

Graphics and Visualization

Holger Kenn

International University Bremen

Spring Semester 2006

Introduction

Colorful pictures

Course Organization

Graphics and Visualization

- ▶ Course Website:
<http://www.cubeos.org/lectures/cg-iub-spring-2006/>
- ▶ Textbook: F.S. Hill: Computer Graphics using OpenGL

What to expect:

This course is about...

- ▶ Programming CG
- ▶ CG Algorithms
- ▶ OpenGL and GLUT
- ▶ Data Structures for CG
- ▶ File Formats for CG
- ▶ Image and Video Codecs
- ▶ Applications of CG

What to expect:

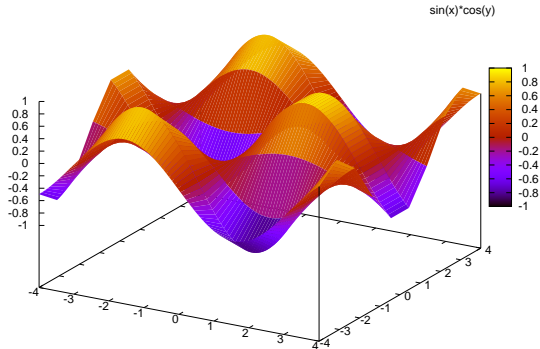
This course is not about...

- ▶ Photoshop / Corel Draw
- ▶ AutoCAD / OrCAD
- ▶ IDL
- ▶ Blender
- ▶ ripping DVDs and making divx files
- ▶ ... some knowledge can help ...
- ▶ ... and these are CG applications ...

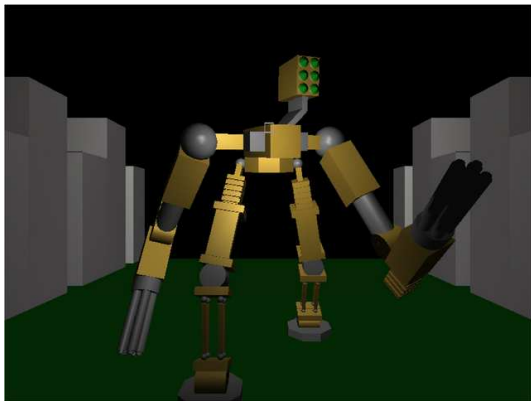
What to expect:

- ▶ Colorful pictures
- ▶ Movies
- ▶ Games
- ▶ Programming (C/C++)
- ▶ Mathematics (Matrix algebra, Trigonometry)

Computer Graphics



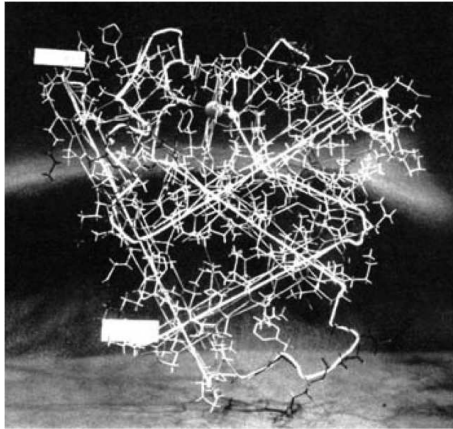
OpenGL Graphics



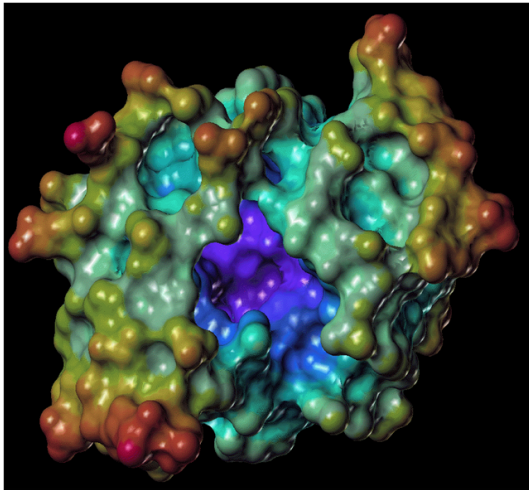
Graphics in Science



Graphics in Science



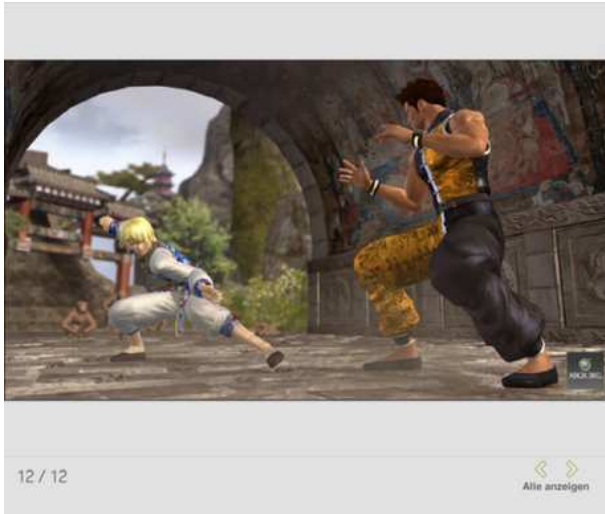
Graphics in Science



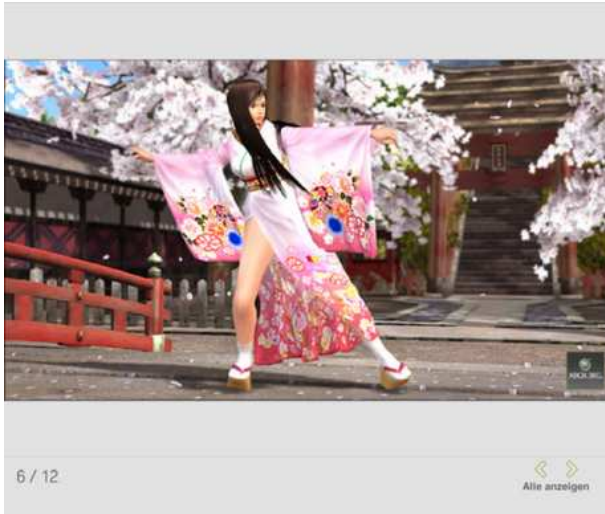
Graphics in Games



Graphics in Games



Graphics in Games



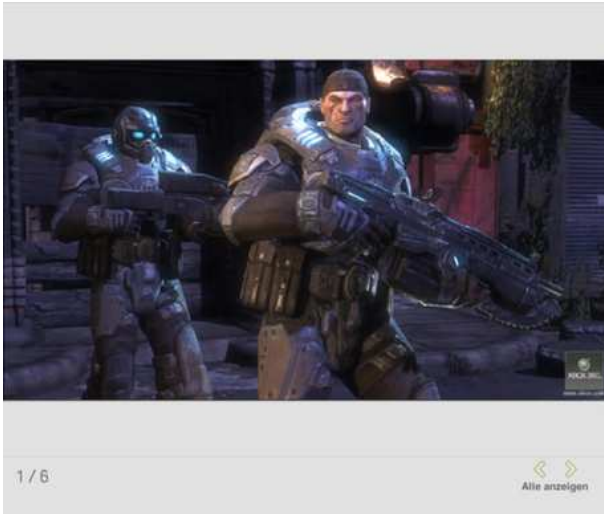
Graphics in Games



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Alle anzeigen

Graphics in Games



Graphics in Movies



Course Overview

- ▶ Pixels, Bitmaps, Aliasing, Color, Gamma Correction, Alpha Blending
- ▶ OpenGL Basics
- ▶ Interactive graphics, i.e. GLUT
- ▶ Coordinate Systems, representation, transformations
- ▶ Drawing lines, affine transformations, clipping, fractals, textures
- ▶ Drawing 3D objects, 3D affine transformations
- ▶ Surfaces, Light and Cameras
- ▶ 3D Texture mapping
- ▶ Ray Tracing, Reflection, Refraction

The Basics

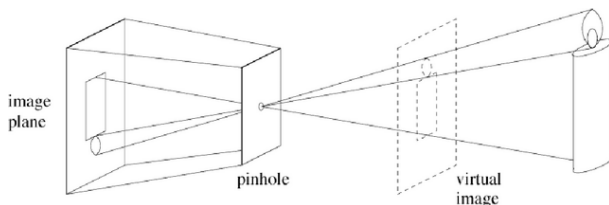
- ▶ Toy Optics:
 - ▶ Light is emitted by a light source and travels in a straight line through space
 - ▶ Light is absorbed or reflected by objects or passes through objects
 - ▶ An observer can detect light, i.e. “see” Observers are the eye or a camera.
- ▶ Holding up a photographic plate (or a CCD sensor) does not give an image.
- ▶ An optical system is needed to “see”.

Camera Obscura



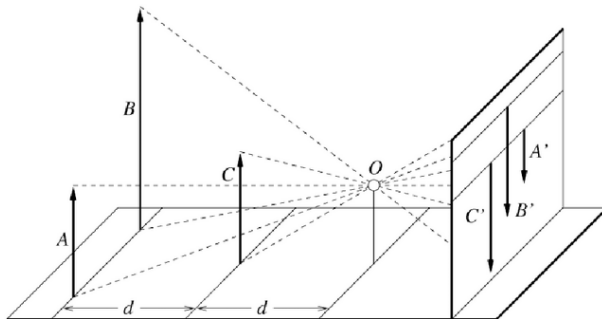
- ▶ Dark room with small hole and projection surface
- ▶ Known since 5th century BC (China)

Pinhole Camera



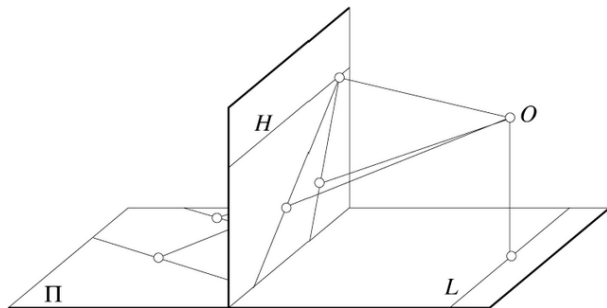
- ▶ Simple abstract camera model
- ▶ Used in many simple CG systems

Pinhole Camera



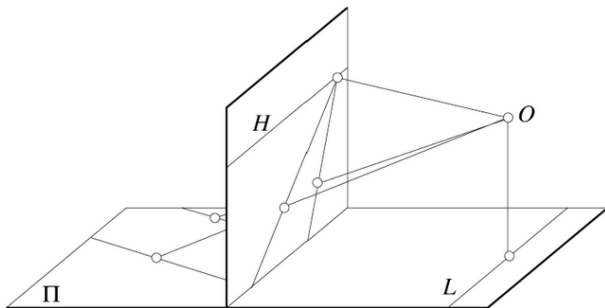
- Perspective: distant objects are smaller

Pinhole Camera



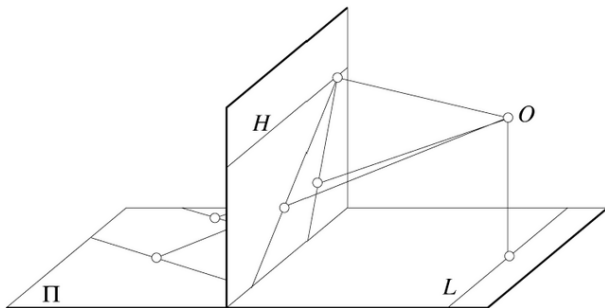
- Drawing convention: Draw focal plane “in front” of the focal point

Pinhole Camera



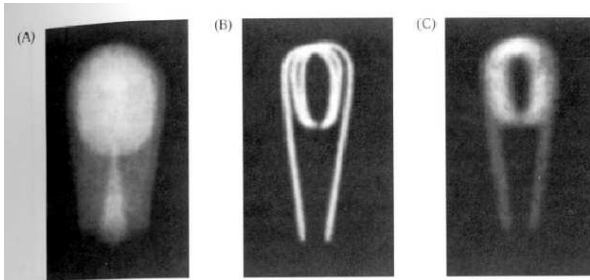
- Observation: Moving the focal plane from or towards the focal point scales the image

Pinhole Camera



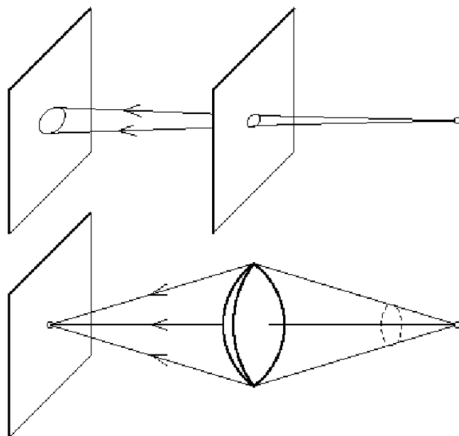
- Observation: Parallel lines in the scene meet in the image

The Real Pinhole Camera

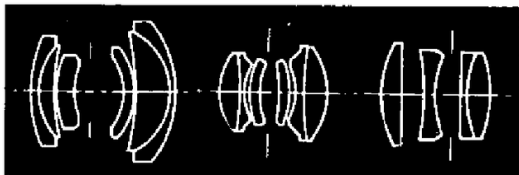


2.18 DIFFRACTION LIMITS THE QUALITY OF PINHOLE OPTICS. These three images of a bulb filament were made using pinholes with decreasing size. (A) When the pinhole is relatively large, the image rays are not properly converged, and the image is blurred. (B) Reducing the size of the pinhole improves the focus. (C) Reducing the size of the pinhole further worsens the focus, due to diffraction. From Ruechardt, 1958.

Pinhole vs. Lens



Lens Systems



- ▶ A lens system breaks the tradeoff between “sharp” images and “bright” images
- ▶ Lens systems are characterized by focal distance and aperture
- ▶ Complex lens systems are used to compensate undesirable lens effects: Pincushion and barrel distortions, Spherical and chromatic aberration, Astigmatic distortions

Camera Optics in CG

- ▶ Complexity of lens-based camera model used to be the reason to use the pinhole camera model in CG
- ▶ Pinhole optics is a simple mathematical model for perspective projection
- ▶ Some lens effects cannot be modeled. (Which?)
- ▶ Modern CG systems model lens effects to create more realistic images

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- ▶ Film: Geri's game, Pixar
- ▶ Task: Watch for lens effects

Course Organization

- ▶ Tuesday, 8.15-11 (if Robotics lecture can be moved)
- ▶ Lectures: West Hall 2
- ▶ Tutorial sessions: CLAMV teaching lab
- ▶ Prerequisites:
 - ▶ Formal: Fundamental CS 1 & 2, CS 2nd year lab course
 - ▶ Informal: C++ programming, Unix-based software engineering
- ▶ Course work:
 - ▶ Reading and understanding OpenGL documentation
 - ▶ Independent OpenGL C++ programming
- ▶ Grading: To be decided ...