Moderovacie a renderovacie techniky

František Dráček
dracek1@uniba.sk

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https://github.com/frantisekdracek/Prezentacie/tree/main

Homogenous coordinates

- translation by vector c:

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} \rightarrow \begin{bmatrix} x \\ y \\ z \end{bmatrix} + \begin{bmatrix} c_x \\ c_y \\ c_z \end{bmatrix} \tag{1}$$

- concise form

$$\begin{bmatrix} 1 & 0 & 0 & c_x \\ 0 & 1 & 0 & c_y \\ 0 & 0 & 1 & c_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} x + c_x \\ y + c_y \\ z + c_z \\ 1 \end{bmatrix} \tag{2}$$

Projection 3D to 2D

Basic projection

- need to projects 3D objects on 2D screens
- point a $\rightarrow x - y$ plane.
- simplest projection:

$$P = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \tag{3}$$

Projection 3D to 2D

Camera to film - Perspective

- simple perspective:

$$P = \begin{bmatrix} d & 0 & 0 & 0 \\ 0 & d & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \qquad (4)$$

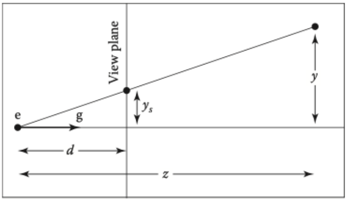
- general perspective matrix:

$$P = \begin{bmatrix} \frac{2n}{r-l} & 0 & \frac{r+l}{r-l} & 0 \\ 0 & \frac{2n}{t-b} & \frac{t+b}{t-b} & 0 \\ 0 & 0 & \frac{-(f+n)}{f-n} & \frac{-2fn}{f-n} \\ 0 & 0 & -1 & 0 \end{bmatrix} \qquad (5)$$

- homogenize resulting vector:

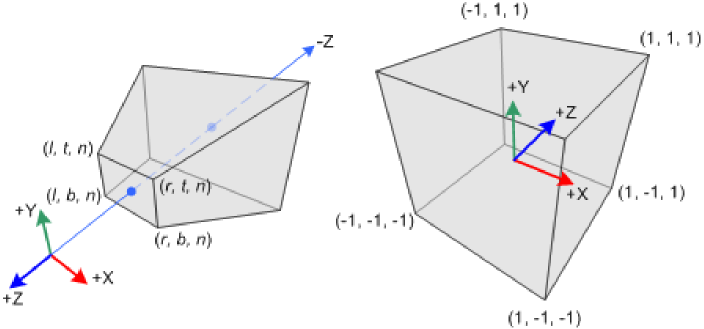
$$\begin{bmatrix} \tilde{\tilde{\tilde{a}}}_x \\ \tilde{\tilde{\tilde{a}}}_y \\ \tilde{\tilde{\tilde{a}}}_z \\ w \end{bmatrix} \rightarrow \begin{bmatrix} \tilde{\tilde{\tilde{a}}}_x/w \\ \tilde{\tilde{\tilde{a}}}_y/w \\ \tilde{\tilde{\tilde{a}}}_z/w \\ 1 \end{bmatrix} \qquad (6)$$

$$y_s = \frac{d}{z} y,$$



Projection 3D to 2D

Camera to film - Perspective



Projection 3D to 2D

World to camera

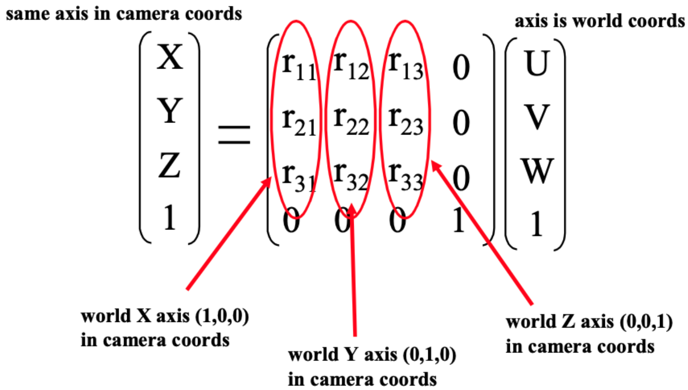
- camera orientation θ
- rotate camera coordinates: $R(\theta)$
- in homogenous:

$$R = \begin{bmatrix} R_{11} & R_{12} & R_{13} & 0 \\ R_{21} & R_{22} & R_{23} & 0 \\ R_{31} & R_{32} & R_{33} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{7}$$

- combined:

$$\begin{bmatrix} \tilde{\tilde{a}}_x \\ \tilde{\tilde{a}}_y \\ \tilde{\tilde{a}}_z \\ 1 \end{bmatrix} = \begin{bmatrix} R_{11} & R_{12} & R_{13} & 0 \\ R_{21} & R_{22} & R_{23} & 0 \\ R_{31} & R_{32} & R_{33} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & -c_x \\ 0 & 1 & 0 & -c_y \\ 0 & 0 & 1 & -c_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} a_x \\ a_y \\ a_z \\ 1 \end{bmatrix} = RT\mathrm{a} \tag{8}$$

rotation from axes



same axis in camera coords

axis is world coords

$$\begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix} = \begin{pmatrix} r_{11} & r_{12} & r_{13} & 0 \\ r_{21} & r_{22} & r_{23} & 0 \\ r_{31} & r_{32} & r_{33} & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} U \\ V \\ W \\ 1 \end{pmatrix}$$

world X axis (1,0,0)
in camera coords

world Y axis (0,1,0)
in camera coords

world Z axis (0,0,1)
in camera coords

write simple rendered that will display rotating cube