1(a) : $Q_{\delta\delta}$ 3-1

$-Wv + A^T k = 0$

$Av + B\delta = -f$ $\Rightarrow$ G.E.

$B^T k + C^T k_c = 0$

$C\delta = g$

$v = QA^T k$

$k = W_e(f - B\delta)$

$\delta = N^{-1}t + N^{-1}C^T k_c$

$k_c = (CN^{-1}C^T)^{-1}(g - CN^{-1}t)$

$\Delta = \boxed{}$ $\Rightarrow$ $y = Ax + b$

make substitutions until you have only 1 random vect.

(only "f") g = constant

$f = d - Al$, $Q_{ff} = (-A)Q(-A^T) = Q_e$ ⋮

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photogrammetry camera cluster $\omega_1, \varphi_1, k_1, X_{c_1}, Y_{c_1}, Z_{c_1}$

$\omega_2, \varphi_2, k_2, X_{c_2}, Y_{c_2}, Z_{c_2}$

$\omega_2 = f_\omega(\omega_1, \varphi_1, k_1)$

$\varphi_2 = f_\varphi(\omega_1, \varphi_1, k_1)$

$k_2 = f_k(\omega_1, \varphi_1, k_1)$

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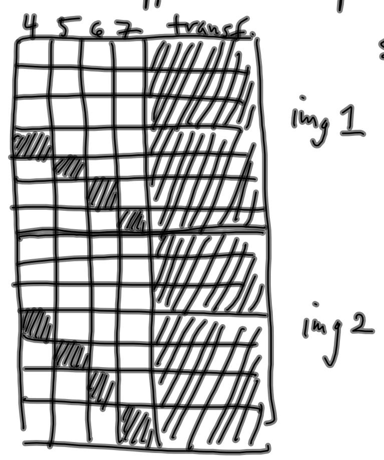
2 cameras	12 unk	6 constr.	3-2
3 "	18 unk	12 constr	
4 "	24 unk	18 constr	
5 "	30 unk	24 constr	

alt. approach 6 parameters

spy(B)



B

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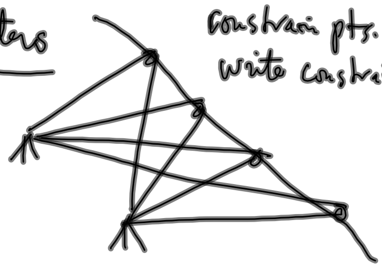
added parameters

constrain pts. to a line
write constraint eqns

3-3



$$\frac{y_3-y_1}{x_3-x_1} = \frac{y_2-y_1}{x_2-x_1}$$

$$\frac{y_4-y_1}{x_4-x_1} = \frac{y_2-y_1}{x_2-x_1}$$

2D

$$y_1 = m x_1 + b$$
$$y_2 = m x_2 + b$$
$$y_3 = m x_3 + b$$
$$y_4 = m x_4 + b$$

introduce m, b

LS treatment of added parameters

$$\underset{c,n}{A}\ \underset{n,1}{v} + \underset{c,u}{B}\ \underset{u,1}{\Delta} = \underset{c,1}{f}$$

$$\underset{s',u}{D_1}\ \underset{u,1}{\Delta} + \underset{s',q}{D_2}\ \underset{q,1}{\Delta'} = \underset{s',1}{h}$$

q added params
s' total # constr. eqs

$\underline{c+s' = r + (u+q)}$

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augmented obj. function :

3-4

$$\phi' = v^T W v - 2k^T(Av + B\Delta - f) - 2k_c^T(D_1\Delta + D_2\Delta' - h)$$

$$\frac{\partial \phi'}{\partial v} = \cancel{2}v^T W - \cancel{2}k^T A = 0$$

$$\frac{\partial \phi'}{\partial \Delta} = -\cancel{2}k^T B - \cancel{2}k_c^T D_1 = 0$$

$$\frac{\partial \phi'}{\partial \Delta'} = -\cancel{2}k_c^T D_2 = 0$$

$$Wv - A^T k = 0$$
$$-B^T k - D_1^T k_c = 0$$
$$-D_2^T k_c = 0$$

$$-Wv + A^T k = 0$$
$$B^T k + D_1^T k_c = 0$$
$$D_2^T k_c = 0$$

$$-Wv + A^T k = 0$$
$$Av + B\Delta = f$$
$$B^T k + D_1^T k_c = 0$$
$$D_1\Delta + D_2\Delta' = h$$
$$D_2^T k_c = 0$$

$$\begin{bmatrix} -W & A^T & 0 & 0 & 0 \\ A & 0 & B & 0 & 0 \\ 0 & B^T & 0 & D_1^T & 0 \\ 0 & 0 & D_1 & 0 & D_2 \\ 0 & 0 & 0 & D_2^T & 0 \end{bmatrix} \begin{bmatrix} v \\ k \\ \Delta \\ k_c \\ \Delta' \end{bmatrix} = \begin{bmatrix} 0 \\ f \\ 0 \\ h \\ 0 \end{bmatrix}$$

full normal equations

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If we did G.E. (blocks) then   3-5

$v = QA^T k$

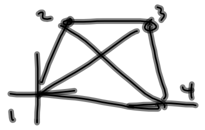
$k = W_e (f - B\delta)$

$\delta = N^{-1}t + N^{-1}D_1^T k_c$

$k_c = (D_1 N^{-1} D_1^T)^{-1} (h - D_1 N^{-1} t - D_2 \delta')$

$\delta' = \left[D_2^T (D_1 N^{-1} D_1^T)^{-1} D_2\right]^{-1} \left[D_2^T (D_1 N^{-1} D_1^T)^{-1} h - D_2^T (D_1 N^{-1} D_1^T)^{-1} D_1 N^{-1} t\right]$

<u>Inner constraint</u>   special case of minimal constraints

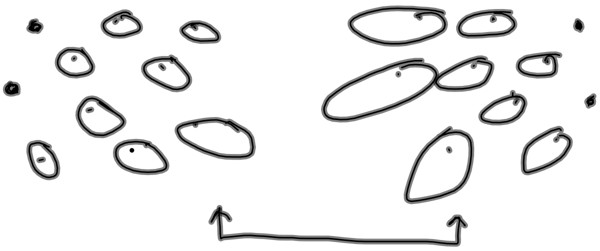


x_1, y_1, y_4

x_1, y_1, y_3

x_3, y_3, y_1

x_1, y_1, x_3 ?? $\times$



3-6

without constraints   N is singular

if choose C whose rows are orthogonal to rows of N

then that C = inner constraint matrix