USC VITERBI SCHOOL OF ENGINEERING

Video Game Graphics
ITP 481x (1 Unit)

Objective This course synthesizes recent developments and methods used in real-time game graphics into a concise, project-driven course that will give students the opportunity to learn how to program and design exciting real-time 3D objects. Complex topics like data structures and algorithms used in games are broken down into easily digestible portions. Students begin designing simple arrays and bit vectors and then move onto intense binary tree graphs, hash tables and rendering techniques. This course is designed for students at varying levels of programming expertise, and guarantees that both beginners and experts alike will be challenged to produce exciting work. The course culminates in the development of a one minute graphics project suitable for submitting on a demo reel to professional studios.

Concepts This course focuses on the following concepts, with a specific emphasis on powerful methods of implementation:
- Algorithms (specifically those used for sorting, searching, compression, and recursion)
- Vectors, matrices, colors and lighting
- Trees
- Graphs
- Rendering Techniques
- Vertex and Pixel Shader Techniques

Prerequisite CS102L

Lab 2 hrs/week

Required Textbooks
- *Data Structures for Game Programmers*, by Ron Penton, Premier Press. 2003. ISBN: 1-931841-94-2.
- *Real-Time Rendering Tricks and Techniques in DirectX*, by Kelly Dempski, Premier Press. 2003. ISBN: 1931841276.

Grading The following point-structure will be used in determining the grade for the course. Final grade will be based upon the total points received, the highest total in the class, and the average of the class.

Labs	25%
Midterm	25%
Final Exam	50%
Total	100%

Examinations Exams cover material from the reading assignments and lab projects. The exams are both closed book and closed notes. The exams will cover the material presented up to the date of the exam. The Final exam is not considered to be cumulative, though knowledge of the material presented during the earlier part of the semester may be helpful in answering some of the questions on the Final.

Students with Disabilities Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to your lab assistant) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. - 5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Policies

- Make-up policy for exams: In order to make up for a missed exam, the student must provide a satisfactory reason along with proper documentation. Usually make-ups are allowed only under extraordinary circumstances.

- Projects: It is YOUR responsibility to turn in your lab projects on, or before, the deadlines as set by the instructor.
  IT IS NOT THE RESPONSIBILITY OF THE LAB ASSISTANT!

- Late Projects: Late submission of projects will lead to loss on points, so please turn in your projects on time! No projects will be accepted after 2 weeks beyond the project's original due date. Everything regarding a project should be settled within 2 weeks of the project's due date.

- Due Dates: All projects must be submitted by midnight on the due date.

- Though working together is encouraged, the projects must be your own effort. "Duplicate" projects will all receive zero points and possible referral to the Office for Student Conduct.

- All students should abide by the University Student Conduct Code
  http://www.usc.edu/dept/publications/SCAMPUS/governance/gov03.html

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Course Outline

Week 1 – Concepts

- Basic Algorithm Analysis
- Templates
- Arrays
- Linked Lists
- Stacks
- Queues
- Hash Tables

Reading Assignment: *Data Structures* Chapters 1-9
Lab: None

Week 2 – Recursion and Trees

- Recursion
- Trees
- Binary Trees
- Binary Search Trees
- Priority Queues
- Heaps
- Game Trees
- Minimax Trees

Reading Assignment: *Data Structures* Chapters 10-16
Lab:

- Recursion and Trees Demo

Week 3 – Graphs and Algorithms

- Graphs
- Using Graphs for AI: Finite State Machines
- Sorting Data
- Data Compression
- Random Numbers
- Pathfinding

Reading Assignment: *Data Structures* Chapters 17-24
Lab:

- Graphs and Algorithms Demo

Week 4 – Introduction to Rendering Techniques

- 3D Graphics: A Historical Perspective
- A Refresher Course in Vectors
- A Refresher Course in Matrices
- A Look at Colors and Lighting
- A Look at the Graphics Pipeline

Reading Assignment: *Rendering Tricks and Techniques* Chapters 1-5
Lab:

- Rendering Techniques Demo

Week 5 – Building the Sandbox

- Setting Up the Environment and Simple Win32 App
- Creating and Managing the Direct3D Device

Reading Assignment: *Rendering Tricks and Techniques* Chapters 6-7

Lab:

- Sandbox Demo

Week 6 – Rendering

- Everything Starts with the Vertex
- Using Transformations
- From Vertices to Geometry

Reading Assignment: *Rendering Tricks and Techniques* Chapters 8-10

Lab:

- Rendering Demo

Week 7 – Lighting and Textures

- Fixed Function Lighting
- Introduction to Textures
- Texture Stage States
- Depth Testing and Alpha Blending

Reading Assignment: *Rendering Tricks and Techniques* Chapters 11-14

Lab:

- Lighting and Textures Demo

Week 8 – Midterm

Reading Assignment: All prior material

Week 9 – Shaders

- Vertex Shaders
- Pixel Shaders

Reading Assignment: *Rendering Tricks and Techniques* Chapters 15-16

Lab:

- Shaders Demo

Week 10 – Vertex Shader Techniques

- Using Shaders with Meshes
- Simple and Complex Geometric Manipulation with Vertex Shaders
- Billboards and Vertex Shaders
- Working Outside of Cartesian Coordinates

Reading Assignment: *Rendering Tricks and Techniques* Chapters 17-20

Lab:

- Vertex Shader Demo

Week 11 – Advanced Vertex Shader Techniques

- Bezier Patches
- Character Animation – Matrix Palette Skinning
- Simple Color Manipulation
- Do-It-Yourself Lighting in a Vertex Shader
- Cartoon Shading

Reading Assignment: *Rendering Tricks and Techniques* Chapters 21-25

Lab:

- Advanced Vertex Shader Demo

Week 12 – Shadows

- Reflection and Refraction
- Planar Shadows
- Shadow Volumes
- Shadow Maps

Reading Assignment: *Rendering Tricks and Techniques* Chapters 26-29

Lab:

- Shadows Demo

Week 13 – Pixel Shader Techniques

- Per-Pixel Lighting
- Per-Pixel Lighting – Bump Mapping
- Per-Vertex Techniques Done per Pixel

Reading Assignment: *Rendering Tricks and Techniques* Chapters 30-32

Lab:

- Pixel Shader Demo

Week 14 – Useful Techniques

- Rendering to a Texture – Full-Screen Motion Blur
- 2D Rendering – Just Drop a "D"
- DirectShow: Using Video as a Texture
- Image Processing with Pixel Shaders

Reading Assignment: *Rendering Tricks and Techniques* Chapters 33-36

Lab:

- Useful Techniques Demo

Week 15 – Other Useful Techniques

- A Much Better Way to Draw Text
- Perfect Timing
- The Stencil Buffer
- Picking: A Plethora of Practical Picking Procedures

Reading Assignment: *Rendering Tricks and Techniques* Chapters 37-40

Lab:

- Final Project

Week 16 – Final Examination