HUNTER
The City University of New York

Computational Vision

CSCI 49369 / 79520, Spring 2020

Thursday 5:35 – 8:15PM, HN 1001C

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Course Overview

This course will provide an introduction to the rapidly growing field of computer vision. This field deals with the analysis of images of various forms (regular color images from cameras of mobile phones, 3-D range images, etc.) and video. An explosion of such data sets is what we experience today. The output of vision processes provide an interpretation of the images in the form of 3-D reconstruction, or object representation. This technology has a wide variety of applications including image retrieval in digital libraries, image search, face recognition, photorealistic 3-D modeling, medical image analysis, digital cinematography, mobile robot navigation, industrial inspection, etc. A recent convergence between the fields of computer vision (inverse rendering) and computer graphics (rendering) opens new avenues of exploration. Recently, there is significant commercial interest by a variety of companies.

Course Format

The lectures will generally follow Szeliski's, Horn's and Trucco's books. Szeliski's book provides a broad overview of the field, Horn's is more theoretical and Trucco's more algorithmic. The detailed schedule provides the specific reading material from each book. The slides and Szeliski's book will be enough, but note that topics from other books and sources will be used. A number of research papers will be presented as well. Slides and research papers will be available at the class website before the lectures. We will have four homeworks (programming and written) [45% of the grade], one final project with presentation [25% of the

grade], one midterm exam [15% of the grade], and one final exam [15% of the grade]. The programming language used is C++ for the programming assignments, but you are free to use any programming environment for the final project. Note that no extension will be granted, so make sure that you complete your work well ahead of the deadline. A separate document will describe the requirements for the programming assignments. For graduate students extra work will be required for homework assignments.

Final Project

For the final project you can form groups of at most four people, but you can also do it on your own. I would suggest that you form groups in order to achieve more interesting results. You have to be proactive in terms of forming the groups and selecting a topic that has to be approved by me. More information about the final project will be uploaded on blackboard. Note, that the project will consist of (a) a project proposal write-up, and a (b) a project presentation.

Prerequisites

CSCI 335.

Course Material and Communication

All course material (i.e. slides or other sources) will be uploaded on *blackboard*. Homework assignments will be uploaded on *blackboard*. We will also use *piazza* for communication. You should have been enrolled automatically via your hunter email address already, but you can signup yourself following this link:

piazza.com/hunter.cuny/spring2020/csci4936979520

The *piazza* page for the class is

piazza.com/hunter.cuny/spring2020/csci4936979520/home

If you have a question about the class, topics covered, homework, etc. please first check the posts in the Q & A section. If you did not find an answer, please post your question there. That will make it easier for all students to see answers. You can also answer questions of fellow students. Do not post any code solutions. For questions involving personal matters you can email me.

Textbook

Computer Vision: Algorithms and Applications, Richard Szeliski, 2010. Free online version
http://szeliski.org/Book/
The book is also available for purchase.

Material from these books will be used as well:

- Robot Vision. B. K. P. Horn, The MIT Press, 1998 (12th printing).
- Introductory Techniques for 3-D Computer Vision. Emanuele Trucco and Alessandro Verri. Prentice Hall, 1998.

Other vision books:

- Computer Vision A Modern approach. David S. Forsyth, Jean Ponce. Prentice Hall 2003.
- Three-Dimensional Computer Vision: A Geometric Viewpoint. Olivier Faugeras, The MIT Press, 1996.
- An Invitation to 3-D Vision. Yi Ma, Stefano Soatto, Jana Kosecka, S. Shankar Sastry. Springer-Verlag, 2004.

Learning goals

This class satisfies the following learning goals as set forth by the Computer Science department:

(1d): In-depth knowledge of the specialized field of Computer Vision.

(1a): Understand the basic foundations and relevant applications of mathematics and statistics.

(2a, 2b, 2c): Be adept at formulating, analyzing and solving computing problems.

(3a): Be able to communicate technical ideas effectively.

(4): Ability to being up-to-date in a quickly developing field.

Intellectual Dishonesty

Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. The college is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures.

ADA Compliance

In compliance with the American Disability Act of 1990 (ADA) and with Section 504 of the Rehabilitation Act of 1973, Hunter College is committed to ensuring educational parity and accommodations for all students with documented disabilities and / or medical conditions. It is recommended that all students with documented disabilities (Emotional, Medical, Physical and / or Learning) consult the Office of AccessABILITY located in Room E1124 to secure necessary academic accommodations. For further information and assistance please call (212-772-4857)/TTY (212-650-3230).

Hunter College Policy on Sexual Misconduct

In compliance with the CUNY Policy on Sexual Misconduct, Hunter College reaffirms the prohibition of any sexual misconduct, which includes sexual violence, sexual harassment, and gender-based harassment retaliation against students, employees, or visitors, as well as certain intimate relationships. Students who have experienced any form of sexual violence on or off campus (including CUNY-sponsored trips and events) are entitled to the rights outlined in the Bill of Rights for Hunter College.

a. Sexual Violence: Students are strongly encouraged to immediately report the incident by calling 911, contacting NYPD Special Victims Division Hotline (646-610-7272) or their local police precinct, or contacting the College's Public Safety Office (212-772-4444).

b. All Other Forms of Sexual Misconduct: Students are also encouraged to contact the College's Title IX Campus Coordinator, Dean John Rose (jtrose@hunter.cuny.edu or 212-650-3262) or Colleen Barry (colleen.barry@hunter.cuny.edu or 212-772-4534) and seek complimentary services through the Counseling and Wellness Services Office, Hunter East 1123. CUNY Policy on Sexual Misconduct Link:
http://www.cuny.edu/about/administration/offices/la/Policy-on-Sexual-Misconduct-12-1-14-with-links.pdf

	SYLLABUS & TENTATIVE SCHEDULE (Spring 2020)		
Date	**Topics**	**Readings**	**Assignments**
Th, 1/30	L1. Introduction / Course Overview	Chapter 1 (RS)	HW1 out
	L2. Image Formation	2.1.5, 2.1.6, 2.2.3 (RS) ----- Ch. 2 pp. 18-29 (Horn) [Ch. 2 pp. 15-28 Trucco]	
Th, 2/6	L3.Image Sensing	2.3 Intro, 2.3.2 (RS) ------ Ch. 2 pp. 28-40 (Horn), [Ch.2 pp. 30-40 Trucco]	
	L4. Binary Images	Ch. 3 pp. 46-58, Ch.4 65-71 (Horn) ----- 3.3 (RS)	HW2 out
Th, 2/13	L5. Convolution and Filtering	3.1.1, 3.2 (RS) ----- Ch. 6, pp. 103-109 (Horn), Ch. 3, pp. 55-60 (Trucco)	HW1 due
	L6. Introduction to Edge Detection	Ch. 8, pp. 159-168 (Horn) ---- 4.2 (RS)	
Th, 2/20	L7. Canny edge detection/Edge linking	4.2.2 (RS) --- Ch. 4 (Trucco)	

	L8.Frequency Domain / Fourier Transform	3.4 (RS) ------- Ch. 6 (Horn), Ch. 7 (Forsyth & Ponce)	
Th, 2/27	L9. Frequency Domain, cont.	-//-	HW2 due HW3 out
	L10.Lines/Hough Transform	4.3 (RS) ----- Ch. 4 pp.82-85 (Trucco) , Ch. 5 95-101 (Trucco)	
Th, 3/5	L11.Segmentation & Boundary Representations	5.1.1, 5.3 (RS) ----- pp. 108-113 (Trucco), Ch. 8 (Ballard & Brown)	
	L12. Feature Detection & Matching / Corners / SIFT / Histogram-of-Oriented-Gradients, Shape Contexts, K-D trees.		
Th, 3/12	L13. Radiometry & Reflectance	2.2 (RS) ------- Ch. 2 (pp. 22-24) and Ch. 10, pp. 202-215 (Horn)	Groups Formed HW3 due HW4 out
	MIDTERM		
Th, 3/19	L14. Introduction to object recognition / Machine Learning		
	L15. Object Recognition -- cont.		
Th, 3/26	L16. Photometric Stereo & Shape from Shading	12.1.1 (RS) ------- pp. 215-232 (Horn)	Project Proposal due
	L17. Camera Calibration	Ch. 6 (Trucco) ------- 6.3 (RS)	

Th, 4/2	L18. Stereo I	11.1 through 11.5 (RS) -------- Ch. 8, pp. 177-198 (Trucco), Ch. 13 (Horn-Optional)	HW4 due
	L19. Stereo II	-//-	
Th 4/9,4/15	**SPRING BREAK**		
Th, 4/23	L20. Optical Flow & Motion	8.4 (RS) ------- Ch. 12 (Horn), Ch. 8, pp. 177-198	
	L21. The Factorization Method (motion)	7.3 (RS) ------- Ch. 8, pp. 203-208 (Trucco)	
Th, 4/30	L22. Structure from motion (Photosynth project)	7.4 (RS)	
	L23. 3D Modeling & Range Scanning	12.2-12.5 (RS)	
Th, 5/7	L24. Topics in 3D Classification	Research Papers	
	Project Presentations		
Th, 5/14	Project Presentations		
Th, 5/21	**Final Exam**: 5:35-8:35 PM		