

Computational Photography

EEL 4403/5406 Section 206H/085C/1FE2/2FED/HYBR

Class Periods: T | Period 4 (10:40 AM - 11:30 AM)

R | Period 4 - 5 (10:40 AM - 12:35 PM)

Location: Classroom location

Academic Term: Fall 2022

Instructor:

Sanjeev J. Koppal

sjkoppal@ece.ufl.edu

3523928942

Office Hours: Tuesday, 1130am-1230pm

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact through the Canvas website

- Justin Folden
- Brevin Tilmon

Course Description

(3 credits) Fundamentals of computational photography, sensing, imaging and illumination.

Course Pre-Requisites / Co-Requisites

EEL 3135 (or equivalent) or consent of instructor.

Course Objectives

The student will be able to demonstrate the basics of computational photography, as it relates to applications in computer vision, graphics and imaging. The student will be able to explain how models of light from radiometry and optics can be used to understand scene information from images, build novel sensors and create new photographs; the intersection between computing and light, a “camera culture” perspective of technology, professionally use sensors and cameras. The student will be able to write code to create new photographs. There will be in-class labs where practical knowledge of computational photography will be experiences.

Materials and Supply Fees

NA

Professional Component (ABET):

This course consists of 1.5 credits of Engineering Design and 1.5 credits of Engineering Science

Relation to Program Outcomes (ABET):

The table below is an example. Please consult with your department’s ABET coordinator when filling this out.

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Medium
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	High
3. An ability to communicate effectively with a range of audiences	Medium
4. An ability to recognize ethical and professional responsibilities in engineering situations and make	Low

informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Medium
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	High
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- Matlab, ideally with image processing / computer vision toolbox
- Access to a computer and a cellphone with a camera

Recommended Materials

- Title: Robot Vision (Recommended, not required)
Author: B. K. P. Horn
Publication date and edition: MIT Press 1986
ISBN number: 0262081598
- Title: Multiple View Geometry in Computer Vision (Recommended, not required)
Author: Richard Hartley and Andrew Zisserman
Publication date, edition, and company: Cambridge
ISBN number: 9780521540513

Course Schedule

Week 1:

- Lec 1: History of cameras, sensors and light
- Lec 2: Camera culture and computational photography
- Lec 3: Pixels, Video and Art

Week 2:

- Lec 4: Reflectance: basic principles
- Lec 5: Image processing

Week 3:

- Lec 6: Reflectance: algorithms and measurements
- Lec 7: Camera calibration
- Lec 8: Image Warping and morphing

Week 4:

- Lec 9: Lighting and shadows
- Lec 10: Programmable imaging
- Lec 11: Human head rendering

Week 5:

- Lec 12: Interreflections
- Lec 13: Structured light
- Lec 14: Image pyramids, retargeting and fusing images

Week 6:

- Lec 15: Reflection and refraction
- Lec 16: Superresolution

- Lec 17: Mosaicing images
- Week 7:
 - Lec 18: Caustics of cameras and reflections
 - Lec 19: Flutter shutter and temporal coding
- Week 8: (Midterm)
 - Lec 20: Light polarization
 - Lec 21: Camera arrays - 1
 - Lec 22: Optical flow and motion
- Week 9:
 - Lec 23: Basic principles of scattering
 - Lec 24: Camera arrays - 2
 - Lec 25: Spatial textures
- Week 10:
 - Lec 26: Advanced scattering in vision and graphics
 - Lec 27: Catadioptric cameras
 - Lec 28: Temporal textures
- Week 11:
 - Lec 29: Modeling fluids
 - Lec 30: Stereo with planar mirrors
 - Lec 31: Create digital mattes
- Week 12:
 - Lec 32: Optical processing with diffraction
 - Lec 33: Deblurring
 - Lec 34: HDR images
- Week 13:
 - Lec 35: Interference and angle sensitive pixels
 - Lec 36: Polarization imaging
 - Lec 37: Geometry from a single image
- Week 14:
 - Lec 38: High-speed flash photography
- Week 15:
 - Lec 39: Photo tourism
 - Lec 40: Image-based rendering
 - Lec 41: Transient imaging
- Week 16:
 - Lec 42: Presentations (Graduate student's report due)
 - Lec 43: Presentations (Graduate student's report due)

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Attendance Policy, Class Expectations, and Make-Up Policy

This class will be presented online using Zoom and requires access to a working webcam and stable internet connection. I prefer that students keep their camera on during the class so that I can see you as I would during normal face-to-face classes. Studies show that if we can see each other's faces then we will have more engagement, more student success, and more faculty success. However, this is not a requirement. I understand if on certain days you can't have your camera on due to internet bandwidth limitations, other family members, health issues, or any other reasons.

Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
In class projects (~10)	100 each	15%
Participation in class and Assigned paper discussion	100 each	20%
Midterm Exam	100	35%
Final Exam	100	15%
Presentation (Graduate student's report is part of the presentation)	100	15%
		100%

Grading Policy

The following is given as an example only.

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 - 83.9	B	3.00
70.0 - 80.9	B-	2.67
65.0 - 70	C+	2.33
50.0 - 64.9	C	2.00
45.0 - 50	C-	1.67
40.0 - 44.9	D+	1.33
30.0 - 39.9	D	1.00
20.0 - 29.9	D-	0.67
0 - 19.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing

staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.