

ESE 568 COMPUTER AND ROBOT VISION

Stony Brook University, Electrical and Computer Engg., Fall 2021, 3 credits.

Instructor: Prof. Murali Subbarao

DRAFT VERSION 1.0. This is subject to some changes.

Pre-requisites: Basic background in Linear algebra, Claculus, Probability, and Programming. Projects will be in MATLAB but you could complete them in Python with some extra effort. If you have prior programming experience (as in ESE 224), then you will need 8 hours to learn enough MATLAB/Python for this course.

Instructor : Prof. Murali Subbarao murali.subbarao@stonybrook.edu

Office Hours: Tue. 11.15 am to 1.15 pm
Thurs. 11.15 am to 1.15 pm
Room 233, Lt. Engg. Bldg.

Text book:

Computer Vision: Algorithms and Applications, Richard Szeliski, Spinger 2021, 2nd Edition, Available free at <http://szeliski.org/Book/>

References

Many online resources.

Some examples:

- [Schedule | EECS 442: Computer Vision \(umich.edu\)](#)
- [CS 6476 Computer Vision \(gatech.edu\)](#)
- [CSCI 1430: Introduction to Computer Vision \(Brown Univ\)](#)
- [16-385 Computer Vision, Spring 2020 \(cmu.edu\)](#)

References on ML/CNN

- [Schedule | EECS 498-007 / 598-005: Deep Learning for Computer Vision \(umich.edu\)](#)
- [Stanford University CS231n: Convolutional Neural Networks for Visual Recognition](#)

Part I Image Formation Models and Image Processing

1. *Introduction:* Introduction, Overview, and applications.
2. Digital images for representing 2D, 3D, and moving objects. Human eye and digital camera models.
3. MATLAB tutorial for computational vision, and Linear algebra overview. (vectors, points, lines, planes, surfaces, matrices). Other CV tools: Python, numpy, OpenCV, Tensor flow, etc.
4. *Photometric information: Color:* Physics of color, human perception of color, color models (RGB, HSI).
5. *Geometric-information:* Representation of points, lines, planes, surfaces, and shapes in 3D, nature and structure of medical images. Two-dimensional and three-dimensional geometric transformations of images and 3D scenes.

6. *Image filtering*: gray-level transformations, histograms, convolution, noise reduction, spatial and Fourier domain filtering and convolution, Gaussian filtering, and image resolution pyramids.

Part II Image Features: detection and matching

7. *Feature detection*: gradient vector, Canny's edge detection, Harris-corner detector.

Mid-term test 1.

8. *Contours*: Model fitting, Total LSE, Least Median Square Error.
9. RANSAC, Hough transform.
10. SIFT vector, image stitching, ICP.

Part III Machine Learning, Object Recognition, Neural Nets, and Artificial Intelligence

1. Machine learning principles and techniques for object recognition. Nearest-neighbor, nearest centroid, K-NN.
2. *Machine learning*: clustering techniques, K-mean clustering. PCA.
3. Support Vector Machines.
4. Neural Nets, Convolution Neural Nets,
5. Deep learning, AI.

Part III 3D Imaging, 3D Motion, Medical imaging.

11. *Three-dimensional shape recovery*: 3D from Stereo Images; Stereo Camera model, calibration, matching, rectification.

Mid-term test 2.

12. Structured-light, RGBD cameras, Laser and LIDAR, and related techniques.
13. 3D Motion from Video, optical flow, other shape-from-x methods (texture, shading, focus/defocus, Optical flow, etc). Machine and robot vision applications and self-driving cars.
14. *Medical Imaging*: Modes of medical imaging, X-ray Computed Tomography, image reconstruction algorithms.

Final Quiz (10%. Final exam will be a 30 minute quiz, with questions having short answers).

Programming Projects (30%) : There will be around 3 programming projects using MATLAB. Each project may take around 10 hours for completion.

Project 1: 2D and 3D Geometric transforms, imaging in a pin-hole camera.

Project 2: Image processing, Feature Detection, and Local Feature Descriptor

Project 3: Convolutional Neural Nets for Image Recognition

Seminar presentation (10%): Each student will have to present a paper published within the last 10 years on a topic of current interest. Length of presentation: 20 minutes.

GRADING

Mid-term Test 1 : 25% (2 hrs, partly open-book)

Mid-term Test 2 : 25% (2 hrs, partly open-book)

Final Quiz : 10% (30 mins)

Projects: : 30%

Presentation : 10%

Grading Policy

Grades are assigned based on absolute percentage of total marks as below.

A : 93—100 , A- : 88—92 ,

B+ : 83—87, B : 78—82, B- : 73--77

C+ : 70—72, C : 65—69, C- : 61—64,

D+ : 56—60, D : 51—55, F : 0—50

Student Accessibility Support Center Statement

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, 128 ECC Building, (631) 632-6748, or via e-mail at: sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Academic Integrity Statement

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. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.