

Computational Vision

CSCI 4270 and 6270

Professor Chuck Stewart

Lecture 01 - Technical Introduction
January 9. 2024

Definition of Computer Vision

Wikipedia (1/04/2024):

Definition [edit]

Computer vision is an [interdisciplinary field](#) that deals with how computers can be made to gain high-level understanding from [digital images](#) or [videos](#). From the perspective of [engineering](#), it seeks to automate tasks that the [human visual system](#) can do.^{[5][6][7]} "Computer vision is concerned with the automatic extraction, analysis and understanding of useful information from a single image or a sequence of images. It involves the development of a theoretical and algorithmic basis to achieve automatic visual understanding."^[8] As a [scientific discipline](#), computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a [medical scanner](#).^[9] As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems. [Machine vision](#) refers to a systems engineering discipline, especially in the context of factory automation, In more recent times the terms computer vision and machine vision have converged to a greater degree.^{[10]:13}

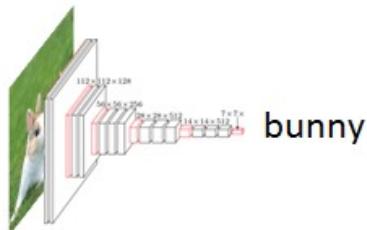
Closely Allied Fields

- Machine learning
- Image processing
- Pattern recognition
- Computer graphics
- Algorithms
- Medical imaging
- Robotics
- Computational photography

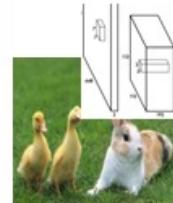
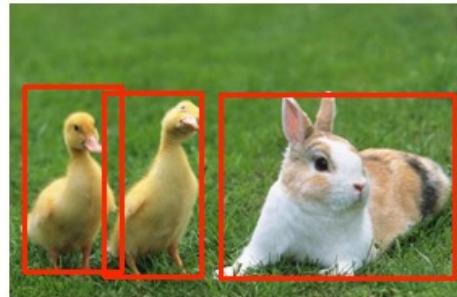
Techniques Used

- Linear algebra
- Multivariable calculus
- Probability and statistics
- Optimization
- Machine learning and in particular
 - Neural networks and deep learning
- Note that deep learning is a tool to help solve computer vision problems.

Fundamental Problems Deep Learning is Used to Solve (and we will study)

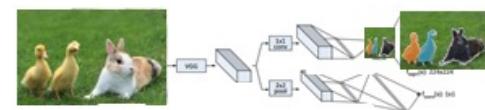


Classification



- 1: Duck ,
[x1, y1, x2, y2]
2: Duck,
[x1, y1, x2, y2]
3: Bunny,
[x1, y1, x2, y2]

Object Detection



Segmentation

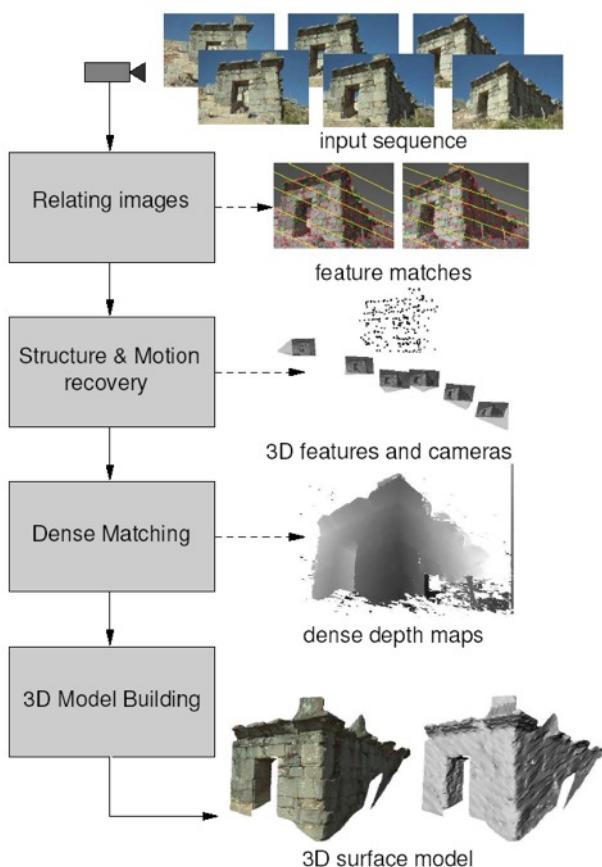
But There's More: Vision for Measurement

Real-time stereo

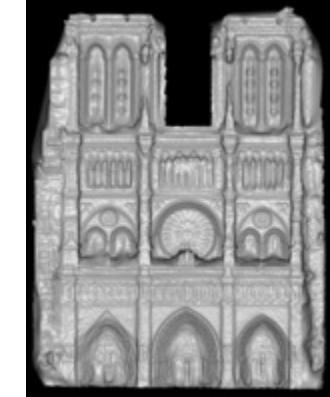
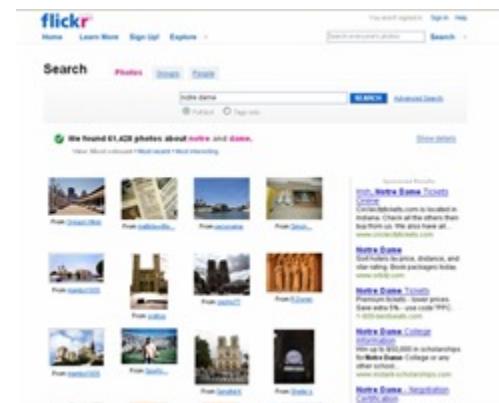


Pollefeys et al.

Structure from motion



Multi-view stereo for community photo collections



Goesele et al.

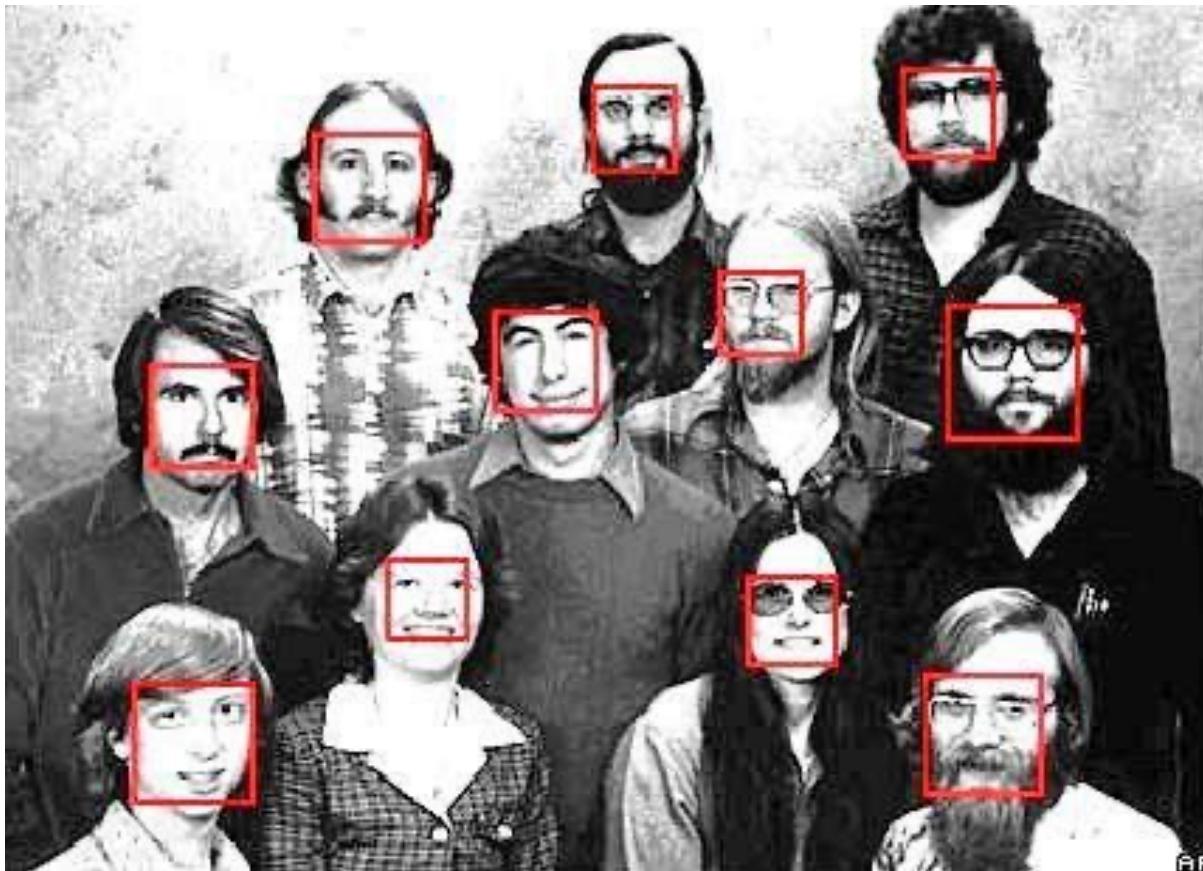
Vision for Recognition and Labeling



What can you recognize in these images?

- Water? Trees? Buildings? Sky?
- How can you recognize the sky?
- Do you know where these were taken?

Drilling Down... Face Detection and Recognition



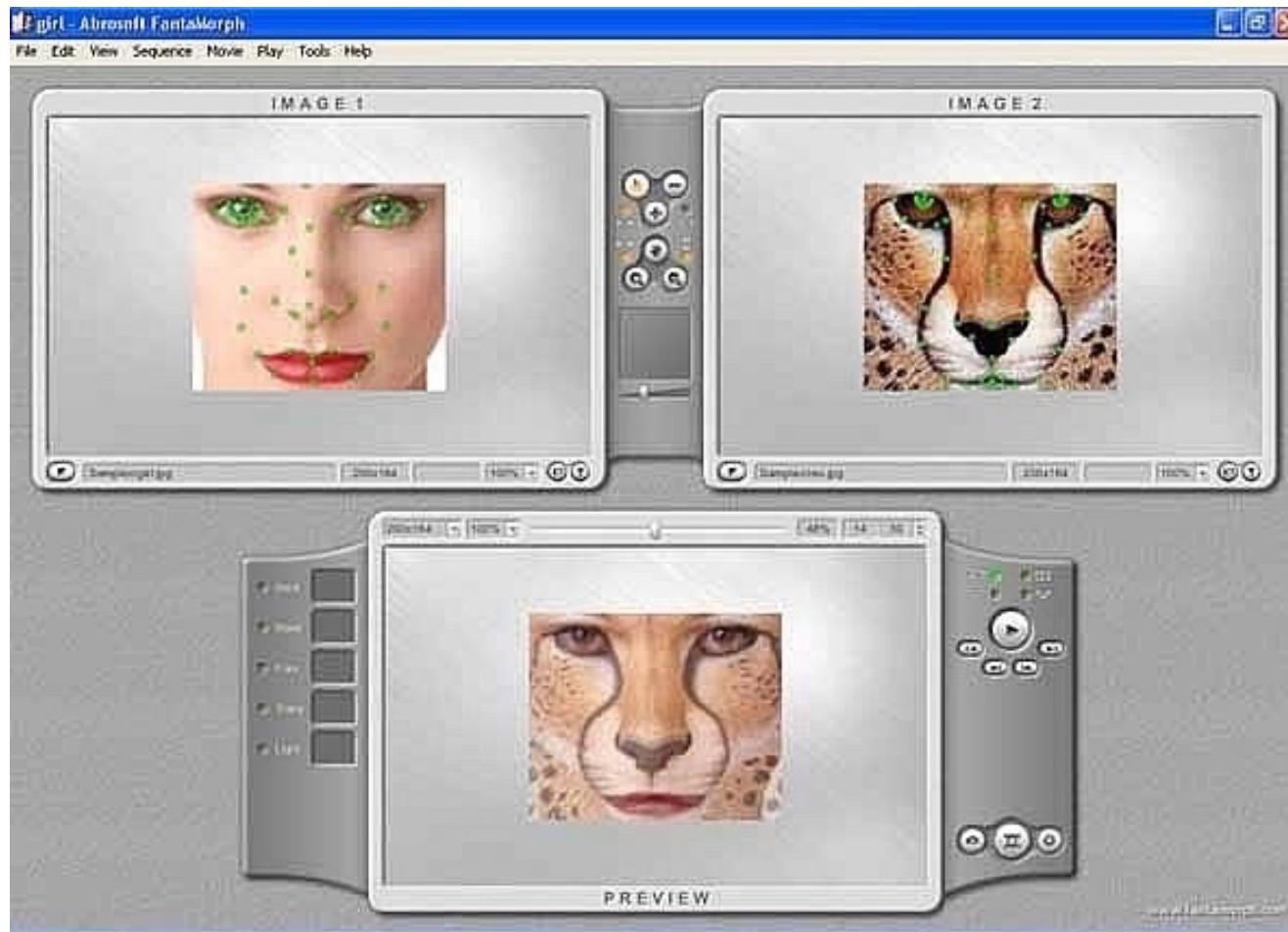
Biometrics



Snapchat...



Special Effects: Face Morphing

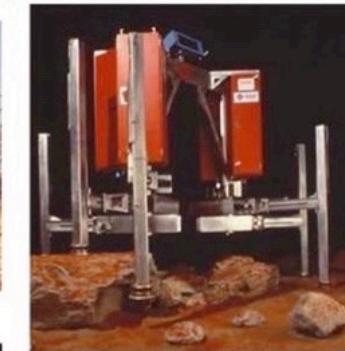
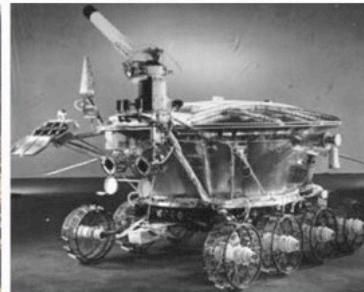


Video Conferencing



Source: theattic.obselisksupport.com

Mobile Robots



Self-Driving Cars / Driver Assist



By Dllu - Own work, CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=64517567>



Search by Image



Google /Users/stewart/Desktop/Rhino Raw JPEGS/White Rhino JPEGS/Gor +Chuck SafeSearch

Web Images Shopping Videos News More Search tools

A Google Images search results page for a white rhinoceros. The search bar shows the query. Below it, there are three rows of image thumbnails. The first row contains four images: a deer-like animal in an indoor setting, a man sitting at a desk with a laptop, a group of rhinos in a field, and a close-up of a rhino's head behind a wire fence. The second row contains four images: two rhinos standing together, three rhinos in a field, a large rhino in a field, and a long line of rhinos in a field. The third row contains five images: a person in a room, a group of rhinos in a field, a man playing a guitar on stage, and a person singing into a microphone. Below each row of thumbnails, there are small snippets of text from the original source pages.

PhotoTourism and Photosynth

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Photosynth Tips

- Click on the white boxes to see different photos.
- Use the arrows to see more of the scene.
- Use the buttons or mouse scroll wheel to zoom in & out.
- Don't show again [More Info](#)



© CNN Robinson

"The Moment" final version By: CNN

Add to Favorites Embed Report Abuse Share

Description

Over 400 iReport photos along with 200 CNN photos, this synth truly captures the moment on January 20, 2009 when Barack Obama became president.

Keep hitting the "out" button (down arrow key) to see more and more of the scene.

Related Photosynths



Comments (10)

Sign in to add a comment

Midov Over 1 year ago
COOL

michaelyas Over 1 year ago



Gaming



Red Light Cameras



Many, Many Other Applications

- HCI
- Image-based search
- Biomedical image analysis and robotic surgery
- Industrial inspection
- ...

Is There a Downside?

- Loss of privacy?
- Job loss, job quality?
- Safety?
- Bias and profiling?
- Loss of autonomy?
- Fake images and videos?



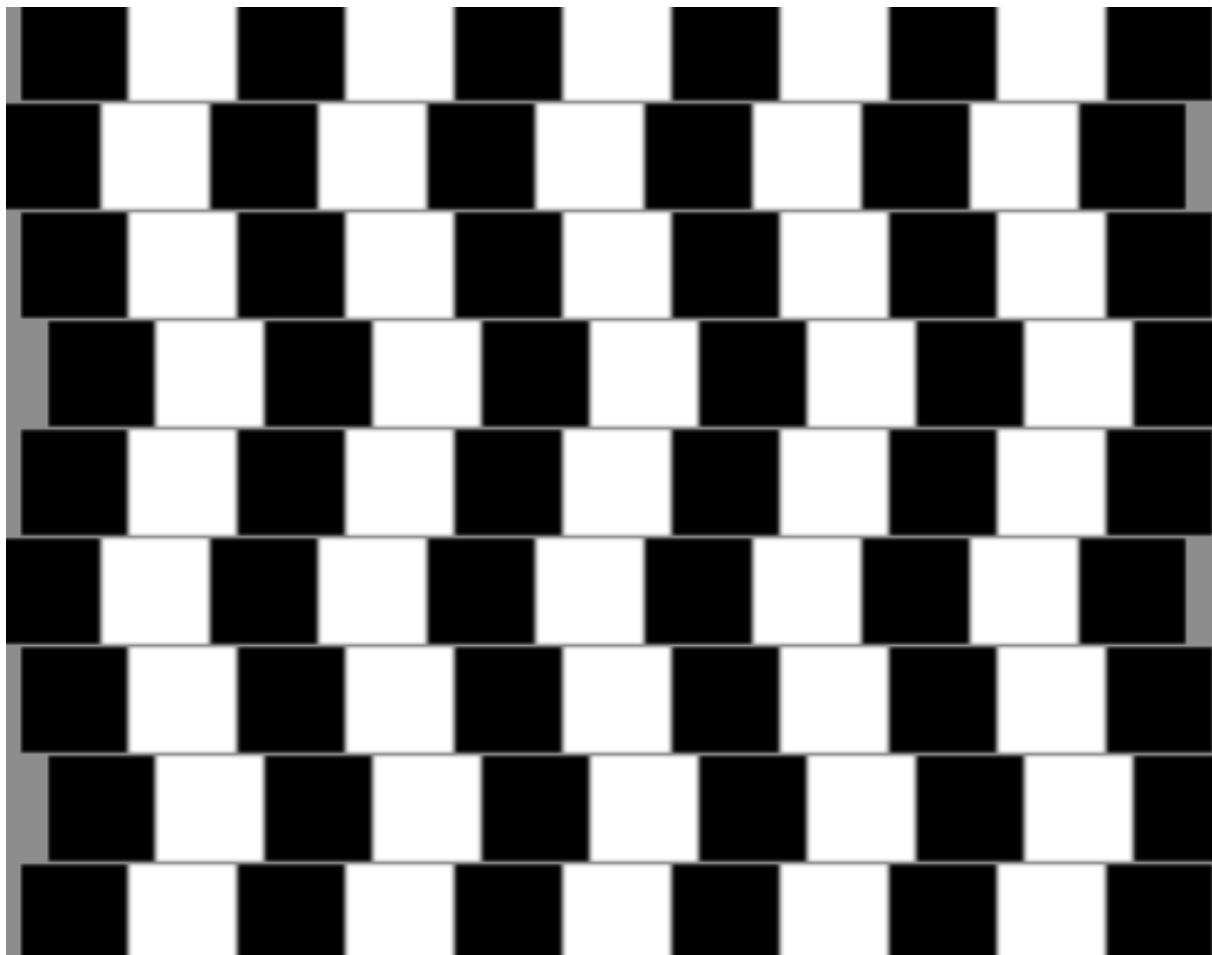
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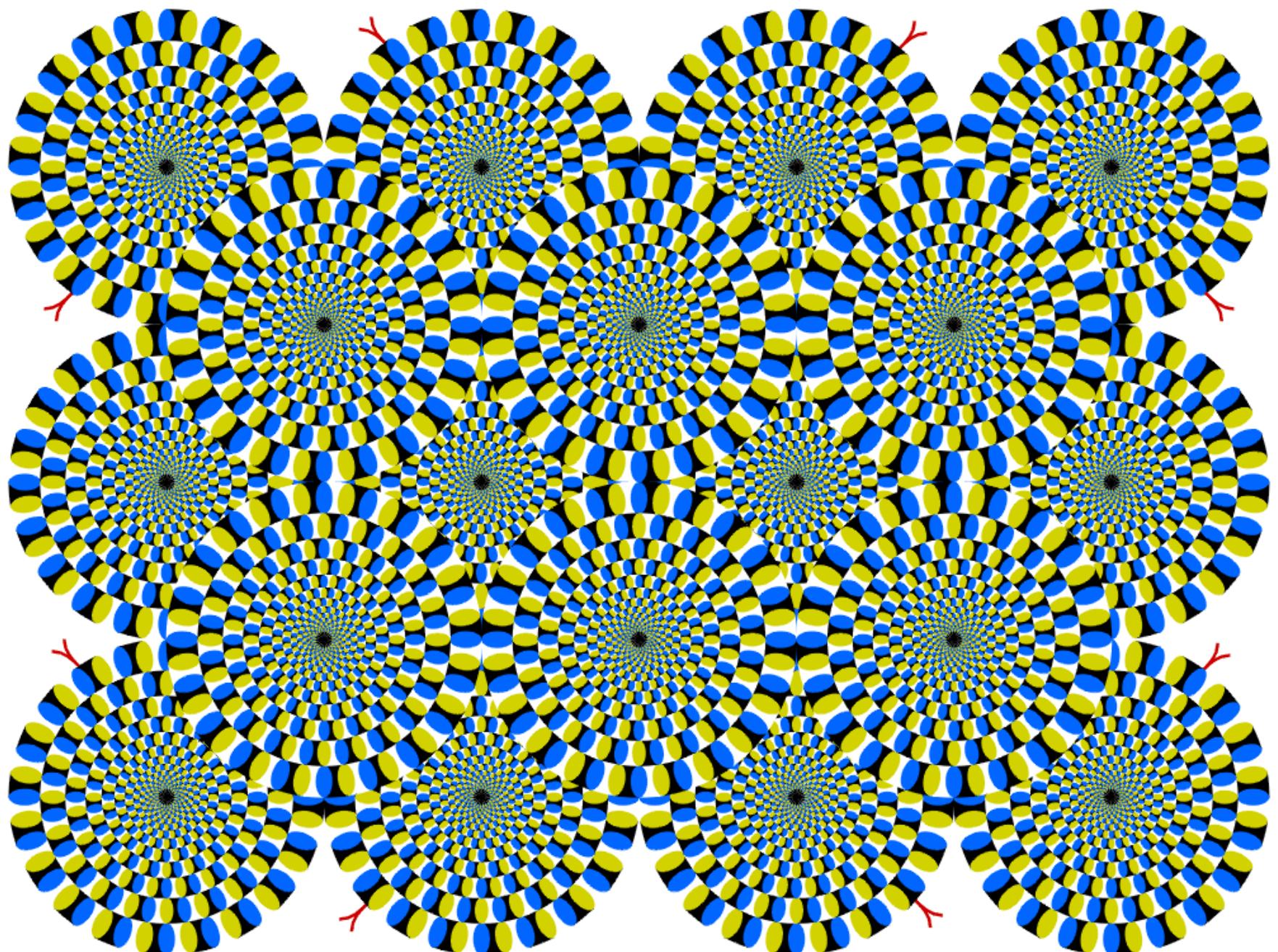
- We will look at some of these questions in more detail as we proceed through the semester.
- I encourage you to ask questions / raise concerns as we proceed through the semester

What Applications Interest You?

- We'll take some time today to quickly discuss some you might be thinking about.

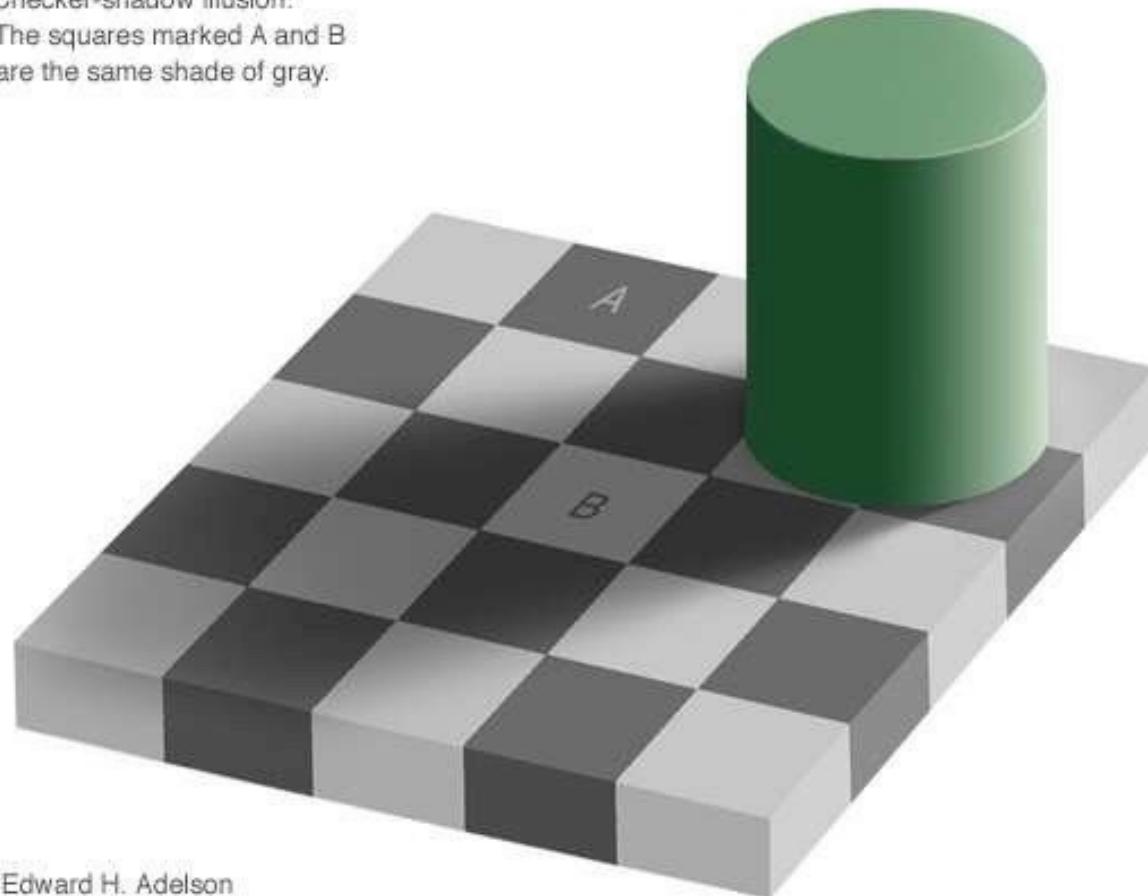
Thinking About Human Vision: Optical Illusions





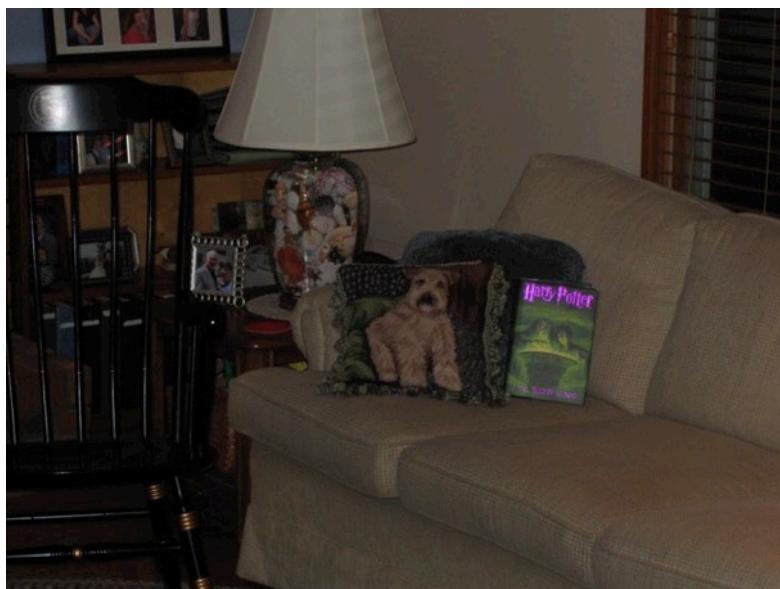
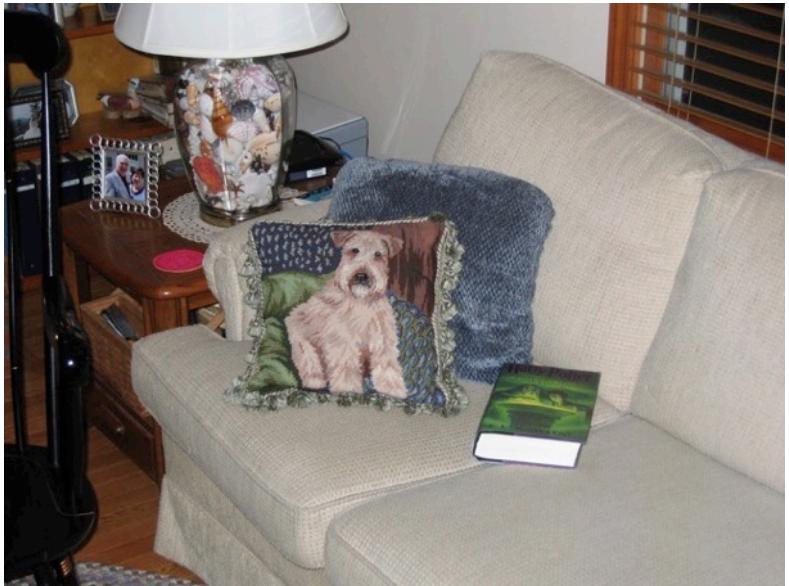
Shadow, What Shadow?

Checker-shadow illusion:
The squares marked A and B
are the same shade of gray.



Edward H. Adelson

Pixel Values: Surface Properties, Geometry, Photometry, Optics



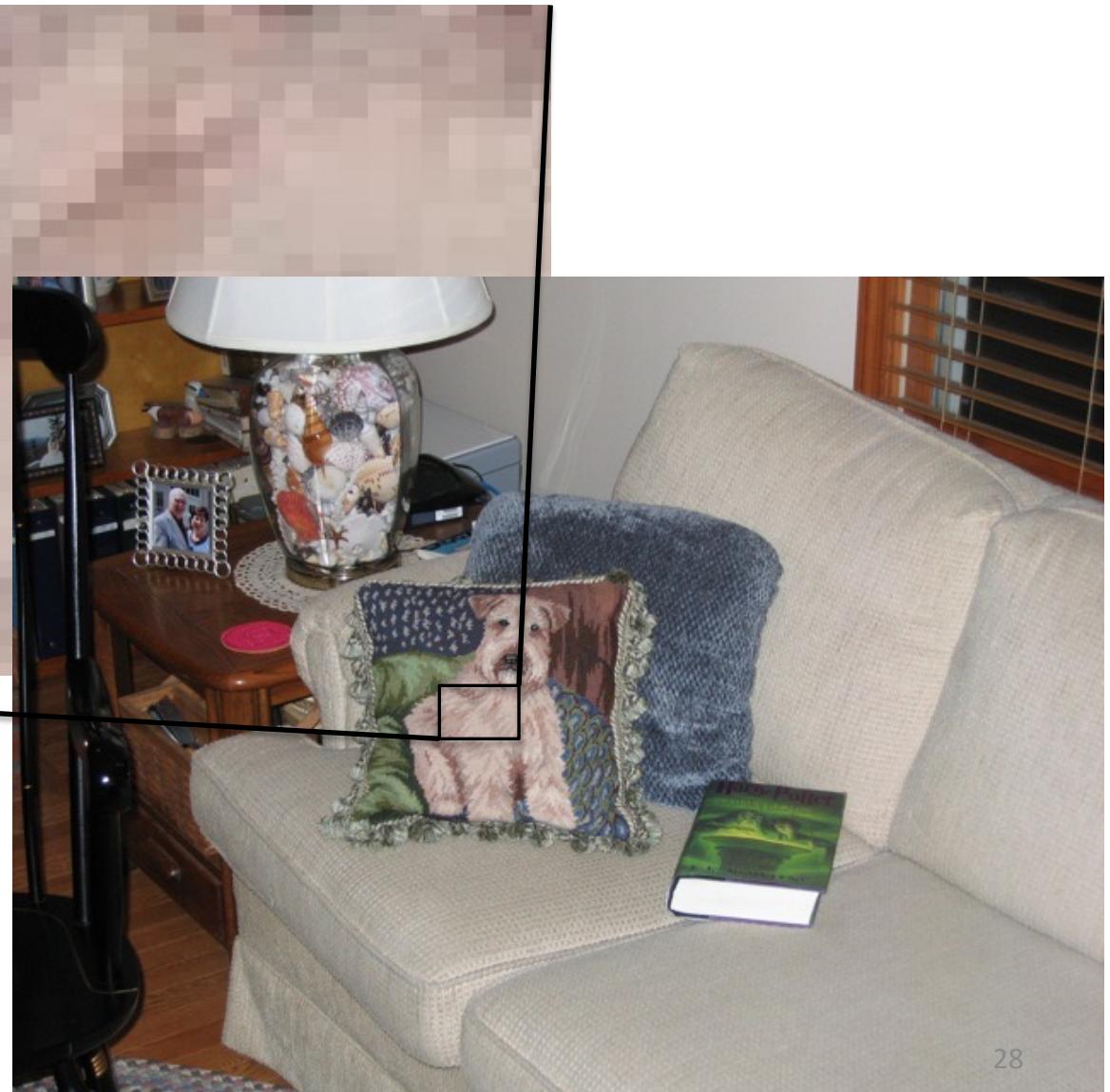
Raw Data of an Image: What's This?



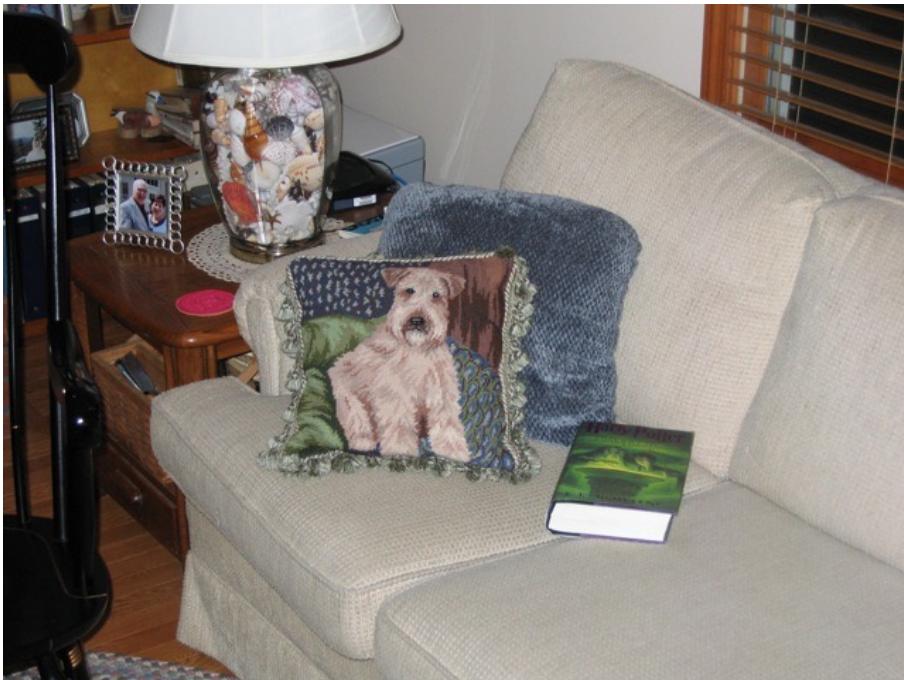
Raw Data of an Image: What's This?



Raw Data of an Image: What's This?



Illumination Affects Brightness and Color



Perspective Affects Size and Angles



Fun Optical Illusions Videos

- Ames Window illusion

<https://www.youtube.com/watch?v=aHjQe8EuKHc>

- 10 illusions:

<https://www.youtube.com/watch?v=-IWk5NkxQF8>

Can We Find Big Ben Among These Pictures of London? How?



Ignore Illumination and Perspective!



But still, somehow, “match” these images and
discard the others!

Before Next Class

- Install on your computer (suggest using Anaconda):
 - Python 3.9, at least
 - OpenCV
 - Numpy, Scipy, Matplotlib
 - Use a virtual environment and perhaps anaconda
- Login in to Submitty and perhaps
 - Introduce yourself and start a discussion about computer vision, or
 - Contribute to an existing discussion
- Work on a NumPy tutorial!
 - See Submitty!
- Lecture 2 notes will be posted on Submitty soon
- Homework 1 will be posted before class