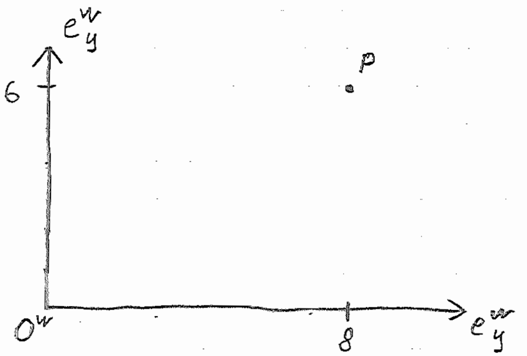
Example of camera projection with extrinsic and intrinsic parameters

a 1D camera assumed, thus we project to a line segment instead of a segment of a plane. The world is flat-world: all world points are in 2D



$$(\overrightarrow{O^wP})_w = \begin{bmatrix}8\\6\end{bmatrix} \; ; \; (\overrightarrow{O^wP})_{wH} = \begin{bmatrix}8\\6\\1\end{bmatrix}$$

$$e_y^w = \begin{bmatrix}0\\1\end{bmatrix} \; ; \; e_x^w = \begin{bmatrix}1\\0\end{bmatrix}$$

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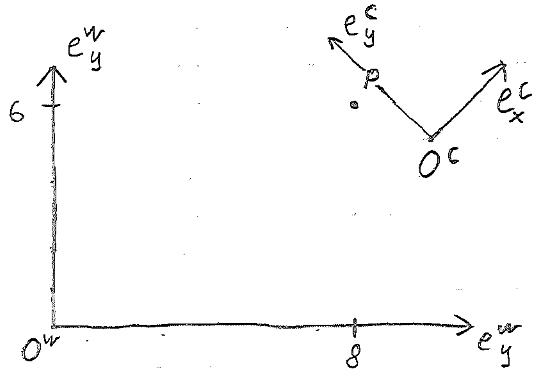

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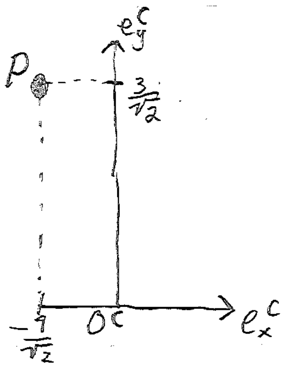
$$e_y^c = \begin{bmatrix}-1\\1\end{bmatrix}\frac{1}{\sqrt{2}}; \quad e_x^c = \begin{bmatrix}1\\1\end{bmatrix}\frac{1}{\sqrt{2}}$$

$$R^T = \left[e_x^c \,\vdots\, e_y^c\right] \Rightarrow R = \begin{bmatrix}1 & 1\\-1 & 1\end{bmatrix}\frac{1}{\sqrt{2}}$$



$$(\overrightarrow{O^wO^c})_w = \begin{bmatrix}10\\5\end{bmatrix}; \quad (\overrightarrow{O^cO^w})_c = -R\cdot\begin{bmatrix}10\\5\end{bmatrix} = \begin{bmatrix}-15\\5\end{bmatrix}\frac{1}{\sqrt{2}}$$

$$M_E = \left[R \,\vdots\, (O^cO^w)_c\right] = \begin{bmatrix}1 & 1 & -15\\-1 & 1 & 5\end{bmatrix}\frac{1}{\sqrt{2}}$$

$$(\overrightarrow{O_cP})_c = M_E\,(\overrightarrow{O^wP})_{wH} = \begin{bmatrix}-1\\3\end{bmatrix}\frac{1}{\sqrt{2}}$$

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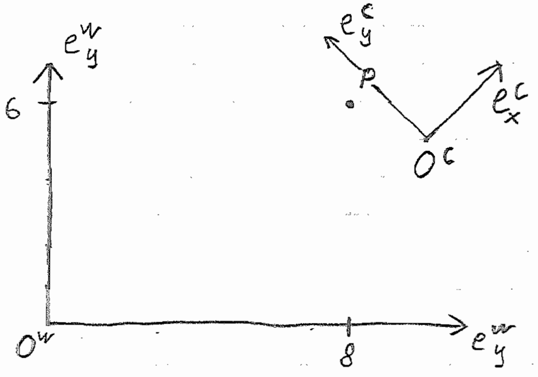

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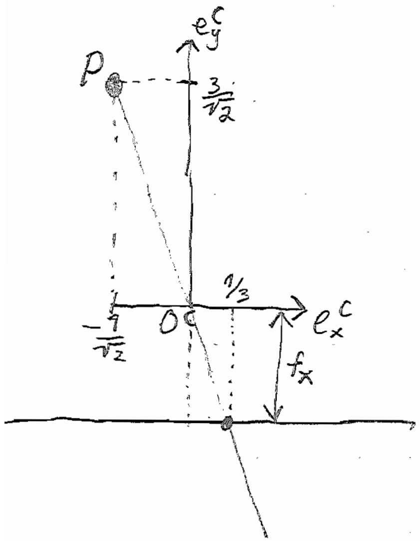

assume 1D camera, wit intrinsics:

$$M_I = \begin{bmatrix}-f_x & c_0\\0 & 1\end{bmatrix} = \begin{bmatrix}-1 & 0\\0 & 1\end{bmatrix}$$

$$(\overrightarrow{CP'})_{DH} = M_I\,(\overrightarrow{O_cP})_c = \begin{pmatrix}1\\3\end{pmatrix}\frac{1}{\sqrt{2}} \Rightarrow \boxed{(CP')_D = \frac{1}{3}}$$