A Brief Summary of Topics in Computer Graphics

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Readings:
Class Introduction (Handout)
Appendix: Mathematics for Computer Graphics, Foley et al

Applications

- Visualization and User Interfaces
- Computer Graphics (CG): Duality with Computer Vision
- Special topics: fractals, information visualization

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
- Virtual environments (VR), 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., information visualization, entertainment CAD)

Lecture Outline

- Course Information: Format, Exams, Resources, Assignments, Grading
  - Overview
    - Topics covered
    - What is computer graphics?
    - Applications
  - Brief Tour of Computer Graphics
    - A case study and some demos
    - Survey of rendering and animation systems
    - Applications to computer-aided design (CAD), manufacturing (CAM), and engineering (CAE)
  - Brief Tour of Visualization Systems
    - Information, data, and scientific visualization
    - Focus on information graphics

Course Information and Administrivia

- Instructor: William H. Hsu
  - E-mail: bhsu@ksu.edu
  - Phone: (785) 532-6350 (office), (785) 539-7180 (home)
  - Office hours: after class; 1-2pm Wednesday, Friday, by appointment
- Grading
  - Assignments (8): 25%, reviews (4): 15%, midterm: 15%, final: 20%, project: 25%
  - Lowest homework score and lowest paper review score dropped
- Homework
  - Six (6) assignments: programming (2), written (2), application (2)
  - Late policy: due on Fridays; free extension to following Monday (if needed by due date); -10% credit per day after 5:00 PM (1700) Monday
  - Cheating: don’t do it; see introductory handout for policy
- Project Option
  - 1-hour project option for graduate students (CIS 798)
  - Sign up by February 14, 2000 if interested (see class web page)
- Reminders, related research, job announcements
- Cheating: don’t do it; see introductory handout for policy
- Due date: -10% credit per day after 5:00 PM (1700) Monday

Class Resources

- Web Page (Required)
  - Lecture notes (MS PowerPoint 97, PostScript)
  - Homeworks (MS Word 97, PostScript)
  - Exam and homework solutions (MS Word 97, PostScript)
  - Class announcements (students responsibility to follow) and grade postings
- Course Notes at Copy Center (Required)
- Class Web Board (Required)
  - Login: Students; password: announced in class
  - Discussions (instructor and other students)
  - Research announcements (seminars, conferences, calls for papers)
  - Reminders, related research, job announcements

Course Overview

- Graphics Systems and Techniques
  - 2-D, 3-D models: curves, surfaces, visible surface identification, illumination
  - Photorealistic rendering and animation: shading models, ray tracing, radiosity
- Special topics: fractals, information visualization
- Operations
  - Surface modeling, mapping
  - Pipelines for display, transformation, illumination, animation
- Computer Graphics (CG): Duality with Computer Vision
- Visualization and User Interfaces
  - Display optimization, hardware, libraries, GUI design
  - Techniques for quantitative information, objects, processes
  - Survey of statistical, data, information, and scientific visualization
- Applications
  - CAD/CAM/CAE: object transformations, surface/solid modeling, animation
  - Entertainment: 3-D games, photorealistic animation, etc.
  - Analysis: info visualization, decision support systems, intelligent displays

Focus on informational graphics

Growth and interest of graphics industries (e.g., information visualization, --
Available computational power, improving price-performance-ratio of hardware
--
Entertainment: 3-D games, photorealistic animation, etc.
--
Analysis: info visualization, decision support systems, intelligent displays
--
Entertainment CAD)
Image Synthesis Pipeline

Hypermedia User Interfaces
- Hypermedia
  - Database format (similar to hypertext) that provides display-based access to (internetworked) multimedia (text, image, audio, video, etc.) documents
  - Chimera: http://www.ics.uci.edu/pub/chimera/
- Virtual Environments
  - Immersion: interactive training, tutoring systems
  - Entertainment hypermedia
- Visualization and Computer-Aided Design and Engineering (CAD/CAE)
  - Visualization: scientific, data/information, statistics
  - User interfaces for CAD/CAE/CAM/CASE: http://www.isi.com

Hypermedia
- NCSA D2K: http://chili.ncsa.uiuc.edu
- Visual programming system for high-performance knowledge discovery in databases (KDD)

Relevant Disciplines
- Analytic Geometry
- Art and Graphic Design
- Cognitive Science
- Computer Engineering
- Engineering Design
- Education
- Film
- Human Factors
- Linear Algebra
- Numerical Analysis

Curve and Surface Modeling in Computer-Aided Design (CAD)
http://www.geocities.com/SiliconValley/Lakes/2057/nurbs.html

Photorealistic Illumination Models
http://www.pixar.com
http://www.ktx.com/3dsmaxr3
http://www.aliaswavefront.com

Fractal Systems
http://sprott.physics.wisc.edu/fractals.html
Information Visualization

Visible Decisions (http://www.vdi.com)

Design Choices and Issues in Computer Graphics

Determine Objectives of Graphics System

- Entertainment
- Decision Support
- Education
- Control

Determine Display Objective

- Interactive
- Analytic
- Data
- Documents

Determine Representations in Graphics Database

- Solid Geometric Model
- Wireframe / Polygon Mesh
- NURBS
- Fractal

Determine and Implement Rendering Pipeline

- Shaded-Polygon Rendering
- Ray Tracing
- Radiosity and Polygon Shading

Completed Design

Completed Design

Math Review

- Overview: First Two Weeks
  - Review of mathematical foundations of CG: analytic geometry, linear algebra
  - Line and polygon rendering
  - Matrix transformations
  - Graphical interfaces
- Line and Polygon Rendering
  - Basic line drawing and 2-D clipping
  - Bresenham’s algorithm
  - Follow-up: 3-D clipping, z-buffering (painter’s algorithm)
- Matrix Transformations
  - Application of linear transformations to rendering
  - Basic operations: translation, rotation, scaling, shearing
  - Follow-up: review of standard graphics libraries (e.g., OpenGL)
- Graphical Interfaces
  - Brief overview
  - Survey of windowing environments (MFC, Java AWT)

Interesting Industrial Applications

Hypermedia and Statistical Visualization

Cartia ThemeScapes
- http://www.cartia.com
- 6500 news stories from the WWW in 1997

Virtual Environments for Immersive Training

DC-ARM
- http://www-kbs.ai.uiuc.edu

Entertainment CGA

Hypermedia and Statistical Visualization

Virtual Environments for Immersive Training