

Wrap-up



Course announcements

- Programming assignment 7 is due on Sunday.
 - Any questions about PA 7?
- Take-home quiz 11 is due on Sunday.
 - Any questions about TQ 11?
- You can use all of your remaining late days on either PA7 or TQ11.

Class evaluation*s* – please take them!

- CMU's Faculty Course Evaluations (FCE): <https://cmu.smartevals.com/>
- 16-385 end-of-semester survey:
<https://docs.google.com/forms/d/e/1FAIpQLSeO2CcSkCpi7RB0KXUm0su8s9tMMBaRLcxNaB9t0Fk7CVxwNg/viewform>
- Please take both, super helpful for developing future offerings of the class.
- Thanks in advance!

Today's lecture

- Structure from motion.
- Class wrap-up.

Course overview

1. Image processing. ← Lectures 1 – 7
See also 18-793: Image and Video Processing
2. Geometry-based vision. ← Lectures 7 – 12
See also 16-822: Geometry-based Methods in Vision
3. Physics-based vision. ← Lectures 13 – 16
See also 16-823: Physics-based Methods in Vision
See also 15-462: Computer Graphics
See also 15-463: Computational Photography
4. Semantic vision. ← Lectures 17 – 20
See also 16-824: Vision Learning and Recognition
See also 10-703: Deep Reinforcement Learning
5. Dealing with motion. ← Lectures 21 – 24
See also 16-831: Statistical Techniques in Robotics
See also 16-833: Robot Localization and Mapping

Image processing



Image filtering

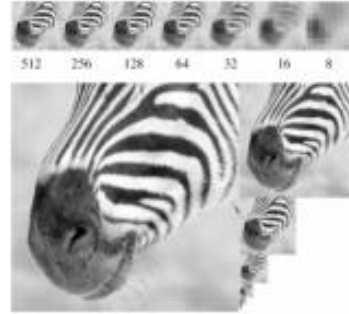


image pyramids



Fourier filtering

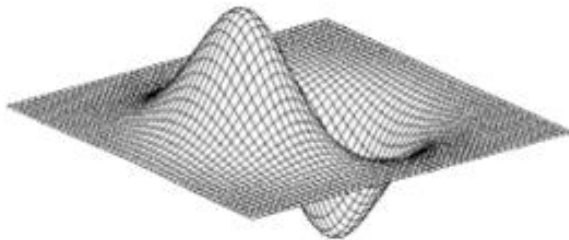
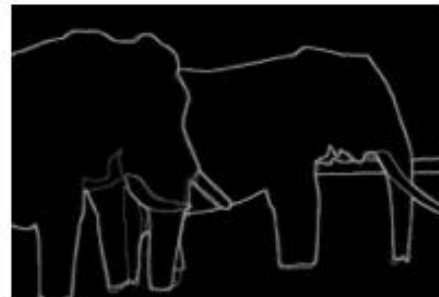
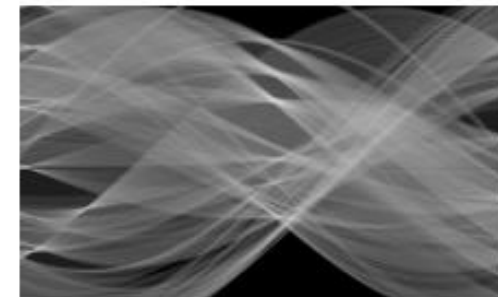


Image gradients



Boundaries



Hough Transform

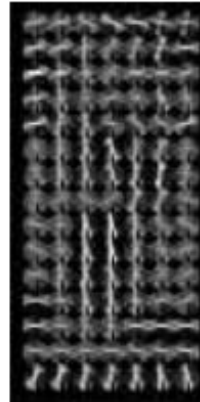
Image features



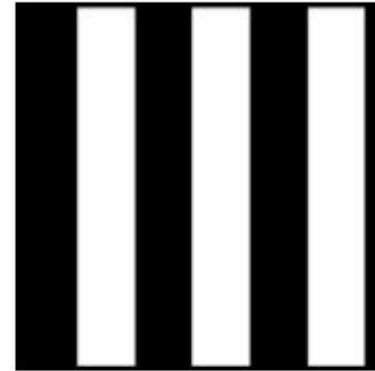
Corner detection Multi-scale detection



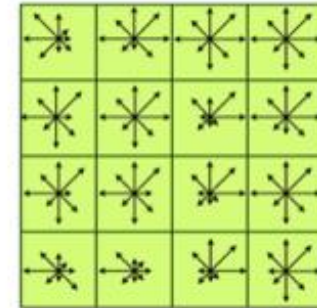
Haar-like



HOG



SURF



SIFT

2D alignment

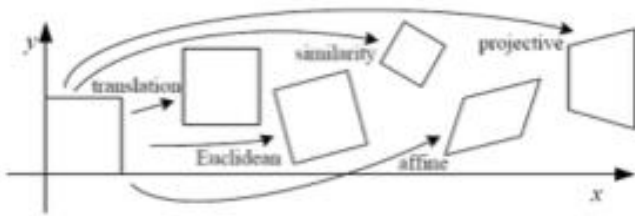


Figure 1: Basic set of 2D planar transformations

2D Transforms



DLT



RANSAC

H

Homography

Camera and multi-view geometry

$$x = PX$$

camera matrix

P

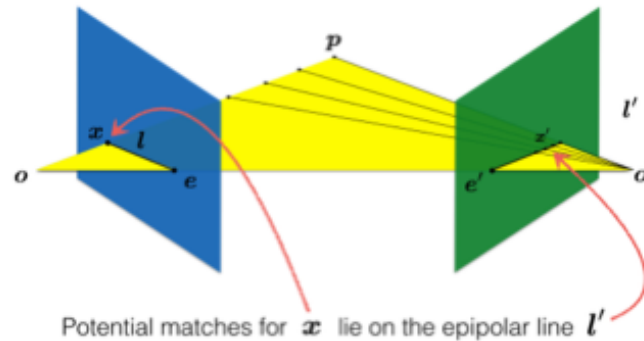
pose estimation

X

triangulation

F

fundamental matrix



epipolar geometry

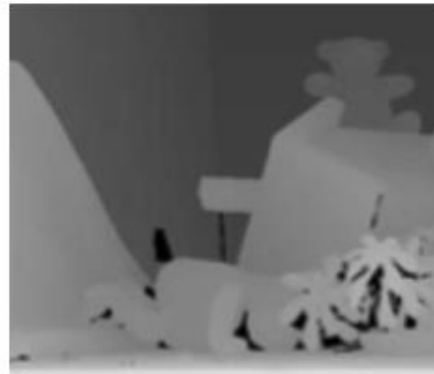


Reconstruction

Stereo



Stereo Rectification

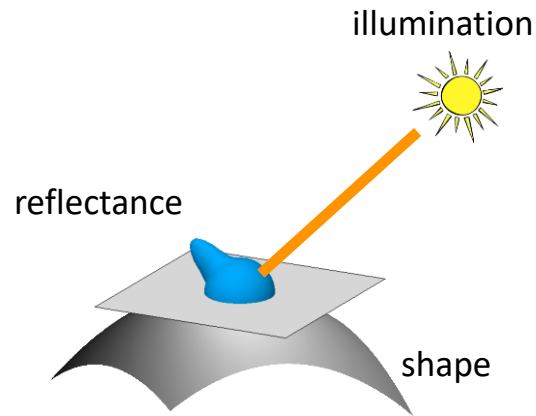


Block matching



Energy minimization

Image formation and physics



Radiometry and image formation

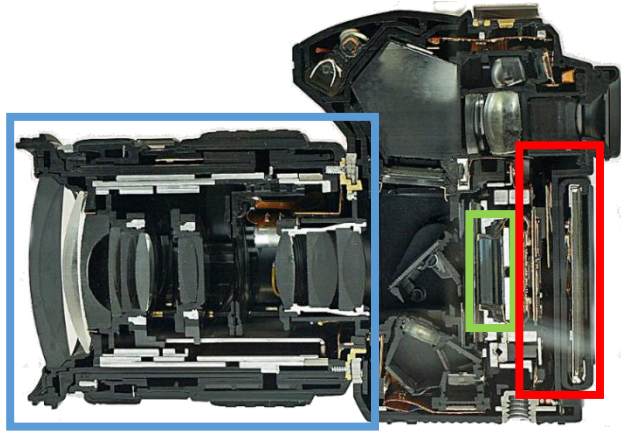
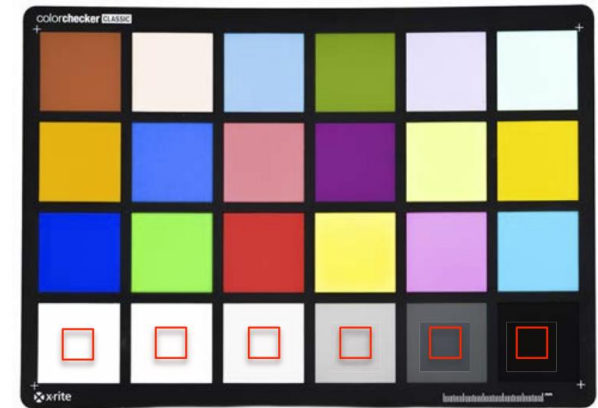


Image processing
pipeline

Photometric stereo

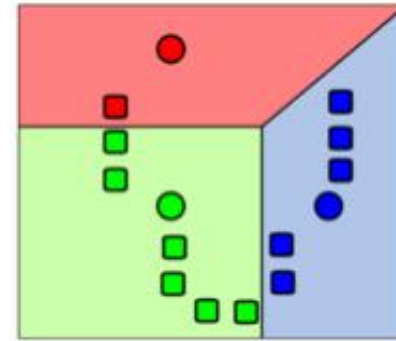


Radiometric and color
calibration

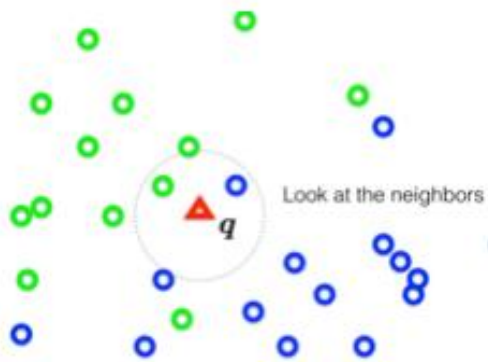
Object recognition



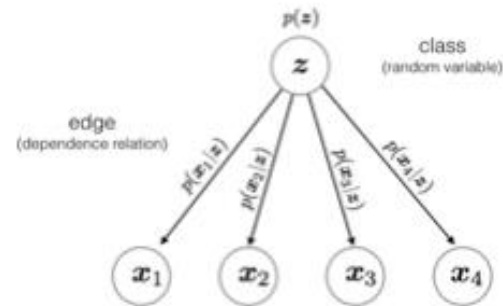
Bag-of-words



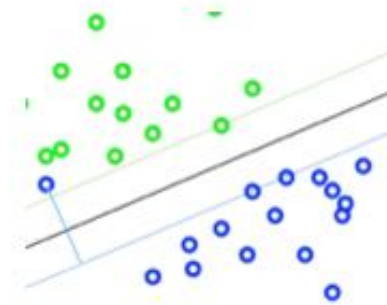
K-means



Nearest Neighbor

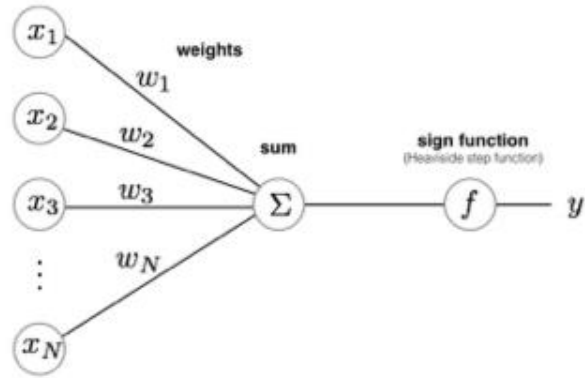


Naive Bayes

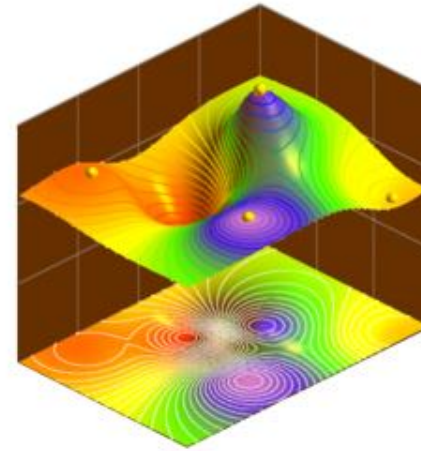


SVM

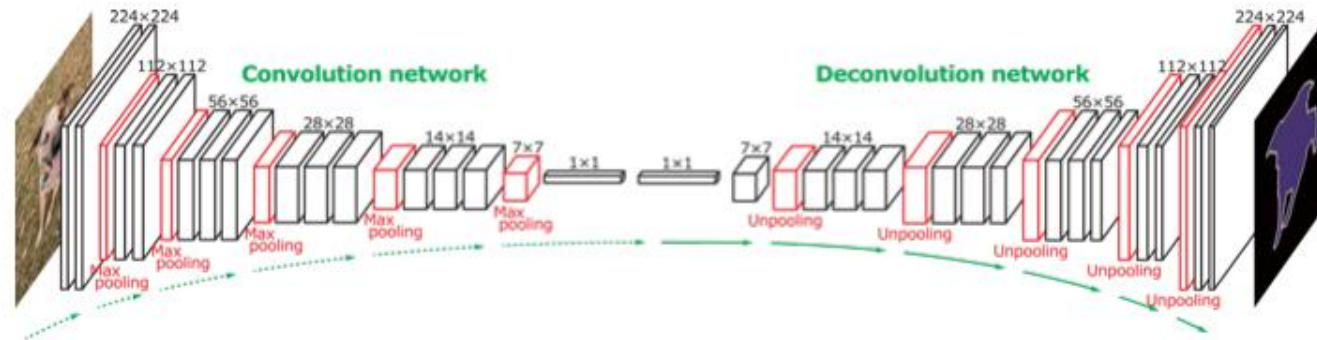
Neural networks



Perceptron



Gradient Decent



Convolutional Neural Networks

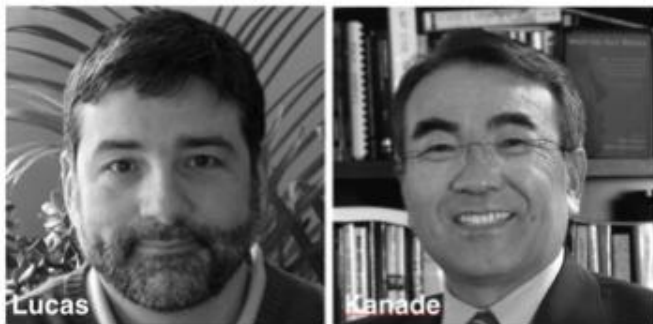
Optical flow and alignment

$$\begin{bmatrix} I_x(\mathbf{p}_1) & I_y(\mathbf{p}_1) \\ I_x(\mathbf{p}_2) & I_y(\mathbf{p}_2) \\ \vdots & \vdots \\ I_x(\mathbf{p}_{25}) & I_y(\mathbf{p}_{25}) \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = - \begin{bmatrix} I_t(\mathbf{p}_1) \\ I_t(\mathbf{p}_2) \\ \vdots \\ I_t(\mathbf{p}_{25}) \end{bmatrix}$$

Constant Flow

$$\min_{\mathbf{u}, \mathbf{v}} \sum_{ij} \left\{ E_d(i, j) + \lambda E_s(i, j) \right\}$$

Horn-Schunck



Lucas-Kanade
(Forward additive)

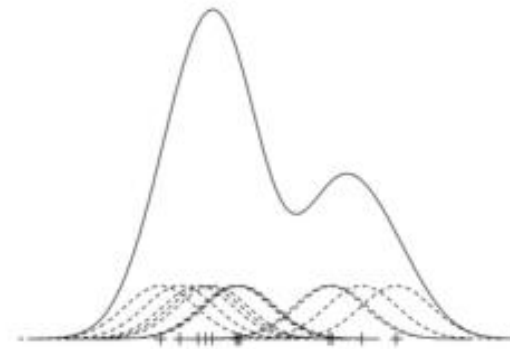


Baker-Matthews
(Inverse Compositional)

Tracking in videos



KLT



Mean shift

Things you should know how to do

1. Detect lines (circles, shapes) in an image.
2. Perform automatic image warping and basic AR.
3. Reconstruct 3D scene structure from two images.
4. Do photometric stereo and render simple images.
5. Recognize objects using a bag-of-words model.
6. Recognize objects using deep CNNs.
7. Track objects in video.

Questions?

Do you plan on taking any other vision courses?

Which part of the class did you like the most?

Which part of the class did you like the least?

Any topics you wanted to learn more about?

Any topics you wanted to learn less about?

Would the class work better if we did learning first?

Which was your favorite programming assignment?

Which was your least favorite programming assignment?

Would it be better if programming assignments were
in Matlab?

Do the take-home quizzes work?

How does course workload compare to other classes?