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CS-E4850 COMPUTER VISION

Exercise Round 12

Exercise 1.

(Done)

Exercise 2.

We have:

$$\begin{cases} P = [I \mid 0] \\ P' = [R \mid t] \end{cases}$$

where $\begin{cases} R \text{ is rotation matrix} \\ t = [t_1, t_2, t_3]^T \text{ is translation vector} \end{cases}$

We have: $\overrightarrow{O'p'} \cdot (\overrightarrow{O'O} \times \overrightarrow{Op}) = 0$

→ Given $x = (x, y, 1)^T$ and $x' = (x', y', 1)^T$ as homegenous image coordinate vectors of p and p':

$$\overrightarrow{O'p'} = x'$$

→ From the camera coordinates and translation between camera origins:

$$\overrightarrow{Op} = Rx \,, \quad \overrightarrow{O'O} = t$$

Therefore, $\overrightarrow{O'p'} \cdot (\overrightarrow{O'O} \times \overrightarrow{Op}) = x' \cdot (t \times Rx) = 0$

$\Rightarrow x'^T \cdot [t]_\times R \, x = 0$

We have $E = [t]_\times R$

$\Rightarrow x'^T \cdot E \cdot x = 0$

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Exercise 3.

a) Assume $d = 1cm$, $b = 6cm$ & $f = 1cm$.

$$d = x - x' = \frac{b \cdot f}{Z_p}$$

$$\Rightarrow Z_p = \frac{b \cdot f}{d} = 6 \ (cm)$$

b) $d_{min} = 1$ pixel

pixel width $= 0.01$ mm

For points with disparity below 1 pixel:

$$d = \frac{b \cdot f}{Z_p} \leq 0.01 \ (mm) = 0.001 \ cm$$

$$\Rightarrow Z_p \geq \frac{bf}{0.001} = \frac{6}{0.001} = 6000 \ cm$$

c) $P_l = [I \ 0]$, where I is identity matrix

$P_r = [I \ t]$ $\quad t = [-6, 0, 0]^T$

$Q(3, 0, 3)$

We have:

$$E = [t]_\times R \text{ , where } R = I \ \& \ t = [-6, 0, 0]^T$$

$$\Rightarrow E = [t]_\times R = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 6 \\ 0 & -6 & 0 \end{bmatrix}$$

$$x = P_l \cdot (3, 0, 3, 1)^T = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 3 \\ 0 \\ 3 \\ 1 \end{bmatrix} = \begin{bmatrix} 3 \\ 0 \\ 3 \end{bmatrix}$$

$$\Rightarrow E \cdot x = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 6 \\ 0 & -6 & 0 \end{bmatrix} \begin{bmatrix} 3 \\ 0 \\ 3 \end{bmatrix} = \begin{bmatrix} 0 \\ 18 \\ 0 \end{bmatrix}$$

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