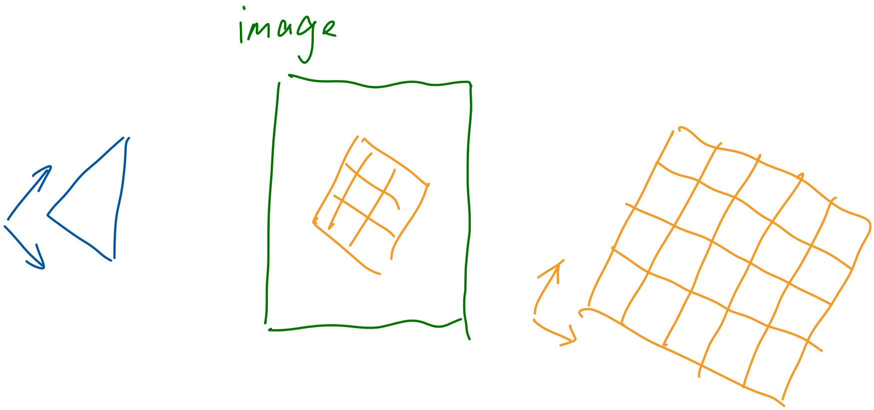

$$\{\theta_k\}, \{T^{camera_j}_{model}\} =$$

$$\underset{\{\theta_k\}, \{T^{camera_j}_{model}\}}{\operatorname{argmin}} \sum_i^m \sum_j^n \left\| P\left(T^{camera_j}_{model} \cdot M_i ; \{\theta_k\}\right) - m_i \right\|_2^2$$

$$\sum_i^m \sum_j^n \|r_{ij}\|_2^2 = \left\| [r_{00} \dots r_{0m} \; r_{10} \dots r_{nm}]^T \right\|_2^2$$

$$a^\wedge = \begin{bmatrix} 0 & -a_3 & a_2 \\ a_3 & 0 & -a_1 \\ -a_2 & a_1 & 0 \end{bmatrix}$$

$$\exp(\phi^\wedge) = \exp(\theta n^\wedge) = \sum_{n=0}^{\infty} \frac{1}{n!} (\theta n^\wedge)^n$$

$$= \cos\theta I + (1-\cos\theta) n n^T + \sin\theta n^\wedge$$

$$\xi = \begin{bmatrix} \rho \\ \phi \end{bmatrix} \in R^6 \rightarrow SE(3)$$

$$\xi^\wedge = \begin{bmatrix} \phi^\wedge & \rho \\ 0^T & 0 \end{bmatrix} \qquad T = \begin{bmatrix} R & t \\ 0^T & 1 \end{bmatrix}$$

$$t = J\rho \qquad J = \frac{\sin\theta}{\theta} I + \left(1 - \frac{\sin\theta}{\theta}\right) a a^T + \frac{1-\cos\theta}{\theta} a^\wedge$$

$$u = f_x \frac{X'}{Z'} + c_x \qquad v = f_y \frac{Y'}{Z'} + c_y$$

$$\frac{\partial e}{\partial \delta \xi} = \lim_{\delta \xi \to 0} \frac{e(\delta \xi \oplus \xi) - e(\xi)}{\delta \xi} = \frac{\partial e}{\partial p'} \frac{\partial p'}{\partial \delta \xi}$$

$$\frac{\partial e}{\partial p'} = \begin{bmatrix} \frac{f_x}{Z'} & 0 & -\frac{f_x X'}{Z'^2} \\ 0 & \frac{f_y}{Z'} & -\frac{f_y Y'}{Z'^2} \end{bmatrix}$$

$$\frac{\partial (TP)}{\partial \delta \xi} = \lim_{\delta \xi \to 0} \frac{\exp(\delta \xi^\wedge) \exp(\xi^\wedge) p - \exp(\xi^\wedge) p}{\delta \xi}$$

$$= \lim_{\delta \xi \to 0} \frac{(I + \delta \xi^\wedge) \exp(\xi^\wedge) p - \exp(\xi^\wedge) p}{\delta \xi}$$

$$= \lim_{\delta \xi \to 0} \frac{\delta \xi^\wedge \exp(\xi^\wedge) p}{\delta \xi}$$

$$= \lim_{\delta \xi \to 0} \frac{\begin{bmatrix} \delta \phi^\wedge & \delta \rho \\ 0^T & 0 \end{bmatrix} \begin{bmatrix} Rp + t \\ 1 \end{bmatrix}}{\delta \xi}$$

$$= \lim_{\delta \xi \to 0} \frac{\begin{bmatrix} \delta \phi^\wedge (Rp + t) + \delta \rho \\ 0^T \end{bmatrix}}{[\delta \rho, \delta \phi]^T}$$

$$= \begin{bmatrix} I & -(Rp + t)^\wedge \\ 0^T & 0^T \end{bmatrix}$$