CS 532: 3D Computer Vision

Instructor: Philipppos Mordohai (Philippos.Mordohai@stevens.edu)

Textbooks


David M. Mount, CMSC 754: Computational Geometry lecture notes, Department of Computer Science, University of Maryland, Spring 2012. (Available free of charge online.)

Office Hours: Tuesday 5-6 in Lieb 215 and by appointment

Objectives

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.

Evaluation

Seven homework assignments: 70%
Weekly quizzes 15%
Final exam 15%

Policies

Collaboration Policy. Homework assignments will be done individually: each student must hand in their own answers. It is acceptable for students to collaborate in understanding the material but not in solving the problems. Use of the Internet is allowed, but should not include searching for previous solutions or answers to the
specific questions of the assignment. Any sources used must be cited. We will assume that, as participants in a graduate course, you will be taking the responsibility of making sure that you personally understand the solution to any work arising from collaboration.

**Late Submission Policy.** No late submissions will be allowed without consent from the instructor. If urgent or unusual circumstances prohibit you from submitting a homework assignment in time, please e-mail me explaining the situation.

**Class Schedule**

**Week 1:** Image formation, homogeneous coordinates (Szeliski Ch. 2, Hartley and Zisserman slides)

**Week 2:** Two-view geometry, homography estimation, RANSAC (Szeliski Ch. 11, Hartley and Zisserman slides)

**Week 3:** Binocular stereo, matching criteria, confidence (Szeliski Ch. 11)

**Week 4:** Feature extraction, KLT tracking, Structure-from-Motion part I (Szeliski Ch. 7, Hartley and Zisserman slides)

**Week 5:** Structure-from-Motion part II, the PnP problem, loop closing (Hartley and Zisserman slides)

**Week 6:** Simultaneous Localization and Mapping, Kalman filtering (Nistér et al. 2006, Welch and Bishop tutorial)

**Week 7:** Multi-view stereo (Szeliski Ch. 12)

**Week 8:** Multi-view stereo part II and image-based rendering (Szeliski Ch. 12)

**Week 9:** Point cloud processing, normal estimation, LIDAR sensors and data (Mount Lec. 21)

**Week 10:** Invariant descriptors for 3D data, k nearest neighbor classifier

**Week 11:** Convex hulls, line intersection, mesh subdivision and simplification (Mount Lec. 3, 4 and 5)

**Week 12:** Triangulation, range search (k-d trees), mesh representation (Mount Lec. 6, 16 and 22)

**Week 13:** Delaunay triangulations and Voronoi diagrams (Mount Lec. 11, 13 and 28)

**Week 14:** The visual hull, silhouette-based modeling, occupancy grids, octrees