NYU POLYTECHNIC SCHOOL OF ENGINEERING

Course Syllabus

Course Title: Advanced 3D Computer Vision: Data-driven 3D Object Processing

Course Number **EL-GY 9183**

Course Description: 3D object processing is an emerging field in computer vision with many applications across areas as diverse as engineering, science and medicine. The advancement in 3D acquisition technology has led to dramatic increase in the size of 3D datasets. We are therefore faced with a dramatic demand for automatic 3D model processing, understanding and analyzing techniques. Traditional works for 3D object processing are focused on the development of handcrafted 3D object feature, which dealt well with individual 3D object or a small-scale 3D object collection. In contrast, data-driven 3D object processing approaches are developed through aggregating the shape information from a collection of 3D objects, reasoning about key features and properties that are common in objects, and exploiting the relationships of objects. This course will introduce students to the techniques of data-driven 3D object processing. The focus of this course will be recent data-driven 3D object processing for 3D shape matching, retrieval, registration, recognition, segmentation, classification and clustering.

Credits 3

Prerequisite Courses EL 9143 (3D Computer Vision) or equivalents (discuss with instructor), and proficiency in programming (Matlab is required and C++ is optional)

Instructor Information

Instructor(s) Prof. Yi Fang

Contact Information: 2 Metrotech Center, 10.084
Email: yfang@nyu.edu

Intended Learning Outcomes: Upon successful completion of this course, students will be able to:

- Describe the representation of 3D image data
- Develop an efficient 3D object search engine
- Develop techniques for 3D object registration and matching
- Develop methods for robust 3D object recognition and segmentation
- Apply knowledge of 3D image data analysis techniques to analyze and model engineering problems to meet desired needs

Course Materials

Textbook: Michael Mortenson, Geometric Modeling, 3rd Edition, 2006 (Optional)

Computer and software: Students should have access to computers (preferably laptop) with the following programs installed: Matlab, Paraview and LaTeX. Discuss with the instructor if you have problems.

Teaching and Learning Methodologies: Students are expected to arrive at class with an understanding of the basic definitions, concepts, and applications of relevant topics. Class time will be devoted to in-depth discussions of course topics. Project assignments are dedicated for reinforcing course topics via solving representative problem sets and holding class discussions.

Assignments and Grades: Students are expected to understand the basic definitions, concepts, and applications of relevant topics in class. Grades will be based on four mini projects, one final project, report and presentation. Project will be assigned after the completion of each specific topic. The distribution of grades is subject to some revision at the discretion of the instructor. Typical weighting values are as follow: First three projects will be worth 15% each and the final project, report, and presentation will be worth 55% of the course grade. The final letter grade is based on a curve.

Course Schedule (tentative): A typical schedule for course topics, projects, and exam dates is given in the table below.

Week	Lecture Topics	Project
Jan. 28	Introduction to 3D Shape Analysis	
Feb. 4	Introduction to Data-Driven 3D Shape Analysis	
Feb. 11	3D Shape Retrieval • Design of global shape descriptor • Shape retrieval engine	
Feb. 18	Data Driven 3D Shape Retrieval • Unsupervised dictionary learning for 3D shape retrieval • Supervised dictionary learning for 3D Shape retrieval • Deep learning for 3D shape retrieval	Project One
Feb. 25	3D Shape Registration • Introduction of shape registration • Shape registration based on point signature	
Mar. 3	Data Driven 3D Shape Registration • Learning a better shape signature • Joint-shape registration	Project Two
Mar. 10	3D Shape Segmentation • Introduction of shape segmentation • Shape segmentation based on point signature • Shape segmentation based on pairwise distance	
Mar. 17	Spring Break. No Class.	
Mar. 24	Data Driven 3D Shape Segmentation • Joint-Segmentation • Deep Learning for Shape Segmentation	Project Three
Mar. 31	Deep Cross-modality Analysis • From 2D Sketch to 3D Shape by Deep Pairwise Neural Network • From 2D Image to 3D Shape by Convolutional Neural Network • From 2.5 Depth Image to 3D Shape by Convolutional Neural Network	Call For Final Project
Apr. 7	3D Scene Analysis	

	• 3D Scene Reconstruction • Object detection & tracking in 3D Scene • Segmentation in 3D Scene	
Apr.14	Final Project Discussion (stage 0) • Topic determined • Presentation of proposed idea • Classroom discussion	
Apr.21	Final Project Discussion (stage 1) • Project Progress update • Presentation of updated progress • Classroom discussion	
Apr. 28	Final Project Discussion (stage 2) • Project Progress update • Presentation of updated progress • Classroom discussion	
May 5	Final Project Demo and Presentation (section I) • Project Demo • Presentation	Final Project and Presentation
May. 12	Final Project Demo and Presentation (section II) • Project Demo • Presentation • Final report paper due	

Policy on Academic Dishonesty:

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