CS 543: Computer Graphics

3D Modeling

Robert W. Lindeman
Associate Professor
Interactive Media & Game Development
Department of Computer Science
Worcester Polytechnic Institute
gogo@wpi.edu

(with lots of help from Prof. Emmanuel Agu :-)

WPI
Overview of 3D Modeling

- Modeling
  - Create 3D model of scene/objects
- Coordinate systems (left hand, right hand)
- Basic shapes (cone, cylinder, etc.)
- Transformations/Matrices
- Lighting/Materials
- Synthetic camera basics
- View volume
- Projection
Coordinate Systems

- Right-handed and left-handed coordinate systems
  - Make an "L" with index finger and thumb
  - Right-handed is used in OpenGL
  - Converting from one to the other is a simple transformation

Right-Handed Coordinate System

Left-Handed Coordinate System
Right-Handed Coordinates

- To determine positive rotations
  - Make a fist with your right hand, and stick thumb up in the air (CCW)
Hierarchical Transformations

- Graphical scenes have object dependencies
- Many small objects
- Attributes (position, orientation, etc.) depend on each other

A Robot Hammer!
Hierarchical Transformations

(cont.)

- Object dependency description using tree structure

Object position and orientation can be affected by its parent, grand-parent, grand-grand-parent, ... nodes

Hierarchical representation is known as **Scene Graph**
Transformations

Two ways to specify transformations

1. Absolute transformation: each part of the object is transformed independently relative to the origin

Translate the base by (5, 0, 0);
Translate the lower arm by (5, 2, 0);
Translate the upper arm by (5, 4, 0);
Translate the hammer head by (5, 4, 4)

...
Relative Transformations

- A better (and easier) way
  1. Relative transformation: Specify the transformation for each object relative to its parent

Step 1:
Translate the base (and its descendants) by (5, 0, 0);
Relative Transformations (cont.)

Step 2:
Rotate the lower arm and (its descendants) relative to the base's local y axis by -90 degrees.
Relative Transformations
Using a Scene Graph

Base

Lower arm

Upper arm

Hammer

Translate (5, 0, 0)

Rotate (-90) about its local y

Apply all the way down

Apply all the way down