CSci 4968 and 6270
Computational Vision,
Fall Semester, 2009-2010
Course Syllabus

Prof. Chuck Stewart
Mon, Thurs 12:00 - 1:20, Low 3045
Office: MRC 304
Email: `stewart@cs.rpi.edu` or `cvstewart@gmail.com`
Phone: x6731
Hours: After class, Tue 1-3, by appointment, drop-in
URL: `http://www.cs.rpi.edu/~stewart/cv_2009`

Overview

Cameras and images are everywhere, with a resulting wide-spread need for algorithms and software that can combine, summarize and interpret these images. This is the field of computer vision and image analysis. Applications include face, object and scene recognition, security and biometrics, photomontaging and virtual tours, special effects in graphics, photography and the movies, autonomous robots, human-computer interaction, and medical diagnosis and treatment. Given the ubiquitous cell phone camera, the potential for new applications in the future seems unlimited. Standing in sharp contrast to this need, computer vision presents us with difficult problems. Each image is a large, noisy, quantized, 2d array. The world, by contrast, is (mostly, at our level) continuous, complicated and three-dimensional. The challenge of computer vision has led researchers and applications programmers to employ a wide variety of physical, engineering, mathematical, statistical, algorithmic and software techniques to develop computer vision systems. Therefore, our goal in this course will be to learn about the problems, the applications, the challenges, and the techniques of computer vision.

Learning Objectives

At the end of this course, the student will be able to

- Apply techniques of calculus and linear algebra to solve problems involved in building the components of a computer vision system.
- Develop efficient algorithms for solving problems in computer vision.
- Write small-sized and intermediate-sized programs for solving problems in computer vision.
- Map potential applications of computer vision into specific technical problems.

- Assess the difficulty of specific technical problems in computer vision and select potential solution techniques.

Requirements, Prerequisites, Etc.

The first 40% of the course will focus on a single application — photomontaging — using it to drive the study of image processing, feature extraction, cameras and transformations, matching, estimation, and blending. After this we will turn to image segmentation, computational photography, three-dimensional modeling, motion and tracking, and various types of recognition.

Prerequisites include a data structures and algorithms course (e.g. CSci 2300), a course in multivariable calculus and linear algebra (Math 2100), and some "mathematical maturity". Students can either earn four undergraduate credits (CSci 4968) or three graduate credits (CSci 6270) for this course.

Requirements include class attendance and participation (10%), seven homework assignments (40%), one exam (20%) and a final project (30%). The homework and the final project will emphasize programming. Programming can be done in Matlab with the Image Processing Toolkit or in C or C++.

Tentative due dates for the homework and final project are listed with the schedule below. These may be modified as the semester progresses. Please note:

- The project will have four submissions, including a proposal, an intermediate progress report, a short presentation (5 minutes or less), and a final submission.

- The last two homework assignments will be given while students are working on the final project. The purpose of these assignments is to give practice with the material covered in the last part of the course. My intent is to make these two less involved than earlier assignments.

The tentative date for the final project submission is Monday, December 14. This may change.

Letter grades will be determined based on the rounded, combined averages. Final cut-offs will be at the instructors discretion, but will be no lower than 92 for an A, 89 for an A-, 86 for a B+, 82 for a B, etc.

Students have three "late" days they can use on homework throughout the semester, with at most two used for any one homework. A late day is defined as any whole or partial day after the submission deadline. After all late days have been used, no late homework submission will be accepted without an excuse from the Dean of Students office. Late days may not be used for any part of the final project.

Academic Integrity

Students are expected to submit their own solutions to the homework, although they may work together to sketch solution ideas. The final project must be done individually. Students who find resources to help with the final project must

(a) reference these resources in their write-up and (b) add to these with their own work. Students will be graded on what is their own.

Textbook

There is no official textbook for this course, although we will be making heavy use of Dr. Rick Szeliski's on-line draft of his textbook. An up-to-date reference will be provided on the course website. Additional references will be provided there to other on-line and printed material.

Schedule

Here is a brief outline of the dates and topics. This is replicated on the course web site and pointers to reading will be added as we go:

Lecture	**Date**	**Topic**	**Due**
1	8/31	Introduction to computer vision	
2	9/3	Image processing, part 1	
3	9/10	Image processing, part 2	
4	9/14	Edge detection	HW 1
5	9/17	Lines and curves	
6	9/21	Corners	
7	9/24	Cameras	HW 2
8	9/28	Camera calibration	
9	10/1	Matching and correspondences	
10	10/5	Alignment	HW 3
11	10/8	Photomontaging	
12	10/13	Structure from motion	
13	10/15	Stereo	
14	10/19	Motion and tracking	HW 4
15	10/22	Segmentation — overview	
	10/26	**Exam**	
16	10/29	Active contours	
17	11/2	Markov random fields	
18	11/5	Graph cuts and global optimization	HW 5
19	11/9	Recognition — overview	
20	11/12	Face recognition	
21	11/16	Face detection	HW 6
22	11/19	Instance recognition	FP: Proposal
23	11/23	Category recognition	
24	11/30	Photometric calibration and HDR	
25	12/3	Image matting and compositing	FP: Progress
26	12/7	Texture analysis and synthesis; inpainting	
26	12/10	FP: short project presentations	HW 7