Computational Photography (CS 445) – Fall 2022

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TAs:

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Lectures: Tues/Thurs 11-12:15 DCL 1320

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 videos 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 may need a mirrored ball that can be purchased on Amazon.

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%
- Exams: 30%
    - Midterm: 15%
    - Final: 15%
- Final project: 15%
    - Proposal: 1%
    - Report / code: 14%

Projects (55%): There are five projects, each with a "core" worth 100 points. Each project also has "bells and whistles" that give you the opportunity to explore projects of interest at greater depth and earn additional points. The number of required points depends on whether you are enrolled in the 3 credit undergraduate or 4 credit graduate version of the course:

- **3 credit: 425 points required**
- **4 credit: 500 points required**

In final grade computation, it does not matter for which projects you earned the points or whether they are core or bells and whistles --- only the total matters. Projects that are not submitted within two weeks of the deadline will receive 0 points, but those points can be made up with bells & whistles from other projects if necessary.

Midterm Exam (15%): The midterm will cover materials up to and including the single view geometry lectures. The midterms and final exams are planned to be administered using PrairieLearn. Sample questions will be provided.

Final exam (15%): The final exam will cover the entire semester. Most students do better on the midterm than final, but *if your final exam grade is higher, it will replace your midterm grade* in the final course grade calculation.

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 2-4 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). You can work with a group of up to four, but you are responsible for forming and managing the group. 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 ten free late days for regular projects*. Use them wisely. Additional late days come at a penalty of five project points per day late. *To receive any credit, your project must be submitted within two weeks of the deadline, with no exceptions, regardless of whether you use free late days.* The reason for this is to ensure that the class is roughly in sync. You have a short grace period for the submission deadline, e.g. a project submitted less than one hour late will not count as late. The final project cannot be submitted late.

Absence policy: In-person lecture attendance is encouraged, but we are planning to make lectures and exams available remotely. Please stay home if you are sick to avoid spreading. Contact the instructor by email if you have a serious illness or hospitalization that requires accommodation. See Part 5, 1-501 of the Student Code for detail.

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.* See http://studentcode.illinois.edu/.

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)*
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)*

To obtain **disability-related academic adjustments** and/or auxiliary aids, students with disabilities must contact the course instructor and the as soon as possible. To ensure that disability-related concerns are properly addressed from the beginning, students with disabilities who require assistance to participate in this class should contact Disability Resources and Educational Services (DRES) and see the instructor as soon as possible. If you need accommodations for any sort of disability, please speak to me after class, or make an appointment to see me or see me during my office hours. DRES provides students with academic accommodations, access, and support services. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TDD), or e-mail disability@illinois.edu. http://www.disability.illinois.edu/.

Mental Health: Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings which are covered through the Student Health Fee. If you or someone you know experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do for yourself and for those who care about you.

- Counseling Center (217) 333-3704
- McKinley Health Center (217) 333-2700
- National Suicide Prevention Lifeline (800) 273-8255
- Rosecrance Crisis Line (217) 359-4141 (available 24/7, 365 days a year)

If you are in immediate danger, call 911.