Homography intuition: transformation of a 2D plane in an abstract 3D space

Current method for panorama stitching: project the plane of one image onto another.

But, what if the angle is unreasonable?

Instead of projecting to a plane, we project to the inside of a sphere.

Additionally, what if our camera moves? Suddenly, distance matters (things far away appear to transform less than things nearby).
Parallax!

Solving for $z_y$:

\[
\begin{bmatrix}
X_w \\
Y_w \\
Z_w
\end{bmatrix}
\]

This is $X_w$.

Correlation optical axis.; $X_w = 0$.

This is $b - X_w$.
Cameras:

Mk I

Mk II

Mk III

center of projection
projection plane
focal length

Brd.

Better.

Best!

optical axis

Talkin' Graphics: Going from world coordinates to camera coordinates to image coordinates

\[ X_{\text{img}} = \begin{bmatrix} \text{Intrinsic} & \text{Projection} & \text{Extrinsic} \end{bmatrix} X_{\text{world}} \]

- Focal length
- Pixel coordinate system
- 3D to 2D
- Camera pose

often smoothed into one matrix
1. Does this mean $Y_{\text{MKIII}} = Y_{\text{MKIII}}$? 
   
   \[
   (x_{\text{MKIII}}, y_{\text{MKIII}}) = -(x_{\text{MKIII}}, y_{\text{MKIII}})
   \]
   
   It's flipped for both (think 3D).

2. 

   \[
   Y = \frac{Y_w}{-2w}
   \]
   
   \[
   Z_w + 1
   \]
   
   So this is $Z' = -1$

   Finally, $X' = \frac{X_w}{-2w}$

3. Now, for matrices:

   \[
   \begin{bmatrix}
   X_w \\
   Y_w \\
   Z_w \\
   \end{bmatrix}
   =
   \begin{bmatrix}
   1 \\
   \end{bmatrix}
   \begin{bmatrix}
   X_w \\
   \end{bmatrix}
   \begin{bmatrix}
   1 \\
   \end{bmatrix}
   \begin{bmatrix}
   Y_w \\
   \end{bmatrix}
   \begin{bmatrix}
   1 \\
   \end{bmatrix}
   \begin{bmatrix}
   Z_w \\
   \end{bmatrix}
   \]
This identity matrix thing only works for focal len I New, focal length = f

$0, x_w, y_w, z_w$

\[ \frac{Y'}{f} = \frac{Y_w}{-2w} \]

\[ Y' = \frac{Y_w f}{-2w} \]

\[ Z' = -f \]

\[ X' = \frac{f X_w}{-2w} \]

\[
\begin{bmatrix}
-\frac{f X_w}{-2w} \\
-\frac{f Y_w}{-2w} \\
1 \\
\end{bmatrix} 
= 
\begin{bmatrix}
-\frac{f X_w}{2w} \\
-\frac{f Y_w}{-2w} \\
1 \\
\end{bmatrix} 
= 
\begin{bmatrix}
-f \\
-f \\
1 \\
\end{bmatrix} 
\begin{bmatrix}
X_w \\
Y_w \\
Z_w \\
\end{bmatrix}
\]

(I mixed these up originally)

Implied: transformation to $W=1$, which sort of implicates normalization step.