MO814A/MC937A: Topics in Computer Graphics

Instructor: Dr. Aurea Soriano-Vargas

Semester I, Year 2020

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Office Hours: W 4-6pm (IC 3.5 - RECOD/ 362)
Class Hours: T/Th 7-9pm (IC 3.5/ 353 - Google Hangouts Meet)
Hours: Two theoretical class per week, 2 hours each. The frequency will be controlled in both.
Minimum frequency: 75%

Description

This course aims to present the mathematical and algorithmic foundations of computer graphics: analytical geometry, mathematical models of curves, surfaces and solids, basic color and lighting theory, and main techniques for the synthesis of images and animations. This part will focus on the basic knowledge necessary for the development of computer graphics software (and not just for the use of such software).

Course Objectives

1. The course covers **visual literacy** (VL) in all lectures and assignments.
2. Develop graphics algorithms for line drawing, polygon filling, etc.
3. Learn about OpenGL (Graphics Library) and interface builder (e.g., FORMS).
4. Understand mathematical concepts used to model geometrical objects.
5. Learn about 3D viewing systems and their use in computer graphics.
6. Understand basic theory used to represent curves and surfaces.
7. Implement simple functions used in computer-aided design systems.
8. Implement 2D and 3D picking mechanisms.
9. Develop simple user interfaces.

Prerequisites

Data structures; Geometry; C, C++ or Java; Basic Linear Algebra (Operations with Matrices and Vectors, Scalar Product, Determinants, Matrix Inversion); Calculus (Limits and Derivatives); and Programming Skills.

Materials

- Course notes available on personal site. Books. Google for education.

Schedule and Tentative Course Outline

The schedule is tentative and subject to change. The learning goals below should be viewed as the key concepts you should grasp after each week, and also as a study guide before each exam, and at the end of the semester.

1. **[03/03]** Student profile, course profile, evaluation criteria. Introduction, history, related areas. **Exercise List 1.**
2. **[05/03]** Light and Color.
3. **[10/03]** Scanline of Lines and Polygons. **Exercise List 2**.
4. **[12/03]** No face-to-face classes due to COVID-19. Deadline of Exercise List 1.
5. **[19/03]** No face-to-face classes due to COVID-19.
6. **[24/03]** Clipping Lines and Polygons [Virtual Class].
7. **[26/03]** Introduction to OpenGL [Virtual Class]. **Exercise List 3**.
8. **[31/03]** Transformations in 2D [Virtual Class].
9. **[07/04]** Transformations in 3D [Virtual Class]. **Exercise List 4**.
10. **[12/04]** No classes. Deadline of Exercise List 2.
11. **[14/04]** Curves (non-parametric and parametric curves, Bezier curves, B-spline curves, cubic spline curves) [Virtual Class].
12. **[19/04]** No classes. Deadline of Exercise Lists 3 and 4.
13. **[16/04]** 3D Geometry. Surfaces (Lagrange Surfaces Interpolating sets of curves, Bezier Surfaces, B-spline Surfaces, and Subdivision Surfaces) [Virtual Class].
14. **[23/04]** Explanation of Final Project. Mid-Term Exam [Virtual Class].
15. **[30/04]** Lighting models for 3D objects [Virtual Class].
16. **[05/05]** Shading/Texturing models for 3D objects [Virtual Class]. **Exercise List 5**.
17. **[07/05]** Hidden Surfaces [Virtual Class].

18. **[12/05]** Ray Tracing (simulating light rays for near-photo-realistic rendering). [Virtual Class].
19. **[14/05 - 19/05]** Radiosity, Path Tracing and Photon Mapping [Virtual Class].
20. **[21/05]** Solid Modeling [Virtual Class].
21. **[26/05]** Shadows [Virtual Class].
22. **[28/05]** Colision Detection [Virtual Class].
23. **[02/06]** Particle Systems. [Virtual Class].
24. **[04/06]** Programmable Shaders [Virtual Class].
25. **[09/06]** Antialising [Virtual Class].
26. **[16/06]** Final Exam [Virtual Class].
27. **[18/06 - 25/06]** Practical Project Presentations [Virtual Class].

Grading Policy

The grade will count the assessments using the following proportions: The alphabetical grade (A, B, C, D) will be calculated from the numeric grade:

Concepts: A (8.0 to 10.0); B (6.5 to 7.99); C (5.0 to 6.49), D (less than 5.0)

- **30%** Practical project.
- **20%** Exercise Lists, performed throughout the semester.
- **20%** Mid-Term Exam.
- **30%** Final Exam.

Fundamental Computer Graphics Books

1. Hughes, J. F., Van Dam, A., Foley, J. D., McGuire, M., Feiner, S. K., and Sklar, D. F. "Computer graphics: principles and practice", Pearson, 2014
2. Donald Hearn, M. Pauline Baker and Warren Carithers: "Computer Graphics with OpenGL – 4th Ed.", Pearson, 2010
3. Foley/van Dam/Feiner/Hughes: "Computer Graphics," 2nd ed., Addison Wesley, 1990
4. Newman/Sproull: "Principles of Interactive Computer Graphics," McGraw-Hill, 1979
5. Rogers/Adams: "Mathematical Elements for Computer Graphics," 2nd ed., McGraw-Hill, 1990
6. Rogers: "Procedural Elements for Computer Graphics," 2nd ed., McGraw-Hill, 1997
7. Pokorny/Gerald: "Computer Graphics," Franklin, Beedle & Assoc., 1989
8. Watt: "Fundamentals of Three-Dimensional Computer Graphics," Add. Wesley, 1989

Interesting Links

- OpenGL: **Nehe**, **Isabel Manssour**, **Nate Robins**.
- 3D Rendering Software: **Ray-Tracing PovRay**, **Terrain Modeler**, **Sunflow Ray tracer**.
- 3D Modeling Software: **Blender (Open Source)**.
- 3D Models: **Turbo Squid 3D models**, **Sweet Home 3D**, **3D model free**, **MeshLab(Editing and Converting Models)**,**Wings 3D (Model Converter)**