

Computer Vision (16-385) Fall 2019

[REV03 - CHECK PIAZZA FOR NEW VERSIONS]

Days: MW

Room: MM A14

Time: 12:00 - 1:30 PM

Lecturer: Kris Kitani

TAs: Xinshuo Weng, Xiaofang Wang, Ye Yuan, Neeraj Sajjan, Anshuman Majumdar, Shruti Chidambaram

Class Discussion, Slides and Office Hours: piazza.com/cmu/fall2019/16385/home

Assignment Submission and Grades: gradescope.com

Description

This course introduces the fundamental techniques used in computer vision, that is, the analysis of patterns in visual images to reconstruct and understand the objects and scenes that generated them. Topics covered include image formation and representation, camera geometry, and calibration, computational imaging, multi-view geometry, stereo, 3D reconstruction from images, motion analysis, physics-based vision, image segmentation and object recognition.

Prerequisites

Programming, Linear Algebra, Multivariate Calculus, Probability

Grading

Programming Assignments 100% (7 programming assignments total)

- (1) Hough Transform (10%)
- (2) Bag of Visual Words (15%)
- (3) Neural Networks (15%)
- (4) Homography Estimation (15%)
- (5) 3D Reconstruction (15%)
- (6) Photometric Stereo (15%)
- (7) Video Tracking (15%)

Late Submissions

5 late days for the entire semester. Use up to 2 late days on one assignment. 33% penalty for each late day after using all allowed late days (e.g., 33% reduction of score if one day late, 66% reduction if two days late).

Educational Outcomes

- (1) Implement the Hough Transform to detect lines in an image
- (2) Extract SIFT features to build a Bag-of-Words representation of an image for classification
- (3) Perform object recognition using a convolutional neural network
- (4) Detect Harris Corners and implement the RANSAC algorithm to find the homography between two images
- (5) Perform sparse and dense 3D reconstruction using Epipolar constraints and stereo block matching
- (6) Implement photometric stereo reconstruction
- (7) Implement an image alignment algorithm to track objects in a video

Academic Integrity

All encouraged to work together BUT you must do your own work (code and write up). If you work with someone, please **include their name in your write up** and **inside any code** that has been discussed or shared. If we find highly identical write-ups or code without proper accreditation of collaborators, we will take action according to university policies.

Take care of yourself

Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

Class Schedule (Fall 2019)

Date	Topic	Lecturer	Assignments
Aug-26	Introduction, Overview, Policies	Kitani	
Aug-28	Filtering, Pyramids, Gradients	Kitani	
Sep-2	NO CLASS (Labor Day)	-	
Sep-4	NO CLASS (Flooding)	Kitani	
Sep-9	Hough Transforms (normal form, param space)	Kitani	HW1 Release (Hough Transform)
Sep-11	Features: Harris Corners (Quadrics, SVD)	Kitani	
Sep-16	Representations: SIFT, MOPS, BoW	Kitani	
Sep-18	Learning: Nearest Neighbor, Naive Bayes, SVM	Kitani	
Sep-23	Neural Nets: Perceptron, MLP	Kitani	HW2 Release (Bag-of-Visual-Words)
Sep-25	Optimization: GD, Backprop	Kitani	
Sep-30	Classification: LeNet, AlexNet	Kitani	
Oct-2	Classification: VGG, ResNet, GoogleNet	Kitani	
Oct-7	Detection: RCNN, Fast, Faster, SSD, YOLO	Kitani	HW3 Release (Neural Network)
Oct-9	Image Formation (Exposure, Focus, Pinhole. Lens)	Narasimhan	
Oct-14	2D Transforms, Homography, RANSAC	Narasimhan	
Oct-16	Camera Models	Narasimhan	
Oct-21	2-view Geometry (PnP, Triangulation)	Narasimhan	HW4 Release (Homography Estimation)
Oct-23	SFM (Reconstruction, TK Factorization, BA)	Narasimhan	
Oct-28	Advanced Topic	Held	
Oct-30	Advanced Topic	-	
Nov-4	Stereo (Block matching, Rectification)	Narasimhan	HW5 Release (3D Reconstruction)
Nov-6	Brightness Constancy, Optical Flow	Narasimhan	
Nov-11	Image Registration (Additive/Inverse)	Narasimhan	
Nov-13	Mean-Shift Tracking, State Estimation	Narasimhan	
Nov-18	Bayesian Inference, Kalman Filtering, Mono-SLAM	Narasimhan	HW6 Release (Video Tracking)
Nov-20	Radiometry and Reflectance	Narasimhan	
Nov-25	Photometrics Stereo, Shape from Shading	Narasimhan	
Nov-27	NO CLASS (Thanksgiving)	-	
Dec-2	Advanced Topics	Narasimhan	
Dec-4	Advanced Topics	Narasimhan	