CSE 3200 Computer Graphics & Image Processing Course Introduction

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University of Guyana

Outline

- Administrative Information
- Course Outline
  - General Discussion/Important Dates
- Course Structure
  - Test & Exams
  - Course Project
- What is Computer Graphics?
  - Application of Computer Graphics
- 2D & 3D Graphics
- The Graphics System
- Some key terms
- Computer Generated Videos
- Conclusion

Administrative Information

- Girendra Persaud

- Primary Email: girendra.persaud@uog.edu.gy

- Office Hours (Office: E36)
  - Wednesday 3:15 – 4:15pm
  - FRIDAY 3:15 – 4:15pm

- Mobile: 626 1032

- Course Group: FB group – "CSE3200-2018/2019"

Class & Lab Times

- Lecturer Sessions:
  - 3-4 Hours per week
    - Wednesdays (E37): 4:15 – 6:10PM
    - Fridays (E37): 4:15 - 6:10PM

- Lab Sessions
  - 1 two-hour session per week
    - Fridays (CS Lab): 5:15 – 7:10PM

Knowledge VS Wisdom

- Is Knowledge = Power?
  - Knowledge = potential power!
- Knowledge = tools
- Wisdom = knowing which tool to use
- Knowledge Gap = knowing what tool to use but you do not have it!

Course Outline

- Description:
  - This course is a third year second semester course intended for students pursuing the two year full time BSc Computer Science program. The course is designed as an introduction to computer graphics. Students will be exposed to methods and techniques to generate, manipulate, process and display raster and vector graphics.
- By the end of this course students will be able to:
  - Model concepts, perform mathematical representation of and implementation of lines, curves and surfaces
  - Describe Rendering and the rendering pipeline: projection, clipping and visible surface determination
  - Describe and Use Rasterisation and buffer management
  - Describe Graphics Hardware and use and create interactive graphics
  - Identify and Use Image processing techniques

Delivery

- Week 1
  - Course Introduction
  - Digital Images and file formats
  - Colour perception & representation

- Week 2
  - Graphics Hardware
  - Input processing
  - Graphics Architecture

- Week 3
  - Introduction to Graphics API
  - 2D & 3D Graphics Pipeline
  - Graphics Programming

Delivery cont.

- Week 4
  - Coordinate Systems
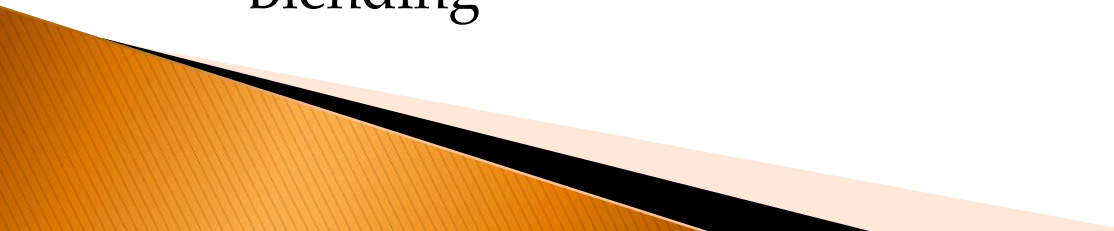 - Vectors and Matrices
  - 2D Coordinate Geometry

- Week 5
  - 3D Coordinate Geometry
  - Algorithms 1 (lines, circles and planes)
  - Algorithms 2 – curves and surfaces

- Week 6
  - Imperative and Declarative Scenes
  - Modeling-Rendering Paradigm
  - The Synthetic-Camera Model

Delivery cont.

- Week 7
  - 3D Viewing
  - Test #1 + Test #1 Review

- Week 8
  - Projections
  - Transformation
  - Visible Surface Algorithms

- Week 9
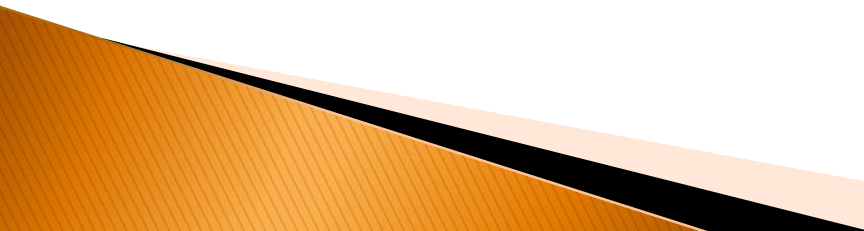 - Lighting Models
  - Shadows Techniques
  - Blending

Delivery cont.

- Week10
  - Anti-aliasing and Other Effects
  - Fog and Polygon offset
  - Texture and Bump mapping
- Week 11
  - Bitmap & Fonts
  - Event-driven Graphics
  - Interaction
- Week12
  - Animation Techniques
  - Hierarchical & Object Oriented Graphics
  - Particle Systems
- Week 13
  - Application of Computer Graphics
  - Test #2 + Revision

Evaluation

- Coursework 40%
  - Tests - X2: 10% each
  - Project/Assignment: 20%

- Final Examination 60%
  - 3 Question based on the content covered…

Recommended Readings

- OpenGL Super Bible
- Addison Wesley - OpenGL Programming Guide, 2nd Edition
- Computer Graphics with OpenGL / Hearn & Baker. ISBN: 0-13-015390-7
- Interactive computer graphics : a top down approach with OpenGL / Edward Angel. ISBN: 0-201-38597-X

Course Project/Assignment

- 3 members per group

- Group List submitted by Feb 8, 2019

Development (Project/Assignment)

- 2D/3D

- OpenGL, Maya, Blender, Cinema 4D

Are you ready?

What is Computer Graphics?

- [digital] - photographs, drawings, movies, or simulations

- The pictorial representation of image data by a computer.

- It involves:
  - Modeling
  - Colour
  - Transformation
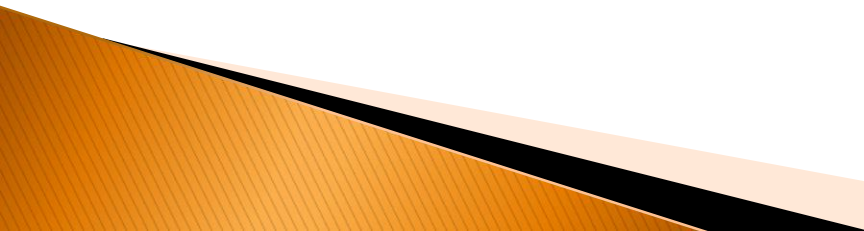 - Light
  - Texture and other effects
  - Viewing
  - Etc.

CG Imitate & Create Reality

CG Imitate & Create Reality

Application of Computer Graphics

- Information & Scientific Visualization
- Info-graphics
- Computational Biology, Physics
- Computer-Aided Design
- Virtual Reality Environment & Simulations
- Graphical User Interfaces
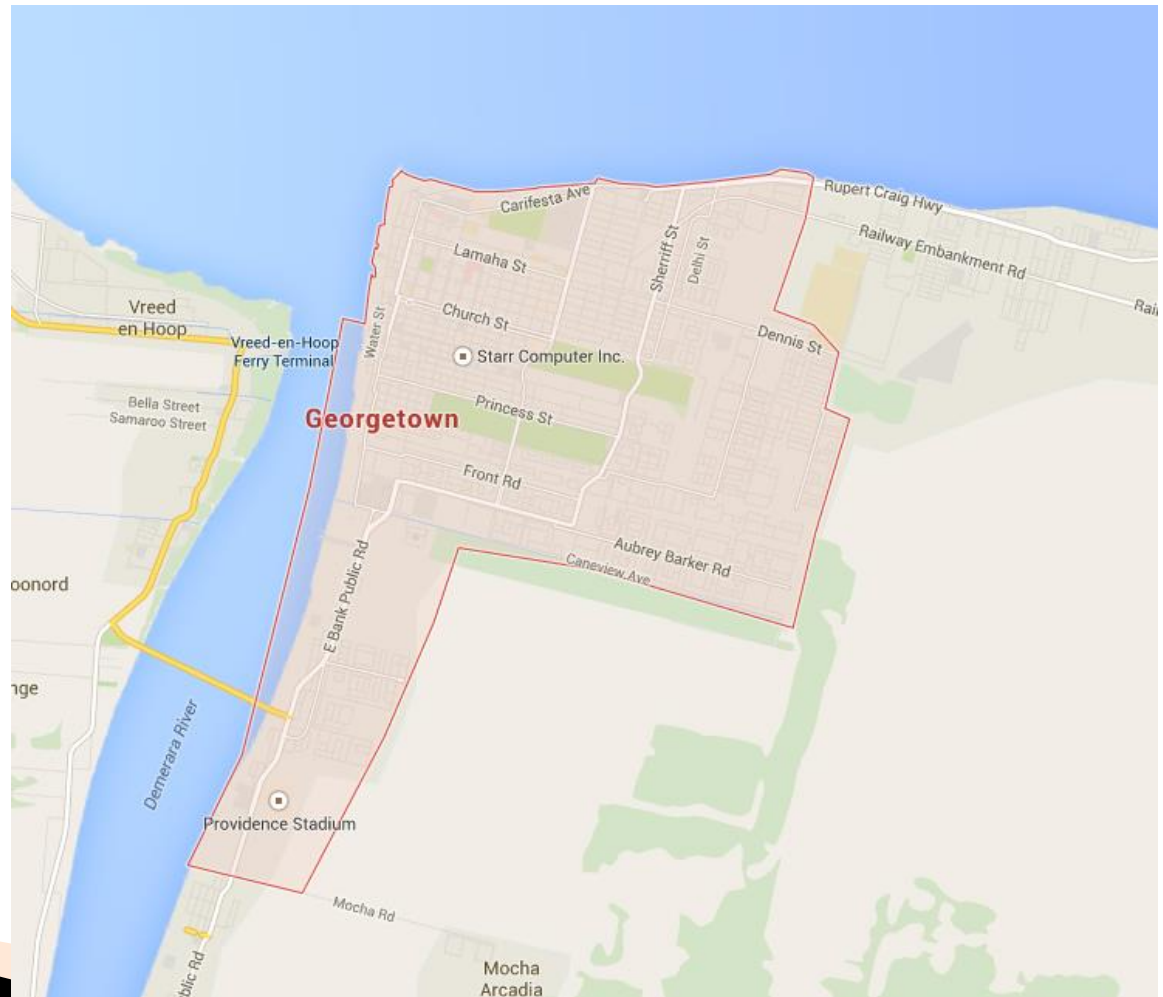- Graphics Design
- Education & Training
- Games/Entertainment

Information & Scientific Visualization
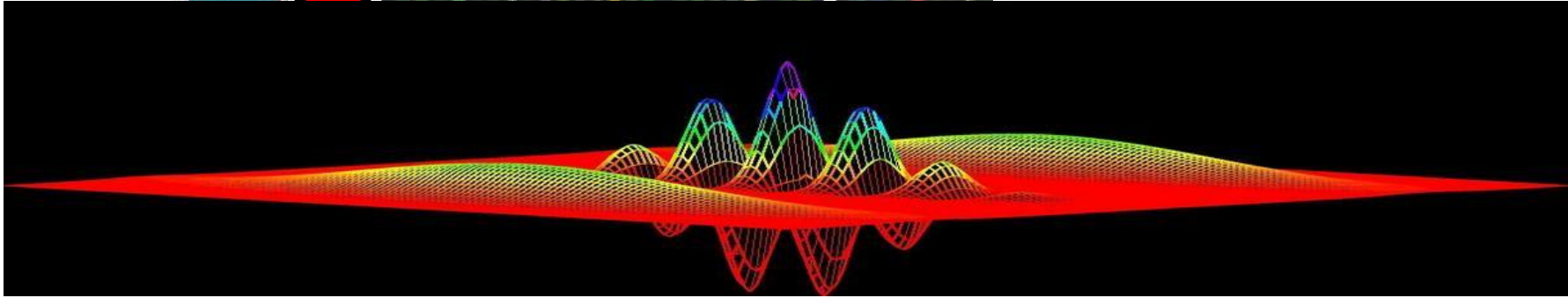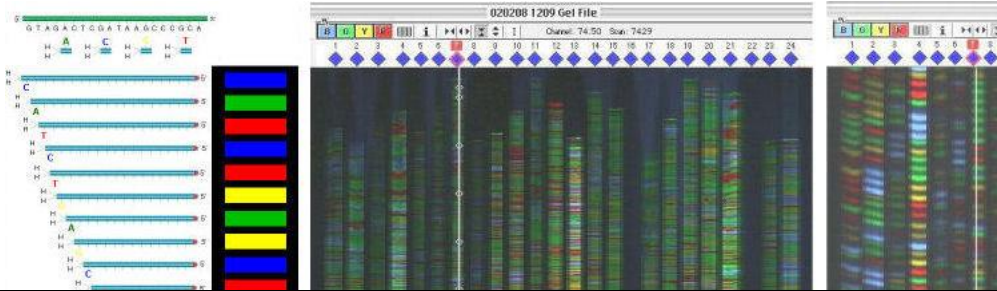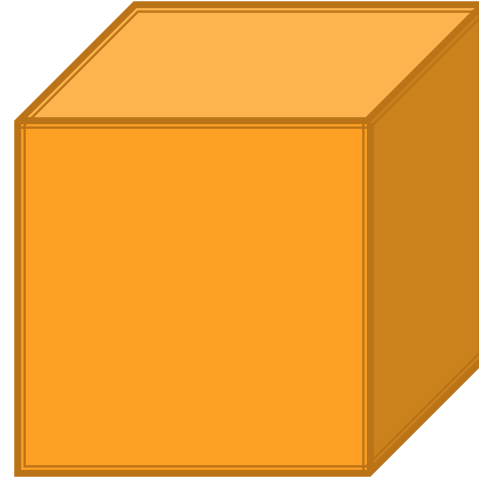
- Charts,
- Graphs
- Data Visualiza
- …
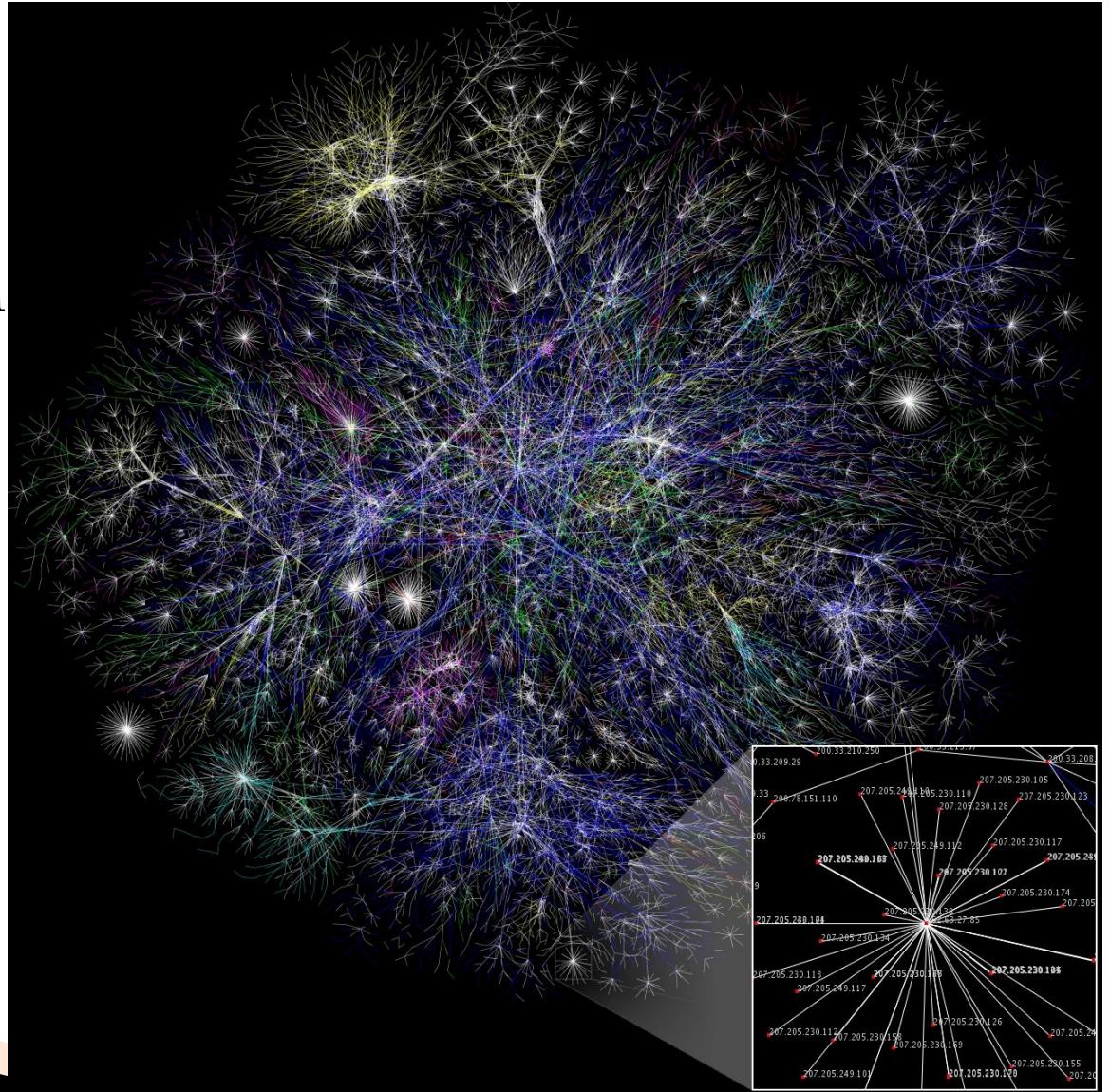
Info-graphics

- Textual displays, Maps etc…
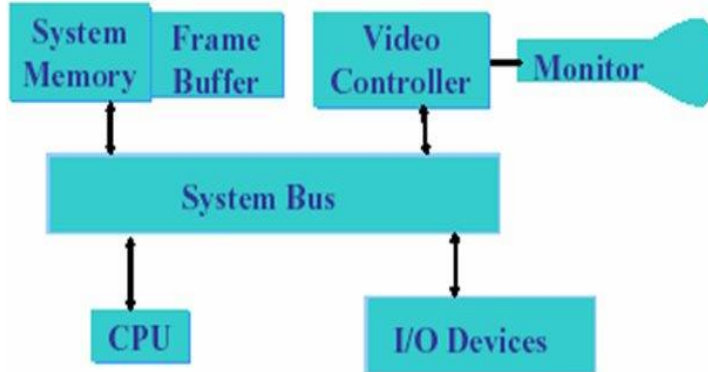
Computational Biology, Physics

2D & 3D Graphics

- What is the difference?
- 2D – width and height but no depth
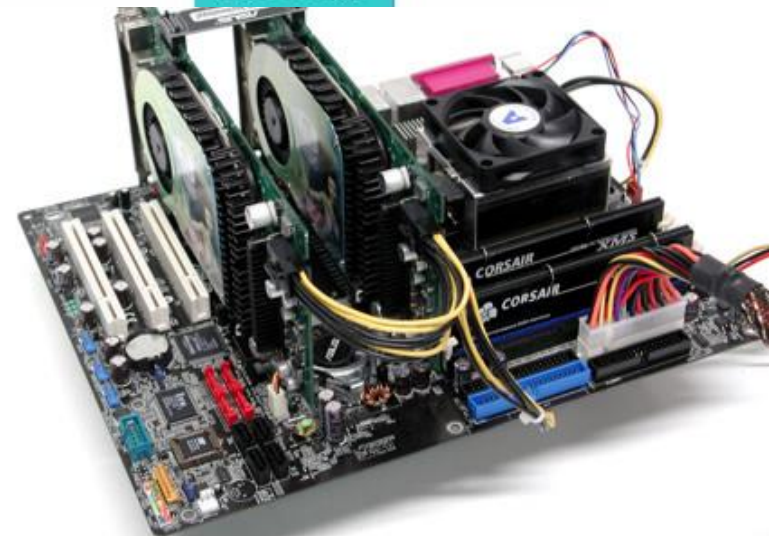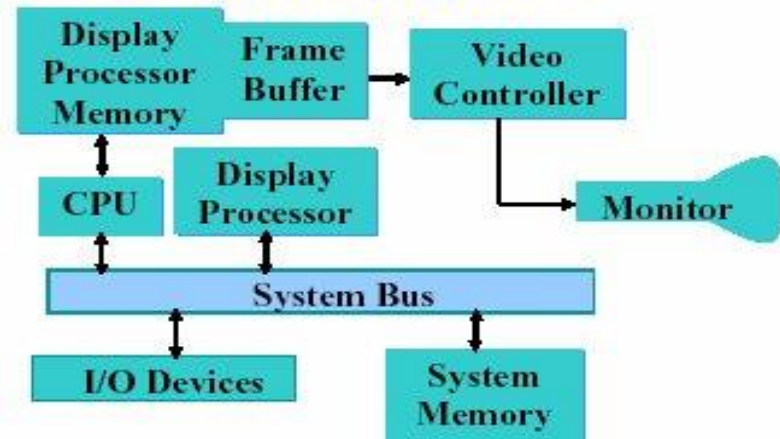- 3D - width, height and depth

The Graphics System

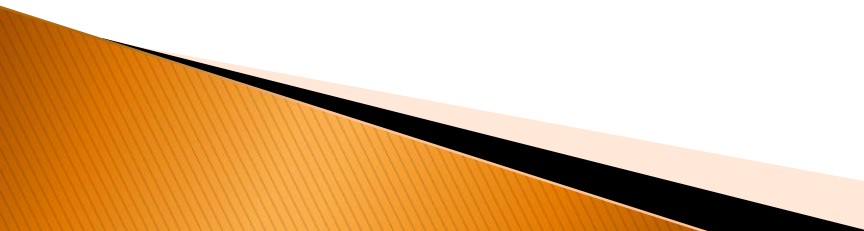- **INPUT >> PROCESSOR/MEMORY >> FRAME BUFFER >> OUTPUT**

RASTER SCAN WITH FRAME BUFFER IN SYSTEM MEMORY

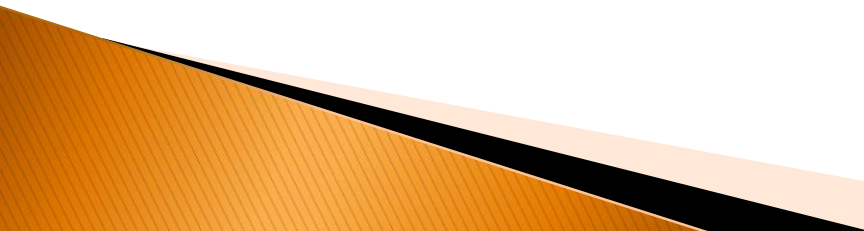Architecture of a raster-graphics system with a display processor

What is a Pixel?

- Picture element
- Parameters: color, location (x,y)
- RGB values at a specific point
- A single point in a raster image
- Sample of the original image

Rasterization

- …the process of converting geometric entities to pixels representation in the frame buffer

- Raster-based graphics refers to an array of picture elements (2d array)

Rendering

- the process of generating an image from a model
- The term may be by analogious with an "artist's rendering" of a scene.
- 'Rendering' is also used to describe the process of calculating effects to produce final output – lighting, atmospheric etc.

CG API

- Application programming interface
- A Graphics API example Direct3D, Renderman, OpenGL
- An interface that allows you to control output, input and processing in a graphics system

GPU

- graphics processing unit
- similar in function to the CPU
- The **difference between** a CPU and GPU is vast, with a GPU only working with the calculations required for graphics and video
- two main manufacturers of graphics and video cards and GPU's, Nvidia and ATI (now AMD).

Model

- The model is a description of three dimensional objects in a strictly defined language
- Model contains g texture and light
- An object that is defined

```
GLfloat cube_vertices[] = {
    // front
    -1.0, -1.0,  1.0,
     1.0, -1.0,  1.0,
     1.0,  1.0,  1.0,
    -1.0,  1.0,  1.0,
    // back
    -1.0, -1.0, -1.0,
     1.0, -1.0, -1.0,
     1.0,  1.0, -1.0,
    -1.0,  1.0, -1.0,
};
```
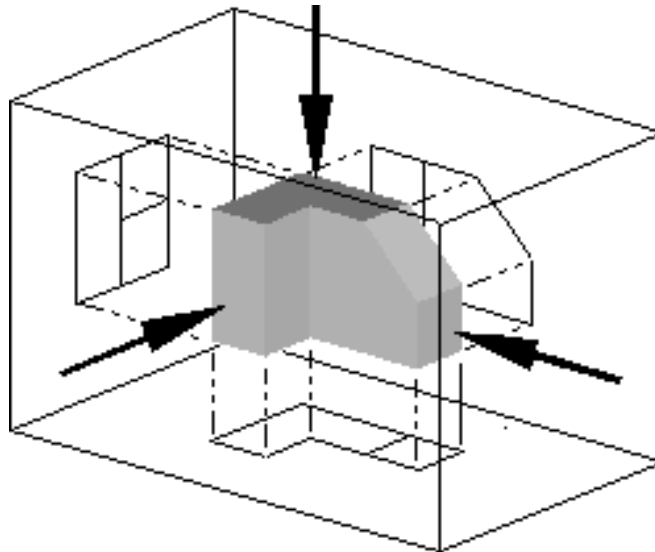
3D Modeling

▸ 3D modeling is the process of developing a mathematical, wireframe representation of any three-dimensional object, called a "3D model", via specialized software (Angel & Shreiner , 2014).
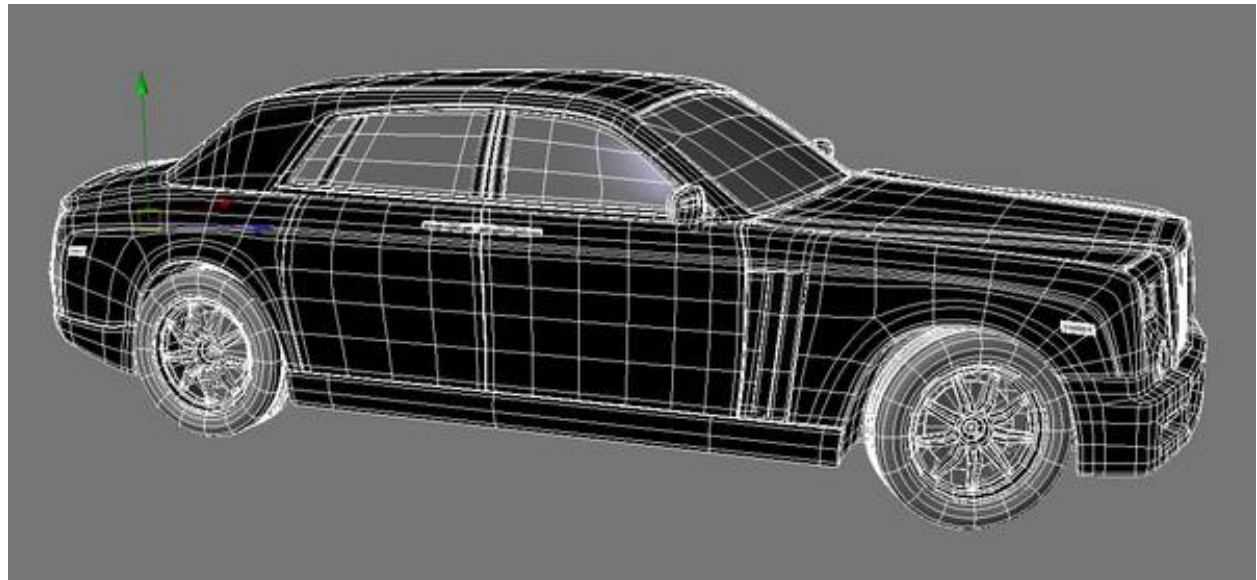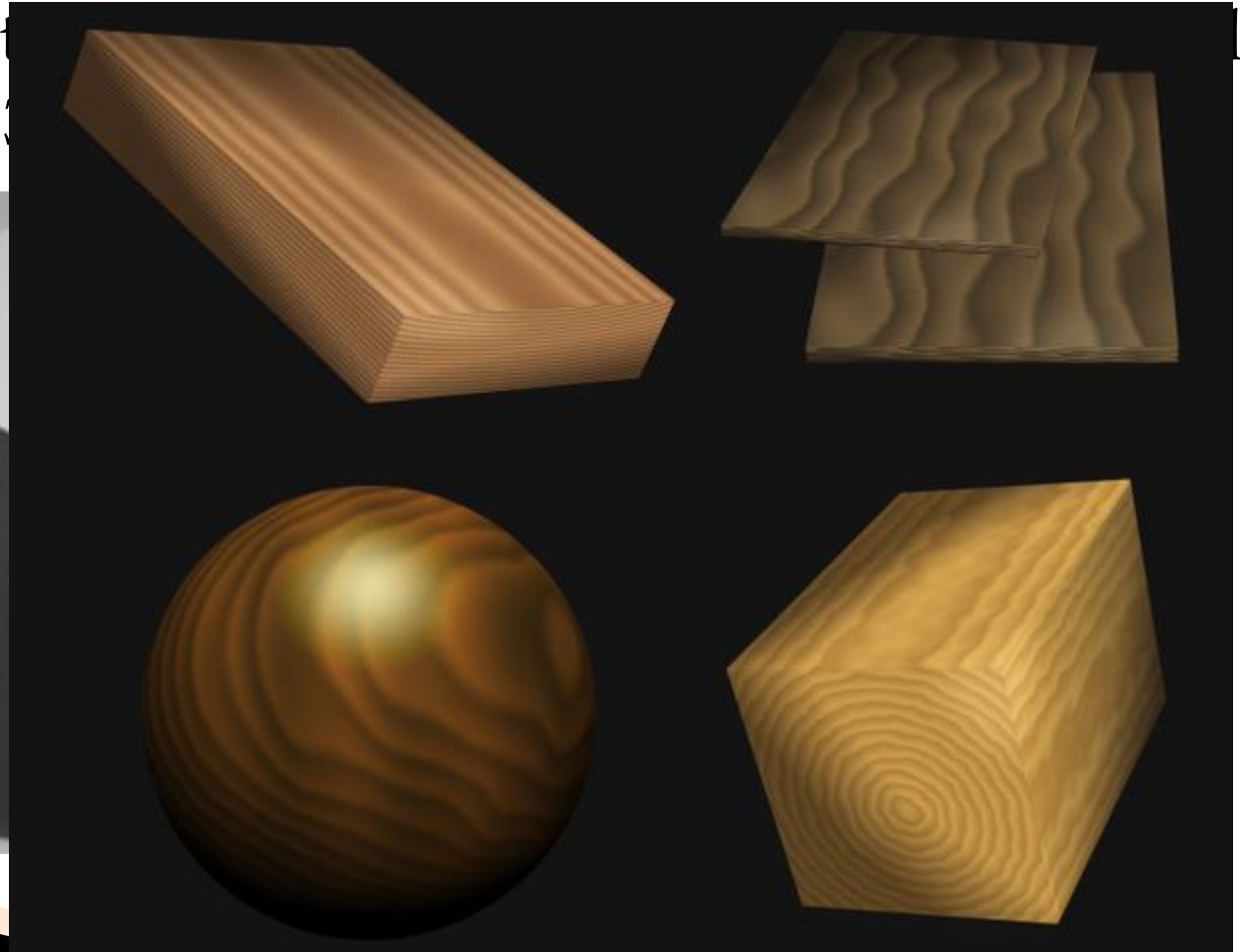
3D Projection

▸ A method of mapping 3 dimensional points to a 2 dimensional plane.

Texture mapping

- Texture mapping is a method for adding detail, surface tex... graphic or 3...
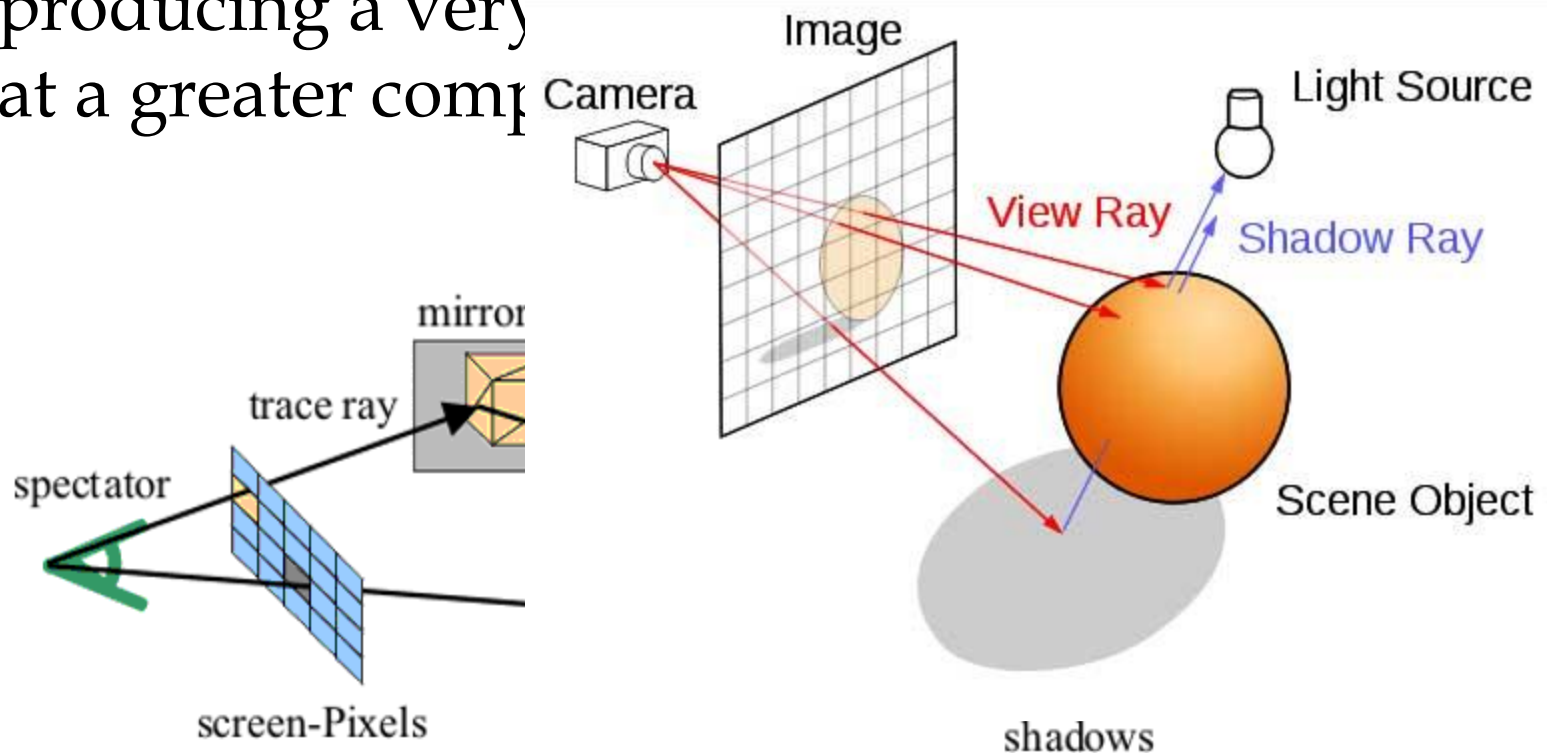
Environmental Mapping

- Used to create appearance of reflective and refractive surfaces without ray tracing which requires global calculations.

Ray Tracing

- Ray tracing is a technique for generating an image by tracing the path of light through pixels in an image plane. The technique is capable of producing a very ~~high degree of photorealism but~~ at a greater comp ~~lexity~~

Image

Camera

View Ray

Shadow Ray

Light Source

Scene Object

shadows

mirror

trace ray

spectator

screen-Pixels

Computer General Animations

Discussion…

Questions?

Assignment #1

- 1. Join the FaceBook Group
- 2. Upload an image into the ALBUM "Assignment #1) – title image USI+NAME
- 3. Setup your Programing Environment for OpenGL
- 4. Comment on the post "Environment Setup"
  - ◦ "good" if all was well in the setup
  - ◦ Otherwise if you encountered problems
- Closing Date for items 2 & 4: Friday 12th 2019

Review Questions

- What is Computer Graphics?
- The difference between 3D and 2D graphics?
- What is a pixel?
- What is rendering?
- What do you have in mind for a course project?

References

- Angel, E & Shreiner, D 2011, *Interactive Computer Graphics: A Top-Down Approach with Shader-Based OpenGL,* 6th edn, Pearson Custom Publishing, USA

- Images:
  ◦ Slide 18: http://xplorenotes.blogspot.com/2009/05/ raster-scan-systems.html