CAP 4453.0001: Robot Vision
Department of Computer Science, CECS
3 Credit Hours

Course Syllabus

Instructor:	Gonzalo Vaca-Castano	Term:	Spring 2024
Office Hours:	Thursday 8PM – 9PM(via zoom)	Class Meeting Days:	Tuesday-Thursday
		Class Meeting Time:	6:00PM – 7:15PM
Email:	Gonzalo.vacacastano@ucf.edu or Webcourses@UCF messaging	Class Location:	MSB 360
		Course Modality:	P

GTA(s):	Vijay Prakash	Email:	vijayprakash.ucf@gmail.com Webcourses@UCF messaging

Course Description
The study of mechanical vision is one of the few areas of science which blends one's intuition with formal methods. Vision (whether in humans or machines) is fundamentally a computational process. Visual processes for machines must be able to deliver the kinds of capabilities that humans have: scene recognition, motion processing, navigational abilities, and so forth. This course will begin by examining some of the elementary concepts in machine vision. Subprocesses to be examined include: edge detection, methods for obtaining shape information from images, object detection, and motion analysis. The student will also be exposed to unsolved problems in these topics, the solutions to which have very high technological pay-offs. The workload consists of interesting reading, programming, and tests. This class is suitable for undergraduate students in Computer Science and Engineering disciplines, and anyone else who wishes an introduction to machine vision.

Student Learning Outcomes
At the end of semester, you should be able to:
- Perform basic image processing
- Compute transformation in images and create image warping
- Become familiar with classic computer vision
- Understand principles behind deep learning to solve computer vision problems

Enrollment Requirements
COP 3503C and MAC 2312 each with a grade of "C" (2.0) or better or C.I.

Desirable: Linear algebra. The course will teach the basic linear algebra required for the understanding of the topics covered during the class.

Course Contents

A tentative list of topics to be covered in this course,

1. Introduction
   - Images, representation
   - Color, sensors
   - Applications of CV.
   - CV road map (history)
   - Hardware
2. Basic of Images
   - Histogram
   - Color spaces

3. Filtering
   - Filtering (salt/peeper)
   - Convolution/correlation
   - Smoothing (low pass filtering), gaussian
   - Median filter
4. Filtering 2

   -
   - Edges
   - Sobel, prewitt
   - Second derivative Marr Hildreth Edge
   - Laplacian of Gaussian
   - Thresholding,

5. Filtering 3: Edge detection
6. Canny Edge detector
7. Segmentation I
8. Segmentation II
9. Feature points I
10. Feature points II
11. Image warping I
12. Image warping II
13. Optical Flow
14. Object detection (HOG + SVM)
15. Introduction to neural networks
16. Training neural networks
17. Pytorch tutorial
18. Introduction to convolutional neural networks
19. What else is out there now?

Weekly homework

Every week a small homework will be assigned. There are two types of homeworks: a) paper based homework or b) programming assignments to be delivered as a colab notes.

Programming mini-projects
Two programming projects will have to be implemented by the students.

NOTE: The classes are currently scheduled for face-to-face lectures. Most of the time, I record the class in webcourses as a courtesy, but you are expected to be in class. If the sound in the recording is not good, do not complain, you MUST be in class.

- The office hours will be virtual using Zoom. The links to the meetings will be shared on Webcourses.

Please take the time to familiarize yourself with Zoom by visiting the UCF Zoom GuidesLinks to an external site. at <https://cdl.ucf.edu/support/webcourses/zoom/>. You may choose to use Zoom on your mobile device (phone or tablet).
Things to Know About Zoom:

- You must sign into my Zoom session using your UCF NID and password.
- The Zoom sessions are recorded.
- Improper classroom behavior is not tolerated within Zoom sessions and may result in a referral to the Office of Student Conduct.
- You can contact Webcourses@UCF SupportLinks to an external site. at <https://cdl.ucf.edu/support/webcourses/> if you have any technical issues accessing Zoom.

Programming
Python will be main programming environment for the assignments. Following book (Python programming samples for computer vision tasks) is freely available.
Python for Computer Vision (Links to an external site.). A tutorial will be given in the class on PyTorch for deep learning.

Collaboration
Students are free to discuss ideas and technical concepts. However, students must submit original work for all assignments, projects and exams, and abide by UCF Golden Rule.
Cheating is not tolerated!

Evaluation
Mid-term Exam: 25%
Final Exam: 30%
Weekly homework: 25%
Programming assignment 1:   10%
Programming assignment 2:   10%

Scores

- 95-100 = A
- 90-94 = A-
- 85-89 = B+
- 80-84 = B
- 75-79 = B-
- 70-74 = C+
- 65-69 = C

- 60-64 = C-
- 55-59 = D+
- 50-54 = D
- 45-49 = D-
- 0-44 = F

Programming assignments
Deliverables: Colab notes containing:

1. Text explanation of the procedures and code.
2. Examples testing input data (images, video)
3. Commented code
4. Analysis and conclusions

Grade Dissemination
Your grades will be available via webcourses

Policy Statements

Statement on Academic Integrity:

Students should familiarize themselves with UCF's Rules of Conduct at
<https://scai.sdes.ucf.edu/student-rules-of-conduct/>. According to Section 1, "Academic Misconduct,"
students are prohibited from engaging in
1. Unauthorized assistance: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
4. Falsifying or misrepresenting the student's own academic work.
5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor.
7. Helping another violate academic behavior standards.
8. Soliciting assistance with academic coursework and/or degree requirements.

Responses to Academic Dishonesty, Plagiarism, or Cheating
Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule* <https://goldenrule.sdes.ucf.edu/>. UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and respond to academic misconduct when necessary. Penalties for violating rules, policies, and instructions within this course can range from a zero on the exercise to an "F" letter grade in the course. In addition, an Academic Misconduct report could be filed with the Office of Student Conduct, which could lead to disciplinary warning, disciplinary probation, or deferred suspension or separation from the University through suspension, dismissal, or expulsion with the addition of a "Z" designation on one's transcript.

Being found in violation of academic conduct standards could result in a student having to disclose such behavior on a graduate school application, being removed from a leadership position within a student organization, the recipient of scholarships, participation in University activities such as study abroad, internships, etc.

Let's avoid all of this by demonstrating values of honesty, trust, and integrity. No grade is worth compromising your integrity and moving your moral compass. Stay true to doing the right thing: take the zero, not a shortcut.

Unauthorized Use of Websites and Internet Resources
There are many websites claiming to offer study aids to students, but in using such websites, students could find themselves in violation of academic conduct guidelines. These websites include (but are not limited to) Quizlet, Course Hero, Chegg Study, and Clutch Prep. UCF does not endorse the use of these products in an unethical manner, which could lead to a violation of our University's Rules of Conduct. They encourage students to upload course materials, such as test questions, individual assignments, and examples of graded material. Such materials are the intellectual property of instructors, the university, or publishers and may not be distributed without prior authorization. Students who engage in such activity could be found in violation of academic conduct standards and could face course and/or University penalties. Please let me know if you are uncertain about the use of a website so I can determine its legitimacy.

Unauthorized Distribution of Class Notes
Third parties may attempt to connect with you to sell your notes and other course information from this class. Distributing course materials to a third party without my authorization is a violation of our University's Rules of Conduct. Please be aware that such class materials that may have already been given to such third parties may contain errors, which could affect your performance or grade. Recommendations for success in this course include coming to class on a routine basis, visiting me during my office hours, connecting with the Teaching Assistant (TA), and making use of the Student Academic Resource Center (SARC), the University Writing Center (UWC), the Math Lab, etc. If a third party should contact you regarding such an offer, I would appreciate your bringing this to my attention. We all play a part in creating a course climate of integrity.

In-Class Recording
Students may, without prior notice, record video or audio of a class lecture for a class in which the student is enrolled for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach enrolled students about a particular subject. Recording class activities other than class lectures, including but not limited to lab sessions, student presentations (whether individually or part of a group), class discussion (except when incidental to and incorporated within a class lecture), clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, private

conversations between students in the class or between a student and the faculty member, and invited guest speakers is prohibited. Recordings may not be used as a substitute for class participation and class attendance, and may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct as described in the Golden Rule.

Course Accessibility Statement
The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need access to course content due to course design limitations should contact the professor as soon as possible. Students should also connect with Student Accessibility Services (SAS) <http://sas.sdes.ucf.edu/> (Ferrell Commons 185, sas@ucf.edu, phone 407-823-2371). For students connected with SAS, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential course access and accommodations that might be necessary and reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SAS, faculty and the student may be warranted to ensure an accessible course experience.

Campus Safety Statement
Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Students should make a note of the guide's physical location and review the online version at <https://centralflorida-prod.modolabs.net/student/safety/index>.
- Students should know the evacuation routes from each of their classrooms and have a plan for finding safety in case of an emergency.
- If there is a medical emergency during class, students may need to access a first-aid kit or AED (Automated External Defibrillator). To learn where those are located, see <https://ehs.ucf.edu/automated-external-defibrillator-aed-locations>.
- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <https://my.ucf.edu> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK."
- Students with special needs related to emergency situations should speak with their instructors outside of class.
- To learn about how to manage an active-shooter situation on campus or elsewhere, consider viewing this video (<https://youtu.be/NIKYajEx4pk>).

Deployed Active Duty Military Students
If you are a deployed active duty military student and feel that you may need a special accommodation due to that unique status, please contact your instructor to discuss your circumstances.