ECE4580 - Computational Computer Vision (3-0-3)

School of Electrical and Computer Engineering
Georgia Institute of Technology

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Office Hours: Klaus 2448
Tu 4:00PM-6:00PM (Alper),
We 4:00PM-6:00PM (Fu-Jen),
Th 5:20PM-7:20PM (Patricio),
or by appointment (Instructor or GTA)

Prerequisites: ECE 2025
Requisites: Programming experience in MATLAB, C/C++, or Fortran.
Linear/matrix algebra, Calculus, Probability & Statistics.

Course Text: Horn, B. Robot Vision.
Class notes will be distributed when applicable.
Online references (for most topics) will be provided also.

Catalogue Description: Computational and theoretical aspects of computer vision. Will cover some basics of image sensing and image processing. Application areas include robotics, autonomous vehicles, tracking, and image-guided surgery. Includes major project.

Assumed Knowledge: Given that this is a senior level course, it will necessarily involve the utilization of material from earlier years. The material that you are expected to know and have mastered includes Matlab programming (CS 1371) as well as Mathematics fundamentals (Math 1501, 1502, 2401, 2403). In some cases, familiarity with C/C++ programming will be needed (based on the group project).

Scope and Goals: The goal of the course is to introduce you to the field of computer vision. As such, the emphasis of the course will be on the implementation of algorithms to achieve said goal. In the process, you will hopefully get a feel for the variety of application domains for which computer vision can be useful.

At the termination of the class, you should be able to:

- understand the components underlying a computer vision problem,
- know the current capabilities and limitations of computer vision,

- propose a solution strategy for a given computer vision problem, and/or
- be able to review the literature for potential solutions to a given computer vision problem.

Course Mechanics and Grading: The course meets two times a week, TuTh 12:05PM-1:25PM, in Weber SST III Room 1. Course evaluation consists of the following components whose percentage of the total grade calculation is also given,

Homework:	40%		60%
Learning Module:	20%	or	20%
Final Project:	20%		20%
Final Exam:	20%		0%

The best of the two will be taken, with the final exam portion being optional.

Homeworks. The homeworks are intended to reinforce the topics presented in class and will be limited in scope. They should be turned in on-line via t-square preferably, or to the ECE4580 inbox in VL W203 (small closet area to the left when you enter). When turned in online, please submit as a pdf document for maximal portability (I use mutiple operating systems and not all have Office). I will also assign in-class or on-line questions (entered as text when done online). These will be graded in ternary (no-, half-, and full-credit), and combined into a single homework grade at the end of the semester.

The late policy for homeworks proper, excluding the in-class/on-line questions, is 10% off if less than 24 hours late without advanced notice, and more if late beyond one day. No credit can be assigned if the solutions are already posted. If you know that you are going to be late, then it is best to ask me in advance. If you do end up being late, it is also best to make sure to let me know, so I can be more understanding.

About the Groups and the Learning Modules. Once the second Tuesday rolls around, the entire class will decide on what the principle challenge areas will be. The challenge areas are determined by what the class as a whole is interested in and each student individually elects to pursue. Each group will have a computer vision challenge that they are responsible for tackling. Given that it may ultimately lead to the final project, it helps to pick something that you are curious about and motivated to learn. Naturally, you will be free to select a different goal for the final project. At the end of the course, everyone should be able to showcase a variety of competencies in computer vision.

The learning module will be something that you will prepare as a group and present to the class. Successfully accomplishing this will require some planning and preparation with me or with my graduate students. I anticipate that this planning and preparation time will happen during class as well as outside of class. The final project will be longer and will require you to synthesize the course material thus far. Both projects will involve a written report and an oral presentation (around week 10 and the week before Finals week, respectively).. I will typically make an effort to be available for a short period after class for any questions that may arise.

About the Final Project. The final project will be of similar difficulty as a challenge problem, possibly more if the challenge problem is limited in scope. Ideally, it will be an implementation,

application, and possibly an extension of the challenge problem. Otherwise it should be something of interest to you that you would like for me and your peers to assist you through to a successful conclusion.

Office Hours. Office hours will occur at the times noted above. To assist with your questions, a mad lib office hours prep sheet has been provided on t-square in the Modules section.

Incomplete and Intended Topical Outline

- Elements of vision and computer vision.
- The geometry and process of sensing.
- Linear filtering.
- Edge detection.
- Segmentation.
- Clustering.
- Optical flow.
- Stereo vision.
- Shape.
- Additional topics as time permits:
  - Mosaicing
  - Snakes/Active Contours.
  - Wavelets.
  - Principle Component Analysis.
  - ...