



CS 532: 3D Computer Vision
School of Engineering and Science
Fall 2015

Meeting Times: Wednesday 6:15-8:45 PM
Classroom Location: TBD
Instructor: Philippos Mordohai
Contact Info: Lieb 215, Philippos.Mordohai@stevens.edu, 201 216 5611
Office Hours: Tuesday 5:00-6:00 PM and by appointment
Course Web Address: http://www.cs.stevens.edu/~mordohai/classes/cs559_f15.html
Prerequisite(s): N/A
Corequisite(s): N/A
Cross-listed with: N/A

COURSE DESCRIPTION

Computer vision addresses the image understanding problem; in other words, it aims to infer what was depicted in still images or video based on pixel intensity or color values. Never is the relationship between the depicted scene and images more explicit than in 3D computer vision that aims to extract 3D information from image and video data, as well as other modalities. This course will introduce students to concepts relating 2D images and 3D scenes including single and multiple-view geometry, structure from motion and 3D reconstruction. It will also cover processing of 3D data regardless of its origin starting from point sets and progressing to lines, polygons, Delaunay triangulations and Voronoi diagrams. Students will acquire in depth knowledge of 3D computer vision topics that have moved to the forefront for a broad range of applications in geospatial information systems (Google and Bing maps), robotics and driver assistance, 3D user interfaces (Microsoft Kinect), augmented reality and visual aids for people with impaired sight.

LEARNING OBJECTIVES

After successful completion of this course, students will be able to...

- Compose the projection matrix from camera intrinsic and extrinsic parameters.
- Diagram and explain epipolar geometry.
- Implement a block matching stereo algorithm on rectified images.
- Estimate surface normals for point clouds.
- Implement Delaunay triangulation.

FORMAT AND STRUCTURE

This course is comprised of weekly three-hour lectures.

COURSE MATERIALS

- Textbook(s):** Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010.
David M. Mount, CMSC 754: Computational Geometry lecture notes, Department of Computer Science, University of Maryland, 2012.
- Other Readings:** Available on course web page
- Materials:** None

COURSE REQUIREMENTS

- Attendance** Attendance is not mandatory, but there will be at least 10 quizzes during the semester.
- Participation** Participation is strongly encouraged.
- Homework** There will be seven homework assignments.
- Quizzes** There will be at least 10 quizzes during the semester, at the beginning of each lecture.
- Project** N/A.
- Exams** The final exam will be held during the regular final exam period. It is an open book exam.

GRADING PROCEDURES

Grades will be based on:

- | | |
|------------|-------|
| Homework | (70%) |
| Quizzes | (15%) |
| Final Exam | (15%) |

ACADEMIC INTEGRITY

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound by the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics.

Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the

report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the [Bylaws of the Honor System](#) document, located on the Honor Board website.

EXAM ROOM CONDITIONS

The following procedures apply to quizzes and exams for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Room Conditions on the quiz or exam.

- Students may use the following devices during quizzes and exams. Any electronic devices that are not mentioned in the list below are not permitted.

Device	Permitted?	
	Yes	No
Laptops		X
Cell Phones		X
Tablets		X
Smart Watches		X
Google Glass		X
Other		X

- Students may use the following materials during quizzes, marked with Q, and exams, marked with E. Any materials that are not mentioned in the list below are not permitted.

Material	Permitted?	
	Yes	No
Handwritten Notes <i>Conditions:</i>	E	Q
Typed Notes <i>Conditions:</i>	E	Q
Textbooks <i>Conditions:</i>	E	Q
Readings <i>Conditions:</i>	E	Q
Other (specify) – The exam is open book, but no electronic devices are allowed	E	Q

- Students are not allowed to work with or talk to other students during quizzes and exams.

LEARNING ACCOMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. Student Counseling and Disability Services works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, and psychiatric disorders in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from SCDS staff. The

SCDS staff will facilitate the provision of accommodations on a case-by-case basis. These academic accommodations are provided at no cost to the student.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the office of Student Counseling, Psychological & Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

For more information about Disability Services and the process to receive accommodations, visit <https://www.stevens.edu/sit/counseling/disability-services>. If you have any questions please contact:

Lauren Poleyeff, Psy.M., LCSW - Disability Services Coordinator and Staff Clinician in Student Counseling and Disability Services at Stevens Institute of Technology at lpoleyef@stevens.edu or by phone (201) 216-8728.

INCLUSIVITY STATEMENT

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in education and innovation. Our community represents a rich variety of backgrounds, experiences, demographics and perspectives and Stevens is committed to fostering a learning environment where every individual is respected and engaged. To facilitate a dynamic and inclusive educational experience, we ask all members of the community to:

- be open to the perspectives of others
- appreciate the uniqueness their colleagues
- take advantage of the opportunity to learn from each other
- exchange experiences, values and beliefs
- communicate in a respectful manner
- be aware of individuals who are marginalized and involve them
- keep confidential discussions private

TENTATIVE COURSE SCHEDULE

Week Starting	Topic(s)	Readings	Assignment
August 31	Image formation, homogeneous coordinates	Szeliski Ch. 2	
September 7	Homography estimation, RANSAC, two-view geometry	Szeliski Ch.11	Homework 1, due 9/16
September 14	Fundamental matrix estimation, binocular stereo, matching criteria	Szeliski Ch. 11	
September 21	Stereo Matching confidence, Feature extraction	Szeliski Ch.7	Homework 2, due 9/30
September 28	KLT tracking	Notes	
October 5	Simultaneous Localization and Mapping, Kalman filtering	Notes	Homework 3, due 10/14
October 12	Structure-from-Motion	Szeliski Ch.7	
October 19	Photo-tourism and multi-view stereo (part I)	Notes	Homework 4, due 10/28
October 26	Multi-view stereo (part II) and silhouette-based modeling	Notes	
November 2	Point clouds, introduction to computational geometry, convex hull in 2D	Mount Lec. 21 and 3	Homework 5, due 11/11
November 9	Convex hulls, line intersection, introduction to polygon triangulation	Mount Lec. 3, 5 and 6	
November 16	3D mesh representation	Mount Lec. 22	Homework 6, due 11/25
November 30	Polygon triangulation, unorganized point clouds, normal estimation, invariant descriptors for 3D data	Mount Lec. 6 and 16	Homework 7, due 12/9
December 7	Delaunay triangulations and Voronoi diagrams	Mount Lec. 11, 12 and 13	
December 14	Final Exam		