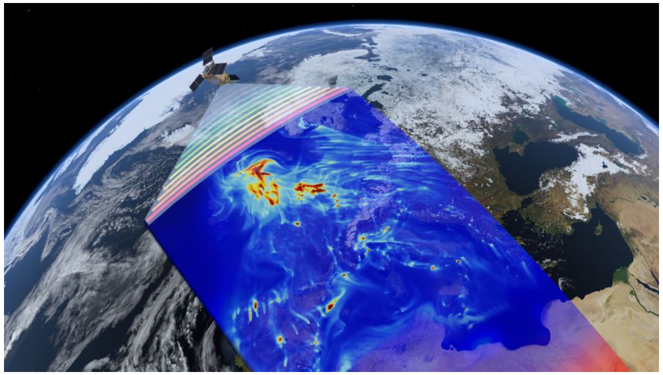
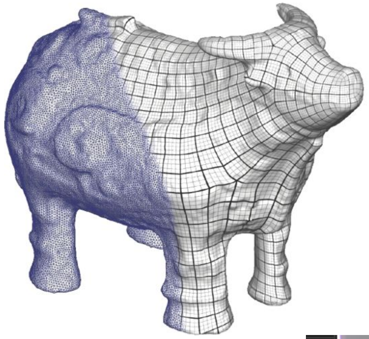
Lecture: Introduction & Administrivia

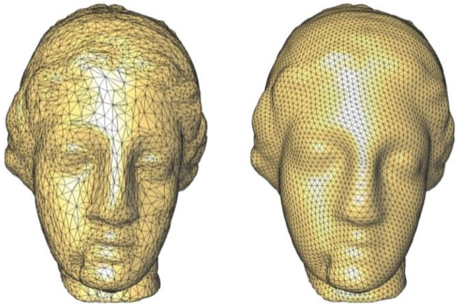
CSE606: Computer Graphics
Jaya Sreevalsan Nair, IIIT Bangalore
January 06, 2025

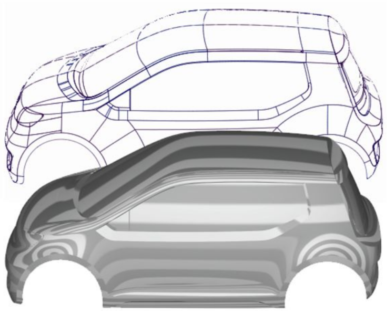
Computer Graphics and Related Areas

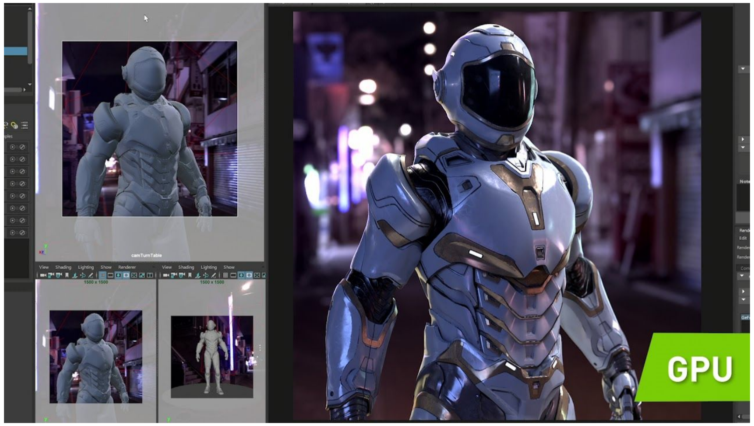
- Imaging: 2D representation
- Modeling: 3D representation
- Rendering: 2D impression of 3D world (Realism)
- Simulation/ Animation: Temporal changes in scenes











Various images from Google Images

State-of-the-Art in Graphics

Technical papers preview at ACM Siggraph

SIGGRAPH 2024
DENVER+ 28 JUL — 1 AUG
THE PREMIER CONFERENCE & EXHIBITION ON COMPUTER GRAPHICS & INTERACTIVE TECHNIQUES

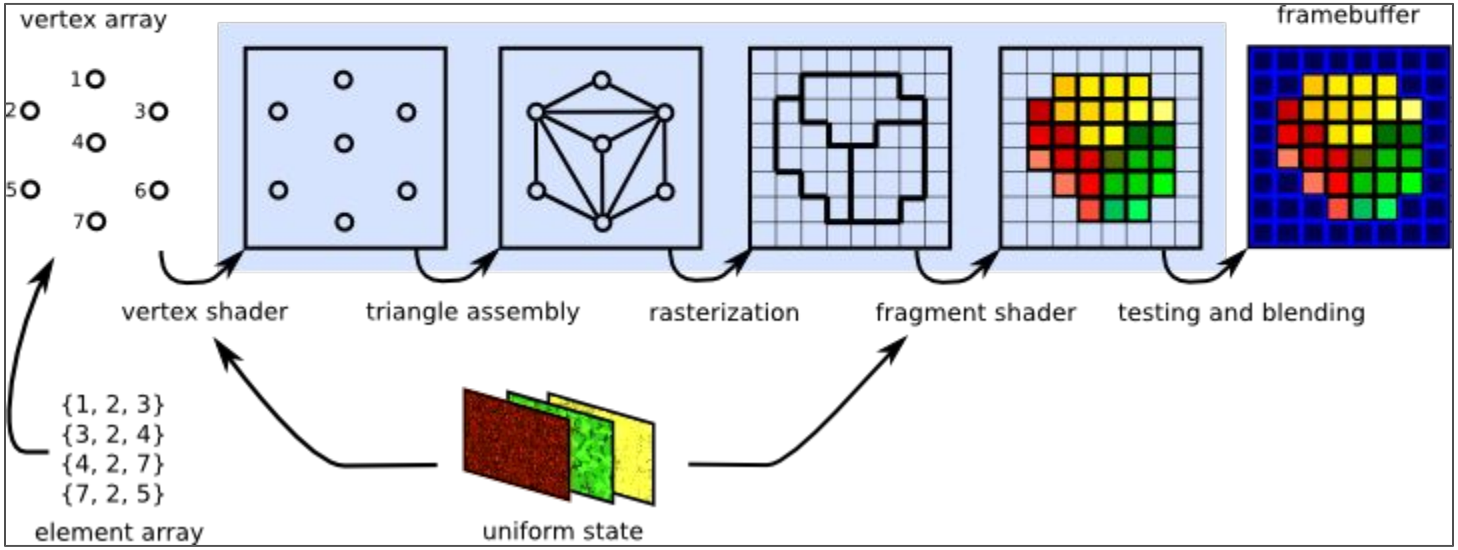
SIGGRAPH 2023
LOS ANGELES+ 6-10 AUG
TECHNICAL PAPERS TRAILER
THE PREMIER CONFERENCE & EXHIBITION ON COMPUTER GRAPHICS & INTERACTIVE TECHNIQUES

2024 2023 2022

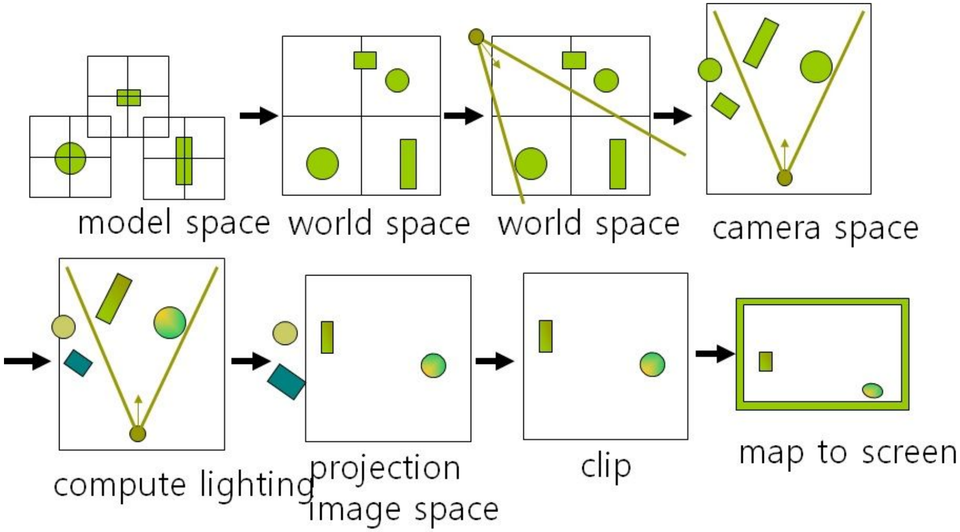
Technical papers preview at ACM Siggraph Asia

2024

What does CG entail?

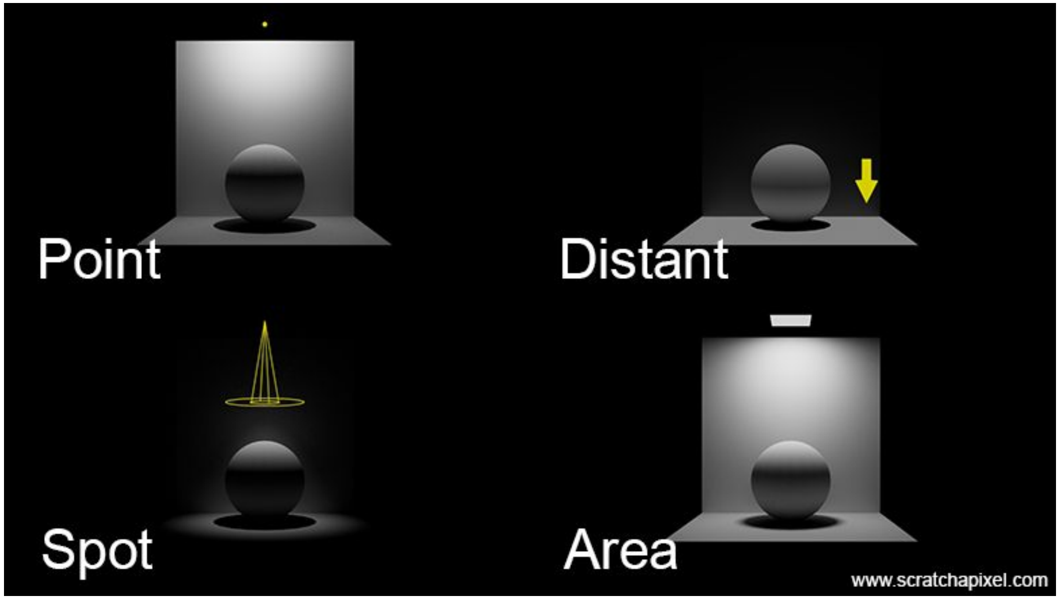


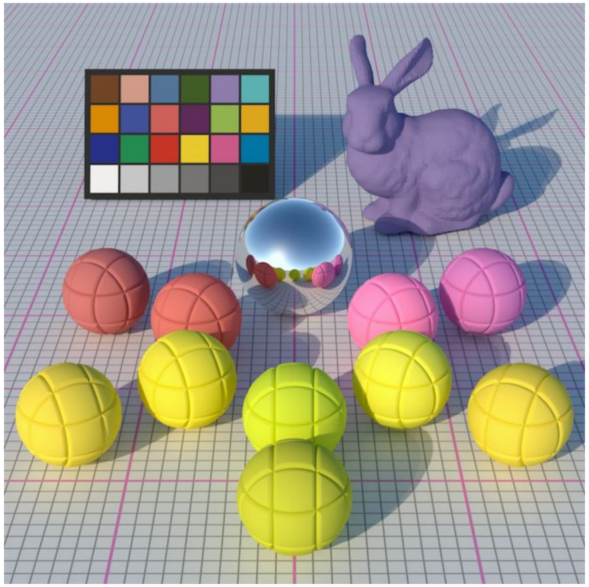
https://graphicscompendium.com/intro/01-graphics-pipeline/



https://dis.dankook.ac.kr/lectures/cg18/2018/09/25/coordinate-system/

What does CG entail?



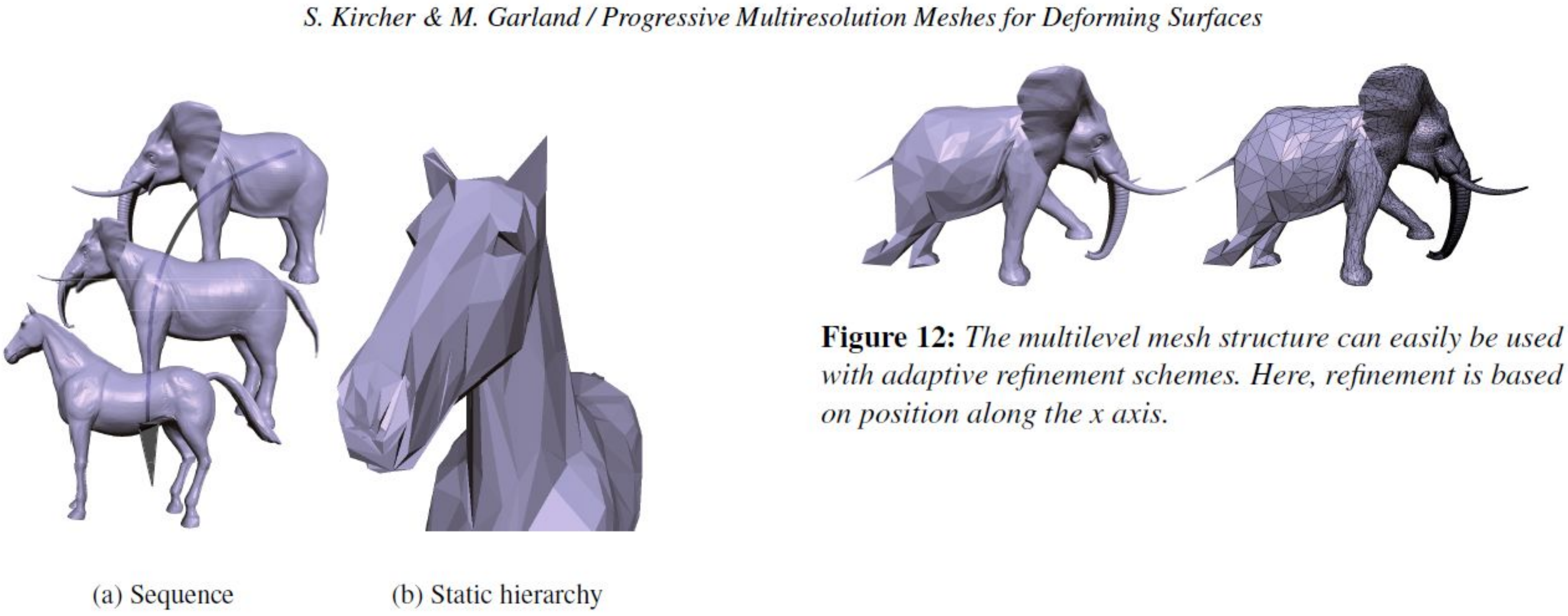


https://www.scratchapixel.com/lessons/3d-basic-rendering/introduction-to-lighting/introduction-to-lighting.html

https://cgg.mff.cuni.cz/members/wilkie/

https://jannovak.info/publications/NeRFTex/index.html

Surface Modeling Using Meshes



S. Kircher & M. Garland / Progressive Multiresolution Meshes for Deforming Surfaces

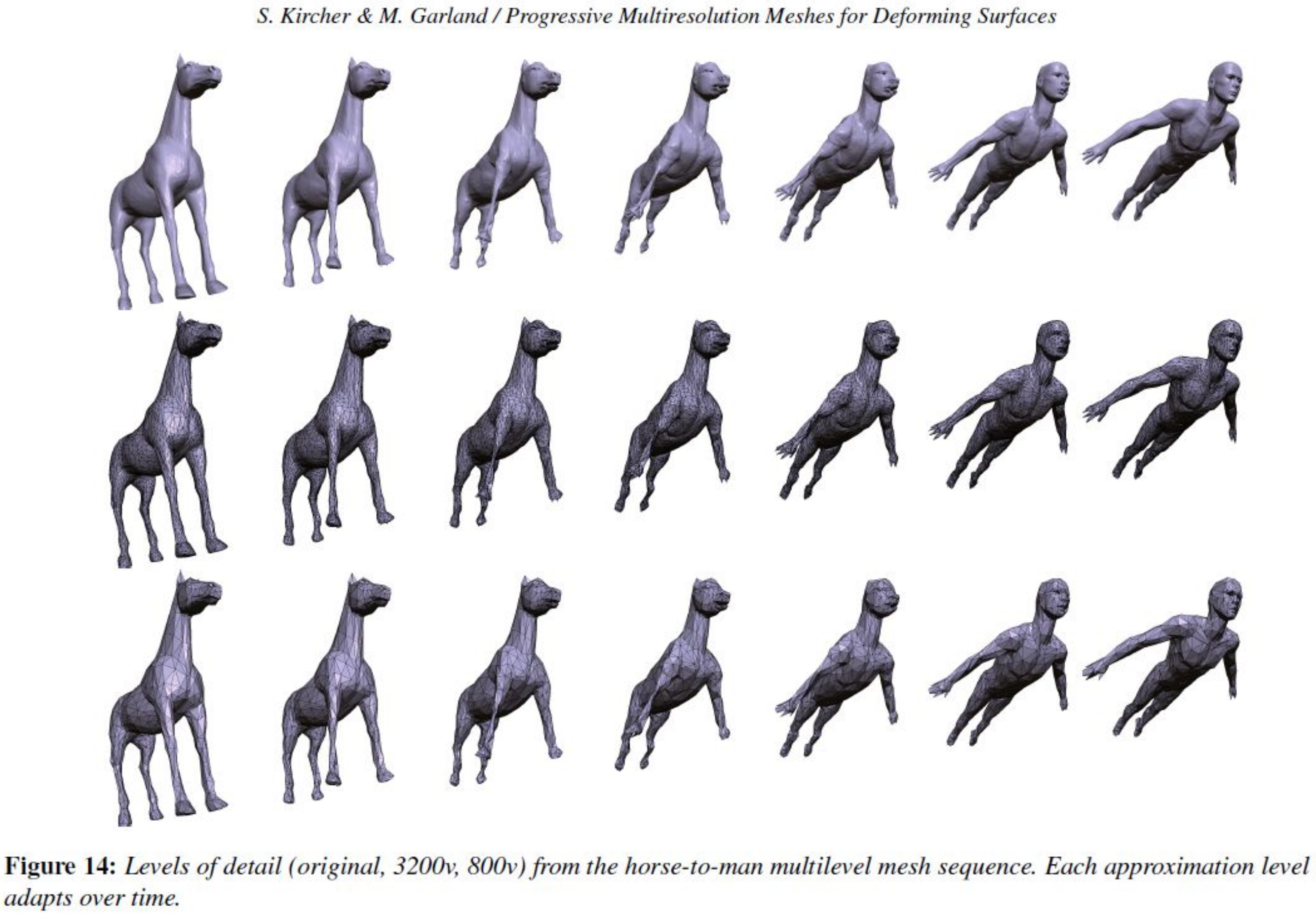
(a) Sequence

(b) Static hierarchy

Figure 12: *The multilevel mesh structure can easily be used with adaptive refinement schemes. Here, refinement is based on position along the x axis.*

Image courtesy: Kircher, Scott, and Michael Garland. "Progressive multiresolution meshes for deforming surfaces." In Proceedings of the 2005 ACM SIGGRAPH/Eurographics symposium on Computer animation, pp. 191-200. ACM, 2005.

Surface Modeling Using Meshes



S. Kircher & M. Garland / Progressive Multiresolution Meshes for Deforming Surfaces

Figure 14: *Levels of detail (original, 3200v, 800v) from the horse-to-man multilevel mesh sequence. Each approximation level adapts over time.*

Image courtesy: Kircher, Scott, and Michael Garland. “Progressive multiresolution meshes for deforming surfaces.” In Proceedings of the 2005 ACM SIGGRAPH/Eurographics symposium on Computer animation, pp. 191-200. ACM, 2005.

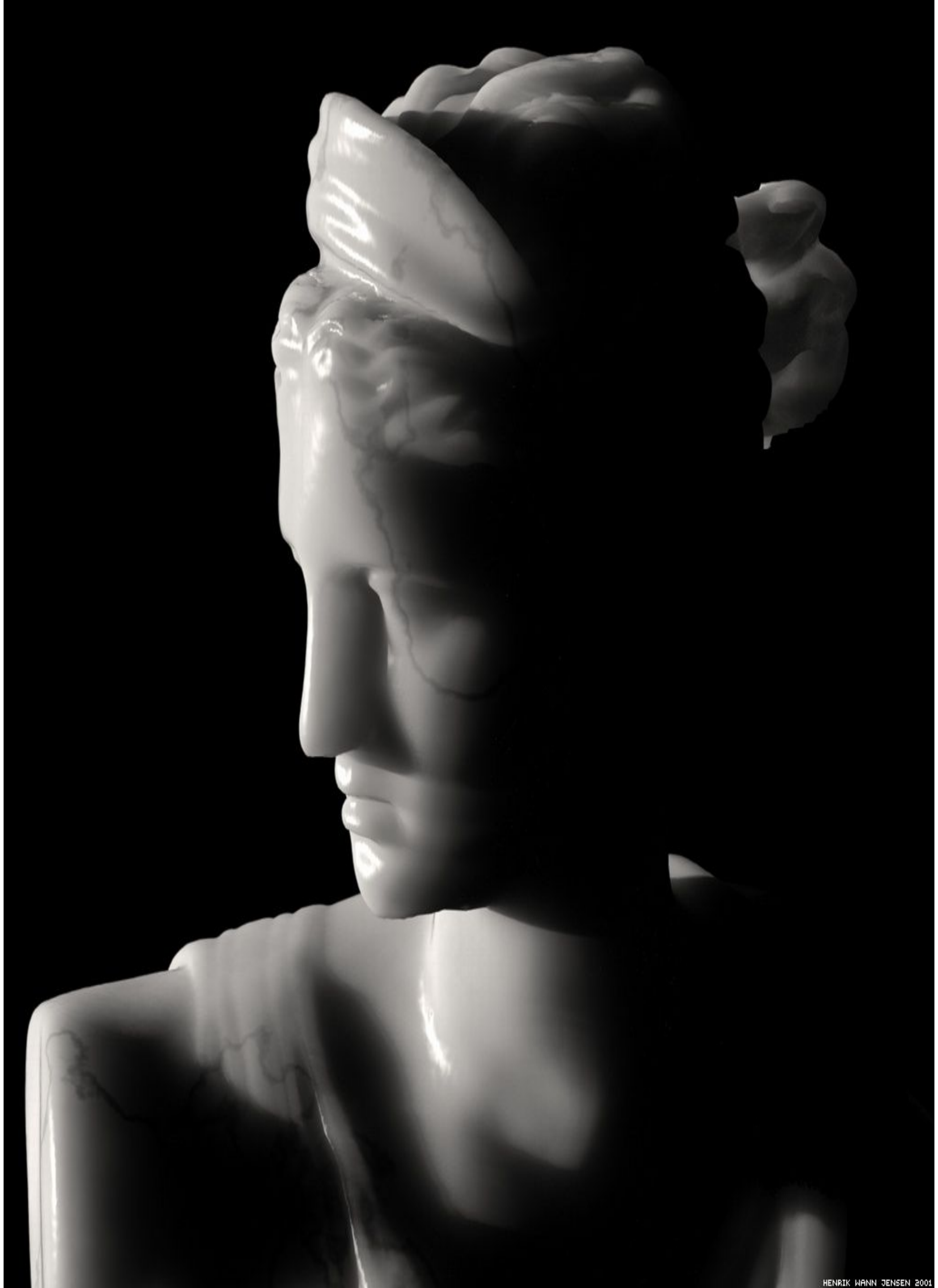
Particle System Modeling

Liquid jet simulation. (Image courtesy: TACC, UT-Austin).

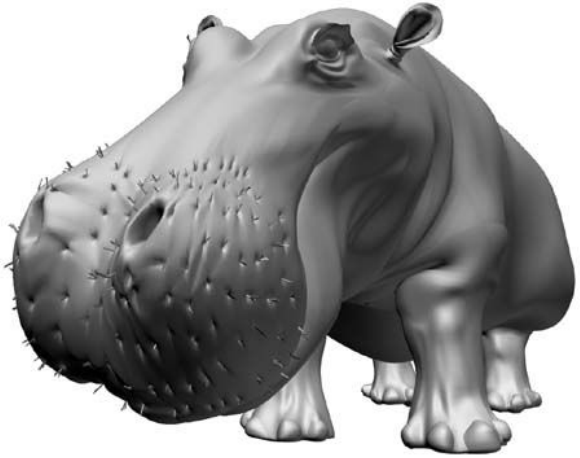
Physics-based simulation of fire. (Image courtesy: Prof. Henrik Wann Jensen, UCSD).

Rendering

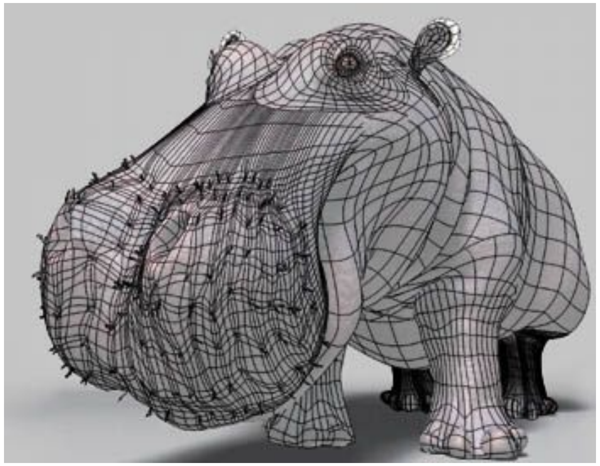
Subsurface scattering. (Image courtesy: Prof. Henrik Wann Jensen, UCSD).



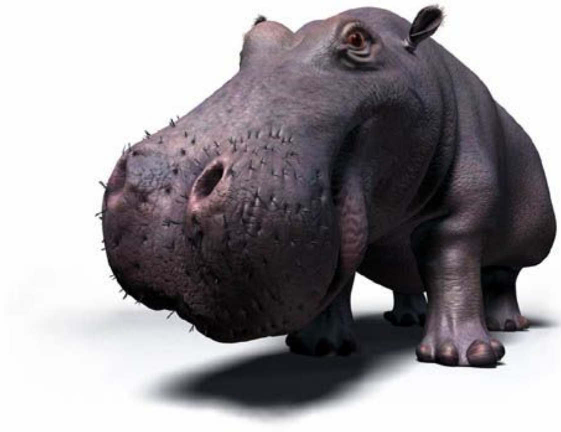
Texture Mapping



Untextured mesh - rendered



Wireframe mesh - with shadows



Textured mesh - rendered with shadows

http://www.3drender.com/jbirn/hippo/index.html
http://www.3drender.com/jbirn/hippo/hairyhipponose.html
http://www.3drender.com/jbirn/productions.html

Photorealistic Rendering Using Ray Tracing

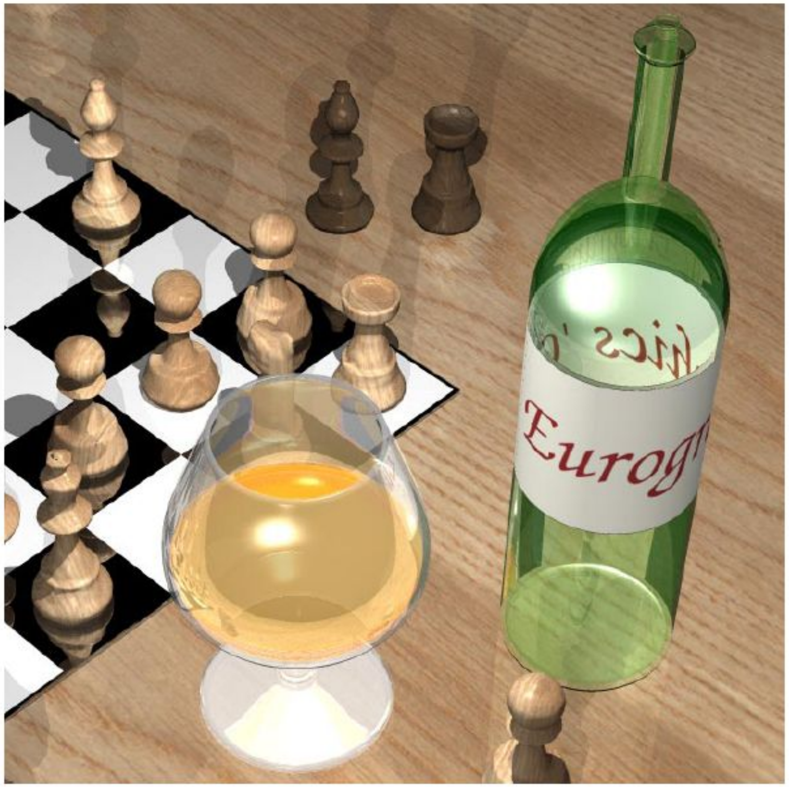


Figure 5: *Image-swept volumes in a multi-object scene.*

Image courtesy: Winter, Andrew S., and Min Chen. “Image-Swept Volumes.” In Computer Graphics Forum, vol. 21, no. 3, pp. 441-450. Blackwell Publishing, Inc, 2002.

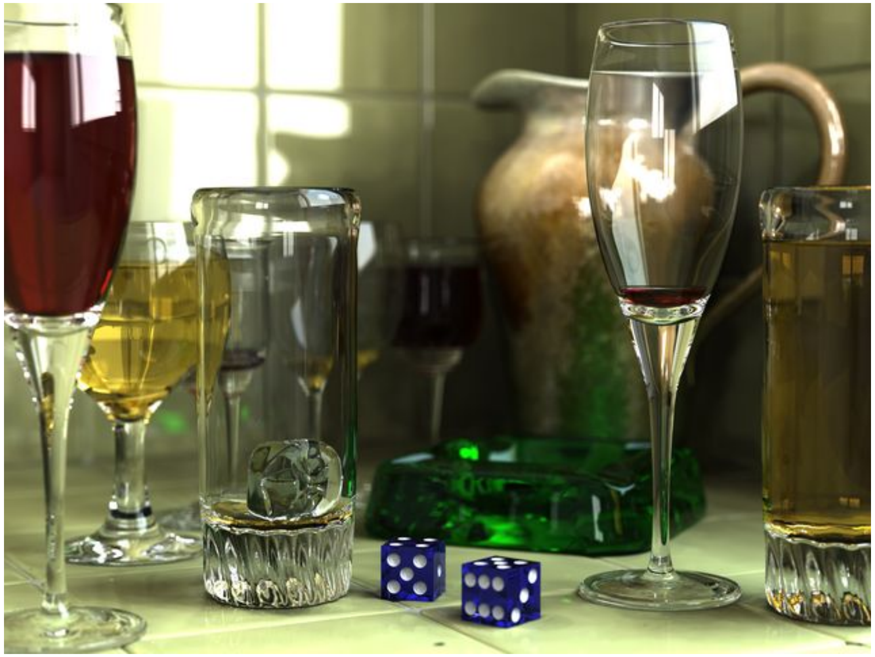
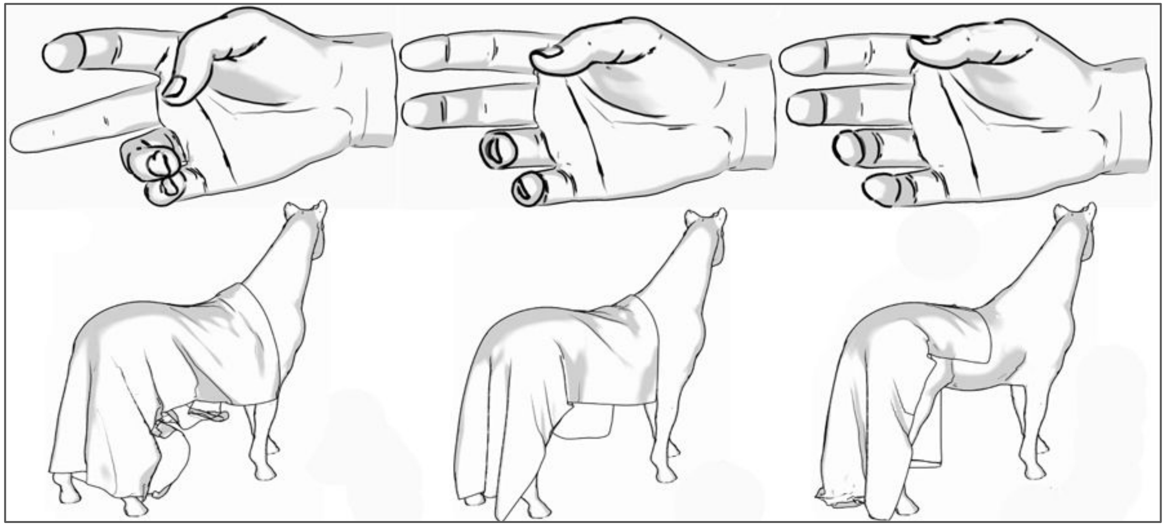
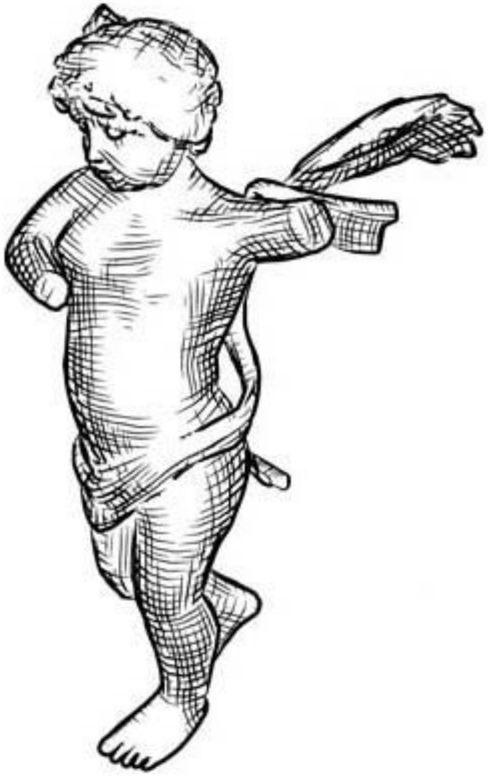


Image courtesy: Wikipedia

Non-photorealistic Rendering

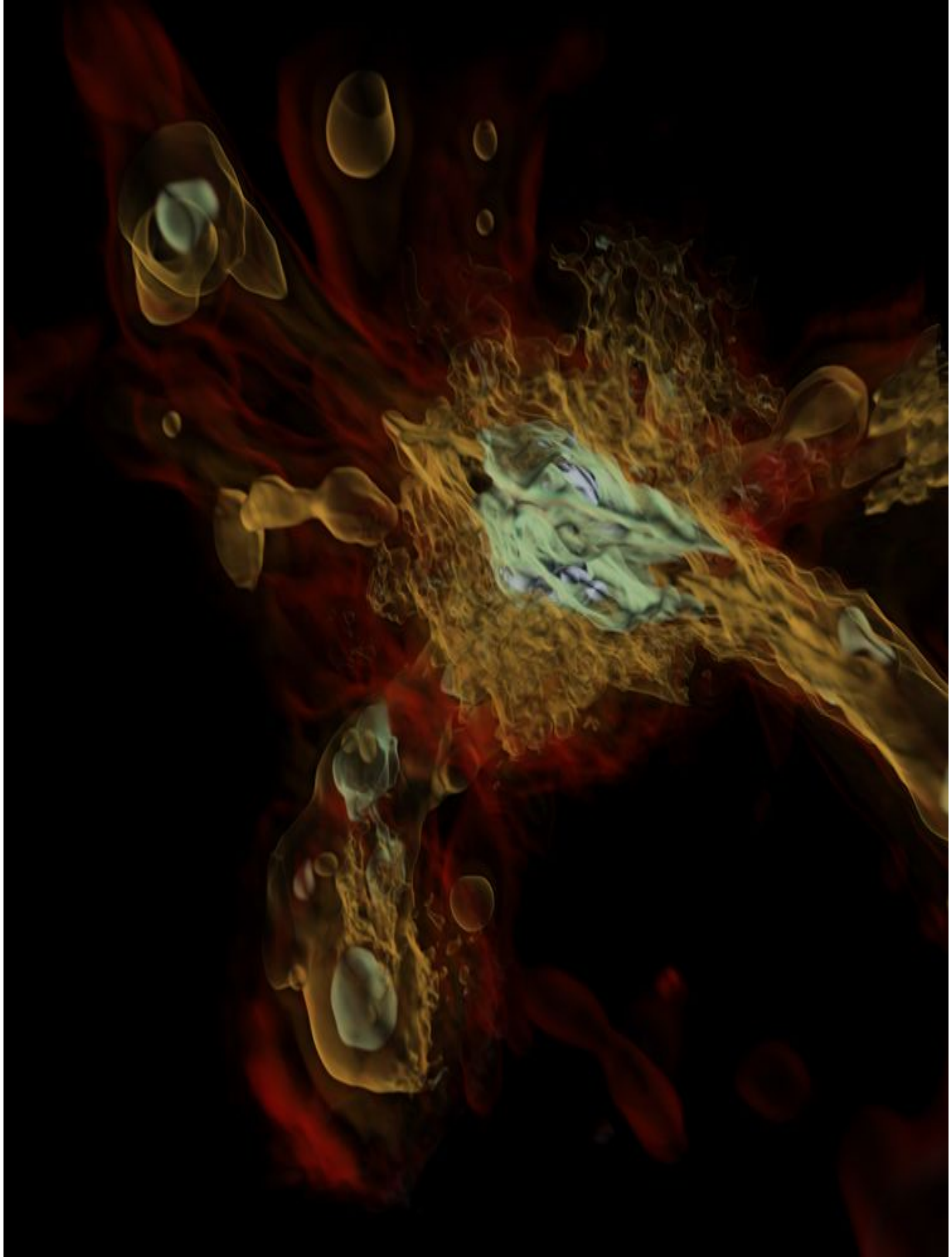


Line-drawing of animation of deformable objects.
(Image courtesy: Dr. Evangelos Kalogerakis, Stanford University).



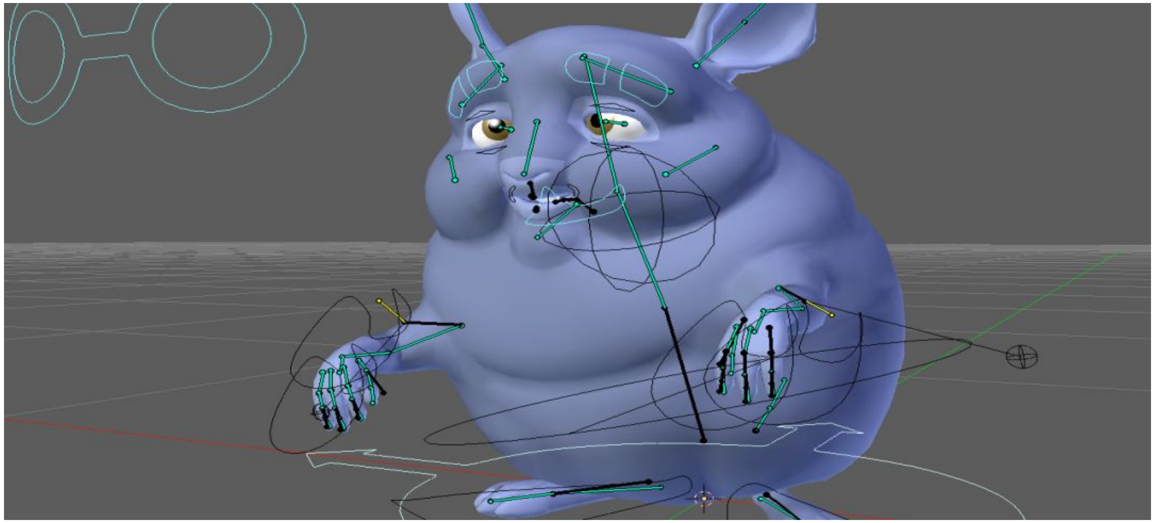
Line-art rendering of smooth surfaces. (Image courtesy: Prof. Aaron Hertzman, Univ. of Toronto).

Volume Raycasting



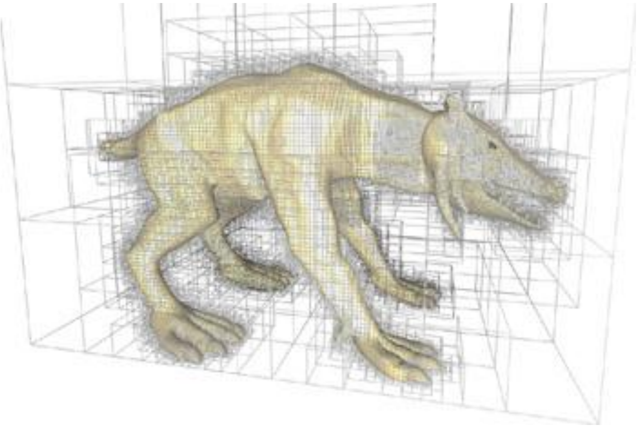
Early galaxy formation.
(Image courtesy: TACC, UT-Austin).

Animation



Animation authoring tools
(Image source: Blender.org)

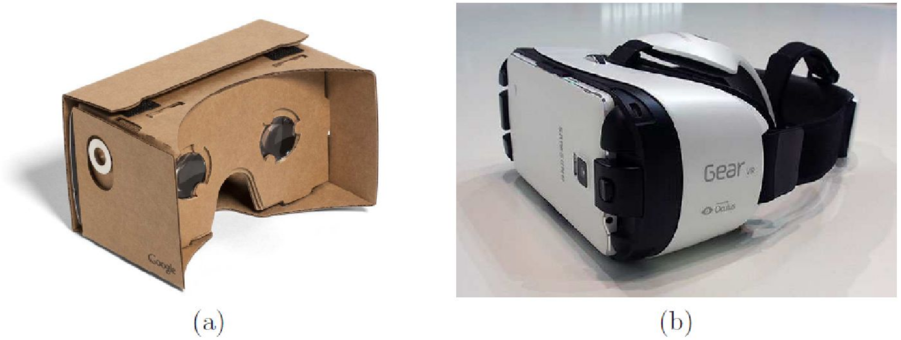
Physics-based animation
https://youtu.be/qi7eo3r4ydA?si=jTytZYioQmMm7iKG



Octree data structure for collision detection.
(Image source: Nvidia)

AR/VR Systems

VR Training simulator
(Image Source: Wikipedia, By ESA)



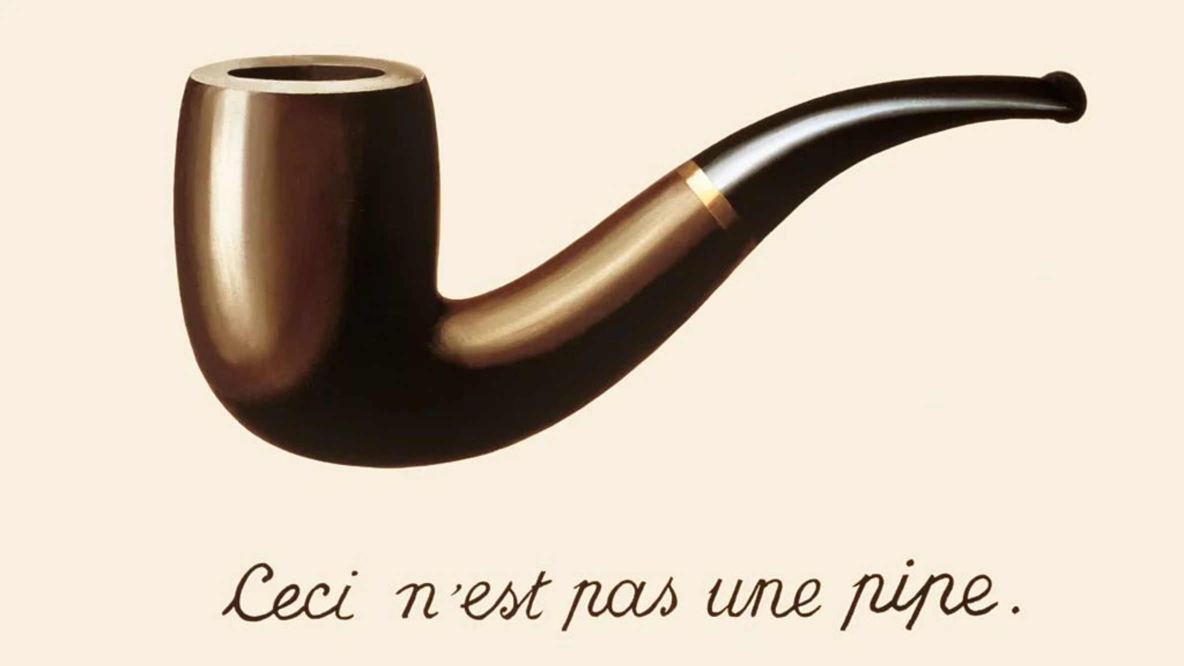
(a)

(b)

Head-mounted displays: Google Cardboard and Samsung Gear

What is after all an image?

https://www.youtube.com/watch?v=8OohzcjQRPI



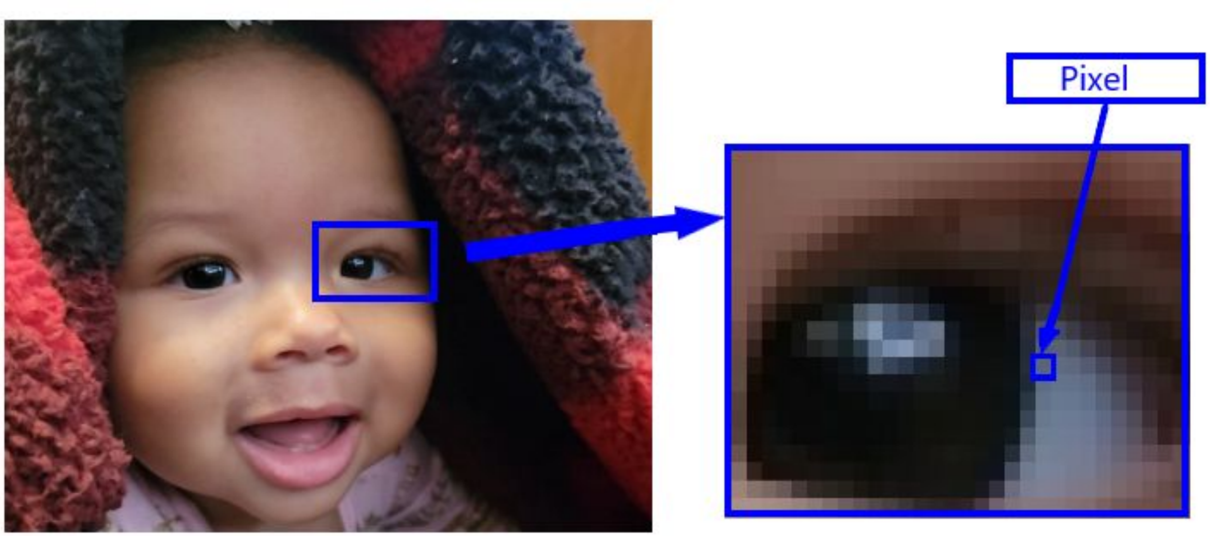
René Magritte's The Treachery of Images (This is Not a Pipe) -
A 1929 surrealist painting by Belgian painter, Magritte.

The famous pipe. How people reproached me for it! And yet, could you stuff my pipe? No, it's just a representation, is it not? So if I had written on my picture "This is a pipe", I'd have been lying!

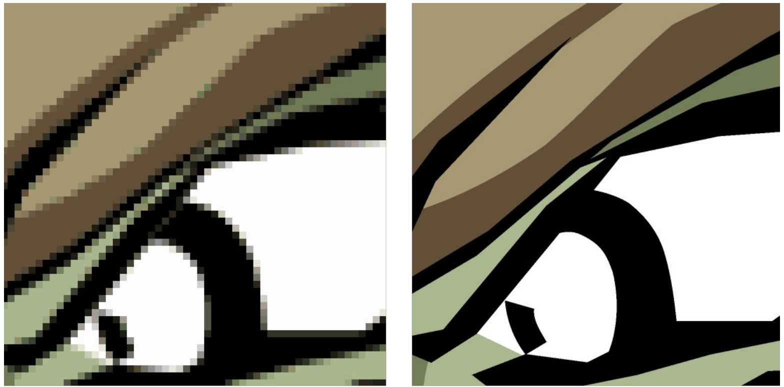
—René Magritte

https://en.wikipedia.org/wiki/The_Treachery_of_Images

What is after all an image? An array of **pixels**!

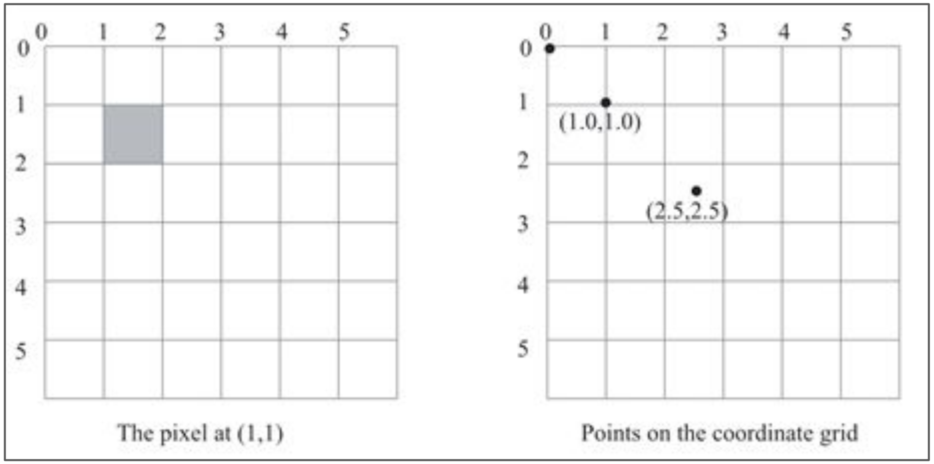


https://www.sony.com/electronics/support/articles/00342545



Raster (PNG) Vector (SVG)

https://commons.wikimedia.org/wiki/File:Orc_-_Raster_vs_Vector_comparison.png



The pixel at (1,1)

Points on the coordinate grid

https://support.cognex.com/docs/cvl_900/web/EN/cvl_users_guide/Content/Topics/Pixels_and_Coordinate_Gr.htm

Administrivia

Syllabus

H1: Introduction

- Graphics pipeline (introduction)
  - Graphics system and OpenGL architecture
  - Geometric transformations
  - Viewing
  - Lighting and shading
- Programming (introduction)
  - Introduction to WebGL
  - Rasterization and shaders
- Geometric Models

H2: Selected advanced topics

- Texture mapping
- Animation
  - Scene graphs
  - Collision algorithms
  - Hierarchies
- Graphics pipeline (advanced)
- Selected applications:
  - Virtual and Augmented Reality
- Lighting (advanced)
  - Ray tracing

References

Lecture Notes: Material mostly from below-mentioned textbooks.

- Interactive Computer Graphics: A Top-Down Approach with WebGL, Edward Angel and Dave Shreiner, seventh edition, Pearson, 2017.
    - Resources from Prof. Angel https://www.cs.unm.edu/~angel/BOOK/INTERACTIVE_COMPUTER_GRAPHICS/SEVENTH_EDITION/
- Fundamentals of Computer Graphics, Peter Shirley, Michael Ashikhmin, and Steve Marschner, A K Peters, third revised edition, 2009.

Additional textbook references:

- Donald Hearn and Pauline Baker, Computer Graphics with OpenGL (third edition), Prentice Hall, 2003.
- F. S. Hill Jr. and S. M. Kelley, Computer Graphics using OpenGL (third edition), Prentice Hall, 2006.

Programming

Environments:

- OpenGL2.0 + WebGL1.0 for assignments (pre-midterm)
  - Blender for creating a model
- Blender and WebGL for project (post-midterm)

References for OpenGL® :

- OpenGL® Programming Guide: The Official Guide to Learning
- OpenGL®, Version 2 (The OpenGL® Red Book),
- OpenGL® Architecture Review Board, Dave Shreiner, et.al., Addison-Wesley Professional, seventh edition, 2009.
- OpenGL® Shading Language (The OpenGL® Orange Book),Randi J. Rost, Bill Licea-Kane, et.al., Addison-Wesley Professional, third edition, 2009.

Resources for Programming

- WebGL code samples and tutorials: https://webglfundamentals.org/
- GLSL Tutorials by Lighthouse 3D: http://www.lighthouse3d.com/tutorials/glsl-tutorial/

Others:

- OpenGL Tutorials for v3.3 or later: http://www.opengl-tutorial.org/
- OpenGL+GLUT Tutorials by Nate Robins (older versions of OpenGL): https://user.xmission.com/~nate/tutors.html
- OpenGL Tutorials (recommended by previous batches): https://learnopengl.com/

System Requirements

WebGL/OpenGL:

- Nothing extra on a relatively new laptop
- Firefox/Chrome browsers

Blender:

- 64-bit dual core 2GHz CPU with SSE2 support
- 4 GB RAM
- 1280x768 display
- Mouse, trackpad, or pen+tablet
- Graphics card 1 GB RAM, supporting OpenGL 3.3
- **< 10 years old**

Administrivia

- TA: To be confirmed, based on final class-size.
- Grading (H1=pre-break; H2=post-break):
    - **H1: 2 programming (warm-up) assignments - A1, A2 (10% each of final grade),**
        - **A2 is announced in H1, but is due in H2**
    - **H1: Written midterm exam (20% of final grade),**
    - **H2: Group assignment (GA) with 2 parts - GA-1, GA-2 (25% of final grade)**
        - **Groups of 3**
    - **H1: 1 technical report writing assignment - RWA (10% of final grade),**
    - **H2: End-term exam (20% of final grade),**
    - **Attendance (5% of final grade).**

Administrivia

- Instructor/TA/Time/Venue:
  - MW 9:15 am - 10:45 am: Prof. Jaya Sreevalsan Nair
  - TA: Shridhar Sharma
- Programming assignments:
  - TA to provide primer for A1, and optionally, for A2
  - Submissions every 2-3 weeks
  - Evaluation of demo, code and report for A1-A2, GA.
    - By TA for A1-A2.
    - Demos could be video (pre-recorded) or live – will be informed during the course.
    - By Instructor for GA-1 and GA-2
- Technical report for RWA is based on reading an ACM Siggraph or ACM TOG paper
  - The report is a review/critique of a paper selected by the student from a list provided by the instructor/TA
  - Evaluated by TA
- **All assignment submissions only through LMS.**
  - Email submissions will not be graded