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

   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

2D Transforms

DLT

RANSAC

Homography
Camera and multi-view geometry

\[ x = PX \]

- **camera matrix**
- **pose estimation**
- **triangulation**

- **F**
- **fundamental matrix**
- **epipolar geometry**
- **Reconstruction**
Stereo Rectification

Block matching

Energy minimization
Image formation and physics

Radiometry and image formation

Photometric stereo

Image processing pipeline

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

\[
\begin{bmatrix}
I_x(p_1) & I_y(p_1) \\
I_x(p_2) & I_y(p_2) \\
\vdots & \vdots \\
I_x(p_{25}) & I_y(p_{25})
\end{bmatrix}
\begin{bmatrix}
u \\
v
\end{bmatrix}
= -
\begin{bmatrix}
I_t(p_1) \\
I_t(p_2) \\
\vdots \\
I_t(p_{25})
\end{bmatrix}
\]

\[
\min_{u, v} \sum_{i,j} \left\{ E_d(i, j) + \lambda E_s(i, j) \right\}
\]

Constant Flow \hspace{1cm} Horn-Schunck

Lucas-Kanade (Forward additive) \hspace{1cm} Baker-Matthews (Inverse Compositional)
Tracking in videos

KLT

Mean shift

Kanade

Tomasi
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?