Syllabus: Image Processing and Computer Vision (IMGS 682)
Spring 2021
Instructor: Prof. Christopher Kanan

Course Description: This course will cover methods in image processing and computer vision, with an emphasis on the state-of-the-art techniques currently used in academia and industry. Topics will include image filtering, edge detection, corner detection, segmentation, object/image/face classification, object detection, morphological operators, object tracking, image registration, and video activity classification. Students are expected to have some familiarity with college-level calculus, linear algebra, and basic probability and statistics (conditional probability, mean, variance, etc.). Computer programming skills are expected (e.g., you are expected to have taken one or more classes involving extensive computer programming and not merely editing other's code). The course requires a significant amount of computer programming. Class 3, Credit 3 (S)

Prerequisites: IMGS-616 or permission of the instructor.

Class Time: Mondays and Wednesdays, 6:30PM - 7:45PM
Class Location: Online via Zoom

Required Text: The main book for the class is "Computer Vision: Algorithms and Applications" (2011) by Richard Szeliski. While you can buy a hardcopy of the text, it is also freely available online. You can download a PDF of the book here: http://szeliski.org/Book/drafts/SzeliskiBook_20100903_draft.pdf There will also be readings from other sources.

Instructor Contact:

Name: Dr. Christopher Kanan
Office Location: Zoom, https://rit.zoom.us/j/99337534126
Office Hours: After class on Wednesdays
Email Address: christopher.kanan@rit.edu

Teaching Assistant:

Name: William Grimble
Office Location: Zoom, https://rit.zoom.us/j/93597890330?pwd=L3BtbTlpaWpQUlhVN2V1R0FYV3ladz09
Office Hours: 1-2pm, Tuesdays & Thursdays
Email Address: wag3983@rit.edu

Evaluation and Grading: The final course grade will be weighted as follows:

Homework: 60% (6 assignments)
Project: 40%

Letter grades will be assigned as follows:

A : 93 or above	A- : 90-92	B+ : 87-89	B : 83-85	B- : 80-82
C+ : 77-79	C : 73-75	C- : 70-72	D : 60-70	F : under 60

Note that C- grades and below do not count toward the fulfillment of program requirements for a graduate degree at RIT. The professor may choose to “curve” the class by giving all students the same number of additional percentage points.

Homework: Your homework submissions must cite any references used (including articles, books, code, websites, and personal communications). All solutions must be written in your own words, and you must program the algorithms yourself. *Unless specifically authorized, you are not to use external code from the web or toolboxes*.

Your homework solutions must be prepared in LaTeX and output to PDF format. If you don't already know LaTeX, this is an excellent opportunity to start using it. Many academic conferences and journals require LaTeX formatted submissions. Your solutions should include all diagrams, written explanations, code, and program output relevant to the problem.

While there are only six homework assignments, each assignment except for Homework 0 will be time consuming. Starting early lets you ask a TA and instructor for help on specific problems if you get stuck. Many students have failed assignments because they did not start as soon as the assignment was given. The homework assignments are planned to cover these topics:

- Homework 0 - Linear Algebra, Python
- Homework 1 - Classifiers, PCA
- Homework 2 - Image Processing, Color, Image Enhancement, Morphological Operators
- Homework 3 - Edge detection, Corner detection, Homographies
- Homework 4 - Segmentation and Object Classification
- Homework 5 - Video Analysis and Object Detection

Project: You are required to complete a project. Your project should be at the frontier of computer vision, but it does not necessarily need to move the frontier forward. You may use the programming language of your choice. Replicating results from a recent paper and comparing it to other works, would be a good project. Run your early ideas by Prof. Kanan via email or in office hours. *You may team with others, but this requires extremely good justification and pre-approval for Prof. Kanan*. Expectations will be greater for teams. The schedule for the project is as follows:

1. **Project Proposal**: The project proposal should clearly state what you plan to do. It should be 4+ pages long (not including references). It should contain a list of three to six milestones and deadlines. You should list the questions the project will address and that will be discussed in the report. You should list what software you will be using or will build upon. Describe the datasets

you will use and how you know if the project is successful. Describe the hypotheses you will test and the related work. The proposal should be a well organized document in continuous english, and it should not be merely an outline. You should be able to reuse much of the text for the final report. It should be typeset using LaTeX, and submitted as a PDF (under 10MB).

2. **Revised Project Proposal (optional)**: The revised proposal is an opportunity to improve your grade if you fail to do the project proposal effectively. You may submit a revised proposal that takes into account the comments received by the instructor and TA. The new grade will replace the original score, but the maximum score for the revised proposal is 80%.
3. **Project Report**: The project report will describe the project, i.e., what you did and the result. It should be eight pages long (not including references) and formatted in CVPR format. It should be typeset using LaTeX, and submitted as a PDF (under 10MB). Read CVPR papers to get an idea for what the style and formatting should be.
4. **Project Presentation**: You will have to give a presentation on your project to the class.

Policy on Late Work: Late work will be penalized at 10% off per day the assignment is late. After the 5th day, the assignment will no longer be accepted. Assignments involve a large time commitment, and you are unlikely to complete them by the deadline if you wait until the night before. I urge you to begin them immediately after they are assigned. If you get stuck, starting early ensures you have enough time to ask us for help.

Programming Environment: All homework assignments must be done in Python. For the class project, you may use the programming environment of your choice.

Prior Course Materials: Unauthorized use of course materials from previous semesters (e.g., material you have received from others), is strictly prohibited.

New Course Materials: Course materials (slides, lectures, assignments, etc.) may not be re-distributed or posted elsewhere online. Redistribution of copyright protected material outside this RIT course may be prohibited by law.

Notes on Plagiarism: Plagiarism is a serious offense and is in violation of the RIT Student Academic Integrity Policy (http://www.rit.edu/academicaffairs/policiesmanual/d080). If you are unsure of what constitutes plagiarism in written documents, a good description can be found here: http://isites.harvard.edu/icb/icb.do?keyword=k70847&pageid=icb.page342054

For your assignments, you must cite all work that you refer to. You must not copy any text verbatim, even if you cite it. The text must be paraphrased, and this should not be done excessively. Plagiarism does not just occur in written documents; it also occurs in code. Many of the algorithms we will code and problems we will solve have been solved by others who have posted code (in various programming languages) online. It is unacceptable (and it is considered plagiarism) to copy code developed by others and submit it as your own. (This includes code that is written by your fellow students!) Even making minor changes, such as changing variable names, function names, formatting, etc., is

not enough to allow you to claim your submission as your own because the underlying structure of the code remains unchanged.

The consequences of plagiarism, whether in code or in written documents, are at the discretion of the instructor, and can be as severe as automatic failure of the course.

Academic Accommodations: RIT is committed to providing reasonable accommodations to students with disabilities. If you need accommodations such as special seating, note taking services, or extended time or a different environment due to a disability, please go to the Disability Services Office. It is located in the Student Alumni Union, room 1150. If you receive accommodation approval, you must make me aware of this fact prior to the date that accommodations will be necessary.

Course Schedule: The following schedule lists dates for class topics. The content in this schedule is tentative and subject to change. It is your responsibility to attend class and to remain informed of any changes that may be announced.

Lecture	Week	Date	Assignments	Class Topics / Activities
1	1	1/25	Homework 0 Assigned	Introduction, Course Overview
2		1/27		Math Background Review
3	2	2/1	Homework 0 Due Homework 1 Assigned	Classifiers: Basics & Nearest Neighbor
4		2/3		PCA & Dimensionality Reduction
5	3	2/8		Classifiers: Perceptron and SVM
6		2/10		Classifiers: Neural Networks & Deep Learning
7	4	2/15	Homework 2 Assigned	Images & Image Enhancement
8		2/17	Homework 1 Due	Color Spaces & Color Constancy
9	5	2/22		Filtering & Paper Anatomy
10		2/24		Binary Images & Morphological Operators
11	6	3/1		Edge Detection
12		3/3	Homework 3 Assigned	Corner Detection
13	7	3/8		Image Features & SIFT
14		3/10	Homework 2 Due	Mosaics and Homographies
15	8	3/15		Unsupervised Segmentation Part 1
-		3/17	Project Proposal Due	No Class
16	9	3/22		Unsupervised Segmentation Part 2
-		3/24	Recharge Day	No Class
17	10	3/29	Homework 4 Assigned	Convolutional Neural Networks
18		3/31	Revised Project Proposal Due	Transfer Learning for CNNs
19	11	4/5	Homework 3 Due	Object Detection
20		4/7	Homework 5 Assigned	Object Detection Continued Publishing in AI
21	12	4/12		Video
22		4/14	Homework 4 Due	Stereo and Beyond RGB
23	13	4/19		Semantic and Instance Segmentation
24		4/21		Deep Learning Applications
25	14	4/26		TBD
26		4/28	Homework 5 Due	TBD
-	15	5/3		Project Presentations
-		5/5	Last Class	Project Presentations
	16		Project Report Due	