From World To View Coordinates

CS116A
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Outline

- Transformations From World To Viewing Coordinates
- Projection Transformations
- Orthogonal Projections
Transformations From World To Viewing Coordinates

The basic idea:

– Translate the viewing coordinates origin to the origin of the world-coordinate system

– Apply rotations to align the $x_{\text{view}}$, $y_{\text{view}}$, $z_{\text{view}}$ axis with the world $x_{\text{w}}$, $y_{\text{w}}$, $z_{\text{w}}$.

Let $u,v,n$ be unit vectors in each direction in the view system. Then the matrices will be:

\[
\begin{bmatrix}
ux & uy & uz & 0 \\
vx & vy & vz & 0 \\
nx & ny & nz & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
1 & 0 & 0 & -x_0 \\
0 & 1 & 0 & -y_0 \\
0 & 0 & 1 & -z_0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\]
Projection Transformations

• In a **parallel transformation** coordinate positions are transformed to view plane along parallel lines (dotted line parallel):

• In a perspective transformations projection converge to a common point
Orthogonal Projections

- A transformation to a view plane along lines that are all parallel to its normal vector is called an orthogonal projection.
- So any orthogonal projection is a parallel projection but not vice versa.

![ Diagram showing orthogonal and parallel projections ]

- Left is orthogonal, right is parallel but not orthogonal
Axonometric versus Isometric

- Front, side, and rear orthogonal projections are often called **elevations**.
- Also, can make orthogonal projections that project more than one face of an object. Such views are called **axonometric** orthogonal projections.
- If such a projection is generated by aligning the projection plane so as to cross each axis of the figure at the same distance, the projection is called **an isometric projection**. Example, box drawn on board.
Orthogonal Projection Coordinates

• Suppose wanted to do an orthogonal projection along the z-axis.
• Then any point \((x,y,z)\) maps to \((x,y)\) in the projection plane.
• We don’t forget the value of \(z\), though -- it is used in doing visibility tests.
Clipping Window and View Volume

• In a camera, the type of lens determines how much of the scene gets transferred to the picture.
• In computer graphics the clipping window is used for this purpose.
• As with 2D viewing, OpenGL only allows clipping normal to z axis.
• We can set the lower left, upper right coordinates of this clipping window.
• In the z-direction we can say where our plane is and also say what the near and far clipping planes are.
• Fancier kinds of viewing arrangements must be implemented by us.
Normalization

- The clipping window and near and far clipping planes define an orthogonal projection view volume.
- Often this view volume is mapped to a normalized volume with x,y,z values between -1 and 1.
- To do this transformation can use $M_{\text{ortho, norm}}$:

$$
\begin{bmatrix}
\frac{2}{(x_{\text{max}}-x_{\text{min}})} & 0 & 0 & -\frac{1}{(x_{\text{max}}-x_{\text{min}})}(x_{\text{max}}+x_{\text{min}}) \\
0 & \frac{2}{(y_{\text{max}}-y_{\text{min}})} & 0 & -\frac{1}{(y_{\text{max}}-y_{\text{min}})}(y_{\text{max}}+y_{\text{min}}) \\
0 & 0 & \frac{2}{(z_{\text{max}}-z_{\text{min}})} & -\frac{1}{(z_{\text{max}}-z_{\text{min}})}(z_{\text{max}}+z_{\text{min}}) \\
0 & 0 & 0 & 1
\end{bmatrix}
$$