Abgabe - Übungsblatt [4]

Einführung in die Computergraphik und Visualisierung

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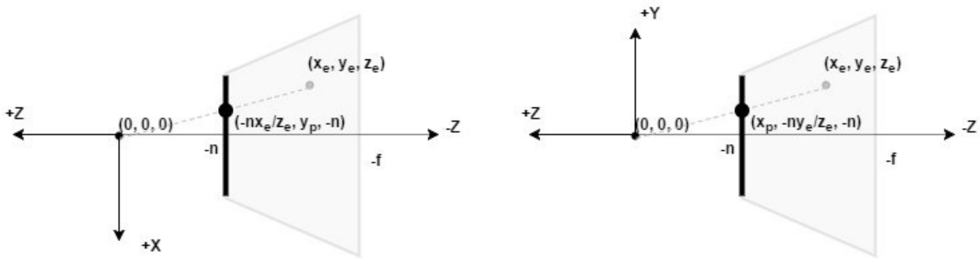
First Exercise

n - distance to the near clipping plane
f - distance to the far clipping plane
l, r, t, b - left, right, top, bottom coordinates of the near clipping plane

Second Exercise



Frustum from top-down view   Frustum from side view

When we do projection from x, y, z to x, y plane we have to divide by $-z_e$ as $\frac{x_p}{x_e} = \frac{-n}{z_e} \Rightarrow x_p = -n\frac{x_e}{z_e}$
The same with $y_p : y_p = -n\frac{y_e}{z_e}$
As we have homogeneous coordinates, we just put -1 into the respective position in the projection matrix.

Third Exercise

$$P = A * C$$

$A = P * C^{-1}$
where C is

$$\underbrace{\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&-1\\0&0&0&1\end{bmatrix}}_{\substack{\text{center frustum}\\ \text{along } z}}\underbrace{\begin{bmatrix}\frac{2}{r-l}&0&0&0\\0&\frac{2}{t-b}&0&0\\0&0&\frac{2f}{(f-n)n}&0\\0&0&0&1\end{bmatrix}}_{\substack{\text{scale view frustum}\\ \text{to size [2, 2, 2]}}}\underbrace{\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&\frac{1}{n}&1\end{bmatrix}}_{\substack{\text{perspective}\\ \text{transformation}}}\underbrace{\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&-n\\0&0&0&1\end{bmatrix}}_{\substack{\text{translate near plane}\\ \text{into x,y-plane}}}\underbrace{\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&-1&0\\0&0&0&1\end{bmatrix}}_{\substack{\text{mirror at}\\ \text{x,y-plane}}}$$

$$C = \begin{pmatrix}\frac{2}{r-l}&0&0&0\\0&\frac{2}{t-b}&0&0\\0&0&\frac{n^2(f-n)-2f}{n(f-n)}&-\frac{2f}{(f-n)}\\0&0&-\frac{1}{n}&0\end{pmatrix}$$

$$C^{-1} = \begin{pmatrix}\frac{r-l}{2}&0&0&0\\0&\frac{t-b}{2}&0&0\\0&0&0&-n\\0&0&-\frac{(f-n)}{2f}&\frac{n^2(f-n)-2f}{2f}\end{pmatrix}$$

$$A = \begin{pmatrix}n&0&0&-\frac{r+1}{r-1}n\\0&n&0&-\frac{t+b}{t-b}n\\0&0&n&\frac{f+n-n^3(f-n)-2fn}{f-n}\\0&0&0&n\end{pmatrix}$$

This transformations makes shearing with respect to x, y and z. We also multiply by n in order to get the proportions we lose during projections at the beginning of the operations.