Sol

$$F = K_2^{-T} R_2^{T} (t_2 - t_1)_{\times} R_1 K_1^{-1}$$

$$K_1 = K_2 = I$$

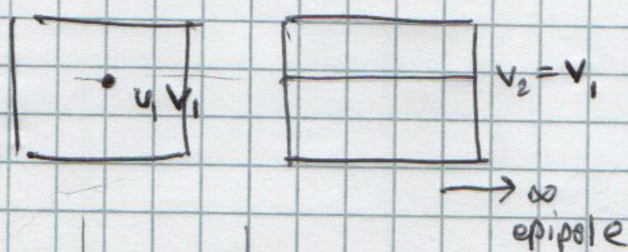
$$R_1 = R_2 = I$$

$$t_2 - t_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

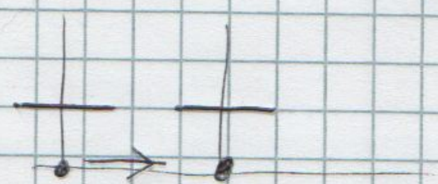
$$\breve{u}_2 F \breve{u}_1 = 0$$

$$\begin{bmatrix} u_2 & v_2 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \times \begin{bmatrix} u_1 \\ v_1 \\ 1 \end{bmatrix} = 0$$

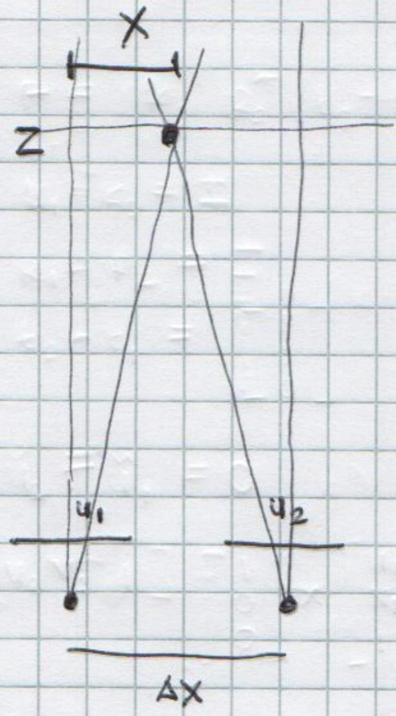
$$\begin{bmatrix} u_2 & v_2 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -1 \\ v_1 \end{bmatrix} = 0 \quad \Rightarrow \quad v_1 = v_2$$



Epipolar lines are horizontal.



5.2

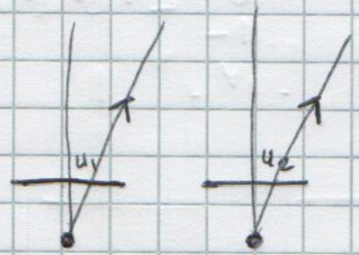


$$u_1 = f\frac{X}{Z}$$

$$u_2 = f\frac{X - \Delta X}{Z}$$

$$u_1 - u_2 = f\frac{\Delta X}{Z}$$

disparity $\propto \frac{1}{Z}$

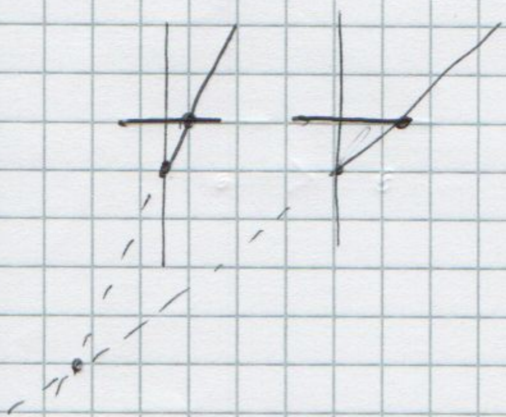


$u_1 = u_2$

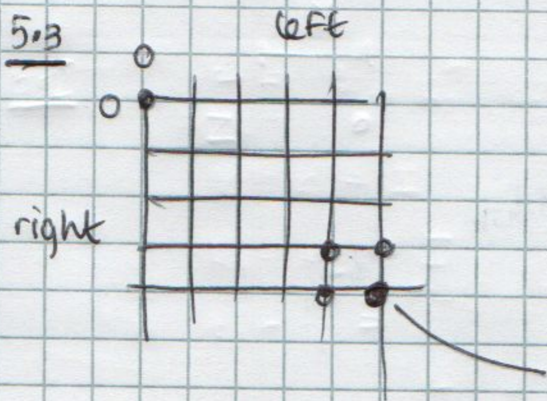
if disparity $= 0$

rays are $\uparrow\uparrow$

(viewing a point in the far distance)



5.3



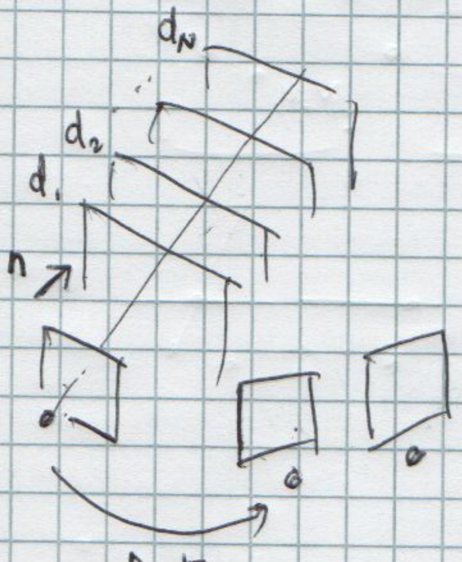
$$C(x,y) = \min \begin{cases} C(x-1,y) + C_{\rightarrow} \\ C(x-1,y-1) + C_{\searrow} \\ C(x,y-1) + C_{\downarrow} \end{cases}$$

$C_{\searrow} = SSD(x,y)$

$C_{\rightarrow}$ and $C_{\downarrow}$ fixed occlusion penalty.

5.4

Plane sweep



$$H = K_2\left(R + \frac{t n^T}{d}\right) K_1^{-1}$$

for plane in cam 1 $n = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

axis aligned $t = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$, $R = I$

$$H = I + \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} (0\ 0\ 1) \frac{1}{d} = \begin{pmatrix} 1 & 0 & 1/d \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

5.5

$$I = k_d \, l^T \underline{n}$$

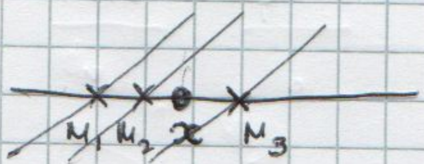
Lambertian reflectance
light direction l
surface normal n

$$k_d \, n = p$$

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} l_1^T \\ l_2^T \\ l_3^T \end{bmatrix} p = k_d \underline{n}$$

given known (3) lights $\underline{l}_i$ we can solve for $\underline{n}$

5.6



$$\min_x e \doteq \frac{1}{2}\sum_i (x - M_i)^2$$

$$\text{SDF at } x = \sum_i (x - M_i)$$

$$\text{SDF} = \frac{\partial e}{\partial x}$$

so SDF $= 0 \rightarrow$ least squared soln for x.

5.7

$$e(\underline{u}) = \left| \underline{I}_1(\underline{x}+\underline{u}) - \underline{I}_0(\underline{x}) \right|^2$$

$$\simeq \left| \underline{I}_1(\underline{x}) + \frac{\partial I}{\partial \underline{x}}^T \Delta u - \underline{I}_0(\underline{x}) \right|^2$$ linearize locally.

of form $e(\underline{v}) = | J \Delta u + r |^2$

minimise via least squares

$$\Delta u = -(J^T J)^{-1} J^T r$$

+ iterate

5.8

$$\frac{\partial I_1}{\partial x}^T \Delta u = I_0(x) - I_1(x)$$

$\div \Delta t$ $$\nabla I^T v = -\frac{\partial I}{\partial t} =$$