NYU POLYTECHNIC SCHOOL OF ENGINEERING

Course Syllabus

Course Title **3D Computer Vision: Techniques and Applications**

Course Number **EL-GY 9143**

Course Description: Advances in informatics technologies coupled with data acquisition techniques have resulted in the production of three dimensional (3D) models at an unprecedented scale across areas as diverse as engineering, science and medicine. We are therefore faced with a dramatic demand for automatic 3D model processing, understanding and analyzing techniques. Researchers are regularly interested in interpreting the 3D shape of such models according to their intrinsic geometric attributes. The effective and efficient interpretation of 3D models is often challenged with the prevalence of non-rigidity within the shapes, the corruption of the shapes due to the presence of geometric noise, and the availability of a large volume of 3D models in innumerable databases. This course will introduce students to the techniques and applications of 3D computer vision. The focus of this course will be recent methods for 3D shape matching, retrieval, registration, recognition, segmentation, classification and clustering.

Credits 3

Prerequisite Courses MA 2012 (Linear Algebra) or equivalents, and proficiency in programming (Matlab is required and C++ is optional)

Instructor Information
Instructor(s) Prof. Yi Fang

Contact Information: 2 Metrotech Center, 10.069 or 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 four projects will be worth 15% each and the final project, report, and presentation will be worth 40% 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
Sept. 2	1. Introduction to 3D Computer Vision 2. Geometric transformation • Linear transformation • Matrix vector products • Affine transformation • Iterative closest point	Project One Assigned
Sept. 9	Group Project Discussion day	
Sept. 16	Introduction to 3D Shape Analysis • 3D model representation • 3D Euclidean distance • 3D Geodesic distance	
Sept. 23	Introduction to 3D Shape Analysis • 3D Diffusion distance • 3D point shape signature • 3D global shape descriptor	
Sept. 30	3D Shape Retrieval • Introduction of shape matching • Design of global shape descriptor • Shape retrieval engine	Project Two Assigned
Oct. 7	Group Project Discussion day	
Oct. 14	3D Shape Registration • Introduction of shape correspondence • Design of robust point shape signature • Shape registration	Project Three Assigned
Oct. 21	Group Project Discussion day	
Oct. 28	3D Shape Segmentation • Introduction of shape segmentation • Shape segmentation based on point signature • Shape segmentation based on pairwise distance	Project Four Assigned
Nov. 4	Group Project Discussion day	
Nov.11	Data-driven shape analysis • Data-driven shape classification • Data-driven shape segmentation	
Nov.18	Data-driven shape analysis • Data-driven shape retrieval • Data-driven shape registration	Call for Final Project
Nov.25	Final Project Discussion (stage 0) • Topic determined • Group Presentation of proposed idea • Classroom discussion	

Dec. 2	Final Project Discussion (stage 1) • Project Progress update • Group Presentation of updated progress • Classroom discussion	
Dec.9	Final Project Demo and Presentation (section I) • Project Demo • Group presentation	Final Project and Presentation
Dec. 16	Final Project Demo and Presentation (section II) • Project Demo • Group presentation • Final report paper due	

Policy on Academic Dishonesty:

The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness. Please see the school's policy on academic dishonesty at our school's website: http://engineering.nyu.edu/academics/code-of-conduct/academic-misconduct and university's policy: https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/academic-integrity-for-students-at-nyu.html