CS 786003-ST: Geometry Processing in Computer Science

Instructor

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Communication

This course uses Moodle for announcements and discussion. If you have questions about the class materials or assignments, requests for clarification, or other issues that may be of interest to the class as whole, post them to the General Discussion Forum. If you have any further questions that you are certain do not belong on Moodle, contact me directly per email.

Course Description

The course provides the mathematical background of differential geometry and its application for representation of geometric objects in computer science. These representations have a lot of applications in computer graphics and related disciplines. The course covers parametric and discrete surface representations and further focuses on mesh processing, mesh optimization, shape optimization, spectral mesh processing, mesh deformation, and mesh parameterization. Practical exercises where the concepts will be applied to real examples will be programmed in MATLAB.

Knowledge in linear algebra, analytical geometry, and optimization is required, however, depending on the background of the students, a recap on these topics will be provided.

Topics

1. Meshes and manifolds.
2. Mesh data structures (Book 1: Chapter 2).
3. Subdivision surfaces.
4. Freeform curves and surface.
5. Mathematical Background: Overview of parametric curves and surfaces.
   (Reading: Differential Geometry Introduction)
6. Mathematical Background: Differential geometry of curves.
   (Reading: Math Background and Differential Geometry of Curves.)
7. Mathematical Background: Differential geometry of surfaces.
   (Reading: Math Background and Differential Geometry Surfaces.)
8. Linear algebra and least Squares optimization. Reading: Linear Algebra Review
9. Mesh smoothing. Further reading: Chapter 4 of Book 1 and Chapter 9 of Book 2.
10. Spectral mesh processing. Further reading: Chapter 9.4 of Book 2.
11. Mesh parametrization. Further reading: Chapter 5 of Book 1 and Chapter 10 of Book 2.
12. Mesh deformation. Further reading: Chapter 9 of Book 1.
13. Non-linear mesh deformation. Further reading: https://igl.ethz.ch/projects/ARAP/arap_web.pdf

Learning Outcomes

The outcome should be that you understand the mathematical background, learn how geometry is processed in practice, and you will also learn to research current cutting-edge literature on that topic.

Textbooks and Material

- Book 1: Polygon Mesh Processing, October 2010
  by Mario Botsch (Autor), Leif Kobbelt (Autor), Mark Pauly (Autor), Pierre Alliez (Autor), Bruno Levy (Autor)Interactive Computer Graphics: A Top-Down Approach with WebGL , 7th Edition,
  ISBN-13: 978-1447140740
- Book 2: Guide to Computational Geometry Processing: Foundations, Algorithms, and Methods
  by J. Andreas Bærentzen (Author), Jens Gravesen (Author), François Anton (Author), Henrik Aanæs (Author)
  ISBN-13: 978-1568814261

Grading Policy

The final grade is computed as a weighted sum of the programming assignments and active course participation. In assignment 2 additional bonus points can be earned to account for other missed points. The sum of all points cannot exceed the total number of regular points. Students whose grade forecast is below A after grading of assignments will have the opportunity to gain additional points in a voluntary oral examination about course topics.

- Assignment 1 (30%)
- Assignment 2 (60%)
- active class participation (10%).

The grading scale normalized to 100 is as following (might be subject to adjustments): A: 100-90, B+: 90-80, B: 80-70, C+: 70-60, C: 60-50.

Assignments

Assignments will have 3-4 tasks where selected code needs to be completed based on the theoretical knowledge treated in the lectures. Each assignment has its detailed instructions. Own research on the details of the implementation needs to be conducted. Assignments need to be completed before dates due (usually around 4 weeks) and submitted via Moodle.

Honor Code

A set of ethical principles governing this course:

- It is okay to share information and knowledge with your colleagues, but
- **It is not okay** to share the code,
- **It is not okay** to post or give out your code to others (also in the future!),
- **It is not okay** to use code from others (also from the past) for this assignment!

Any noticed disregard of these principles will be sanctioned as per the Academic Integrity Policy of NJIT.

Late Policy

- There will be a -10% penalty of achieved points for every day the assignment is late.
- Max late submission is 7 days late.

Academic Integrity / Institutional Policies

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is the professional obligation and responsibility of the instructor to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu.