

ESE 358 COMPUTER VISION

Dept. Electrical and Computer Engg., Stony Brook University,

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Office Hours: Tues. & Thurs.: 10 am to 11 am, and 1 pm to 2 pm.
Room 233 Light Engg. Bldg.

Catalog Description:

Introduces fundamental concepts, algorithms, and computational techniques in visual information processing. Covers image formation, image sensing, binary image analysis, image segmentation, Fourier image analysis, edge detection, reflectance map, photometric stereo, basic photogrammetry, stereo, pattern classification, extended Gaussian images, and the study of the human visual system from an information processing point of view.

3 credits.

Prerequisites: EE/CE majors: ESE 305; ESE 224 or CSE 230. CSE majors: CSE 214 and CSE 220.

Informal prerequisites: Sophomore level Calculus (e.g. AMS 261/361) and Linear Algebra (e.g. AMS 210), intermediate level programming in any language (e.g. ESE 224). Recommended: Matlab.

Intended students: Junior and Senior level students in Electrical/Computer Engineering and Computer Science.

Text book:

Computer Vision: Algorithms and Applications, Richard Szeliski, Springer 2010, Available free at <http://szeliski.org/Book/>

Reference

Machine Vision, Ramesh Jain, Rangachar Kasturi, and Brian G. Schunck, McGraw-Hill, Inc., 1995. ISBN 0-07-032018-7 OR ISBN 0-07-113407-7.

Approximate list of topics in four roughly equal parts:

Part I Image Formation Models and Image Processing

1. *Introduction:* image formation, photometric and geometric information in a 3D scene, human visual system, pin-hole camera model and perspective projection.
MATLAB/Octave for computational vision.
2. Representation of points, lines, planes, and surfaces in 3D, nature and structure of medical images and imaging. Two-dimensional and three-dimensional geometric transformations of images and 3D scenes.
3. *Color:* Physics of color, human perception of color, color models (RGB, HSI, CMYK, etc). Color image processing.

4. *Binary image analysis*: algorithms for area, position, perimeter, and connected component labeling algorithms; morphological operations.
5. *Image filtering*: convolution, noise, spatial and Fourier domain approaches, Gaussian filtering.

Part II Edges, Contours, and Regions.

6. *Feature detection*: gradient vector (magnitude, direction), smoothing filter, Canny's edge detection algorithm, Harris- corner detector.
7. *Contours*: Line fitting, Total LSE, Least Median Square Error, Hough transform, RANSAC,
8. *Image segmentation*: Image features, SIFT and related feature vectors, clustering techniques, K-mean clustering, split-and-merge algorithms.

Part III Medial Images, 3D Imaging, 3D Motion

9. *Medical Imaging*: Modes of medical imaging, X-ray Computed Tomography, image reconstruction algorithms; processing images from MRI.
10. *Three-dimensional shape recovery*: 3D from Stereo Images; Camera model, calibration, matching, structured-light, Laser and LIDAR, and related techniques.
11. 3D Motion from Video, other shape-from-x methods (texture, shading, focus/defocus, etc). Machine and robot vision applications and self-driving cars.

Part IV High-level Vision: Pattern Recognition, Learning, and AI.

12. *High-level Vision*: Feature space, feature vectors, Image Matching, Pattern Recognition.
13. Machine learning principles and techniques.
14. Object representation and recognition, SVM, Artificial Intelligence.

There will be about 4 programming projects using Matlab/Octave.

GRADING

Part I: Assignments

Programming projects : 25 %

Homeworks: 15 %

Part II : Tests 60%

Test 1 : 1 hr. 15 mins. : 20 %

Test 2 : 1 hr. 15 mins. : 20 %

Test 3 (Final exam): 1 hr. 15 mins. : 20 %

Late submission of assignments

Homeworks: Late submissions are not accepted as the weight for any individual homework is small, around 1% of the overall total. Homeworks help prepare for tests and be engaged in a continuous learning process.

Projects: One or two days late: graded out of 75% (at a penalty of 25%). Submissions that are more than two days late or not accepted.

See the SBU Blackboard website of the course for all the latest announcements.

Grading Policy

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

A : 91--100 A- : 86--90

B+ : 81--85 B : 76--80 B- : 71--75

C+ : 68--70 C : 64--67 C- : 61--63

D+ : 56--60 D : 51--55 F : 0--50

Reference websites:

http://sb.cc.stonybrook.edu/bulletin/current/policiesandregulations/policies_expectations/min_instructional_student_resp.php

Excerpt: “Students are expected to attend class regularly unless other arrangements are made; arrive for class on time and leave the classroom only at the end of class; engage in class discussions and activities when appropriate; exhibit classroom behavior that is not disruptive of the learning environment; secure and turn off all electronic communications and entertainment devices during class time unless otherwise directed by the course instructor. Any use of a cell phone or other unauthorized electronic device during an examination may lead to an accusation of academic dishonesty.”

The University Senate Undergraduate and Graduate Councils have authorized that the following required statements appear in all teaching syllabi (graduate and undergraduate courses) on the Stony Brook Campus.

Americans with Disabilities Act: If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC(Educational Communications Center) Building, Room 128, (631)632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.<http://studentaffairs.stonybrook.edu/dss/index.shtml>.

Academic Integrity: 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.