CMSC 848B: Computational Imaging

Fall 2022

Instructor:

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Course Overview:

By combining optics and algorithms, computational imaging systems can perform high-dynamic-range and super-resolution imaging, reconstruct 3D structure and depth information, construct holograms, image through fog and tissue, and even see around corners. Today, computational imaging sits at the heart of most medical and scientific imaging systems and it is becoming an increasingly important component of various consumer imaging systems as well.

This mixed lecture/seminar course will introduce both the optical systems and the algorithms behind computational imaging. Monday lectures will introduce the various computational imaging systems (and the physics behind them). Wednesday seminars and assigned readings will provide a deep dive into the algorithms that underlie these systems' operation.

Prerequisites: Mastery of python and linear algebra required. Familiarity with deep learning and statistics will be useful.

Course Work, Exams, and Grading: Students will be responsible for weekly readings and will take turns presenting papers as if they were their own (10% of grade) and will provide weekly summaries of assigned readings (5% of grade). There will three programming assignment (10% of grade each). Students will complete a semester-long group project on a computational imaging topic of their choice (25% of grade). There will also be a midterm exam (30% of grade).

Late Policy: The class requires that every student takes turns preparing and presenting lectures. Accordingly, *an unexcused absence during your turn to present will result in failure of the course*. If you're going to be out of town during your time to present, please contact me at least two weeks beforehand so that another student can be scheduled. Similarly, if unable to present due to illness, please let me know as soon as possible.

Final Project: The final project will be due on Dec 7th. Students will present their final project on Dec 7th or 12th.

Midterm Exam: The course will have a mid-term exam.

Piazza: We will be using Piazza (www.piazza.com), a question-and-answer system designed to streamline discussion outside of the classroom.

ELMS: Lecture slides and grades will be posted to ELMS.

Disability Support Services: Any student eligible for and requesting reasonable academic accommodations due to a disability is requested to provide, to the instructor via email, a letter of accommodation from the Office of Disability Support Services (DSS) within the first two weeks of the semester.

Course Evaluations: The Department of Computer Science takes the student course evaluations very seriously. Evaluations will usually be open during the last few weeks of the course. Students can go to www.courseevalum.umd.edu to complete their evaluations.

Copyright: Students are permitted to use course materials for their own personal use only. Course materials may not be distributed publicly or provided to others (excepting other students in the course), in any way or format.

Class Concerns: If you have any class concerns, feel free to contact the instructor. If an issue arises with the instructor, report it using the form available at https://www.cs.umd.edu/classconcern

Syllabus: This is the current version of the syllabus. The instructors reserve the right to change it at any time.

Office Hours: By appointment.

Topics: The following is a *tentative* list of topics and readings in *approximate* order.

System Topics and Lectures	Algorithm Topics and Papers
• Digital photography • Pinholes, lenses, optics and aberrations • Exposure and high-dynamic-range imaging • Noise modeling and calibration • Focal stacks and depth from defocus • Coded photography • Compressive sensing and ghost imaging • Fourier optics 101 • Ptychography and phase retrieval • Holography and interferometry • Speckle-based imaging • Structured light • Time-of-flight imaging • Non-line-of-sight imaging	• Imaging as estimation • BM3D • PnP ADMM • Hypernetworks • Noise2noise • Deep image prior, implicit neural representations • Neural radiance fields and extensions • Computational imaging with deep generative models • Computational imaging with diffusion models • Light cone transform and phasor fields • End-to-end design of optics and algorithms • Deep correlation imaging, deep inverse correlography • All photon imaging