



3D Rendering Geometry

CS 355: Interactive Graphics and Image Processing

Rendering Geometry

- Transform from object to world coordinates
- Transform from world to camera coordinates
- Clipping: near plane, far plane, field of view
(we're going to skip this for the moment)
- Perspective projection
- View transformation

Object to World

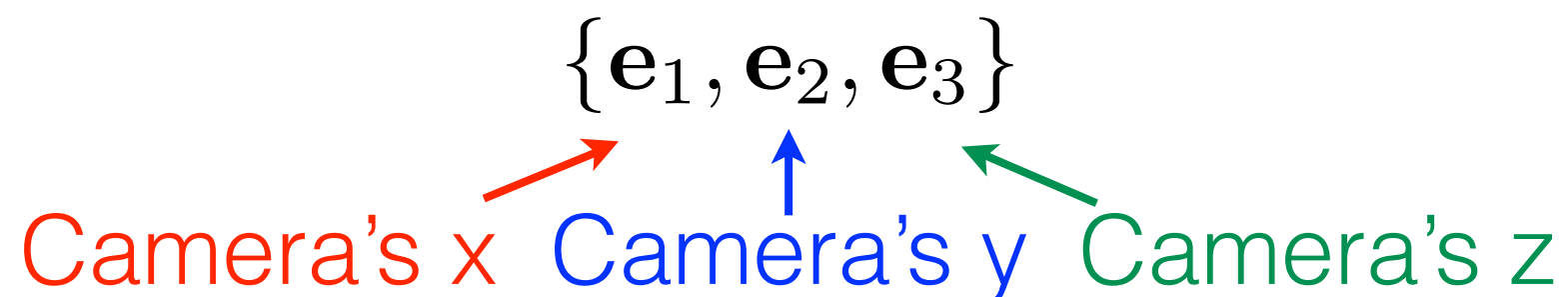
- Like what you've done in 2D, only in 3D:
 - Scale (while still at origin in object space)
 - Rotate (while still at origin in object space)
 - Translate to position the object

World to Camera

- Suppose that you know
 - Position of camera in world coordinates

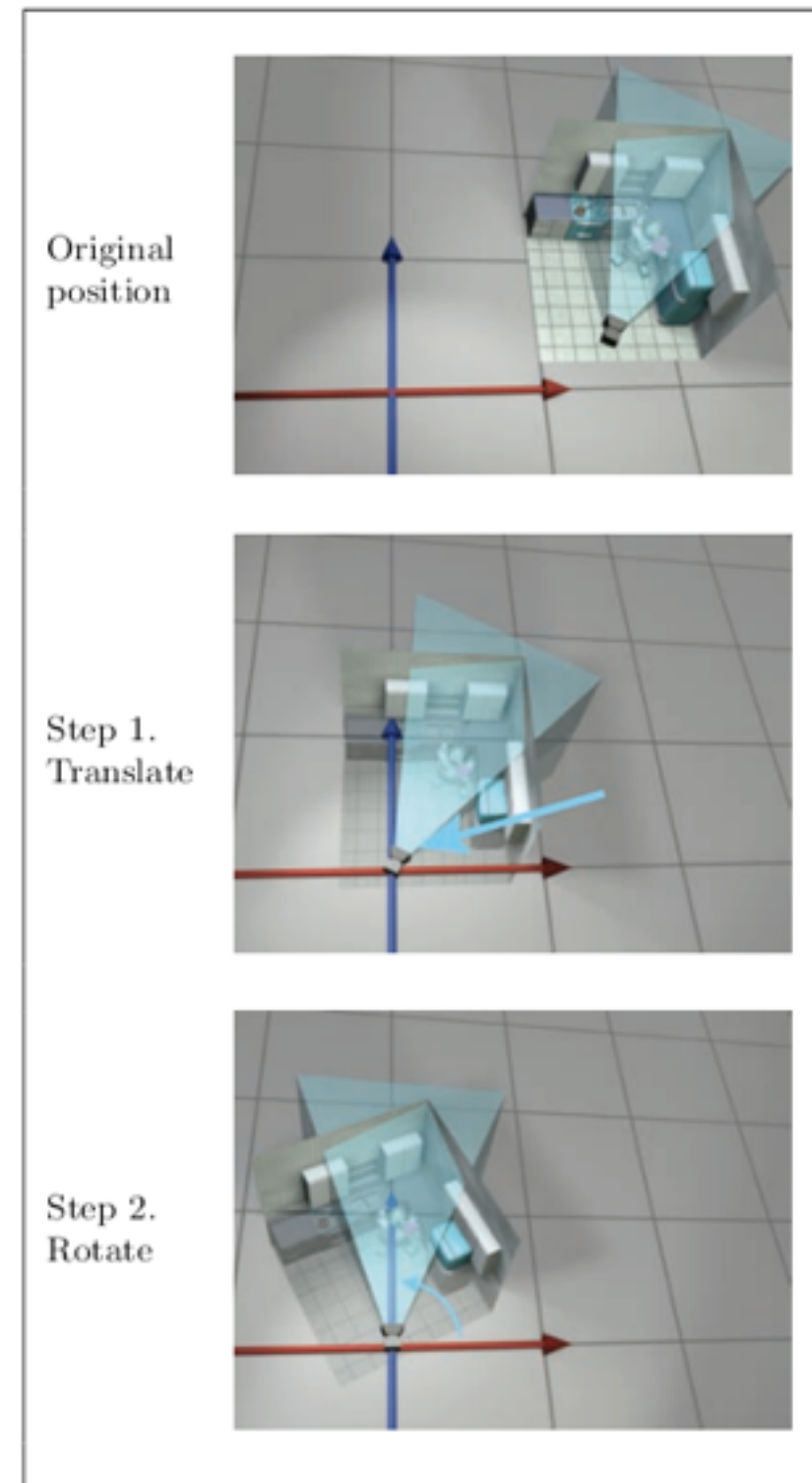
$$\mathbf{c} = (c_x, c_y, c_z)$$

- Orientation of camera as given by a set of basic vectors in world coordinates



World to Camera

- Two steps:
 - **Translate**
everything to be relative to the camera position
 - **Rotate**
into the camera's viewing orientation



World to Camera

- Two steps:
 - **Translate**
everything to be relative to the camera position
 - **Rotate**
into the camera's viewing orientation

$$\begin{bmatrix} 1 & 0 & 0 & -c_x \\ 0 & 1 & 0 & -c_y \\ 0 & 0 & 1 & -c_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} e_{11} & e_{12} & e_{13} & 0 \\ e_{21} & e_{22} & e_{23} & 0 \\ e_{31} & e_{32} & e_{33} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Putting It Together

$$\begin{array}{c}
 \begin{bmatrix} x \\ y \\ f \\ 1 \end{bmatrix} \sim \begin{bmatrix} X_c \\ Y_c \\ Z_c \\ Z_c/f \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/f & 0 \end{bmatrix} \begin{bmatrix} e_{11} & e_{12} & e_{13} & 0 \\ e_{21} & e_{22} & e_{23} & 0 \\ e_{31} & e_{32} & e_{33} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & -c_x \\ 0 & 1 & 0 & -c_y \\ 0 & 0 & 1 & -c_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} \\
 \begin{array}{cccc}
 \text{Normalize} & \text{Project} & \text{Rotate} & \text{Translate}
 \end{array}
 \end{array}$$

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Rendering Geometry

- ✓ Transform from object to world coordinates
- ✓ Transform from world to camera coordinates
 - Clipping: near plane, far plane, field of view
- ✓ Perspective projection
 - View transformation

Coming up...

- Specifying camera pose and orthogonalizing the rotation
- Clipping space
- Screen transformation