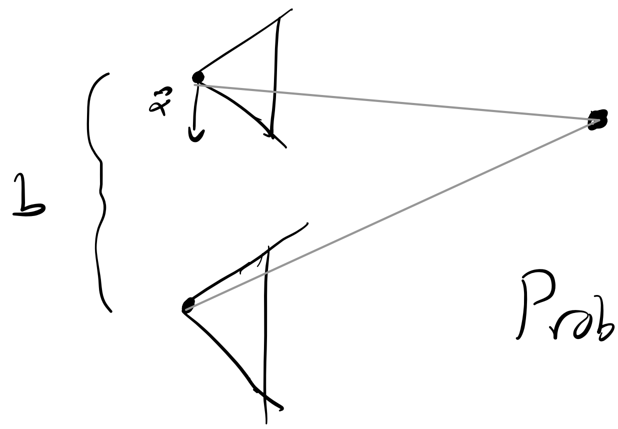
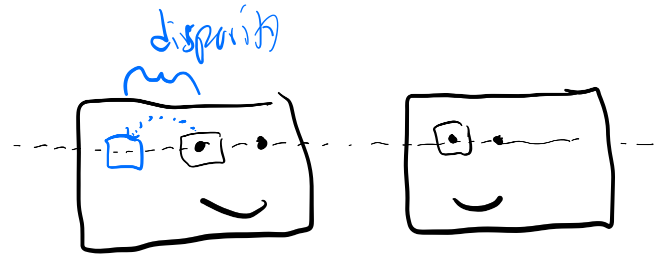
Lecture 12 - Rectified Stereo; Camera Matrix

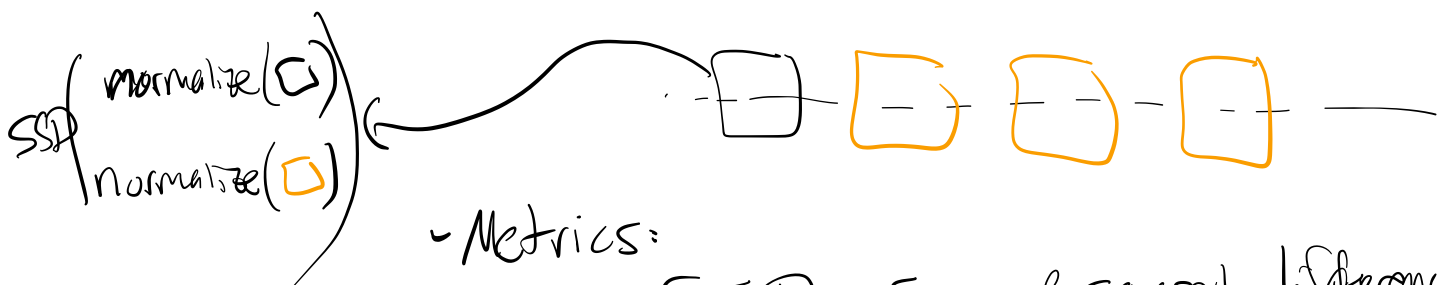




Problem: correspondence

Matching: Local Methods

- "photoconsistency" over a range of disparities



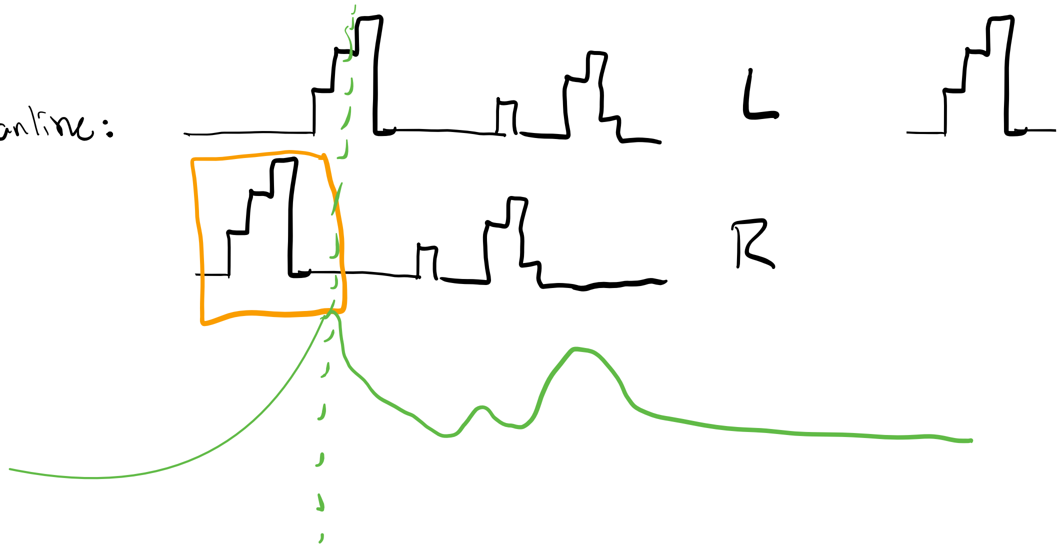
- Metrics:

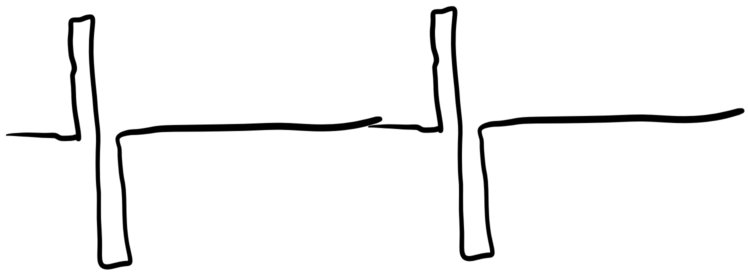
  SSD - sum of squared differences
  (MSE)

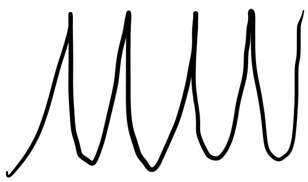
  SAD - absolute
  (MAE)

Normalized cross-correlation

1D scanline:

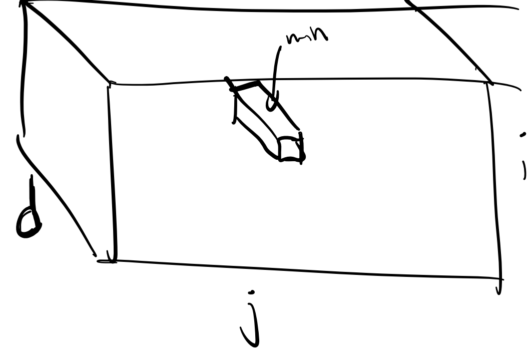






Rectified Stereo: Cost Volume: (r, c, d)

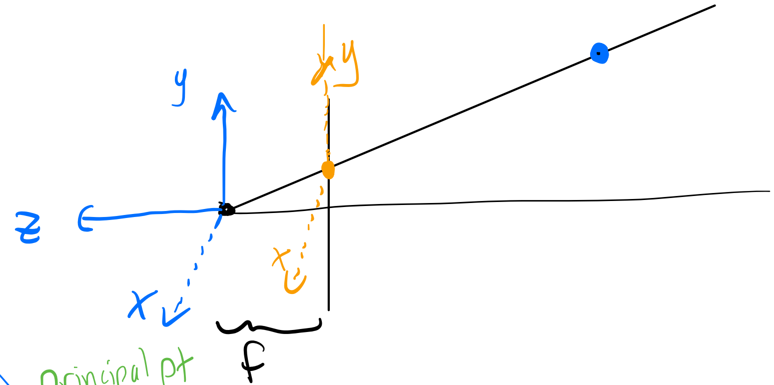
```
for each row i:
    for each column j:
        for each disparity d:
            C[i, j, d] = cost(patch, (i,j), patch2[i, j+d])
depth = zfromd(np.argmin(C, axis=2))
```



The Camera Matrix

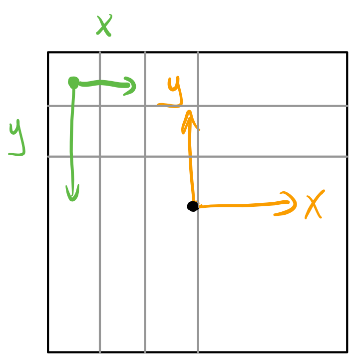
So far:

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} \begin{bmatrix} -f & & \\ & -f & \\ & & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

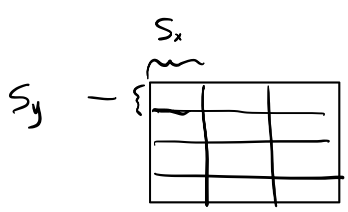


expressed in pixels

principal pt



$$\begin{bmatrix} -f & 0 & c_x \\ 0 & -\alpha f & c_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$



$$\alpha = \frac{S_x}{S_y}$$

3D Homog

$$\begin{bmatrix} M_{3\times 3} & \vec{t}_{3\times 1} \\ 0\ 0\ 0 & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix}$$

intrinsics

↓

projection

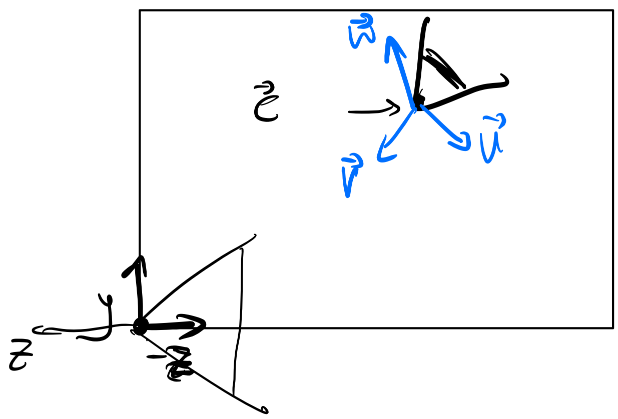
↓

$$\begin{array}{cc} K & P \\ \begin{bmatrix} -f & & c_x \\ & -\alpha f & c_y \\ & & 1 \end{bmatrix} & \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \end{array} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

Suppose: Camera is centered at world $\vec{c} = \begin{bmatrix} c_x \\ c_y \\ c_z \\ 1 \end{bmatrix}$

Can be rotated to world orientation by:

$$R^T = \begin{bmatrix} \vec{u} & \vec{v} & \vec{w} \end{bmatrix}$$

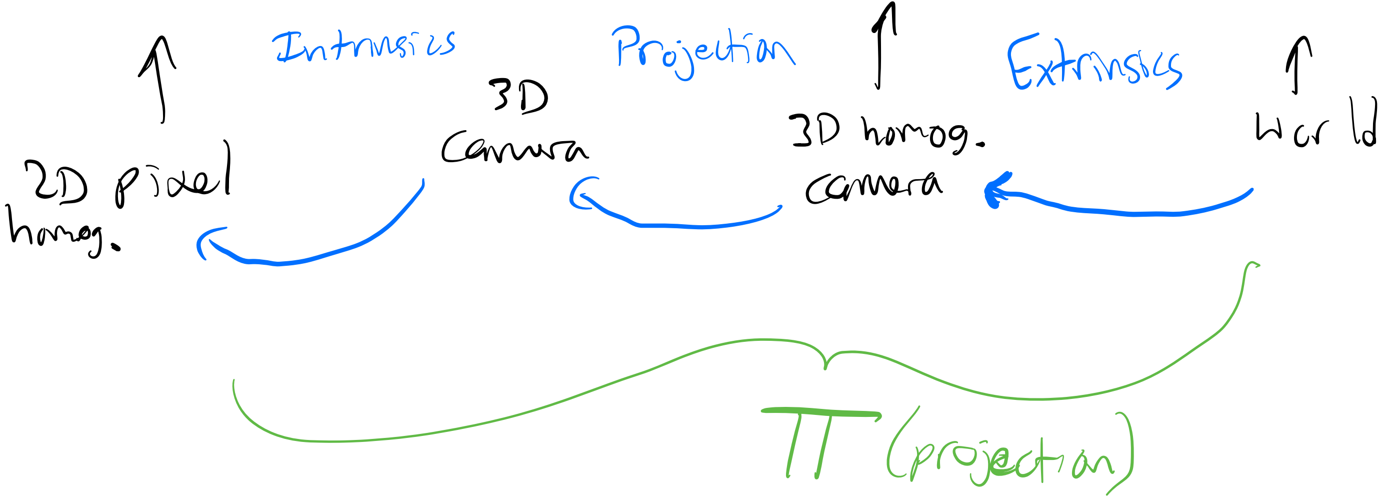


$$\begin{bmatrix} x_w \\ y_w \\ z_w \\ 1 \end{bmatrix} = \begin{bmatrix} | & | & | & | \\ \vec{u} & \vec{v} & \vec{w} & \vec{c} \\ | & | & | & | \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix}$$

extrinsics

$$\begin{bmatrix} R | t \end{bmatrix} = \left(\begin{bmatrix} \vec{u} & \vec{v} & \vec{w} & \vec{c} \\ 0 & 0 & 0 & 1 \end{bmatrix} \right)^{-1}$$

$$\begin{bmatrix} x_p \\ y_p \\ 1 \end{bmatrix} = \begin{bmatrix} -f & 0 & x_c \\ 0 & \alpha f & y_c \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} | & | & | & | \\ \vec{u} & \vec{v} & \vec{w} & \vec{c} \\ | & | & | & | \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1} \begin{bmatrix} x_w \\ y_w \\ z_w \\ 1 \end{bmatrix}$$


Intrinsics
Projection
Extrinsics
2D pixel homog.
3D camera
3D homog. camera
world
Π (projection)