13a. Particle Systems for Animator

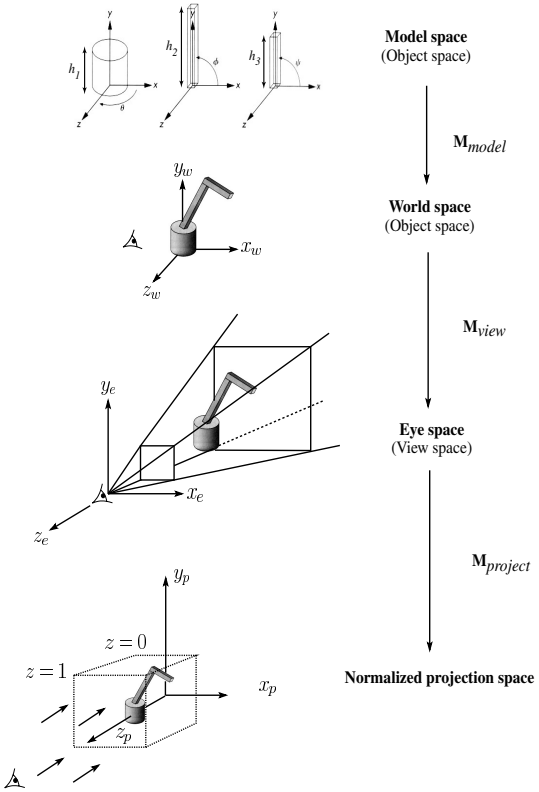
Particle frame of reference

Let's say we had our robot arm example and we wanted to launch particles from its tip.

How would we go about starting the particles from the right place?

First, we have to look at the coordinate systems in the OpenGL pipeline…

The OpenGL geometry pipeline



Projection and modelview matrices

Any piece of geometry will get transformed by a sequence of matrices before drawing:

$$\mathbf{p}' = \mathbf{M}_{\text{project}}\,\mathbf{M}_{\text{view}}\,\mathbf{M}_{\text{model}}\,\mathbf{p}$$

The first matrix is OpenGL's GL_PROJECTION matrix.

The second two matrices, taken as a product, are maintained on OpenGL's GL_MODELVIEW stack:

$$\mathbf{M}_{\text{modelview}} = \mathbf{M}_{\text{view}}\,\mathbf{M}_{\text{model}}$$

Robot arm code, revisited

Recall that the code for the robot arm looked something like:

```
glRotatef( theta, 0.0, 1.0, 0.0 );
base(h1);
glTranslatef( 0.0, h1, 0.0 );
glRotatef( phi, 0.0, 0.0, 1.0 );
upper_arm(h2);
glTranslatef( 0.0, h2, 0.0 );
glRotatef( psi, 0.0, 0.0, 1.0 );
lower_arm(h3);
```

All of the GL calls here modify the modelview matrix.

Note that even before these calls are made, the modelview matrix has been modified by the viewing transformation, $\mathbf{M}_{view}$.

Computing the particle launch point

To find the world coordinate position of the end of the robot arm, you need to follow a series of steps:

1. Figure out what $\mathbf{M}_{view}$ before drawing your model.

```
Mat4f matCam = ps>glGetMatrix(GL_MODELVIEW_MATRIX);
```

2. Draw your model and add one more transformation to the tip of the robot arm.

```
glTranslatef( 0.0, h3, 0.0 );
```

3. Compute $\mathbf{M}_{model} = \mathbf{M}_{view}^{-1}\mathbf{M}_{modelview}$

```
Mat4f particleXform = ps->getWorldXform( matCam);
```

4. Transform a point at the origin by the resulting matrix.

```
Vec3f particleOrigin = particleXform * Vec3f(0,0,0);
```

Now you're ready to launch a particle from that last computed point!

See complete example, robotarm.cpp, now included with the first "W2K Sample" on the animator page.

Summary

What you should take away from this lecture:

- How to hook your particle system into the coordinate frame of your model