Introduction to Computer Graphics

1. What is Computer Graphics?
2. How to get a picture onto the screen...
3. Applications
4. Graphics Group (GG)
5. Computer Graphics Courses

1. What is Computer Graphics?

Computer graphics (CG) is the field of visual computing, where one utilizes computers both to generate visual images synthetically and to integrate or alter visual and spatial information sampled from the real world.

[http://en.wikipedia.org/wiki/Computer_graphics]

INPUT \ OUTPUT	descriptions	images
descriptions		Computer Graphics
images	Computer Vision	Image Processing

The Evolution of Computer Graphics

- 2D Rendering
  - 2D geometry (curves, 2D objects,...), drawing algorithms

- 3D Rendering
  - 3D geometry (surfaces, 3D objects, …), lighting, view transformations, hidden surface removal, …

The Evolution of Computer Graphics (cont'd)

- Animation
  - Adding a time dimension (4D)
  - Simulation becomes part of CG

Alien song - http://www.hash.com/users/navone/HTML/MakingAlienSong.htm

- Interactive Computer Graphics
  - Animation at interactive frame rates
  - "Immersion in a virtual world"
  - Computer games, medicine, scientific visualization, ….

Crysis

The Evolution of Computer Graphics (cont'd)

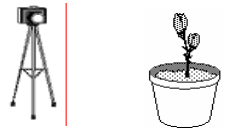
- Virtual Reality (VR)
  - "Visual immersion" → complete sensory immersion (ideally)
  - Head mounted display + haptic feedback + sound + ...

- Augmented Reality (AR)
  - enhance experience of a real environment by augmenting it with computer generated information

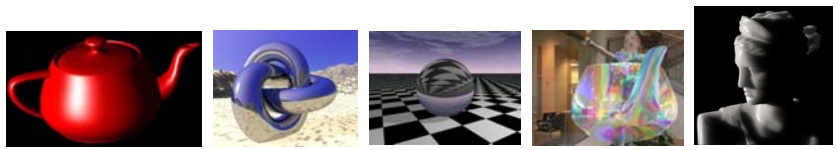
2. How to get a picture onto the screen

Elements of image formation

- Objects
- Light sources
- Viewer (camera)



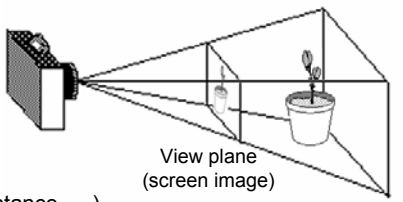
- Attributes that determine how light interacts with the scene (material parameters, atmospheric effects, …)



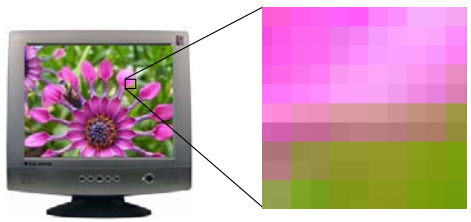
How to get a picture onto the screen (cont'd)

The Synthetic Camera Model

- View point
- View direction
- View orientation
- (projection, field of view, focal distance, …)

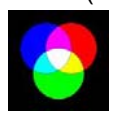


In raster graphics the screen image consists of pixels (picture elements). Hence in order to render an image we have to compute the colour of each pixel representing a part of the scene.



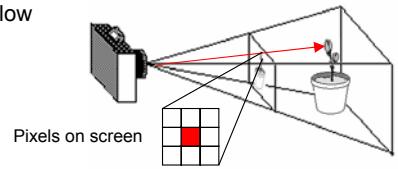
How to get a picture onto the screen (cont'd)

- Image stored as a 2D array of *pixels* in a *frame buffer* (Video RAM)
- Scanned out of frame buffer row by row, pixel by pixel
- Examples
  - CRT/LCD monitor
  - Hardcopy devices (e.g. laser printer)
- For colour monitors we usually have 24-bit colour information for each pixel (8-bit Red (R), Green (G) and Blue (B) [RGB value]).
  - (0,0,0) = Black
  - (255,255,0) = Yellow
  - (255,255,255) = White

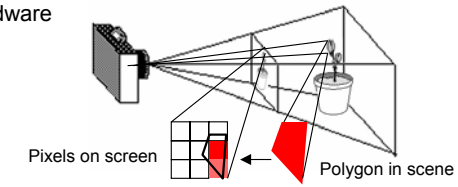


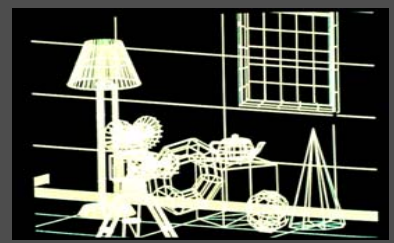
How to get a picture onto the screen (cont'd)

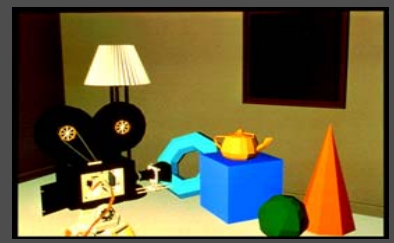
- Raytracing: Trace rays from viewpoint through pixels on the screen into the scene → high quality but slow

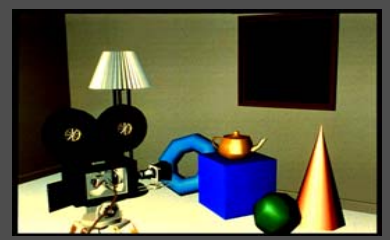


- Polygon rendering: Project polygons representing objects in the scene onto the view plane and render pixels covered by the projected objects → fast with graphics hardware



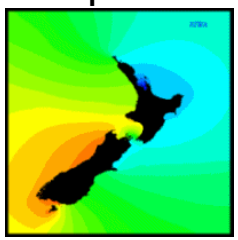






3. Applications of Computer Graphics

- Entertainment
  - Movies - CGI (Computer Generated Imagery)
  - Computer Games
- Engineering/Science/Medicine/Education
  - CAD/CAM (Computer Aided Design/Manufacturing)
  - Visualization
    - Biomedical Imaging (CT, MRI)
    - Scientific Visualisation (Biochemistry, Engineering, Education, …)
    - Information Visualisation, Algorithm Visualisation
- Architectural Design / Landscape Planning
- Advertising / Commerce
- Military / GIS

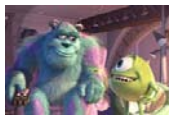


Space shuttle simulation

Surgery planning

Animation Production

- Storyboard
- Modelling **[Computer Graphics]**
  - Curves and surfaces
  - 3D Shapes
- Animation
  - Keyframing (motion capture and/or human animator)
  - Physically-based animations
- Lighting and Texturing
- Rendering
  - Preview (polygon rendering)
  - Production quality rendering (e.g. ray tracing)
- Post-Production
  - Special effects, sound, …



© Pixar Inc. – How We Do It
http://www.pixar.com/howwedoit/index.html#

4. The Graphics Group

- 1 academic staff
- 1 research programmer
- 3 PhD & 2 MSc Students
- Numerous project students

- > 60 international publications since 2000
- 4 research grants (≈75,000 NZ$) in the past three years
- > 20 student scholarships in the past five years

URL: http://www.cs.auckland.ac.nz/GG

The Graphics Group - Some Research Interests

Imaged-based Rendering

Lightfields: 4D function encoding 2D images of the model from different view points.

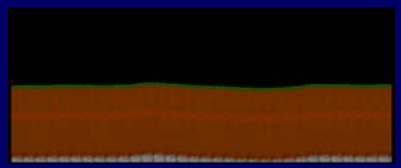
Billboard clouds: Model approximated by set of planes with texture and transparency maps.

The Graphics Group - Some Research Interests

Modelling and Animation

Physically-based modelling: Realistic behaviour obtained by implementing laws of physics.

AI techniques: Evolution of realistic behaviour (machine learning algorithms)



The Graphics Group - Some Research Interests

Interactive Rendering and Simulations

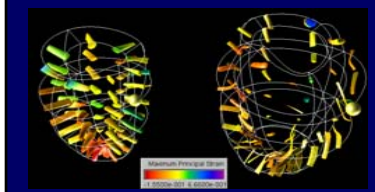
Meshless deformation

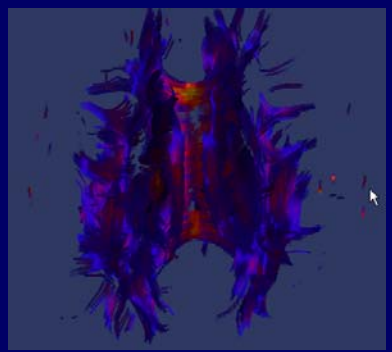
Interactive photorealistic hair modelling

Division for Biomedical Imaging and Visualization

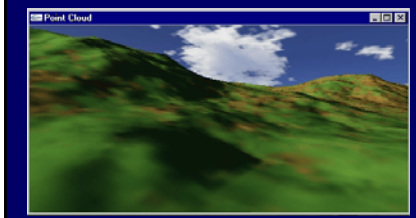
Biomedical Modelling and Visualization

Modelling and visualization of biomedical structures. Used for diagnosis, surgical planning, patient communication and education.





The Graphics Group - Collaborations



- Innes-strategy, Auckland, NZ.
- Right Hemisphere, Auckland, NZ.
- Massive Software, Auckland, NZ.
- HIT Lab NZ, Christchurch, NZ.

- Defence Technology Agency (DTA), Auckland, NZ.
- Industrial Research, Auckland, NZ.
- Bioengineering Institute, Auckland, NZ.
- VR Medical, Auckland, NZ.

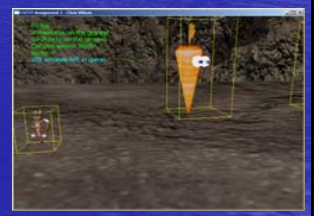
5. Computer Graphics Courses

Stage 3 Courses

- COMPSCI 372 – Computer Graphics
  - Lecture based
  - Use C/C++ programming language
  - Learn 2D/3D geometry, OpenGL, modelling and animation techniques

Stage 4 Courses

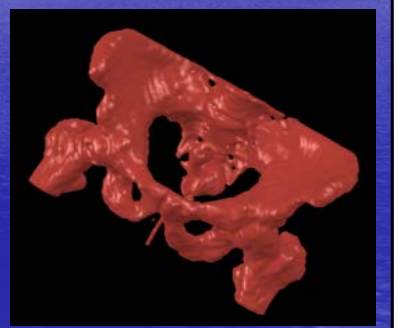
- COMPSCI 715 – Advanced Computer Graphics
  - Project based
  - Explore the latest Computer Graphics research (SIGGRAPH conference)
- COMPSCI 777 – Game Technology
  - Project based
  - Learn about the Graphics and AI techniques used for creating computer games and related software (educational software, simulation software, …).



© 2004 Christopher Wilson

Stage 4 Courses

- COMPSCI 716– Visualization
  - 8 weeks lectures, 4 weeks group project
  - Learn about techniques for scientific and biomedical visualization
  - Explore a specific problem in more detail in the group project



© 2003 COMPSCI 716 - Project Group 2 - Hexane

Thank you! ☺ … Questions?