ECE 5554: COMPUTER VISION

Summer 2022, July 6 – August 10 ♦ 3 credits

M W 2:00 PM – 5:30 PM ♦ Zoom (ID 894 6832 3879, passcode **summer**)

Instructor

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Office hours: by appointment

All course files, lecture videos, assignments and announcements are hosted in Canvas.

Description

Techniques for automated analysis of images and videos. Image formation, feature detection, segmentation, multiple view geometry, recognition and video processing.

Computers increasingly require the ability to "see" their surroundings in order to interact with humans and with the three-dimensional world. This course introduces theory and techniques for analyzing the content of images. Applications of computer vision include robotics, autonomous vehicle navigation, industrial automation, content-based search in image databases, face and gesture recognition, and aids for the seeing-impaired.

Formal learning objectives

Having successfully completed this course, the student will be able to

- contrast common image formation models;
- implement various ways of extracting features from images;
- segment an image into meaningful regions;
- derive the theory behind multi-view geometry;
- implement various approaches to recognizing objects and scenes in images; and
- implement techniques for processing video sequences.

Prerequisites

Graduate standing. Familiarity with linear algebra and vector calculus. Ability to use a programming language. (This course does not assume any prior experience in image processing or computer graphics.)

Required materials

Textbook: Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2011. (The Sept. 2010 draft version is available at no cost from http://szeliski.org/Book.)

Software: We will use Python and OpenCV for all homework assignments. You can use any Python environment, but I recommend PyCharm (https://www.jetbrains.com/pycharm/). OpenCV for Python is freely available (https://opencv.org/).

Assessment

Homework Assignments

There will be five homework assignments during the course; these are individual assignments! Students may discuss among themselves general approaches to solving homework problems. The final solutions are expected to be the original work of each individual student. Unless I specify otherwise in the assignment, you are welcome to use relevant snippets of code from online sources **as long as you clearly indicate which lines of code you have borrowed and give me the source!** Code from other students or acquaintances may not be used! If you have any questions, please ask me. Failure to clearly cite a source will be treated as an Honor Code violation.

All assignments should be submitted in electronic form via Canvas (check the assignment files for more detail). Homework assignments **only** will be accepted up to three days late and will be penalized 10% per day.

Exam

We will have a final exam on Thursday, August 11, from 7 PM to 9 PM Eastern time. You MUST be available at this time; make sure and clear your calendar now. More information will be provided.

Quizzes

We will have five quizzes during the course. Each will be fully online, in Canvas, and will consist of around ten questions. You will have twenty minutes to complete the quiz, and it must be taken within the time window assigned (typically six hours). No late quizzes will be administered.

Grading

Grades are calculated per the following:

Graded Item	# of Items	Points per Item	Total Points	Percentage
Homework Assignments	5	40	200	50%
Final Exam	1	100	100	25%
Quizzes	5	20	100	25%
			400	100%

I use the following mapping from percentage scores to letter grades:

Letter Grade	Range
A	100 % to 93.0%
A-	< 93.0 % to 90.0%
B+	< 90.0 % to 87.0%
B	< 87.0 % to 83.0%
B-	< 83.0 % to 80.0%
C+	< 80.0 % to 77.0%
C	< 77.0 % to 73.0%
C-	< 73.0 % to 70.0%
D+	< 70.0 % to 67.0%
D	< 67.0 % to 63.0%
D-	< 63.0 % to 60.0%
F	below 60%

Course delivery

All lectures will be given online, synchronously via zoom. I invite and will reply to questions during lecture; use the chat feature of zoom to ask your question.

All lectures will be recorded and available for viewing later, but I strongly encourage you to participate in the lectures at the scheduled time! I expect each of you to participate synchronously in at least some of the lectures. Note that you are accountable for all material, regardless of any technical issues that may occur in recording and posting videos of the lectures.

General policies

Students may discuss among themselves general approaches to solving homework problems. The final solutions are expected to be the original work of each individual student. Course projects may be done independently or with a partner. All assignments should be submitted in electronic form via Canvas (check the assignment files for more detail). Only homework assignments will be accepted up to three days late and will be penalized 10% per day. No other work may be submitted late.

Piazza and office hours

I use use the Piazza forum tool in Canvas, accessible from the course site in Canvas; it's a great place to post questions on lectures or homework. I allow anonymous posts to Piazza, but not private questions. Whether you post questions or not, please be sure and check there for additional information that you may find useful.

You are also welcome to contact me via email with questions; be sure to use your VT email account, and put "5554" somewhere in the subject line!

Summer office hours are hard to arrange and very sparsely used, so I won't be having set office hours. If you would like to meet, please drop me an email and I will arrange a zoom session.

So, your options for asking questions are:

- During lecture (remote students use the Chat feature of Zoom)
- Piazza in Canvas (public question, anonymous is fine)
- Send me an email (put 5984 in the subject line!)

Honor code

Compliance with the Graduate Honor Code requires that all graduate students exercise honesty and ethical behavior in all their academic pursuits at the university. Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code. Academic integrity expectations are the same for online classes as they are for in-person classes.

For additional information about the Graduate Honor System, please visit the following page: https://graduateschool.vt.edu/academics/expectations/graduate-honor-system.html .

Disabilities

Virginia Tech welcomes students with disabilities into the University's educational programs. The University promotes efforts to provide equal access and a culture of inclusion without altering the essential elements of coursework. If you anticipate or experience academic barriers that may be due to disability, including but not limited to ADHD, chronic or temporary medical conditions, deaf or hard of hearing, learning disability, mental health, or vision impairment, please contact the Services for Students with Disabilities (SSD) office (540-231-3788, ssd@vt.edu, or visit www.ssd.vt.edu). If you have an SSD accommodation letter, please meet with me privately during office hours as early in the semester as possible to deliver your letter and discuss your accommodations. You must give me reasonable notice to implement your accommodations, which is generally 5 business days and 10 business days for final exams.

ECE5554 SU22 Daily Schedule					
Module	**Day**	**Lec**	**Reading**	**Topics**	**Due**
1 - Introduction; Image Processing	6-Jul	1	1.1 - 1.2, 2.1 - 2.3	Introduction; image formation; coordinate transformations	
	11-Jul	2	3.1 - 3.2, 4.2	Pixel operations; filtering; edge detection	
	12-Jul				Quiz 1 (Tue)
	13-Jul	3	3.4 - 3.5	Edges; Fourier transforms; image pyramids	HW1
2 - Features	18-Jul	4	4.1 - 4.3	Patch location; corner detection; Hough and SIFT	
	19-Jul				Quiz 2 (Tue)
	20-Jul	5	8.2 - 8.4	Motion tracking; optical flow; texture	HW2
	25-Jul	6	4.2 - 4.3, 3.3.4	Contours; curvature; region properties	
	26-Jul				Quiz 3 (Tue)
3 - Segmentation	27-Jul	7	3.1, 5.2	Segmentation methods	HW3
	1-Aug	8	5.1 - 5.4	Segmentation by clustering; graph methods; active contours	
	2-Aug				Quiz 4 (Tue)
4 - Structure	3-Aug	9	6.1, 9.1, 3.6.3	Feature-based alignment; image stitching; image morphing	HW4
	8-Aug	10	6.2, 11.1 - 11.5	Pose estimation; stereo vision	
	9-Aug				Quiz 5 (Tue)
	10-Aug	11	12.1	Shape from shading and motion; deep learning; review	HW5
	11-Aug	**FINAL EXAM, 7 PM - 9 PM**			