# Computational Photography (CS 445) –Spring 2020

## Instructor: **Derek Hoiem**

## TAs:

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## Overview

Computational photography is an emerging field created by the convergence of computer graphics, computer vision, and photography. Its role is to overcome the limitations of the traditional camera by using computational techniques to capture, enhance, and combine imagery for a more vivid and lifelike visual experience.

## Course Objectives

By the end of this course, you will have written programs to create optical illusions, add or remove objects from a photograph, insert 3D objects into pictures, automatically stitch together photos into panoramas, and more. Through lectures and hands-on projects, you will learn core principles of computer vision and graphics that will be of great use in robotics, psychology, media design, art, photography, information retrieval, entertainment technology, and a host of other growing areas. Beyond the practical benefits, the course also aims to provide a greater appreciation of our own amazing visual ability and to have fun in writing programs that can be used with your own photo collections.

## Prerequisites

You should enter the course with basic programming skills and a working knowledge of **linear algebra** and calculus. Previous experience with Python, image processing, computer vision, or computer graphics will be very helpful but is not required. Students are recommended to own or purchase a digital **camera**, ideally with manual controls (smart phone should be fine). For the image-based lighting project, you will need a mirrored ball that can be purchased on Amazon.

## General Information

**Textbook:** Lectures are not based on any particular textbook. The most closely related textbook is Computer Vision: Algorithms and Applications by Rick Szeliski, which is available for

free online and for purchase at Amazon. You may also want to purchase either Computer Vision by Linda Shapiro and George Stockman or Computer Vision: A Modern Approach (2nd edition) by David Forsyth and Jean Ponce. I have them both in my office, so you can look them through.

**Other useful books:**

Linear Algebra and its Applications, Gilbert Strang *(excellent book on linear algebra)*
Multiple View Geometry in Computer Vision, Hartley & Zisserman *(bible on recovering 3D geom.)*
Photography (8th edition), London and Upton, *(a great general guide to taking pictures)*
Vision Science: Photons to Phenomenology, Stephen Palmer *(great book on human perception)*
Digital Image Processing, 2nd edition, Gonzalez and Woods *(a good general image processing text)*
The Art and Science of Digital Compositing, Ron Brinkmann *(everything about compositing)*
3D Computer Graphics (3rd Edition), Watt *(a good general graphics text)*
Fundamentals of Computer Graphics, Peter Shirley *(another good general graphics text)*

To obtain **disability-related academic adjustments** and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TDD), or e-mail a message to disability@uiuc.edu.

## Assignments and Grading

Grading is based on projects, midterm, and the final project. Letter grades will be assigned based on the following thresholds:

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 97 | 94 | 90 | 87 | 84 | 80 | 77 | 74 | 70 | 67 | 64 | 60 | <60 |
| A+ | A | A- | B+ | B | B- | C+ | C | C- | D+ | D | D- | F |

In summary, the point distribution is:

- Assigned Projects: 55%
  - 5 Core Projects: 10% each
  - Selected Bells and Whistles: 5%
- Exams: 30%
  - Midterm: 15%
  - Final: 15%
- Final project: 15%
  - Proposal: 1%
  - Report / code: 14%

**Projects** (55%): Each of the five "core" project is worth 100 points and worth 10% of your grade. Each project also has "bells and whistles" that give you the opportunity to explore projects of interest at greater depth. You are also required to do 75 points worth of "bells and whistles", worth 5% of your course grade, cumulative across the five projects. The bells and whistles are submitted at the same time as the corresponding core project. Although there are hundreds of "bells and whistles" points available, and you can do as many as you chose, you can get points for only 75.

**Midterm Exam** (15%): The midterm will cover materials up to and including the single view geometry lectures. Sample problems and answers will be provided.

**Final exam** (15%): The final exam will cover the entire semester.

**Final project** (15%): Do a final project of your choice. You could implement a paper that you find interesting, something discussed in class, a big extension of one of the existing projects, or something entirely of your own design. The deliverable is a 2 page abstract describing your project and the results. The scope of the project should be similar to those of the assigned projects (excluding the "hybrid image" project). Details are in a separate document. The proposal is worth 1%, and the final submission is worth 14%.

**Late policy**: Aim to get all projects in on time to stay on track in the course. You have a total of seven free late days. Use them wisely. Additional late days come at a penalty of ten points of the core project grade per day late. You have a short grace period for the submission deadline, e.g. a project submitted 15 minutes late will not count as late.

## Academic Integrity

You are welcome to discuss projects with your classmates, but do not show or share any code. Also, you may not use any code from the Internet or any other outside sources, unless it is specifically approved by the instructor. Be sure to acknowledge any help that you do get from other students or outside works, even if it's just a small suggestion. *Violations will go on record at the university, and the minimum penalty will be a zero for the entire assignment.*