18CSE390T
Computer Vision

Bundle Adjustment

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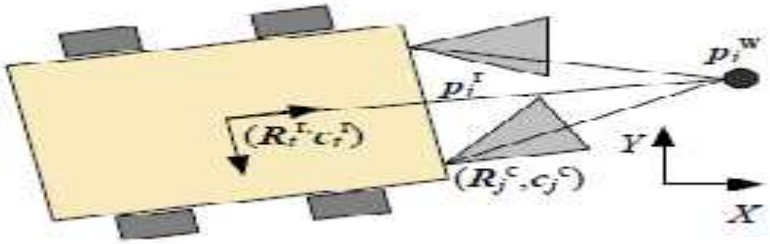
- The most accurate way to recover structure from motion is to perform robust nonlinear minimization of the measurement (re-projection) errors, which is known as photogrammetry (in computer vision) communities as *bundle adjustment.*
- Our feature location measurement x_{ij} now depends only on the point (track index) $\boldsymbol{i}$ but also on the camera pose index $\boldsymbol{j}$.
- $\boldsymbol{x_{ij} = f(p_i, R_j, c_j, K_j)}$
- 3D point positions p_i are also updated simultaneously

Bundle Adjustment (cont.)



- The leftmost box performs a robust comparison of the predicted and measured 2D locations $\hat{\boldsymbol{x}}_{ij}$ and $\tilde{\boldsymbol{x}}_{ij}$ after re-scaling by the measurement noise covariance Σ_{ij}.

- Operation can be

$$\begin{aligned} \boldsymbol{r}_{ij} &= \tilde{\boldsymbol{x}}_{ij} - \hat{\boldsymbol{x}}_{ij}, \\ s_{ij}^2 &= \boldsymbol{r}_{ij}^T \Sigma_{ij}^{-1} \boldsymbol{r}_{ij}, \\ e_{ij} &= \hat{\rho}(s_{ij}^2), \end{aligned}$$

$$\hat{\rho}(r^2) = \rho(r).$$

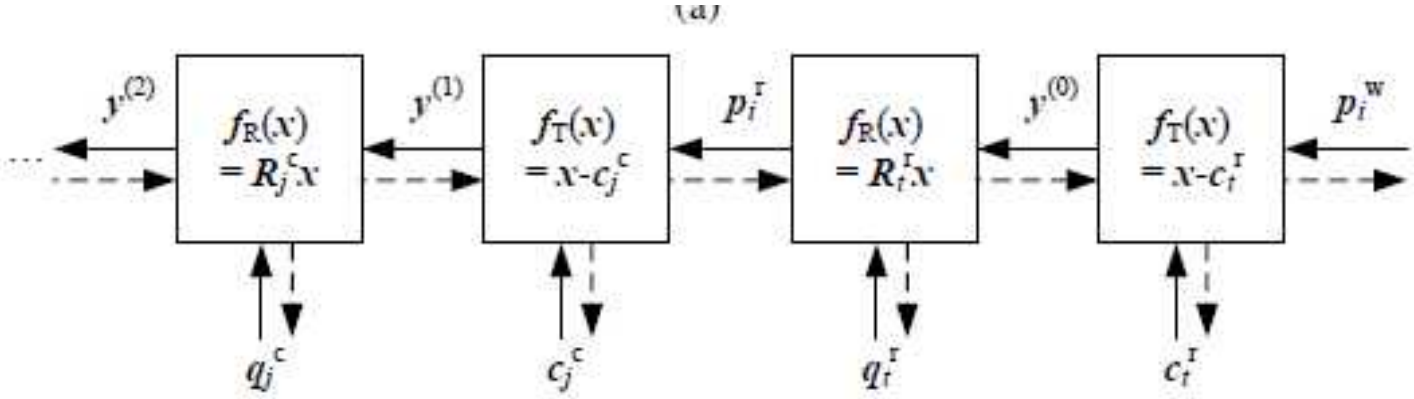


Figure: A camera rig and its associated (b) transform chain. (a) As the mobile rig (robot) moves around in the world, its pose with respect to world at time t is captured by (R^r_t, c^r_t). Each camera's pose with respect to the rig captured by (R^r_t, c^r_t). (b) A 3D point with world coordinates p^w_i is first transformed into rig coordinates p^r_i, and then through rest of the camera-specific chain.