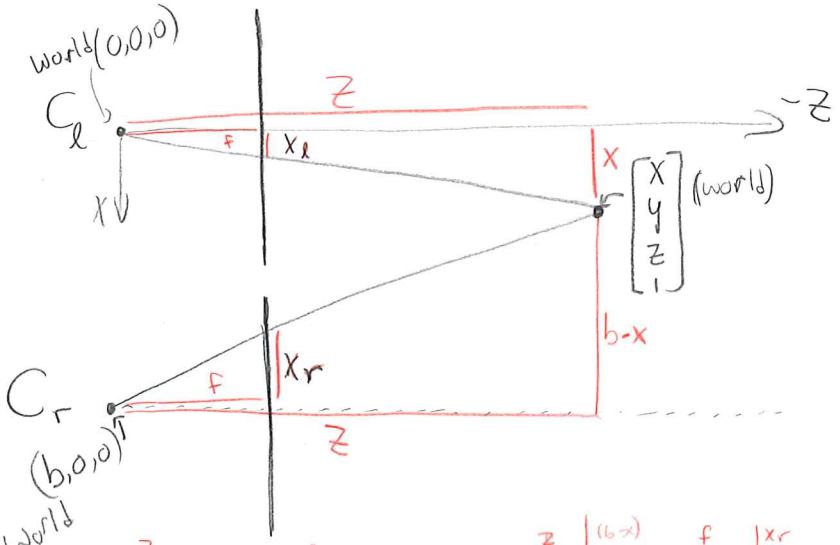
Depth from Disparity

Assumptions:
- 2 cameras
- same f
- same PP
- COP off by b in x only



Similar triangles: $\frac{X}{z} = \frac{x_l}{f}$ $\frac{(b-x)}{z} = \frac{x_r}{f}$

$\frac{fX}{x_l} = z = z = \frac{f(b-x)}{x_r}$

eliminate z

$\frac{fx}{x_l} = \frac{f(b-x)}{x_r}$

$z = \frac{fX}{x_l}$

$\frac{Xx_r}{x_l} = b - X$

$= \frac{f\,b x_l}{(x_r + x_l)} \cdot \frac{1}{x_l}$

Solve for X

$\frac{Xx_r}{x_l} + X = b$

plug x into z

$Xx_r + Xx_l = bx_l$

$X(x_r + x_l) = bx_l$

$X = \frac{b\,x_l}{x_r + x_l}$

focal length

$z = \frac{fb}{x_r + x_l}$ ← baseline

↑ disparity

Note: x_r, x_l are usually treated as signed quantities; this derivation used absolute distances. If signed, disparity = $x_l - x_r$

Depth (z) in world is proportional to $\frac{1}{\text{disparity}}$! If we can find x_l and x_r, we can get z!