

Fundamentals of Computer Graphics

Lecture 1. Introduction

Yong-Jin Liu

liuyongjin@tsinghua.edu.cn

<http://cg.cs.tsinghua.edu.cn/people/~Yongjin/Yongjin.htm>

Outline

- What is computer graphics
 - Topics
 - Grading policy
-

What is computer graphics?

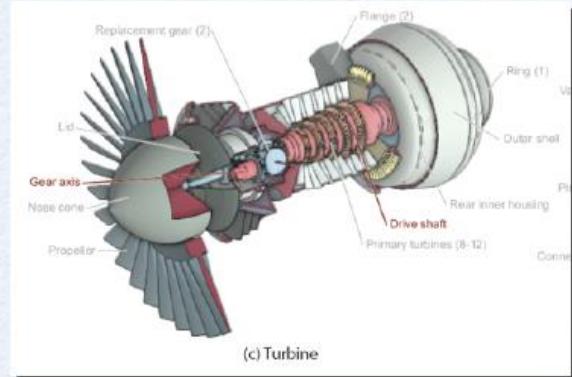
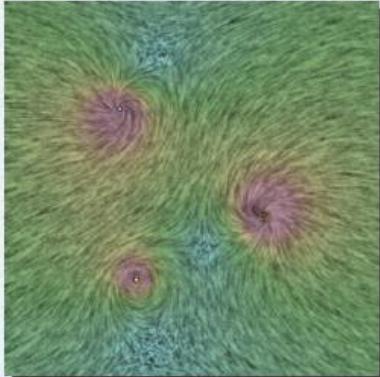


What is computer graphics?

Definition by IEEE

- Computer graphics is the **art** or **science** of producing graphical images with the aid of computer.
-

What is computer graphics?



Scientific Visualization

Illustration



NPR / Art

Computational Photography

Virtual Life

and much more....

What is computer graphics?

More than entertainment

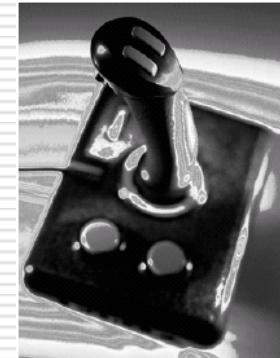
- Movie, game ⋯
- Training, simulation, education ⋯

Industrial applications

Computer Graphics Tools

Hardware

- Hardware tools include video monitors, graphics cards, and printers that display graphics.
- They also include input devices such as a mouse, data glove, or trackball—that let users point to items and draw figures



Computer Graphics Tools

Hardware



Computer Graphics Tools

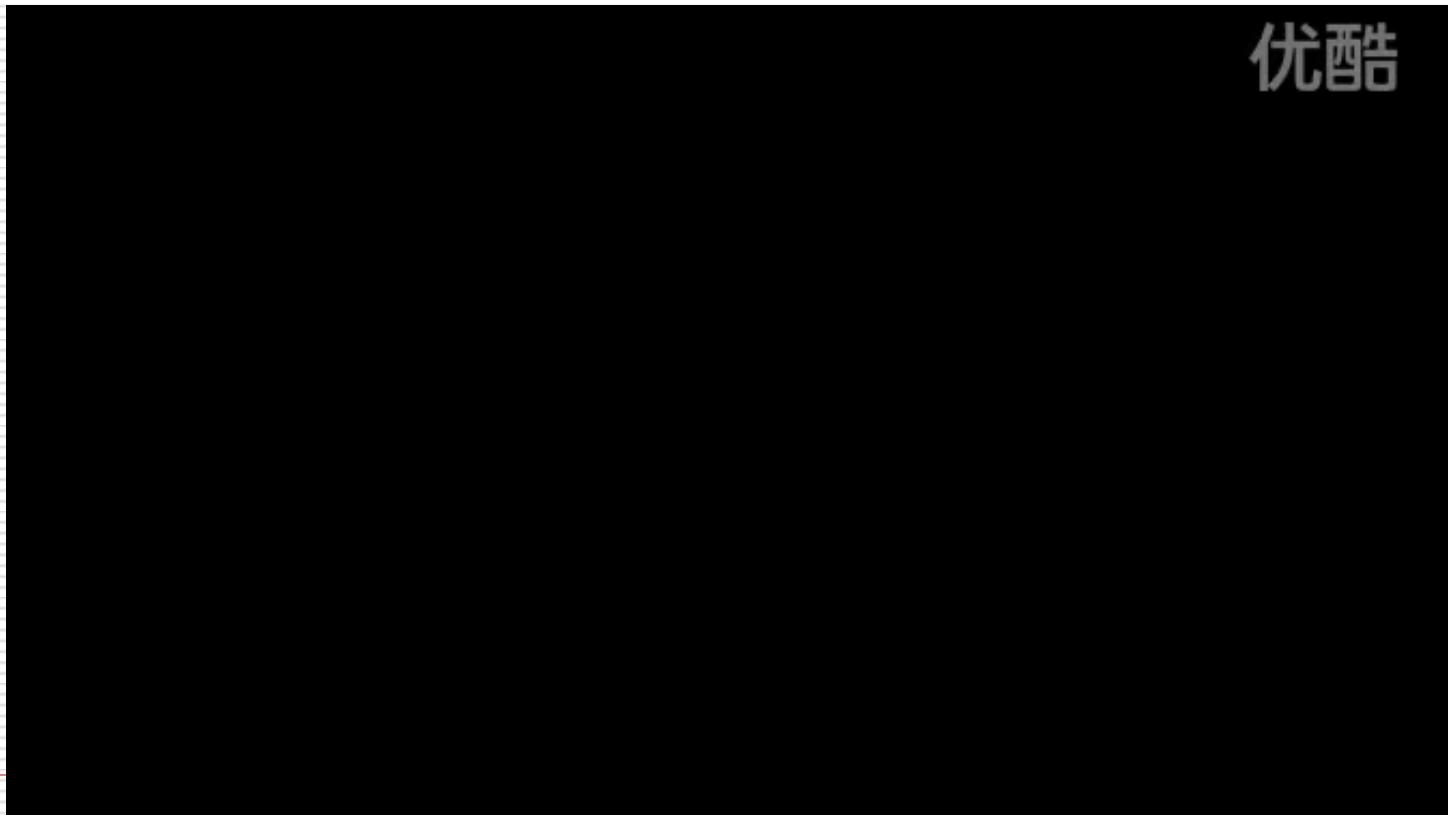
- CAD
design;
- Conceptual
design

ILoveSketch:
As-Natural-As-Possible Sketching System
for Creating 3D Curve Models

Seok-Hyung Bae
Ravin Balakrishnan
Karan Singh

Computer Graphics Tools

- Better communication between people



Computer Graphics Tools

Hardware



Computer Graphics Tools

Software:

- Operating system, editor, compiler, debugger
 - Graphics routines: e.g., functions to draw a simple line or circle (or characters such as G).
 - Functions to manage windows with pull-down menus, input, and dialog boxes
-

Device Independent Graphics

Device independent graphics libraries:

- Allow the programmer to use a common set of functions within an application, and to run the same application on a variety of systems and displays are available.
 - **OpenGL** is such a library, and is the tool we shall use in this book. The OpenGL way of creating graphics is used widely in both academia and industry
-

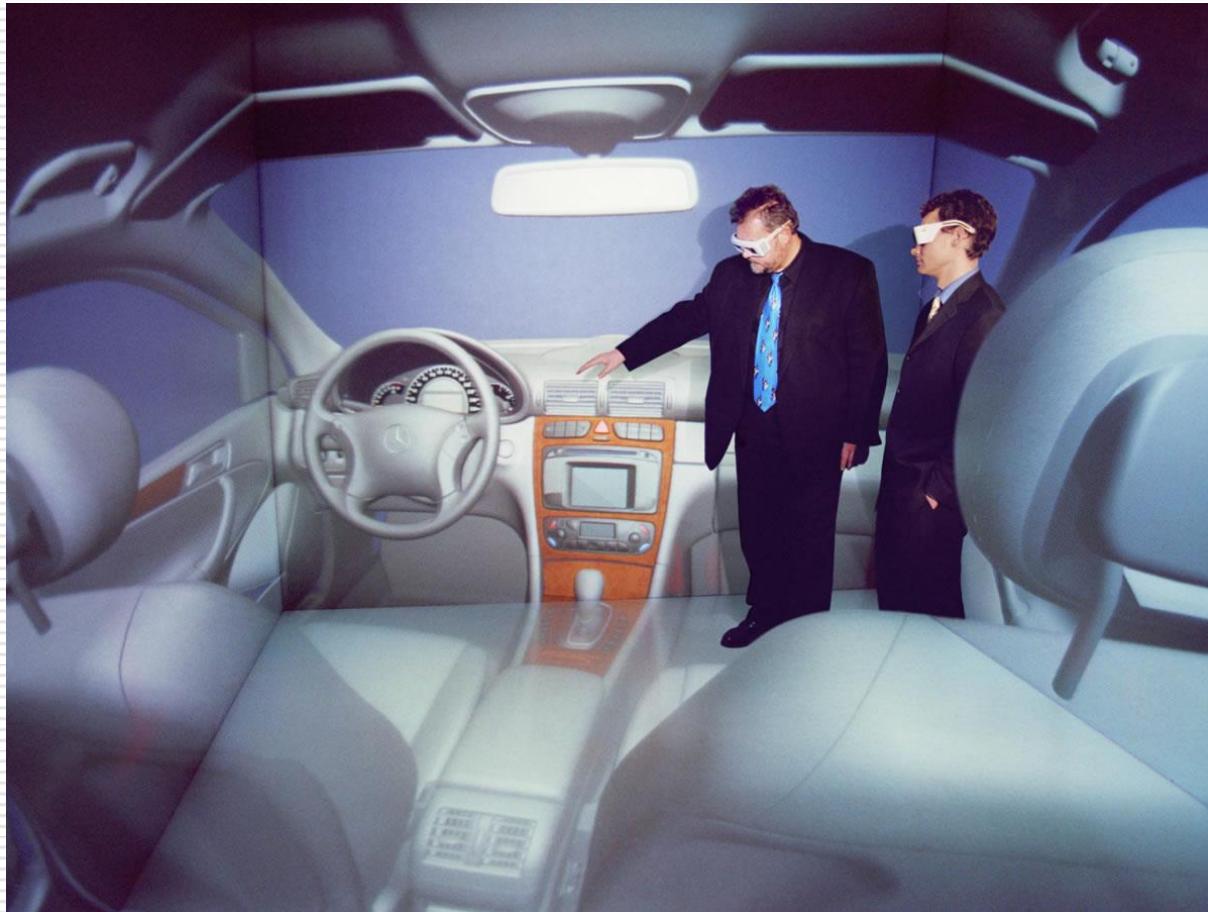
Why Study Computer Graphics?

- Some people want a better set of tools for plotting curves and presenting the data they encounter in their other studies or work
 - Some want to write computer-animated games, while others are looking for a new medium for artistic expression.
 - Most people want to be more productive, and to communicate ideas better, and computer graphics can be a great help.
-

Communicate ideas better



Communicate ideas better



Communicate ideas better



How CG Presentations?

- Frame-by-frame: A single frame can be drawn while the user waits. (**very boring**)
 - Frame-by-frame under control of the user: A sequence of frames can be drawn, as in a PowerPoint® presentation; the user presses a key to move onto the next slide, but otherwise has no way of interacting with the slides. (**much less boring**)
-

How CG Presentations?

- Animation: A sequence of frames proceeds at a particular rate while the user watches with delight; (**exciting**, as in such animated movies as The Incredibles® and Shrek®)
 - Interactive Program: In an interactive graphics experience, the user controls the flow from one frame to another using an input device such as a mouse or keyboard in a manner that was unpredictable at the time the program was written. This can delight the eye. A computer game is a familiar case of an interactive graphics presentation. (**delightful!**)
-

Where Are Computer Graphics Used

- Production of movies, television programs, games
 - Browsing on the World Wide Web: the browser rapidly interpret the data on a page and draw it on the screen as high quality text and graphics
 - Slide, Book, and Magazine Design: Computer graphics are used in page layout programs to design the final look of each page of a book or magazine. The user can interactively move text and graphics around to find the most pleasing arrangement
-

Outline

- What is computer graphics
 - Topics
 - Grading policy
-

Topics

- 3D Modeling / Geometry
 - Textures and Color
 - Lighting / Lighting Transfer
 - Simulation / Animation / Character
 - Post-Process: image processing
 - Camera tricks / Optics
-

Administration

Course webpage

□ <http://learn.tsinghua.edu.cn/>

The screenshot shows the homepage of the Tsinghua University Network Learning Platform (网络学堂). The header features the university's logo and the text "清华大学" and "Tsinghua University". Below the header, there is a navigation bar with links for "School bulletin" and "Exit system". On the left, a sidebar menu titled "主菜单" (Main Menu) lists several options: "My courses", "Personal information", "Personal homepage", "My notebook", "Online file cabinet", "Virtual space", and "Default setting". The main content area has a blue header with the text "2014-2015 春季学期" (Spring Semester 2014-2015), "2014-2015秋季 学期及以前学期" (Autumn Semester 2014-2015 and previous semesters), "All online courses", "Opening discussion courses", "Course openings to students on campus", and "Course openings to the world". A yellow banner below the header reads "网络学堂推出新版，欢迎各位老师使用！(鼠标悬浮于文字上，可查看新版的详细介绍)" (The Network Learning Platform has launched a new version, welcome all teachers to use it! (Hover over the text to view the detailed introduction)). Below the banner, there are sections for "Courses for teachers", "Co-teaching Courses", and "Assisted courses". At the bottom right of the main content area, there is a button labeled "切换为新版" (Switch to New Version).

Administrivia

Course webpage

- <http://learn.tsinghua.edu.cn/>

Teaching Assistants

- Mr. Chun-Xu Xu, Cheng-Chi Yu
 - Contact mobile no. 15120003845
 - xu-cx12@mails.tsinghua.edu.cn
-

Textbook

Optional: not necessary to buy

- Computer Graphics Using Opengl, 3rd edition. By Hill & Kelley, Prentice Hall
 - <http://www.4twk.com/shill/3rd-edition.html>
 - Chinese translation available in Tsinghua Univ. Press
-

Textbook

Supplement

- OpenGL Red Book

<http://www.glprogramming.com/red/>

OpenGL programming guide (8th edition)

- NEHE OpenGL Tutorial

<http://www.opengl-tutorial.org/>

<http://nehe.gamedev.net/>

Course organization

Monday, 13:30~, 16 weeks

- Three classes per week:

13:30-14:15,

14:20-15:05,

15:10-15:55

Course organization

Monday, 13:30~, 16 weeks

- Teaching: basic CG theory and algorithms
(About 1~1.5 classes)
 - Programming practice
(About 1~1.5 classes)
-

Pre-requisites

- Basic programming skill in C++
 - Basic data structure
 - Matrix algebra; Geometry
 - Basic on computer system
-

Grading policy

Good news

- No paper examination

Grading based on ...

- Programming homework (course work)
every week
 - Choose one from seven candidate course
projects
-

Course organization

Monday, 13:30~, 16 weeks

- Teaching: basic CG theory and algorithms
(About 1~1.5 hours)
 - Programming practice
(About 1~1.5 hours)
-

Course organization

Monday, 13:30~, 16 weeks

Programming practice

(About 1~1.5 hours)

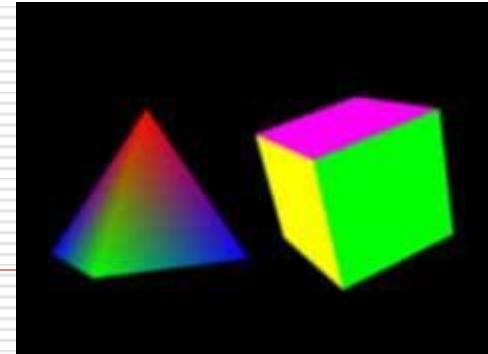
- Detailed document, step by step
(discuss with TA)
 - Topics from beginning to mid-level
-

Topics

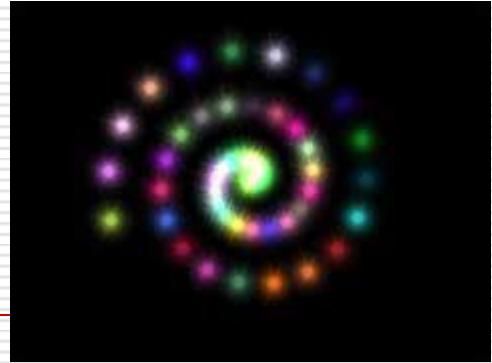
Week 2 (finish all in the class)

- Setting Up An OpenGL Window
- Your First Polygon
- Adding Color
- Rotation
- 3D Shapes

NEHE lessons 01-05



Topics



Week 3 (Choose some to finish in the course,
the left for homework)

- Texture Mapping
- Texture Filters, Lighting & Keyboard Control
- Blending
- Moving Bitmaps In 3D Space
- Loading And Moving Through A 3D World

NEHE lessons 06-10

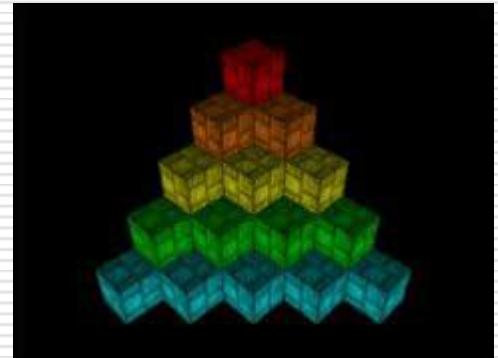
Topics



Week 4 (Choose some to finish in the course,
the left for homework)

- Flag Effect (Waving Texture)
- Display Lists
- Bitmap Fonts
- Outline Fonts
- Texture Mapped Outline Fonts

NEHE lessons 11-15



Topics

Week 5 (Choose some to finish in the course,
the left for homework)

- Cool Looking Fog
- 2D Texture Font
- Quadrics
- Particle Engine Using Triangle Strips
- Masking

NEHE lessons 16-20



Topics

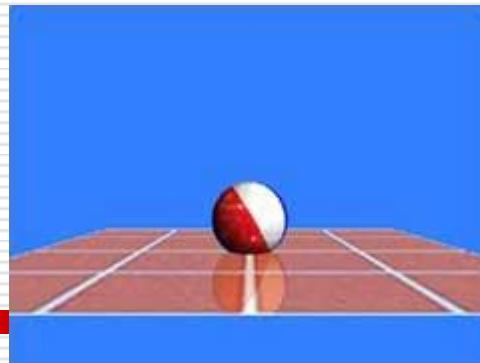


Week 6 (Choose some to finish in the course,
the left for homework)

- Lines, Antialiasing, Timing, Ortho View And Simple Sounds
- Bump-Mapping, Multi-Texturing & Extensions
- Sphere Mapping Quadrics In OpenGL
- Tokens, Extensions, Scissor Testing And TGA Loading
- Morphing & Loading Objects From A File

NEHE lessons 21-25

Topics



Week 8 (Choose some to finish in the course,
the left for homework)

- Clipping & Reflections Using The Stencil Buffer
- Shadows
- Bezier Patches / Fullscreen Fix
- Blitter Function, RAW Texture Loading
- Collision Detection



NEHE lessons 26-30

Topics

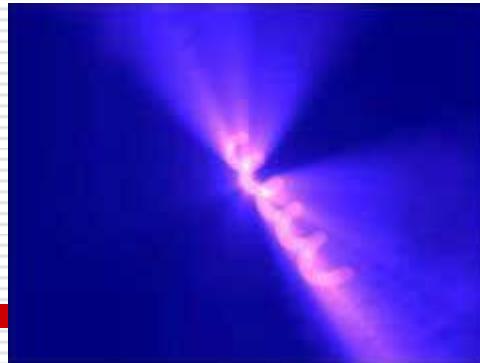


Week 9 (Choose some to finish in the course,
the left for homework)

- Model Loading
- Picking, Alpha Blending, Alpha Testing, Sorting
- Loading Compressed And Uncompressed TGA's
- Beautiful Landscapes By Means Of Height Mapping
- Playing AVI Files In OpenGL

NEHE lessons 31-35

Topics



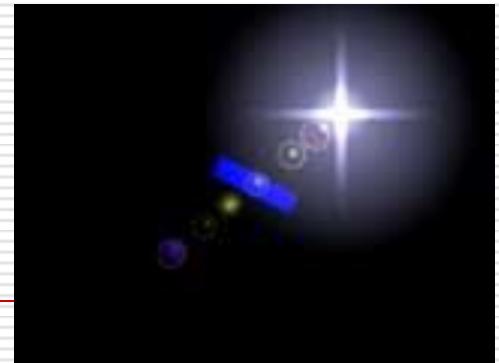
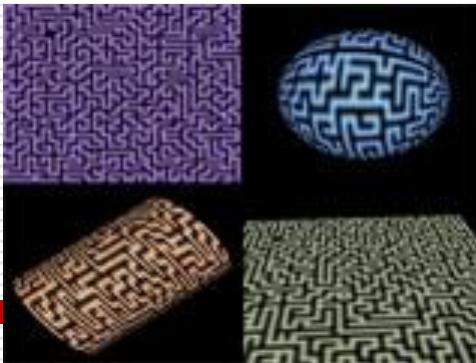
Week 10 (Choose some to finish in the course,
the left for homework)

- Radial Blur & Rendering To A Texture
- Cel-Shading
- Loading Textures From A Resource File & Texturing Triangles
- Introduction to Physical Simulations
- Rope Physics

NEHE lessons 36-40



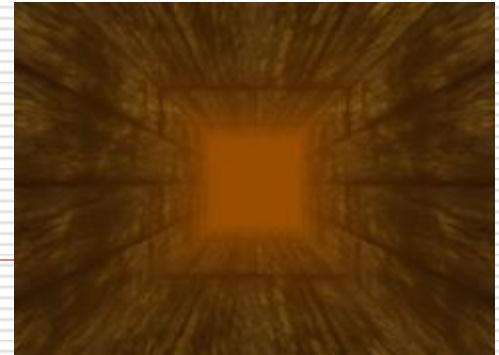
Topics



Week 11 (Choose some to finish in the course,
the left for homework)

- Volumetric Fog & Picture Image Loading
- Multiple Viewports
- FreeType Fonts in OpenGL
- 3D Lens Flare With Occlusion Testing
- Vertex Buffer Objects

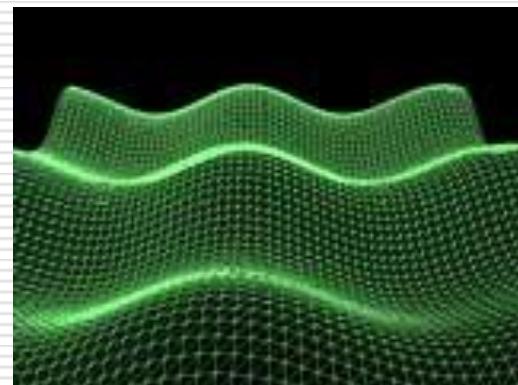
NEHE lessons 41-45



Topics

Week 12 (Choose some to finish in the course,
the left for homework)

Fullscreen AntiAliasing



CG Vertex Shader

ArcBall Rotation

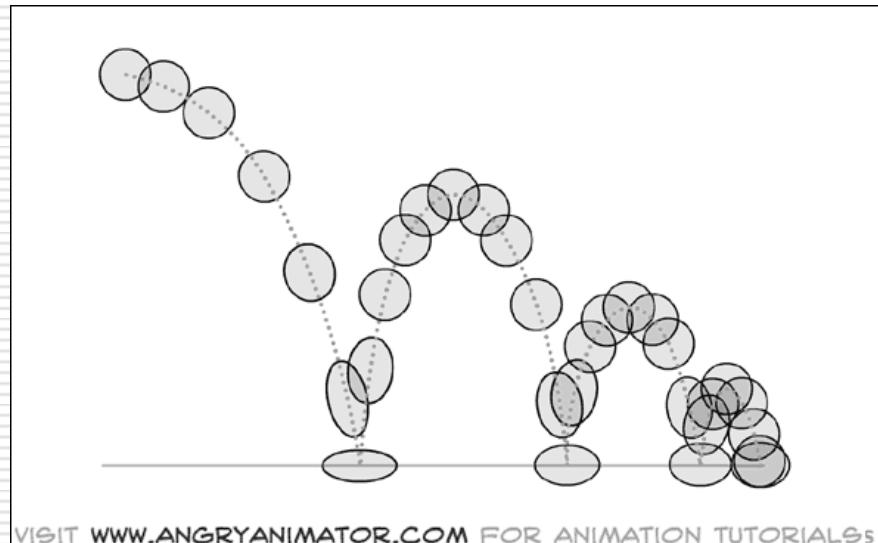


NEHE lessons 46-48

Topics

Week 13 (Try at least one to practice)

- The Bouncing Ball
- The Walk Cycle
- Lip sync/dialog
- Preston blair



Course+home work

All source code available for
VC++.net 2010

- Programming practice
(About 1~1.5 hours)
 - Understand the code, compile and edit
the code by yourself
 - Cheating policy
-

Cheating policy

Please do not cheat! (Zero tolerance)

- Using code from the web is fine
- Discussion with classmate and TA is fine
- Must compile and edit the code by yourself
- Must understand the code individually

Grading policy

Good news

- No paper examination

Grading based on ...

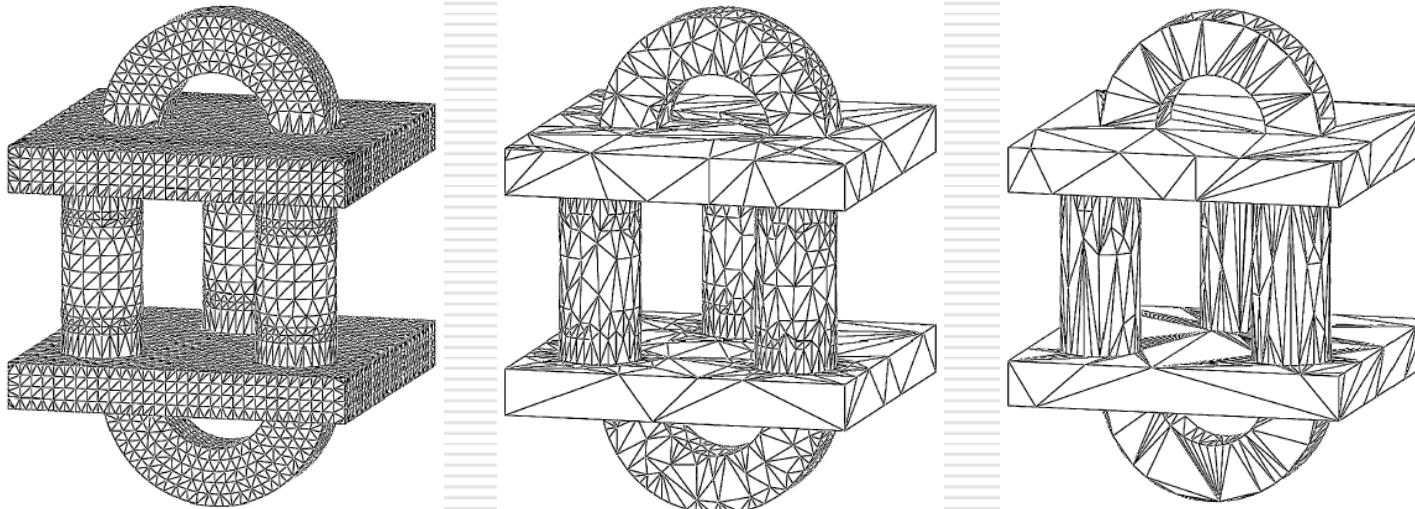
- Programming homework (course work)
every week
- Course Project**: choose one from seven
candidates

Candidate course projects

1. Mesh simplification and subdivision

Key points:

Geometry modeling; Level-of-details

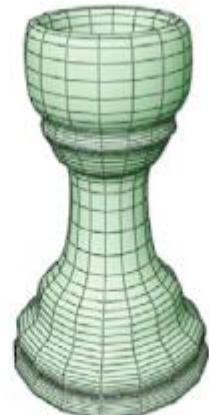
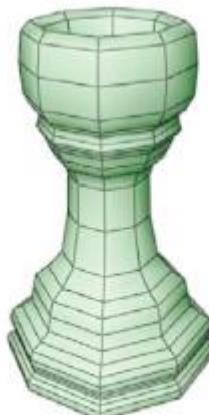
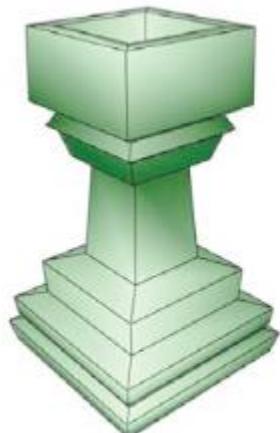


Candidate course projects

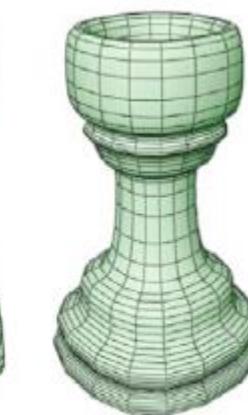
1. Mesh simplification and **subdivision**

Key points:

Geometry modeling; Level-of-details



Catmull-Clark scheme



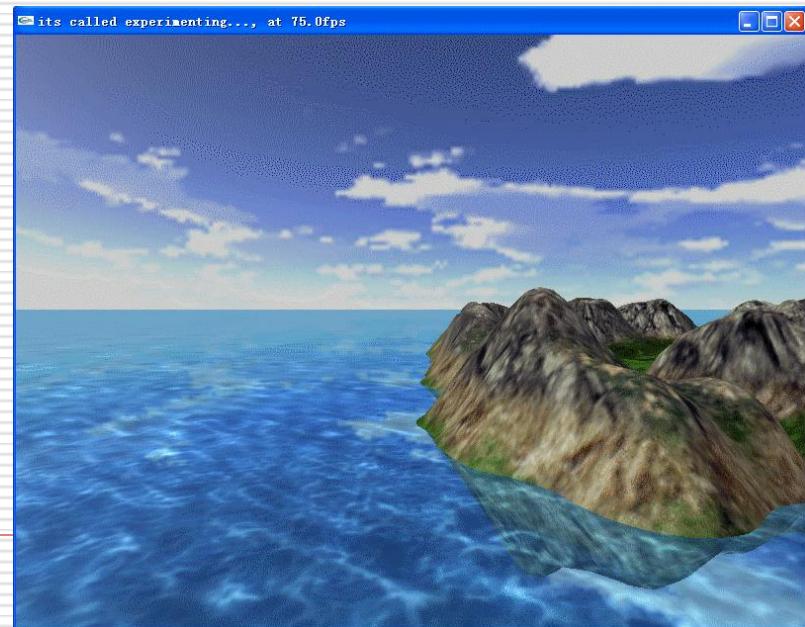
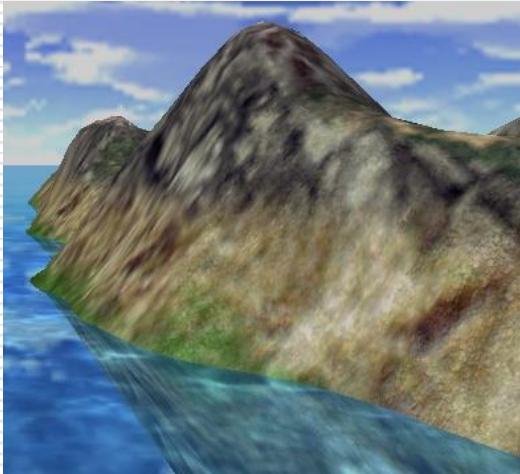
Doo-Sabin scheme

Candidate course projects

2. Interactive virtual scene walkthrough

Key points:

3D modeling; Texture mapping

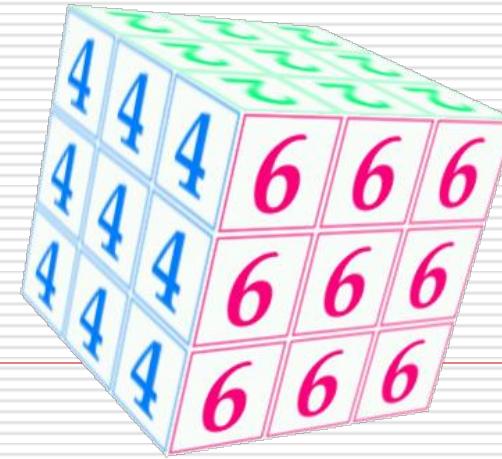
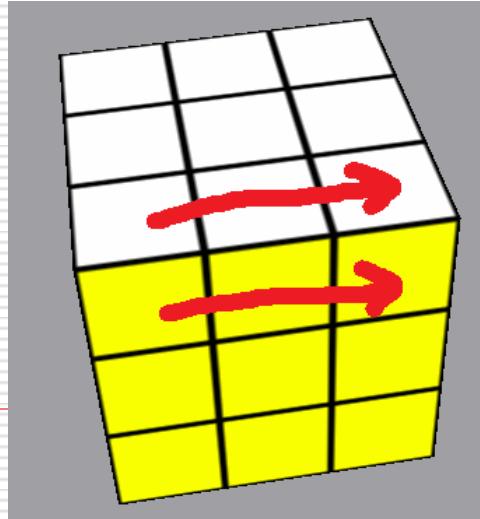


Candidate course projects

3. Interaction with magic cube

Key points:

Texture mapping; 3D transformation;
Selection; Interaction



Candidate course projects

4. Ray tracing or photon mapping render

☐ Key points:

Global illumination; Photon mapping



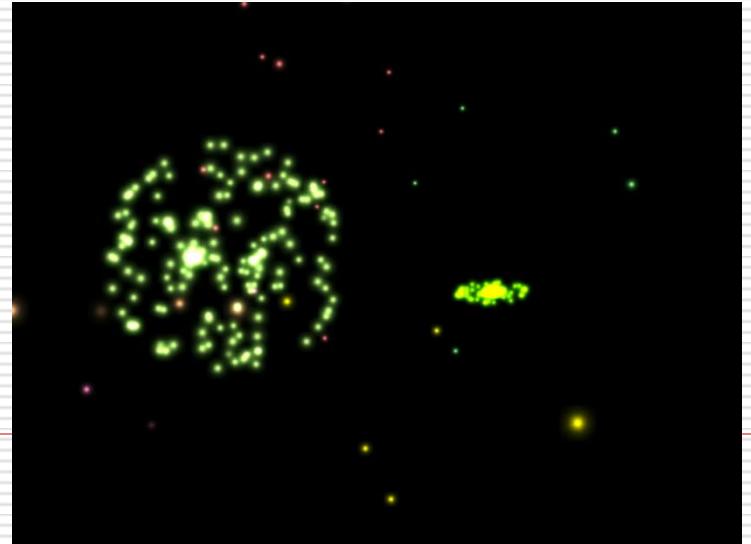
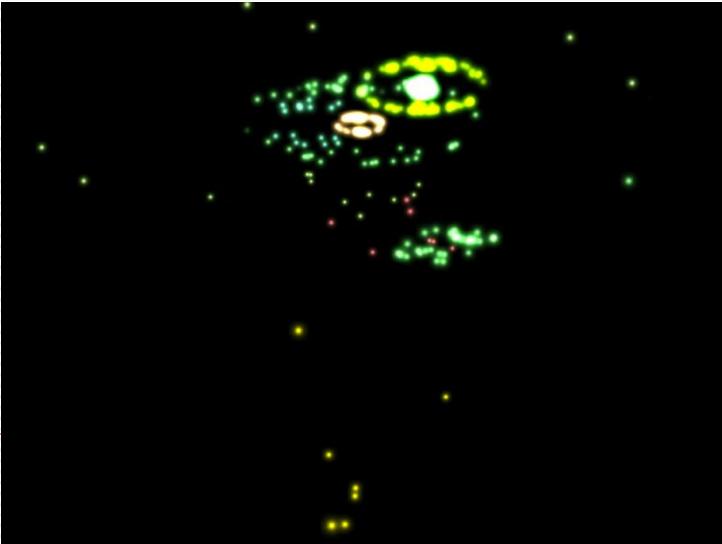
HENRIK WANN JENSEN 1996

Candidate course projects

5. Chinese firework

Key points:

Physical based modeling;
Particle system



Candidate course projects

6. Simple physics engine

Key points:

Physical based modeling;
Collision detection;
Physical law simulation



Candidate course projects

7. Game design

Key points:

Design “Asteroids” game with game engine Irrlicht

Using everything you know

<http://irrlicht.sourceforge.net>

Next lecture

- Basics of OpenGL
- How to start programing
- Coursework Week 2 assigned

Detailed document will be uploaded to learning web before lecture

- Prepare it earlier



Outline

- What is computer graphics
 - Topics
 - Grading policy
-

Fundamentals of Computer Graphics

End.

Thanks