CS 4732:
Computer Animation

Orientation Representations

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

Euler Angles: Idea

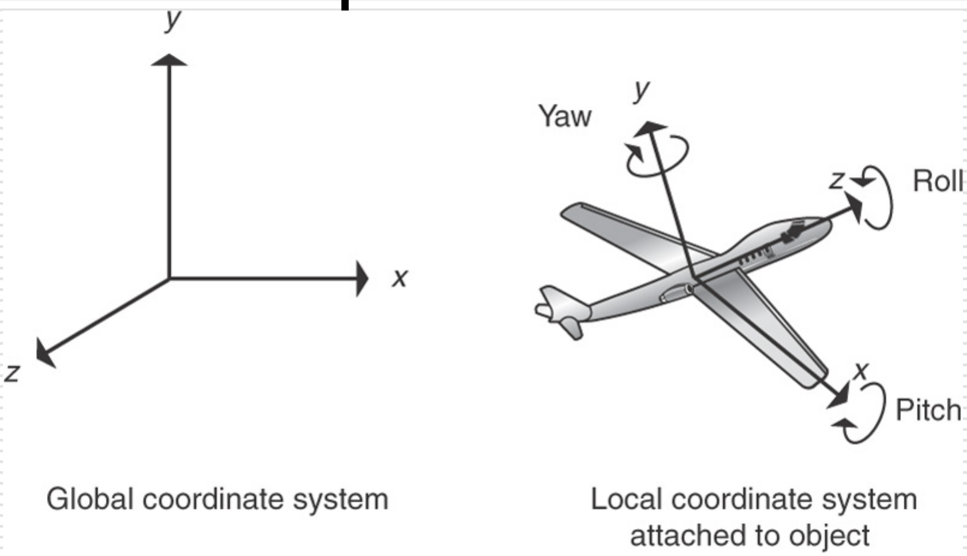
- Represent object orientation as a sequence of rotations about X, Y, & Z,
  - e.g., roll (z) then pitch (x) then yaw (y).
- Or as a rotation matrix:

$$\begin{pmatrix} c2c3 & c2s3 & -s2 & 0 \\ s1s2c3 - c1s3 & s1s2s3 + c1c3 & s1c2 & 0 \\ c1s2c3 + s1s3 & c1s2s3 - s1c3 & c1c2 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

  - c1 & s1 are the x-axis cos & sin, etc.

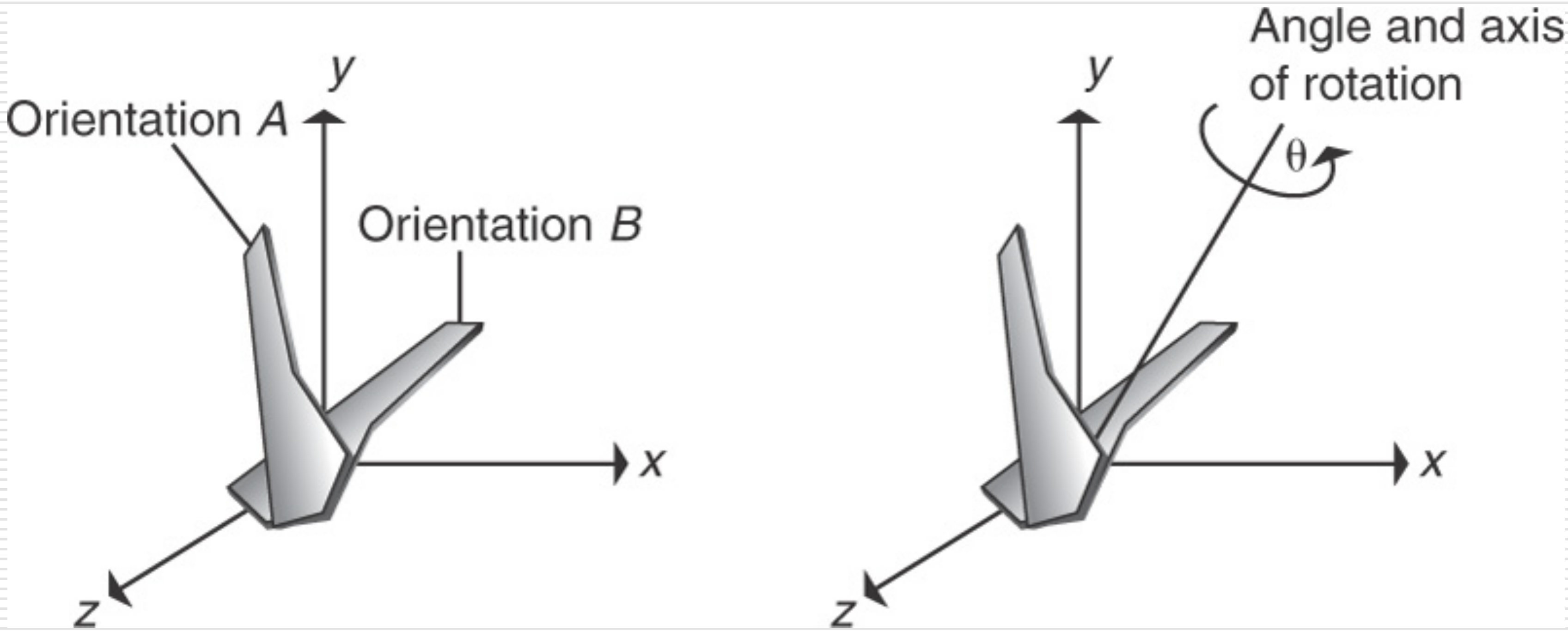
Euler Angles: Good & Bad

- Easy for us to understand/specify
- Gimbal lock
  - Lose one DOF after some rotations
- How do we interpolate?



Angle & Axis Representation

- Going from one orientation to another can be represented as a single rotation about a single axis.



Quaternions

- A quaternion is a scalar and a vector
  - q = [s, v]
  - [s, v] = [-s, -v]
- Addition:
  - [s1, v1] + [s2, v2] = [s1 + s2, v1 + v2]
- Length:
  - ||q|| of [a, (b, c, d)] = sqrt(a^2, b^2, c^2, d^2)
- Multiplication:
  - q1*q2 = [s1s2 – v1•v2, s1v2 + s2v1 + v1×v2]

Quaternions (cont.)

- A series of rotations can be concatenated by multiplying them together.
- Multiplicative identity:
  - [1, (0, 0, 0)]
- We can think of quaternions as being derived from Angle & Axis notation.
- Interpolation of quaternions is covered next week (Sec. 3.3)