CS 678 Computer Vision

Fall 2021
Thursday 5:00pm – 7:50pm, AER 135

Instructor

Dr. Gianfranco Doretto   357 Advanced Engineering Research Building
Email gidoretto@mix.wvu.edu   304-293-9133
Office Hours: Held virtually via Zoom by appointment (send email)

Course Format and Credit hours

3 hr Lecture
3 hr Credit

Class Webpage

http://vision.csee.wvu.edu/classes/cs678-f21/

Technology Requirements

The student must have access to a computer, an internet connection, and a webcam to attend this class.

Communication and Supplementary Materials

Course announcements, homework, study aids, and supplementary readings will be posted on eCampus, and the class webpage. Students should regularly check the class webpage, the eCampus course page, and their MIX email.

For class discussion we will be using Piazza. If you have questions about concepts explained in class, or need help with homework, you should post on Piazza instead of emailing the course instructor directly. Since Piazza is a shared discussion forum, asking and answering questions there can benefit other students as well. The system is highly catered to getting you help fast and efficiently from classmates, and the instructor. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza.

Find our class page here at: https://piazza.com/wvu/secondsemester2021/cs678/home

Prerequisites

Students entering the class are expected to have a pre-existing working knowledge (at the level of an undergraduate class) of multivariate calculus, linear algebra, probability and statistics, and computer programming and algorithms, though the class has been designed to allow students with a strong numerate background to catch up and fully participate. Basic knowledge of signal processing, or optimization and machine learning is a plus. Please contact me if you are not sure whether your background is right for the course. In addition, the course assignments will be in Python. You should have prior experience with this language, or you should be willing to quickly learn a new language.

Course Description

This is an introductory course to Computer Vision at graduate level. We will first introduce low-level image analysis concepts such as image formation and filtering, edge detection, and interest point detection and matching. We will move forward by introducing the problems of object detection and recognition with shallow models, and then present their extensions based on deep learning models. In the last part of the course, we will focus on 3D scene understanding aspects, including camera calibration, stereo vision, epipolar geometry, and structure from motion.

Course Objectives

The purpose of this graduate course is to provide an introduction to the fundamental set of techniques and algorithms that constitute computer vision as of today, while providing a thorough grounding in the methodologies and mathematical foundations.

Expected learning outcomes

1. Become familiar with theoretical and practical aspects of computing with images.
2. Ability to design, implement, and test an algorithm for a given computer vision task.
3. Ability to assess the correctness of a computer vision algorithm based on basic principles.

Tentative Schedule (total of 15 weeks)

The instructor reserves the right to make changes in the syllabus. Any changes that are made will be in, what the instructor deems, the best interests of the class.

- Image formation and filtering (2 weeks)
- Feature detection and matching (2 weeks)
- Machine learning primer (1 week)
- Object detection and recognition (2 weeks)
- Deep learning approaches (2 weeks)
- Camera calibration and stereo vision (2 weeks)
- Depth estimation and motion (2 weeks)
- Selected topics (2 weeks)

Grading

The course format will predominantly consist of lectures. Students will receive programming assignments, as well as reading assignments, for which they will have to turn in a critique. Each student will complete a final project and give a project presentation to the class. Participation in discussions can be an important component of the grade, and as time permits, some students may increase their participation by volunteering to present a reading assignment.

Final grades will be based approximately on the following distribution:

50% Reading and Programming Assignments
25% Mid-term
25% Final Project

Up to 10% of extra bonus points may be assigned based on exceptional class engagement and participation or based on creative solutions to programming assignments and original ideas for final projects.

Grades will be assigned according to the following scale:

A = 90-100
B = 80-89
C = 70-79
D = 60-69

Programming Languages

In class examples will be given in Python. The programming assignments are expected to be executed in this language. Having prior experience with array manipulation in Python (with numpy) is a big plus.

Assignment Policy

I expect you to try solving each assignment on your own. However, when being stuck on a problem, I encourage you to collaborate with other students in the class, subject to the following rules:

1. You may discuss a problem with any student in this class and work together on solving it. This can involve brainstorming and verbally discussing the problem, going together through possible solutions, but should not involve one student telling another a complete solution.
2. Once you solve the homework, you must write up your solutions on your own, without looking at other people's write-ups or giving your write-up to others.
3. In your solution for each problem, you must write down the names of any person with whom you discussed it. This will not affect your grade.
4. Do not consult solution manuals or other people's solutions from similar courses.

Late Assignment Policy

Each student may use three "late days" for the whole course. The late day count starts from the day and time of the due date of each assignment. Fractional late days are taken into account. Additional "late days" after the first three come at a day cost of 20% of the assignment.

Textbook

Notes and reading material will be distributed. Much of the material covered is included in the two books listed below. Purchasing them is not a strict requirement.

Computer Vision: Algorithms and Applications, by Richard Szeliski.
NOTE: The second edition of this book is also kindly made available online for free.

Deep Learning, by Ian Goodfellow and Yoshua Bengio and Aaron Courville
NOTE: This book is also kindly made available online for free.

Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, and Jerome Friedman
NOTE: This book is also kindly made available online for free.

Other optional books are listed here:

Computer Vision: A Modern Approach, (Second Edition) by David Forsyth and Jean Ponce.

Multiple View Geometry in Computer Vision, (Second Edition) by Richard Hartley and Andrew Zisserman.

Engagement Policy

The student is expected to make the effort to attend lectures. Attendance will be recorded. Participation during lectures, or via electronic discussion boards (e.g., Piazza), will also be recorded whenever possible, and will constitute important basis for assigning engagement grades.

Attendance Policy

The WVU Catalog contains the full Attendance Policy (available at the following url: http://catalog.wvu.edu/undergraduate/enrollmentandregistration/#Attendance). Consistent with WVU guidelines, students subject to University Sanctioned Absences from regularly scheduled class work, will have the opportunity to make-up for them at an alternate time. Make-up class work (e.g., assignment, exams) for absences due to any other reason will be at the discretion of the instructor.
Please note that absences due to COVID-19 are no longer considered University Sanctioned Absences.

Notice of Class Recording Policy

Meetings of a course at West Virginia University (WVU), whether online or in-person, may be recorded. Recordings are not guaranteed, and are intended to supplement the planned class session. Recordings will be made available to class participants, which may include students, assistants, guest lecturers, and co-facilitators. Recordings may be shared by the instructor or institution in accordance with WVU Rules and policies. The Recordings are owned by and contain intellectual property of WVU. The Recordings may not be shared, copied, reproduced, redistributed, transferred, or disseminated in any form or by any means without the prior written consent of authorized officials of WVU.

COVID-19 Syllabus Statement

WVU is committed to maintaining a safe learning environment for all students, faculty, and staff. Should campus operations change because of health concerns related to the COVID-19 pandemic or other campus-wide emergency, it is possible that this course will move to a fully online delivery format. If that occurs, students will be advised of technical and/or equipment requirements, including remote proctoring software.

In a face-to-face environment, our commitment to safety requires students, staff, and instructors to observe the social distancing and personal protective equipment (PPE) guidelines set by the University at all times. While in class, students will sit in assigned seats when required and will wear PPE according to current University guidelines. Students who fail to comply may be referred to the Office of Student Conduct for sanctions.

COVID related absences fall under the University attendance policy. As detailed in the policy, a student who becomes sick or is required to quarantine during the semester should notify the instructor. The student should then work with the instructor to develop a plan to complete the course learning outcomes while he or she is absent.

Sale of Course Material Statement

All course materials, including lectures, class notes, quizzes, exams, handouts, presentations, and other course materials provided to students for their courses are protected intellectual property. As such, the unauthorized purchase or sale of these materials may result in disciplinary sanctions under the Student Conduct Code (available at the following url: https://studentconduct.wvu.edu/campus-student-code). [adopted 5-11-2015]

Appropriate Use of Technology Statement

Use of technology in the classroom should always be directly related to class activities and/or course learning outcomes. Inappropriate technology use can be an impediment to learning and a distraction to all members of the class. As such, inappropriate use of technology in the classroom may be considered a disruption of the class and constitute a violation of the WVU Student Conduct Code (available at the following url: https://studentconduct.wvu.edu/campus-student-code) and could potentially result in a referral to the Office of Student Conduct. Use of technology in the classroom when specifically prohibited by the instructor may also constitute a violation of WVU's Academic Integrity (available at the following url: http://catalog.wvu.edu/undergraduate/coursecreditstermsclassification/) policy.

Mental Health Statement

Mental health concerns or stressful events can adversely affect your academic performance and social relationships. WVU offers services to assist you with addressing these and other concerns that you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus at the Carruth Center for Psychological and Psychiatric Services (CCPPS) website: https://carruth.wvu.edu/

If you are in need of crisis services, call the CCPPS main number 24/7: (304) 293-4431.
Crisis services are also available through text: Text WVU to 741741 for support 24/7 from a trained Crisis Counselor.

Adverse Weather Statement

In the event of inclement or threatening weather, everyone should use his or her best judgment regarding travel to and from campus. Safety should be the main concern. If you cannot get to class because of adverse weather conditions, you should contact your instructor as soon as possible. Similarly, if your instructor(s) are unable to reach the class location, they will notify you of any cancellation or change as soon as possible, using agreed upon methods to prevent students from embarking on any unnecessary travel. If you cannot get to class because of weather conditions, instructors will make allowances relative to required attendance policies, as well as any scheduled tests, quizzes, or other assessments. [adopted 9-8-2014]

Inclusivity Statement

The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion.
If you are a person with a disability and anticipate needing any type of accommodation in order to participate in your classes, please advise your instructors and make appropriate arrangements with the Office of Accessibility Services (available at the following url: https://accessibilityservices.wvu.edu/).
More information is available at the Division of Diversity, Equity, and Inclusion (available at this url: https://diversity.wvu.edu/) as well. [adopted 2-11-2013]

Academic Integrity Statement

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be

sacrificed to expediency, ignorance, or blatant fraud. Therefore, instructors will enforce rigorous standards of academic integrity in all aspects and assignments of their courses. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the West Virginia University Academic Standards Policy (available at the following url: http://catalog.wvu.edu/undergraduate/coursecreditstermsclassification/). Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see your instructor before the assignment is due to discuss the matter.