CSE 527: Introduction to Computer Vision

https://www3.cs.stonybrook.edu/~hling/Teaching/21S-527/index.html

Spring 2021

Basic Course Information

- **Instructor**: Haibin Ling (hling@cs.stonybrook.edu)
- **Time**: Spring 2021: Mon/Wed 7:50pm – 9:10pm, Office hour: Tue 3pm-5pm
- **Room**: Session 1 (527-01): online
  Session 2 (527-02): hybrid – (NCS 120 | online)
- **TA**: Heng Fan (hefan@cs.stonybrook.edu): 3:30-5:30pm Monday
  Zuhui Wang (zuhui.wang@stonybrook.edu), office hour: 9-11am Wednesday
  Pavani Tripathi (pavani.tripathi@stonybrook.edu), by appointment

For the hybrid section: The hybrid section requires student's presence on campus to complete. We require the hybrid students to be present in the physical classroom during the class period for a small number of lectures and attend the online class from there, detailed plan will be communicated to students later.

Course Description

The aims of this course are to provide an understanding of the fundamentals of Computer Vision and to give a glimpse in the state-of-the-art, at a moment when the field is achieving "critical mass" and has significant commercial applications. Apart from basic theory we will look at applications of Computer Vision in Robotics, Graphics and Medicine.

Lecture Topics (roughly ordered by lecturing date)

Note: contents may be up to change to reflect the fast evolution of the frontier of computer vision.

1. **Image Formation**
   - Basic facts about light
   - Camera anatomy, matting
2. **Image Noise**
   - Modeling image noise
   - Convolution, image smoothing, pyramid
3. **Image Features**
   - Points, corners, edges
   - Scale and orientation
4. **Model Fitting**
   - Lines, curves, Hough transform
   - Deformation, RANSAC
5. **Perspective Projection**
   - Homogeneous coordinates
   - Image warping, mosaics
6. **Multiview Geometry**
   - Stereo viewing and reconstruction
   - 3D range scanning
7. **Object Recognition**
   - Object representation, classifiers
   - Category classification
8. **Deep Learning**
   - Convolutional neural networks
   - Architectures and applications
9. **Deep Learning Practice**
   - Pre-training
   - Data augmentation
10. **Illumination**
    - Shading, shadows
    - Reflectance properties
11. **Deep Generative Models**
    - Autoencoders, VAEs, GANs
    - Application in computer vision
12. **Segmentation**
    - Grouping, superpixels
    - U-Net, semantic segmentation
13. **Motion**
    - Motion and flow
    - Tracking
14. **Advanced Topics**
    - Simultaneous localization and mapping
    - Selected topics

Intended Audience

This course is intended for graduate students with interests in all areas of Visual Computing and Machine Learning, such as Computer Vision, Computer Graphics, Visualization, Biomedical Imaging, Robotics, Virtual Reality, Computational Geometry, Deep Learning, HCI. Prerequisites include a foundation in Linear Algebra and Calculus, and the ability to program. We will be programming in Python (OpenCV, NumPy, SciKit).

Textbook

- **Computer Vision: Algorithms and Applications** (Texts in Computer Science), by Richard Szeliski, Springer; 1st Edition. ISBN-10: 1848829345, ISBN-13: 978-1848829343, http://szeliski.org/Book/
- **Deep Learning**, Goodfellow and Yoshua Bengio, Aaron Courville, 2016, MIT press. http://www.deeplearningbook.org/
- **Mastering OpenCV with Practical Computer Vision Projects**, by Daniel Lélis Baggio, Shervin Emami, David Millán Escrivá, Khvedchenia Ievgen, Naureen Mahmood, Jasonl Saragih, Roy Shilkrot, Packt Publishing, ISBN-10: 1849517827, ISBN-13: 978-1849517829
- **Vision: A Computational Investigation into the Human Representation and Processing of Visual Information**, by David Marr, The MIT Press, ISBN-10: 0262514621, ISBN-13: 978-0262514620.
- Papers assigned in the class.

Grading

- There will be five or six homeworks, one midterms and one final.
  - Homeworks will be 60%, the midterm 20%, and the final 20%.
  - Weights are approximate and subject to change. You are expected to do homeworks (5-6) by yourselves. Even if you discuss them with your classmates, you should turn in your own code and write-up. Do not share your code!
  - There will be 3 free late dates for the semester. After that there will be 10% penalty per day.
- You can do a project instead of the final exam. Projects will be done in up-to 2 people teams, and will require a significant programming and documentation effort. This will probably be much more work than doing the final homework. Two people projects will be scaled accordingly.

Don't Cheat!

Cheating on anything will be dealt with as academic misconduct and handled accordingly. I will not spend a lot of time trying to decide if you actually cheated. If I think cheating might have occurred, then evidence will be forwarded to the University's Academic Judiciary and they will decide. If cheating has occurred, an F grade will be awarded. Discussion of assignments is acceptable, but you must do your own work. Near duplicate assignments will be considered cheating unless the assignment was restrictive enough to justify such similarities in independent work. Just think of it that way: Cheating impedes learning and having fun. The labs are meant to give you an opportunity to really understand the class material. If you don't do the lab yourself, you are likely to fail the exams. Please also note that opportunity makes thieves: It is your responsibility to protect your work and to ensure that it is not turned in by anyone else. No excuses! The University has a relevant policy:

"Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Any suspected instance academic dishonesty will be reported to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/."

Disability Note

If you have a physical, psychological, medical or learning disability that may impact on your ability to carry out assigned course work, I would urge that you contact the staff in the Disabled Student Services office (DSS), Room 133 Humanities, 632-6748/TDD. DSS will review your concerns and determine, with you, what accommodations are necessary and appropriate. All information and documentation of disability is confidential.

Special Note Spring 2021: Students are expected to attend every class, report for examinations and submit major graded coursework as scheduled. If a student is unable to attend lecture(s), report for any exams or complete major graded coursework as scheduled due to extenuating circumstances, the student must contact the instructor as soon as possible. Students may be requested to provide documentation to support their absence and/or may be referred to the Student Support Team for assistance. Students will be provided reasonable accommodations for missed exams, assignments or projects due to significant illness, tragedy or other personal emergencies. In the instance of missed lectures or labs, the student is responsible for review posted slides, review recorded lectures, seek notes from a classmate or identified class note taker, write lab report based on sample data. Please note, all students must follow Stony Brook, local, state and Centers for Disease Control and Prevention (CDC) guidelines to reduce the risk of transmission of COVID. For questions or more information click here.