

INF01009 – Computação Gráfica

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UFRGS

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What is Computer Graphics?

- Computer technology used to create, manipulate and communicate visual information
- Computer Graphics assists interactions between
 - Human → Computer (e.g., Graphics User Interface - GUI)
 - Computer → Human (e.g., Display of results of a simulation)
 - Human → Human (e.g., Discussion among designers of a new product)

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Applications of Computer Graphics

- Examples
 - Computer-Aided Design (CAD)
 - Architecture
 - Computer Animation and Special Effects
 - Medicine
 - Chemistry, Biology and Physics
 - Visualization of Simulations
 - Games
 - Art and Publishing

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Computer Aided Design (CAD)

A model aircraft engine



External



Internal



Detail

Images: Copyright Department of Mechanical Engineering, University College London (http://www.meng.ucl.ac.uk/~p_jeavons/cad.html) created using I-DEAS software from SDRC.

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Architecture

Architecture and landscape design



Image courtesy of Lightscape (<http://www.lightscape.com>)



Image courtesy of Andrea Starkley

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Architecture

Architectural Walkthroughs and daylight study



Image courtesy of Lightscape (<http://www.lightscape.com>)



Image courtesy of Michael Fowler and Leo Daly
Rendered with Lightscape

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Computer Animation

Short films



Gerl's Game: Oscar for best animated short film of 1997



For the Birds

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Computer Animation

Feature films – Toy Story



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Computer Animation

Feature films – A Bug's Life



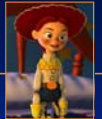
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Computer Animation

Feature films – Toy Story 2



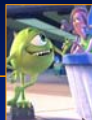
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Computer Animation

Feature films – Monsters, Inc.



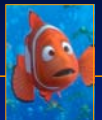
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Computer Animation

Feature films – Finding Nemo



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Special Effects

Creating effects for movies

- Spectacular and unreal effects
- Cost reduction



Independence Day (1996):
20th Century Fox - all rights reserved



Stuart Little 2 (2002):
Columbia TriStar - all rights reserved

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Medicine

Visualization of a human head

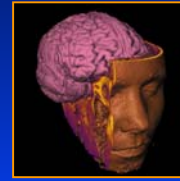


Image courtesy of Prof. Arie Kaufman, SUNY Stony Brook

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Chemistry, Biology and Physics

UNC NanoManipulator: a virtual-environment to a scanned-probe microscope that allows chemists, biologists and physicists to explore the surface of a material at nanometer scale.



Biology postdoctoral student Martin Guthold uses the nanoWorkbench to examine carbon nanotubes. Image courtesy of UNC NanoManipulator Project.
Photo by Larry Ketchum.

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Visualization of Simulations

Reentry heating effects on the shuttle orbiter

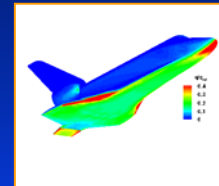


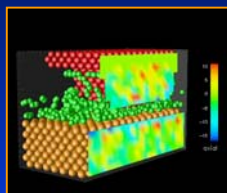
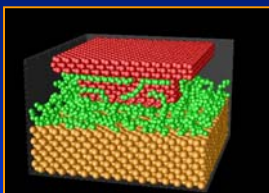
Image by Peter A. Gnoffo et al. NASA Langley Research Center

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Visualization of Simulations

Visualization of molecular motion and atomic normal stresses



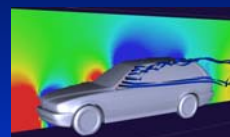
Images courtesy of Tai-His Fan

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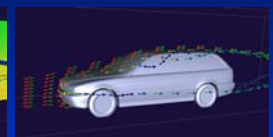
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Visualization of Simulations

Flow visualization



Cutting plane showing areas of low (blue) and high pressure (red)



The length of the arrows represent velocity. Their colors represent both pressure and total pressure in the flow

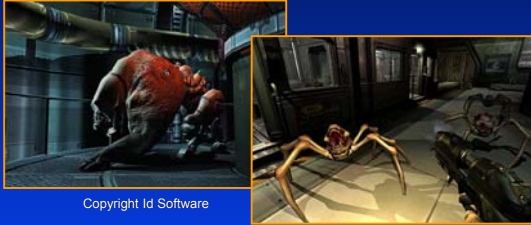
Images courtesy of the University of Stuttgart

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Games

DOOM³



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Games

Quake III Arena



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CG Interdisciplinary Nature

- **Computer Science:** Algorithms, Software Systems, Hardware
- **Mathematics:** Linear Algebra, Analytic, Projective and Differential Geometry, Calculus, Topology, ...
- **Physics:** Optics, Energy Transport, ...
- **Engineering:** Finite Element Methods, ...
- **Biology:** Human Visual System
- **Psychology:** Perception
- **Art:** Aesthetics
- **Ergonomic:** More Effective Interactions

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About Computer Graphics

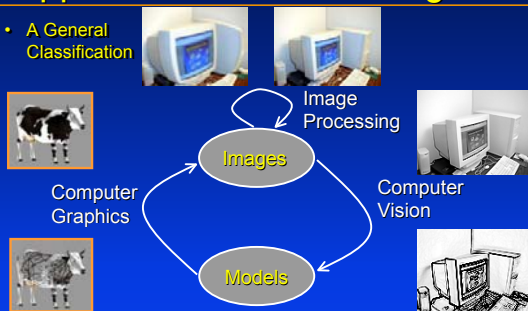
- What kinds of applications deal with images?
- Are all such applications Computer Graphics?
- If not, how can we classify these related areas?

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Applications that Use Images

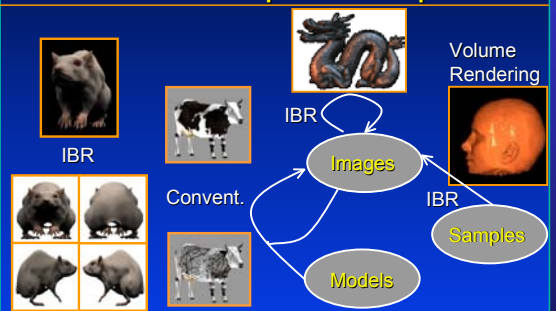
- A General Classification



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"Kinds" of Computer Graphics



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3-D Computer Graphics

We will focus primarily on image synthesis from 3-D models

Geometric model



rendering
algorithm

Picture



Courtesy of Alan Watt and Lee Cooper
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Computer Graphics Basics

- What does it take to render images from 3-D scenes?
 - Model the geometric transformations and projections
- How do we improve their realism?
 - Simulate the interaction of light with object surfaces
- But, what is an *image*?
 - $f: U \rightarrow C$, $U \subset \mathbb{R}^2$ is called the support of the image and C is its color space
 - **discrete image**: U is a uniform lattice, giving rise to a matrix representation

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Discrete Images

- Finite Representation
 - why? Is it practical to represent a continuous image?
 - finite resources (computing power, storage, etc.)
 - limitations human visual system
 - limitations of display resolution



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Interactivity x Photo-Realism

- Conflicting Goals
 - Interactivity (20 to 30 frames per second) requires simple models and fast rendering algorithms
 - Photo-realism usually requires accurate simulation of the energy transfer among the surfaces in the scene
 - The more accurate the simulation, the longer it takes, but part of it can be computed as a pre-processing, reducing rendering time
- Games need interactivity
- Movies and Still Images need rendering quality

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