Lecture O of 41:
Part B – Course Content

Introduction to Computer Graphics:
Course Organization and Survey

William H. Hsu
Department of Computing and Information Sciences, KSU

Course web site: http://www.kddresearch.org/Courses/CIS636
Instructor home page: http://www.cis.ksu.edu/~hhsu

Reading for Next Class:
Chapter 1, Eberly (2006)

Why Computer Graphics?

- Developing Computational Capability
  - Rendering: synthesizing realistic-looking, useful, or interesting images
  - Animation: creating visual impression of motion
  - Image processing: analyzing, transforming, displaying images efficiently

- Better Understanding of Data, Objects, Processes through Visualization
  - Visual summarization, description, manipulation
  - Virtual environments (VE), visual monitoring, interactivity
  - Human-computer intelligent interaction (HCI): training, tutoring, analysis, control systems

- Time is Right
  - Recent progress in algorithms and theory
  - Rapidly emergence of new I/O (display and data acquisition) technologies
  - Available computational power, improving price-performance-ratio of hardware
  - Growth and interest of graphics industries (e.g., games, entertainment, computer-aided design, visualization in science and business)

Course Overview

- Graphics Systems and Techniques
  - Main emphasis: shaders, lighting, mappings (textures, etc.) in OpenGL
  - Photorealistic rendering and animation (Maya 2010, Blender, Ogre3D)
  - 2D, 3D models: curves, surfaces, visible surface identification, illumination
  - Special topics: global illumination (ray tracing, radiosity), particle systems, fractals, scientific visualization (viz) and information visualization (infographics)

- Operations
  - Surface modeling, mapping
  - Pipelines for display, transformation, illumination, animation

- Computer Graphics (CG): Duality with Computer Vision

- Visualization and User Interfaces

- Applications
  - CAD/CAM/CAE: object transformations, surface/solid modeling, animation
  - Entertainment: 3-D games, photorealistic animation, etc.
  - Analysis: info visualization, decision support, intelligent displays

User Interfaces & Hypermedia

NCSA SEARS/MEANDRE
Visual programming systems for high-performance knowledge discovery in databases (KDD), cloud computing, and more

- Hypermedia & Web 2.0
  - Web 2.0: SLATES (search, links, authoring, tags, extensions, signals)
  - Database format (similar to SuperText, Internet/networked multimedia)

- Virtual Environments
  - Immersion: interactive training, tutoring systems

- Graphical User Interfaces (GUIs)
  - Visualization: scientific, data/information, statistics
  - GUIs: Computer-Aided Design/Engineering (CADD/ME/MAC/CARE), etc.

Rendering (Image Synthesis) Pipeline

“Polygons-to-Pixels” Pipeline

“Back-End
(Selection)

“Back-End
(Rasterization)

“Front-End
(Geometry Processing)

“Front-End
(Shading)

“Front-End
(Rendering)

“Front-End
(Viewing)

Relevant Topic Areas

- Analytic Geometry
  - Art and Graphic Design
  - Cognitive Science

- Computer Engineering
  - Engineering Design

- Education
  - Film

- Human Factors
  - Linear Algebra

- Numerical Analysis
  - Physics Engines
  - Fluid Simulation

- Computer Graphics (CG)
  - User Modeling
  - Image Processing

- Computer Graphics (CG)
Computing & Information Sciences
Kansas State University

CIS 536/636
Introduction to Computer Graphics

Shading Pipeline & Surface Modeling
(Boundary Representations)

Computer-Generated Animation (CGA)

Shading Pipeline & Surface Modeling
(Boundary Representations)

Computer-Generated Animation (CGA)

Fractals: Iterated Function Systems (IFSs)

Information Visualization

Fractals of the Day: http://sprott.physics.wisc.edu/fractals.htm

Information Visualization

Math Review for CIS 536 / 636

Design Choices & Issues
In Computer Graphics

Math Review for CIS 536 / 636

Overview: First Month (Weeks 2-5 of Course)
- Review of mathematical foundations of CG: analytic geometry, linear algebra
- Line and polygon rendering
- Matrix transformations
- Graphical interfaces

Line and Polygon Rendering (Week 3)
- Basic line drawing and 2-D clipping
- Bresenham’s algorithm
- Follow-up: 3-D clipping, z-buffering (painter’s algorithm)

Matrix Transformations (Week 4)
- Application of linear transformations to rendering
- Basic operations: translation, rotation, scaling, shearing
- Follow-up: review of standard graphics libraries (starting with OpenGL)

Weeks 5 – 6: More OpenGL and Direct3D
- Graphical Interfaces
  - Brief overview
  - Survey of windowing environments (SDL in OpenGL, Direct3D)
Textbook and Recommended References

Required Textbook

Recommended References

Summary

This course is a lot of work
- Reading: Eberly 2nd big book, like Foley et al.
- Programming assignments (4), expect to spend 10+ hours on each
- Written assignments (4), about 6-10 hours
- Term project: at least 20 hours (people have spent up to 50 or more)
... but it can also be fun
- Visible results
- Nifty algorithms, high-performance hardware
- "Putting it all together", very interdisciplinary field
- Needed job market for people with right development skills, ideas
- Applicable to many other areas of CS and EE

Emphasis
- "Polygons to pixels pipeline": viewing, VSD, lighting, shading, texturing
- Other topics to be covered: animation, curves and surfaces, collisions
- Brief survey of: ray tracing, visualization and color, fractals
- Tutorials (GameDev aka Nehe): http://nehe.gamedev.net

Next Class

Photorealism

3-D Camera Model

http://realismstudio.com
2.841 Square Enix Making
http://ch.r/WhI2y

Computer Graphics, Digital Synthesis, Manipulation of Visual Content

- Geometry: representation and processing of surfaces
- Animation: representation and manipulation of motion
- Rendering: computationally reproducing appearance of light in scenes
- Imaging: image acquisition, editing, processing

Different Approaches to Graphics
- Raster (bitmaps, picture elements aka pixels) vs. vector (lines)
- Sample-based (cf. Photoshop) vs. geometry-based (cf. OpenGL, Direct3D)

Purpose of Graphics
- Entertainment – games, visual effects in movies and television
- Communications – advertising, journalism
- Modeling / simulation – displaying objects, events via graphical user interfaces (GUI)
- Visualization – displaying events for analysis and understanding

Summary

Dual Problem: Inverse Input and Output
- Graphics (rendering): geometry to sample (image)
- Vision: sample to geometry

Terminology