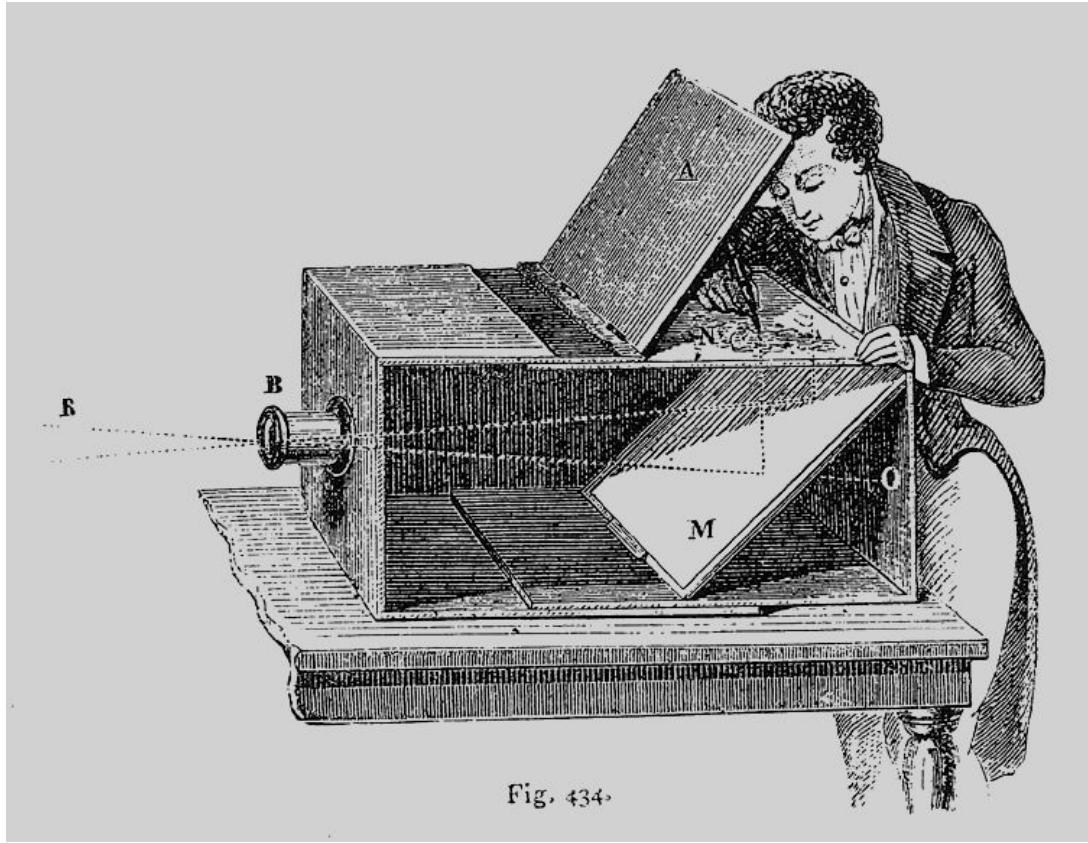


Fig. 434.

## Lens Based Camera Obscura

# Shark tank



[https://www.youtube.com/watch?v=kjQilmx6H\\_I](https://www.youtube.com/watch?v=kjQilmx6H_I)

# First captured image



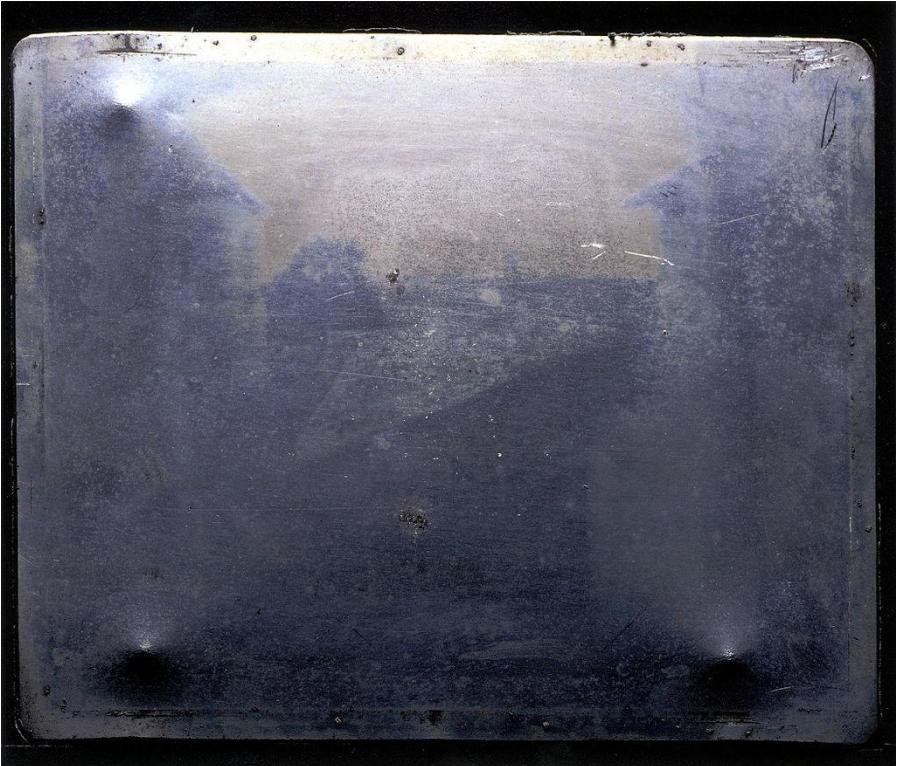
View from the Window at Le Gras (1826-1827)

# Recreated scene



# Original plate

□ Exposed for 8 hours



# First captured image



**View from the Window at Le Gras (1826-1827)**

# First commercial camera



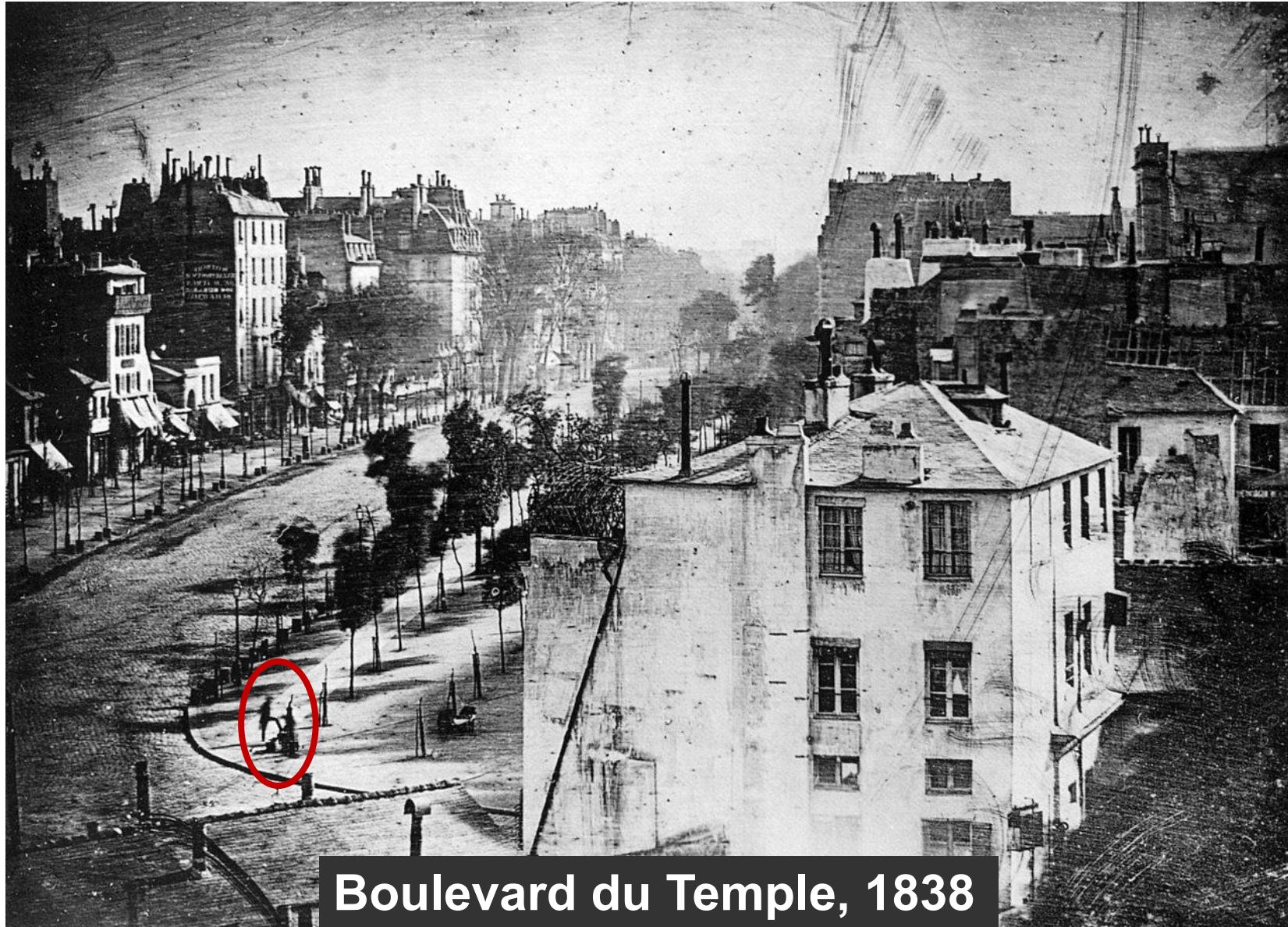
Daguerreotype camera (1839)

# The earliest daguerreotype



*Still Life*, Louis Daguerre, 1837

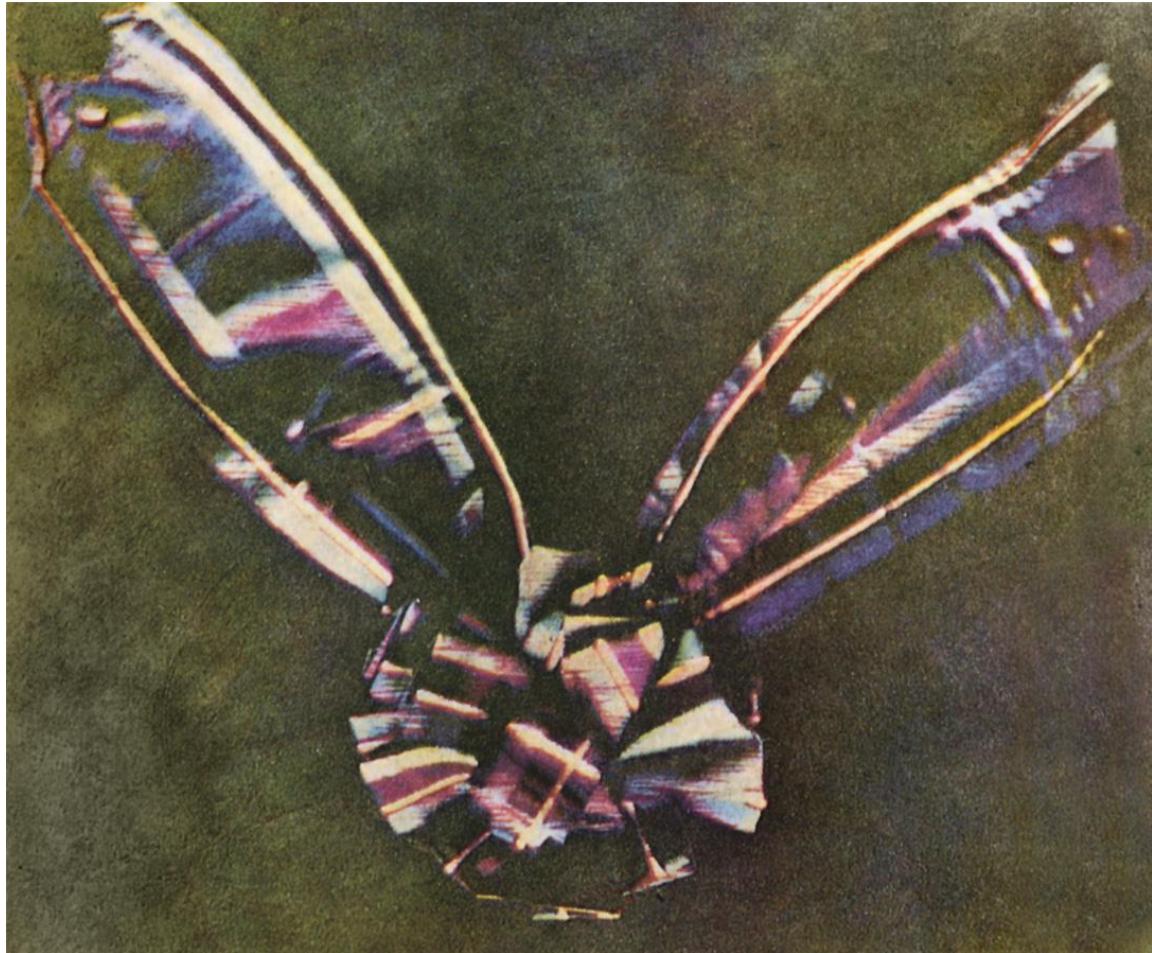
# Earliest image to include people



Boulevard du Temple, 1838

# First color photography

- Introduced by Maxwell in 1855, demonstrated in 1861



# Sergey Prokudin-Gorskii



1909 - 1915

# Beginning of hobby photography?

- 1900 Kodak Brownie
- 1935 Kodachrome (color film)



# Digital cameras

- **Fujix DS-1P by Fuji (1989)**
- **Resolution: 0.4 MP – Price: \$20,000**



# Modern digital cameras



# Modern digital cameras



Apple



Google



Samsung



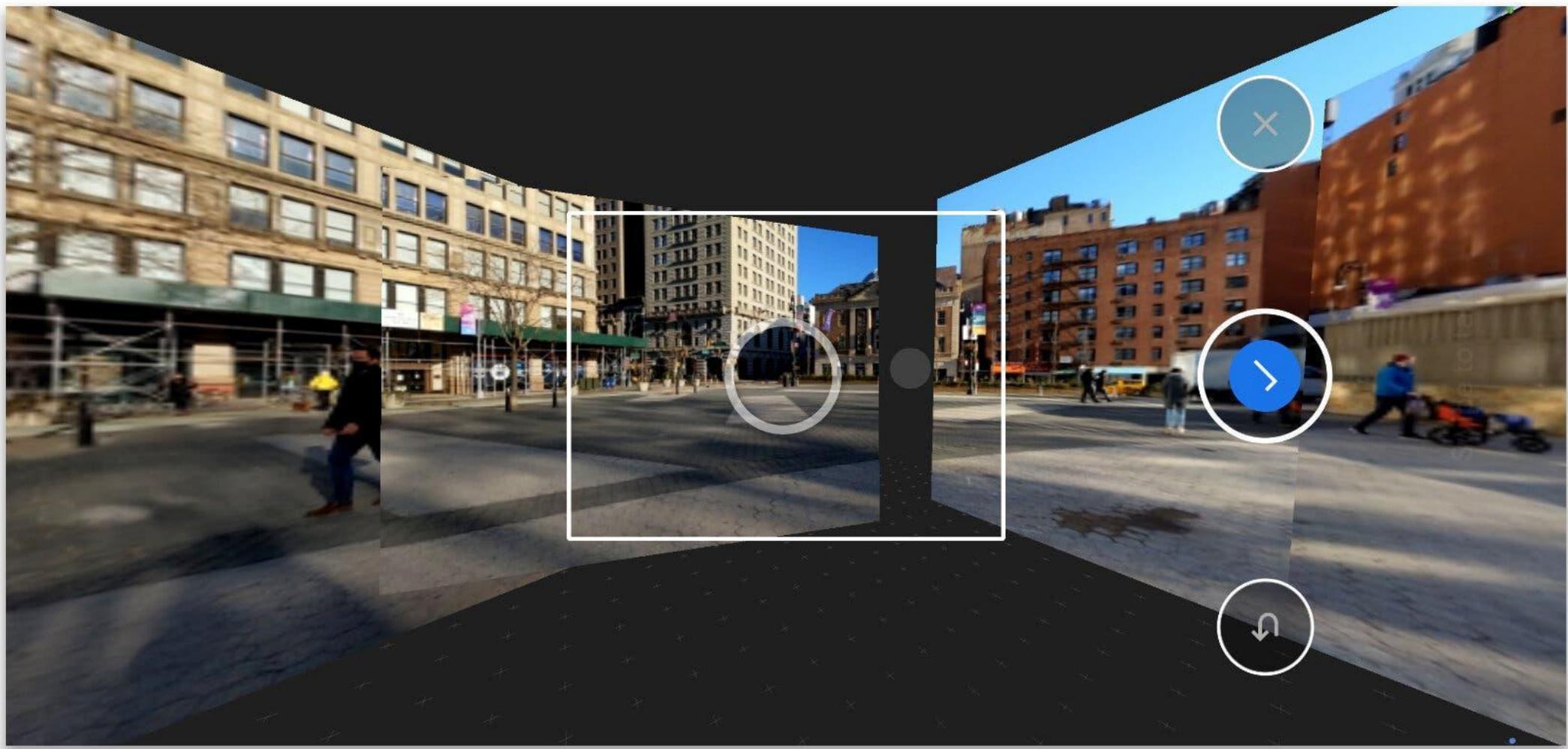
ANDROID AUTHORITY

LG

# **Computational Photography**

- Standard digital cameras have limitations**
- Enable novel imaging applications through combination of algorithms and innovative hardware**

# Panorama



# High dynamic range imaging



Without HDR+



With HDR+

# Portrait mode



Normal Mode



Portrait Mode

# Magic Eraser



Original



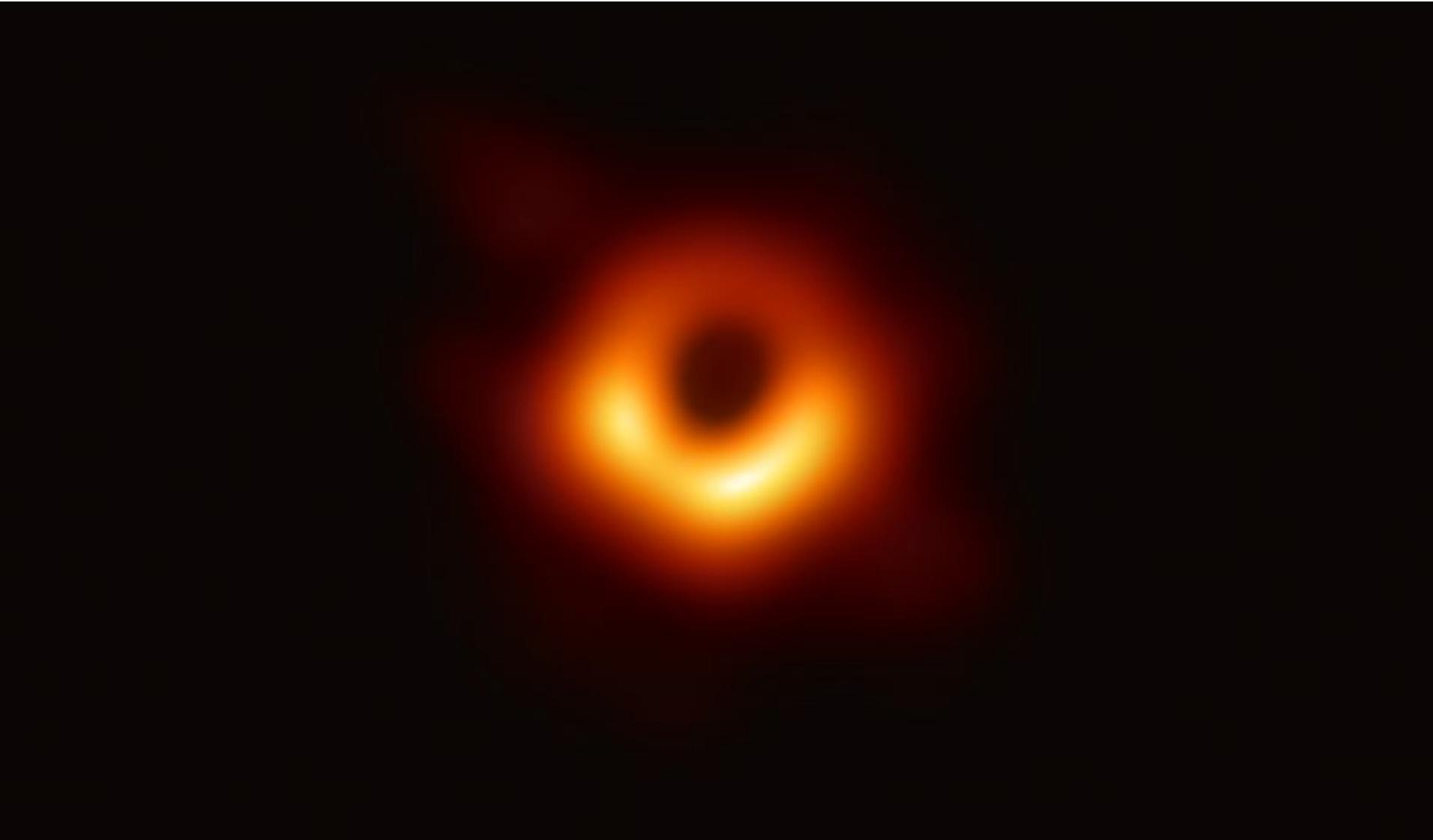
Output

Google Pixel

# Light field cameras



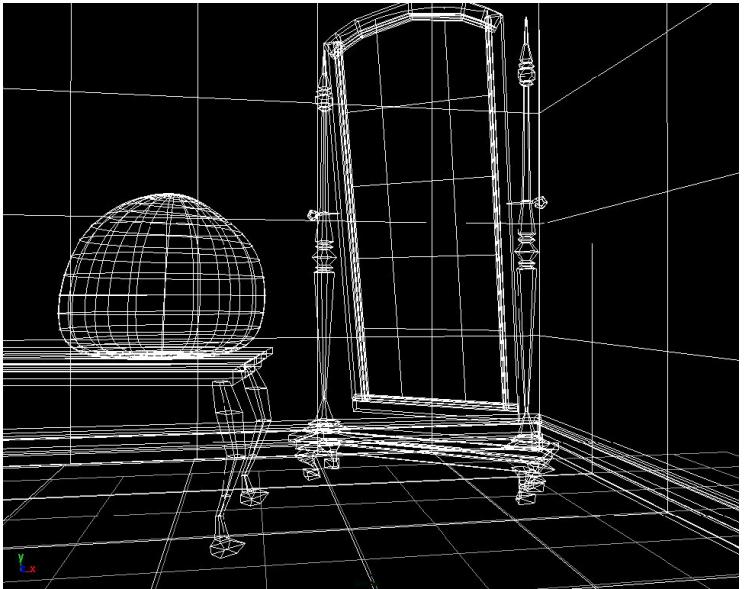
# Capturing Black Hole



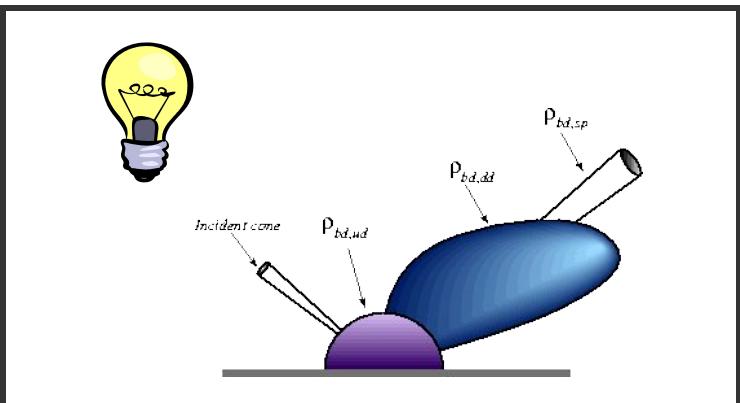
Event Horizon Telescope

# **Traditional Computer Graphics**

# Traditional Computer Graphics



3D geometry



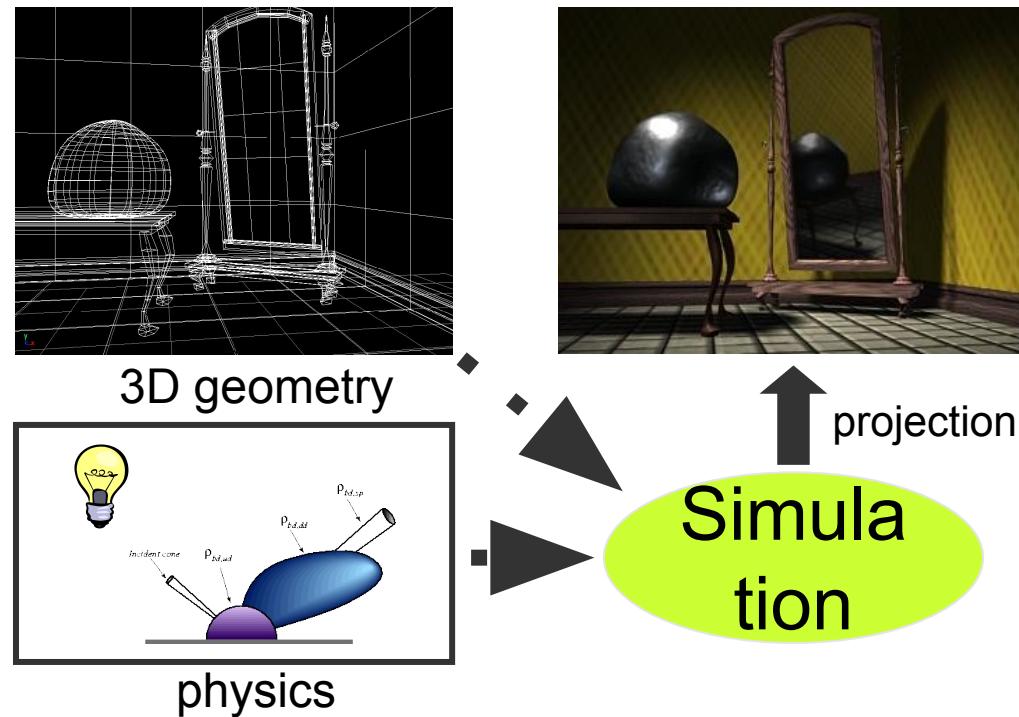
physics

Simulation

↑ projection

# Traditional Computer Graphics

- Easy to manipulate
- Great creative possibility



# FAKE OR FOTO



By Autodesk (<https://area.autodesk.com/fakeorfoto/>)

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# FAKE OR FOTO



*Arno Schmitz  
25 - 08 - 2021*

By Autodesk (<https://area.autodesk.com/fakeorfoto/>)

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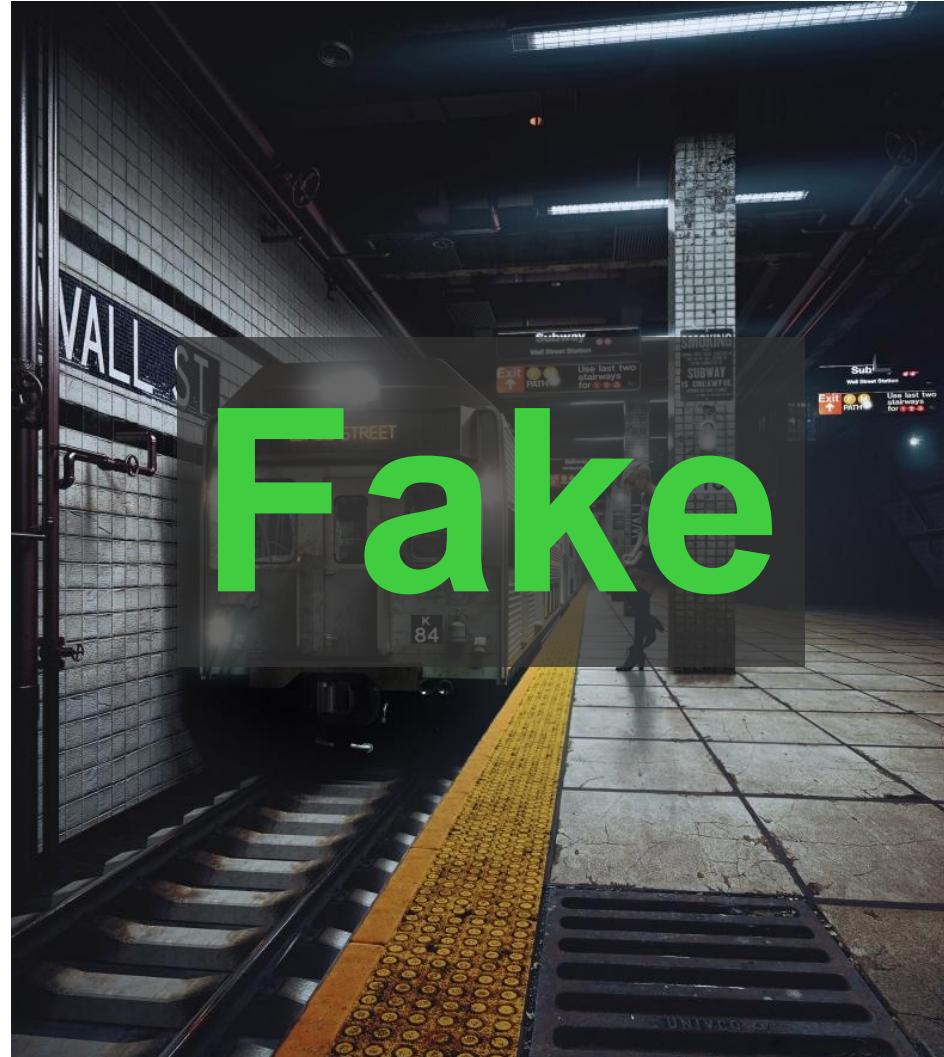
By Autodesk (<https://area.autodesk.com/fakeorfoto/>)

# FAKE OR FOTO



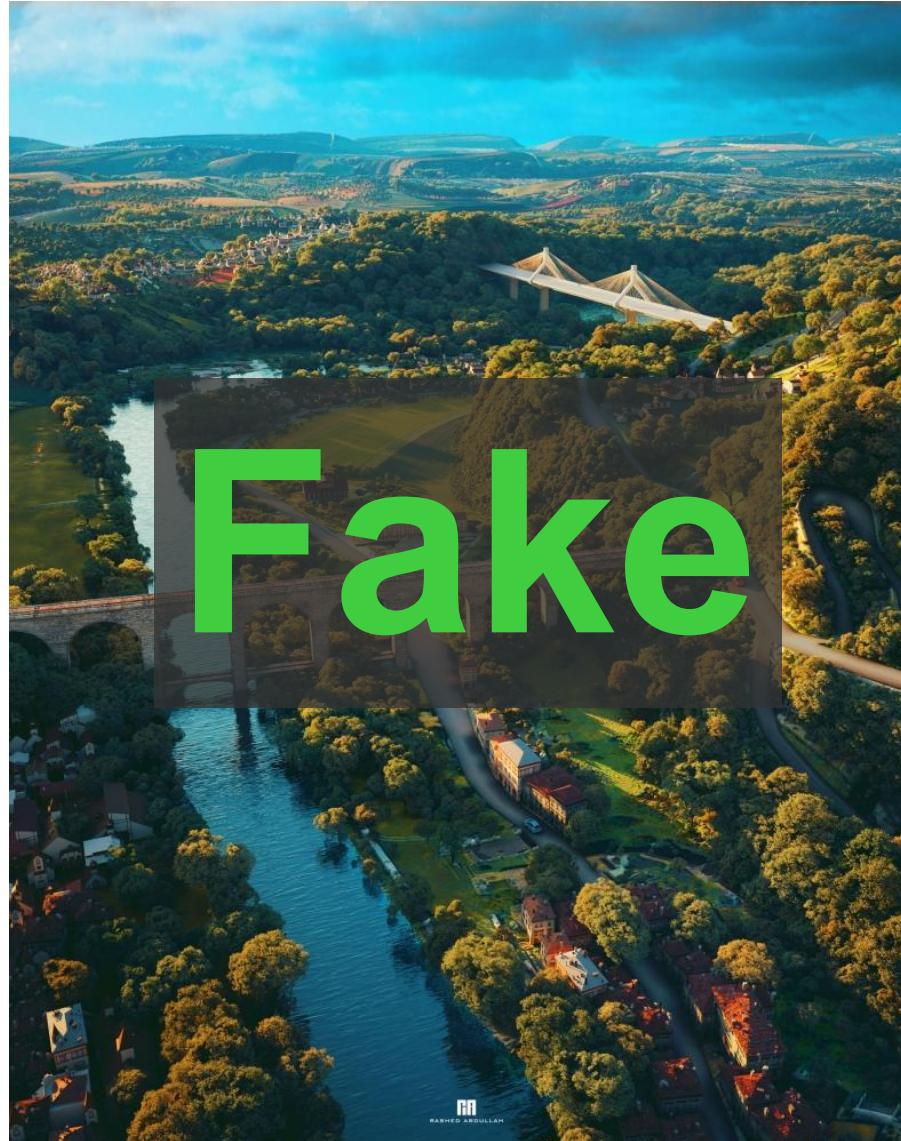
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# Summary

## □ Difficult to model

- Human face/hair
- Richness of the world



# Creating Realistic Imagery

## Computer Graphics



- + Great creative possibilities
- + Easy to manipulate
- Tremendous expertise

## Computational Photography

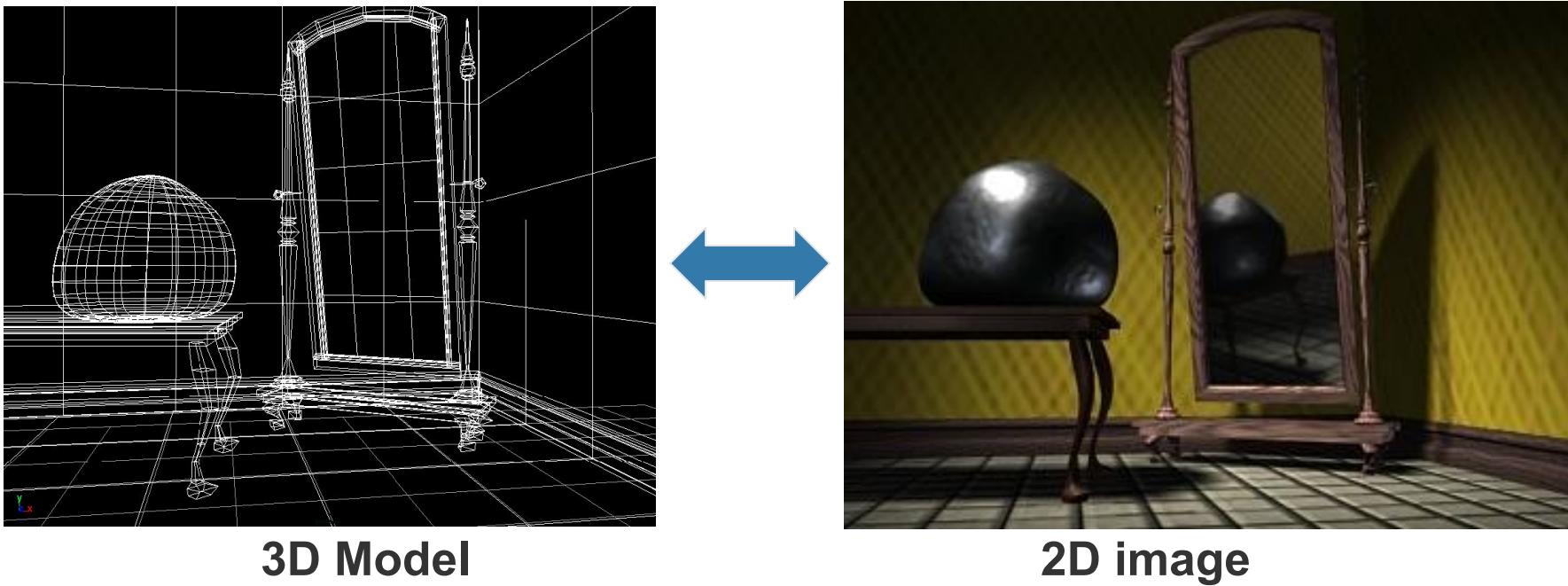
Realism  
Manipulation  
Ease of capture

## Photography



- + Instantly realistic
- + Easy to acquire
- Very hard to manipulate

# Relationship to Vision and Graphics



- **Computer Graphics: Models to Images**
- **Computer Vision: Images to Models**
- **Computational Photography: Images to Images**

# **Outline**

- What is computational photography?**
- Course objective**
- Administrative stuff**

# Course objectives

- You will have new abilities for visual creation



Graphic by James Hays

# Course objectives

- You will have new abilities for visual creation
- Learn mathematical and computational concepts
  - Convolutions
  - Filtering
  - Gradient
  - Dynamic programming
  - ...

# **Course objectives**

- You will have new abilities for visual creation**
- Learn mathematical and computational concepts**
- Have fun doing cool things!**

# Colorization by alignment



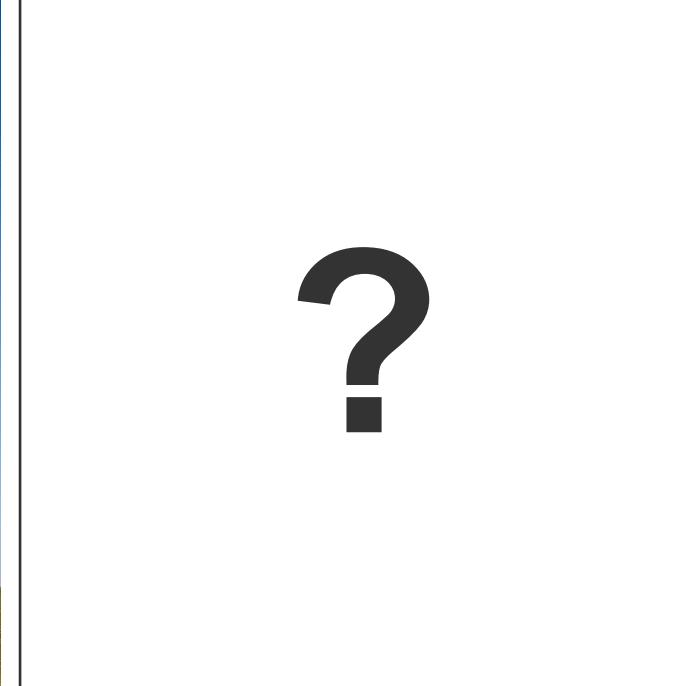
# Poisson Blending



# Image retargeting



**Input image**



**Resized**

# Image retargeting



**Input image**



**Resized - Scaling**

# Image retargeting



**Input image**



**Resized – Seam Carving**

# **What the course is NOT about**

- **Artistic side of photography**
- **How to use a camera**
- **Adobe Photoshop**
  - **Will explain how its coolest tools work**
- **Optics**
- **In depth discussion of hardware**
  - **sensors, A/D, ...**

# **What the course is about**

- Basic image processing**
  - Linear & non-linear, statistical, color**
- Algorithmic tools**
- Little bit on hardware aspects**
  - Lenses, funky new camera designs**
- Cool applications**

# **Outline**

- What is computational photography?**
- Course objective**
- Administrative stuff**

# Prerequisites

- **Undergrad students**
  - **CSCE 315/331 and MATH 304/311**
- **Grad students**
  - **Linear algebra and calculus**
  - **Programming experience in Python**
- **Basic knowledge of computer graphics and vision, as well as image processing is preferred, but not required**

# Grading

- **Assignments: 65%**
  - **Six assignments (Python)**
  - **Grad students need to do extra parts**
- **Late policy**
  - **Five late days (can't use on final project)**
  - **20% each late day afterwards**
  - **1 minute over counts as full day**

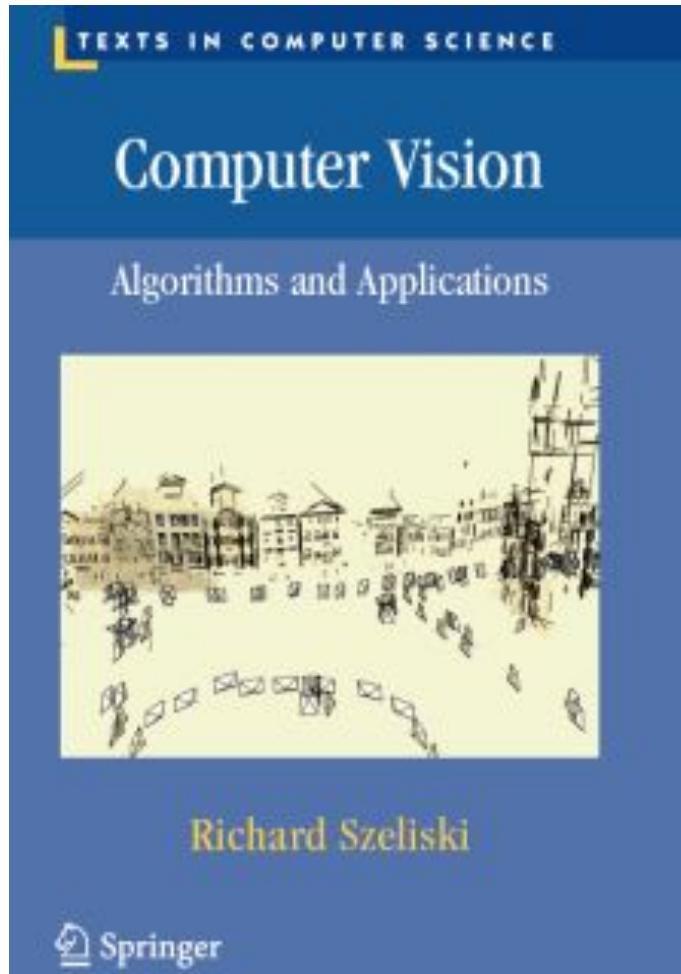
# Grading

- **Midterm: 15%**
  - March 25<sup>th</sup> during class
- **Final project: 20%**
  - Free to choose
  - Related to computational photography
  - Groups of up to 3
  - Proposal is due mid semester
  - Final submission due May 2<sup>nd</sup> (**strict deadline**)

# Honor code violation

- ❑ **Collaboration with other students beyond general discussion (like what we do on campuswire)**
- ❑ **Looking at other students' code or written answers**
- ❑ **Looking at online codes**
- ❑ **Use of generative AI**
- ❑ **Posting your code online even after the deadline**

# Textbook



<http://szeliski.org/Book/>

# Materials

- **Slide will be posted to the class website**
- **Not everything is included in the slides**
  - **Take notes!**
- **Reference to the book or relevant papers on class website**