

## **ECE 2390/1390: Image Processing and Computer Vision (3 Credits, Fall 2021)**

**Description:** This is an introductory course to computer vision including fundamentals of image formation, camera imaging geometry, feature detection and matching, multiview geometry including stereo, motion estimation and tracking, and classification. The focus of the course is to develop the intuitions and mathematics of the methods in lecture, and then to learn about the difference between theory and practice in the problem sets. We focus less on the machine learning aspect of CV as that is really classification theory best learned in an ML course. This course is designed for both senior level undergraduates interested in computer vision as well as MS graduate students.

**Prerequisite:** Linear algebra, Vector calculus, Data structures, Programming (MATLAB or Python). No prior knowledge of vision is assumed though any experience with Signal Processing is helpful.

**Class Meetings:** Monday/Wednesday 4:30pm–5:45pm, 1211 BEH.

**Instructor:** Dr. Ahmed Dallal, (office) 1203 Benedum Hall, (email) [ahd12@pitt.edu](mailto:ahd12@pitt.edu), (office hours) Tuesday 9:30 am – 10:30 am, Wednesday 6:00 pm–7:00 pm, or by appointment; via zoom ([link](#)). In-person appointments are available upon request.

**TA:** Mr. Shuda Zhong, (email) [shz116@pitt.edu](mailto:shz116@pitt.edu), (office hours) Thursday 3:30 pm–5:00 pm, or by appointment; in person in 1139 BEH or via zoom ([link](#))

**UTA:** Mr. Adam Johnson, (email) [adamjohnson@pitt.edu](mailto:adamjohnson@pitt.edu), (office hours) Friday 12:00 pm – 1:30 pm, or by appointment; in person in 1139 BEH or via zoom ([link](#))

### **Text:**

Forsyth & Ponce (**FP**), Computer Vision: A Modern Approach (2nd Edition), Prentice Hall, 2011.

### **References:**

Richard Szeliski (**SZ**), Computer Vision: Algorithms and Applications ([online](#))

M. Sonka, V. Hlavac and B. Boyle, Image Processing, Analysis, and Machine Vision, 4th edition, Cengage Learning, Stamford, 2014.

R. Gonzalez and R. Wood, Digital Image Processing, 4<sup>th</sup> edition, Pearson, 2018.

### **Covered Topics**

1. Image processing for computer vision
2. Camera models and views
3. Features and matching
4. Lightness and brightness
5. Image motion
6. Classification and recognition
7. Segmentation
8. Miscellaneous operations

### **Course Evaluation:**

Homework 65%, quizzes 15%, final exam 15%, class participation 5%.

**Homework:**

Besides evaluating students' performance, the purpose of these assignment is to train students on and encourage them to expand their understanding of the studied algorithms and applications. The homework assignments are where the majority of the learning happens.

- There are 6 – 8 assignments.
- Homework assignments will include mainly programming problems.
- Students can program using either MATLAB or Python only.
- **Codes that do not run will be credited 0.**
- **Copied codes will be credited 0.**
- Students can submit their assignment up to 24 hours late with a penalty of **25% off** the grade. No submission will be accepted 24 hours after the posted deadline.
- Some of the problems may require you to read and summarize external materials.
- Solutions of the problems **may not** be provided.
- Each student is responsible for his or her own work. Discussion of assignments and programs should be limited to clarification of the handout itself, and should not involve any sharing of pseudocode or code or simulation results. Violation of this policy is grounds for a semester grade of F.

**Quizzes:** about six short quizzes will be held at the beginning of some Wednesday's lectures to cover the important concept that we study in class.

**Plagiarism and Academic Integrity:**

Students must do their own work. Plagiarism of another student's work or other references is a serious offense, and can result in dismissal from the University of Pittsburgh. Students may consult each other with regard to the homework problems, but **must not** copy work or code from one another or any source. The only exception to this rule is the use of code examples that are provided in the course text or on the course website for this purpose. Students are responsible for explaining how their code works whenever this is requested by the instructor. All grades are contingent on the ability of the student to explain his or her work to the instructor. All students are expected to adhere to the standards of academic integrity. Any student engaged in cheating, plagiarism, or other acts of academic dishonesty would be subject to disciplinary action. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the Pitt Guidelines on Academic Integrity (<http://www.provost.pitt.edu/info/acguidelinespdf.pdf>). This may include, but is not limited to the confiscation of the examination of any individual suspected of violating the University Policy.

**Course website:** Slides, notes, homework, and announcements will be posted to the class courseweb (Canvas).

**Illness:**

As in any situation regarding class absence, a student who becomes ill (albeit COVID-19 related or not) is responsible for communicating with us regarding course absences. Please contact us and provide documentation when absences affect quizzes/exams. This should be done via email as soon as possible.

**COVID-19 statement:**

During this pandemic, it is extremely important that you abide by public health regulations and University of Pittsburgh health standards and guidelines. While in class, at a minimum, you must

wear a face covering that covers your nose and mouth; other requirements may be added by the University during the semester. These rules have been developed to protect the health and safety of all community members. Failure to comply with these requirements will result in you not being permitted to attend class in person and could result in a Student Conduct violation. For the most up-to-date information and guidance, please visit [coronavirus.pitt.edu](http://coronavirus.pitt.edu) and check your Pitt email for updates before each class.

**Texting:**

Use of personal communication devices such as cell phones is not permitted in class. This includes texting. If you receive a call or message to which you must respond immediately because of a personal or family emergency, please leave the classroom to do so.

**Statement on Classroom Recording:**

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use. In case the class needed to meet virtually, the instructor will record lectures via zoom, and you can access these recordings through the zoom link on Canvas.

**Disability Services:**

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, [drsrecep@pitt.edu](mailto:drsrecep@pitt.edu), (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

**Religious Observance:**

The observance of religious holidays (activities observed by a religious group of which a student is a member) and cultural practices are an important reflection of diversity. As your instructor, I am committed to providing equivalent educational opportunities to students of all belief systems. At the beginning of the semester, you should review the course requirements to identify foreseeable conflicts with assignments, exams, or other required attendance. If at all possible, please contact us within the first two weeks of the semester to allow time for us to discuss and make fair and reasonable adjustments to the schedule and/or tasks.

**Diversity and Inclusion:**

The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. For more information about policies, procedures, and practices, see: <http://diversity.pitt.edu/affirmative-action/policies-procedures-and-practices>.

We ask that everyone in the class strive to help ensure that other members of this class can learn in a supportive and respectful environment. If there are instances of the aforementioned issues, please contact the Title IX Coordinator, by calling 412-648-7860, or e-mailing [titleixcoordinator@pitt.edu](mailto:titleixcoordinator@pitt.edu). Reports can also be filed online: <https://www.diversity.pitt.edu/make-report/report-form>. You may also choose to report this to a faculty/staff member; they are required to communicate this to the University's Office of Diversity and Inclusion. If you wish to maintain complete confidentiality, you may also contact the University Counseling Center (412-648-7930).

**Tentative schedule: (quiz dates are confirmed, HW deadlines are tentative)**

<b>Week #; date</b>	<b>Topic</b>	<b>Reading</b>	<b>Homework assigned</b>	<b>Quiz (Wednesdays)</b>
1; 8/30	Introduction, image as function,	SZ 1.1, 1.2	HW 0; dues 9/13	
2; 9/6	Image filtration	FP 4 (all)		
3; 9/13	Edges and lines; edge detection Hough transform	FP 5.1, 5.2 FP 10.1	HW 1; dues 9/29	Quiz 1
4; 9/20	Frequency domain analysis Aliasing Camera Models	FP 4.3 FP 4.4 FP 1, 2.1, 2.2		
5; 9/27	Camera Models Stereo geometry	FP 7		Quiz 2
6; 10/4	Stereo geometry	FP 7	HW 2; dues 10/18	
7; 10/11	Camera Calibration	FP 1.2, 1.3; SZ 5.2, 5.3	HW 3; dues 11/1	
8; 10/18	Multiple views	FP 7.1 and 8 (all)		Quiz 3
9; 10/25	Feature detection, corners  No meeting on 10/14 – student self-care day	FP 5.3, 5.4; SZ 4.1		
10; 11/1	Feature descriptors	FP 5.3, 5.4; SZ 4.1	HW 4; dues 11/17	Quiz 4
11; 11/8	Model fitting and RANSAC	FP 10.2 – 10.4		
12; 11/15	Motion and optical flow	FP 10.6	HW 5; dues 12/1	Quiz 5
13; 11/22	Thanksgiving recess			
14; 11/29	Motion and optical flow Introduction to recognition Classification – Generative models	FP 15.1, 15.2, 16.1.5	HW 6; dues 12/10	Quiz 6
15; 12/6	Color spaces and segmentation	FP 9		
16; 12/13	<b>Final exam on 12/15 during class time</b>			