



Computer Graphics

Synthesis of static/dynamic 2D images from 3D geometry using computers

The image shows two versions of a 3D rendered human face: a wireframe model on the left and a fully shaded, realistic model on the right. A small 'W.I.P.' logo is in the bottom left corner.

Teaching Staff

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www.csl.cornell.edu/courses/cs5620

+plazza

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Grading Policy

Programming Assignments: 20% each

- Simple wireframe renderer
- Surface renderer
- Shading renderer
- OpenGL renderer
- OpenGL animator

Work in pairs !

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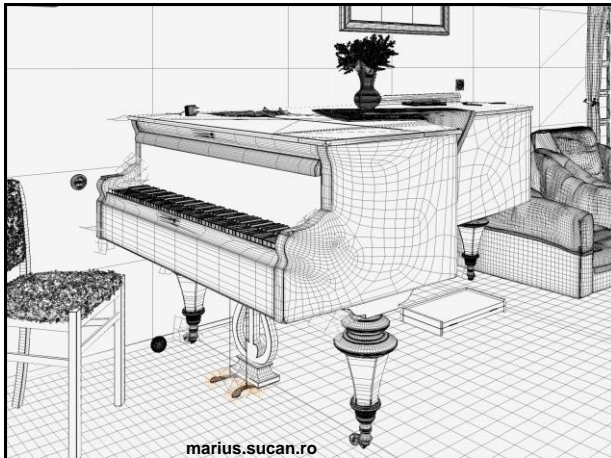
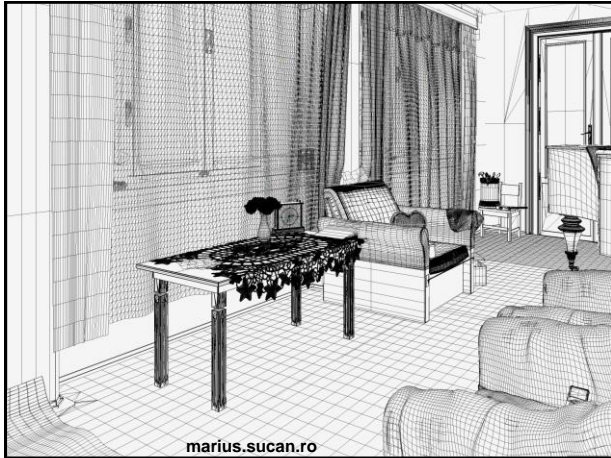
A cartoon illustration of a person with a red cap and yellow shirt sitting at a desk with a computer, looking at the screen.

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A 3D rendered scene from a game, showing a character with a sword and a character with red hair in a stone-walled environment.



Representing 3D Geometry

Explicit

$$z = f(x, y) = +\sqrt{R^2 - x^2 - y^2} \cup$$

$$z = f(x, y) = -\sqrt{R^2 - x^2 - y^2}$$

Implicit

$$x^2 + y^2 + z^2 - R^2 = 0$$

Parametric

$$(x, y, z) = (R\cos\theta\cos\psi, R\sin\theta\cos\psi, R\sin\psi)$$

$$\theta \in [0, 2\pi], \psi \in [-\frac{\pi}{2}, \frac{\pi}{2}]$$

Free-form

Polygon Mesh

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Triangle Meshes

Indexed Face Set

geometry		(x_0, y_0, z_0)
0.0	0.0	0.0, (x_1, y_1, z_1)
1.0	0.0	0.0, (x_2, y_2, z_2)
0.0	1.0	0.0, (x_3, y_3, z_3)
0.0	0.0	1.0,

connectivity		
1, 0, 2,	t_1	
3, 1, 2,	t_2	
3, 0, 1,	t_3	
3, 2, 0,	t_4	

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More Examples



Fred



Floops

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Graphics Pipeline: Input Manual Modeling



www.youtube.com/watch?v=y4wxZvg5r1

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Graphics Pipeline: Input Digitization



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Graphics Pipeline: Input Laser scanning

www.jhu.edu/digitalhammurabi/



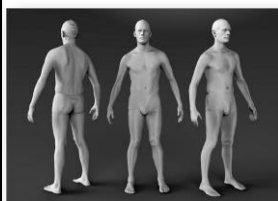
graphics.stanford.edu/projects/mich/



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www.2h3dscanning.com/

Graphics Pipeline: Input Laser scanning



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Graphics Pipeline: Input Color + depth

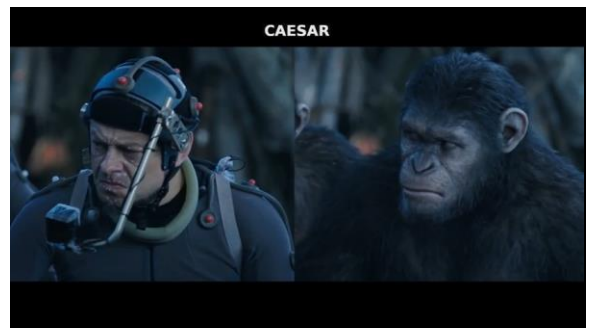


Graphics Pipeline: Input Motion Capture



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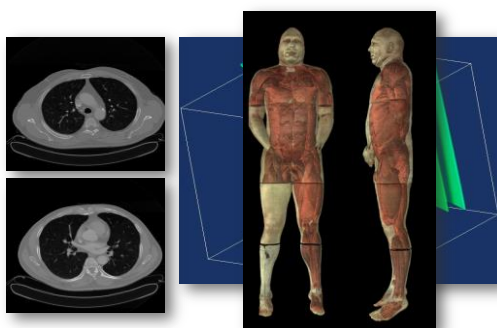
Graphics Pipeline: Input Motion Capture



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www.youtube.com/watch?v=lezfSnO9n5g

Graphics Pipeline: Input Medical Imaging



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Graphics Pipeline: Processing Rigged Animation



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www.youtube.com/watch?v=gdXR3hOyyiY

Graphics Pipeline: Output Rendering

Material Properties

- Fog
- Texture
- Reflectivity
- Refraction



Computer Graphics vs. Computer Vision

Graphics



Synthesis

Vision



Analysis

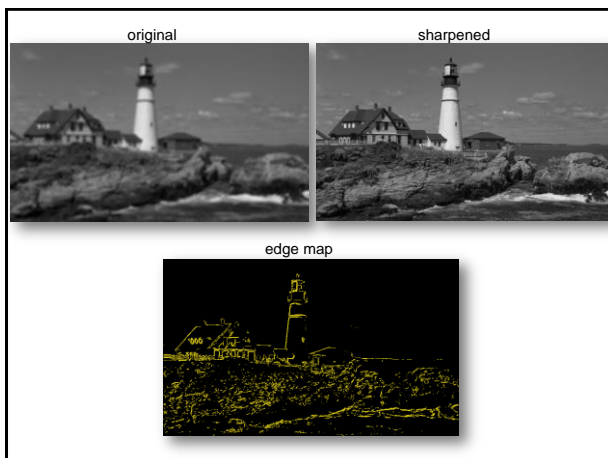
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Image Processing and Computer Vision

- Image enhancement
- Feature extraction
- Object recognition
- 3D model extraction
- Image understanding



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Applications

Computer Games



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Applications

Movies



Cartoon



Photo-real

www.youtube.com/watch?v=q_IYQdKkWsU

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Applications

Special Effects



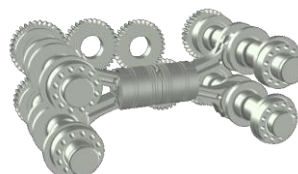
www.youtube.com/watch?v=Y9twsVqWRR8



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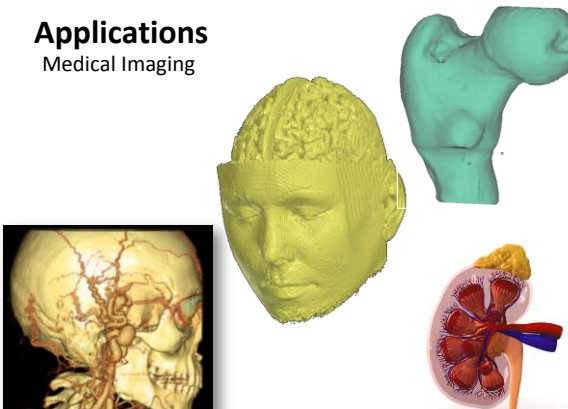
Applications

Geometric Modeling
Mechanical Design
Simulation




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Applications
Medical Imaging



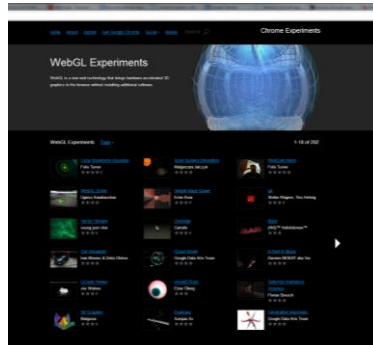
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Applications
Design
Advertising
Art
Architecture



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Online 3D Applications




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Syllabus


- Introduction
- Geometry & Transformations
- Scan Conversion
- Hidden Surface Removal
- Illumination and Shading
- Color Theory
- Geometric Modeling
- Mapping Techniques
- Animation
- Shadow Algorithms
- Ray Tracing
- OpenGL + GLSL

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Literature

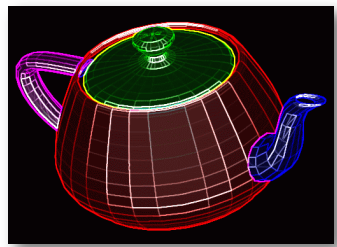
 **Interactive Computer Graphics: A Top-Down Approach with Shader-Based OpenGL**
E. Angel and D. Schreiner, Pearson, 6th Ed., 2011.

 **Fundamentals of Computer Graphics**
P. Shirley and S. Marschner, A.K. Peters, 3rd Ed., 2010.

 **OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.3 (the Red Book)**
D. Schreiner et al., Addison-Wesley, 8th Ed., 2009.

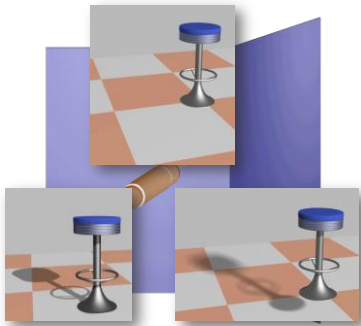
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Sample Homework
Hidden Surface Removal



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Sample Homework
Shadows



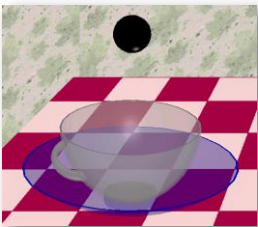
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Sample Homework
Texture Mapping



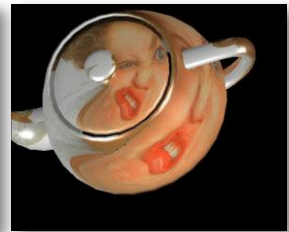
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Sample Homework
Transparency



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Sample Homework
Environment Mapping



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