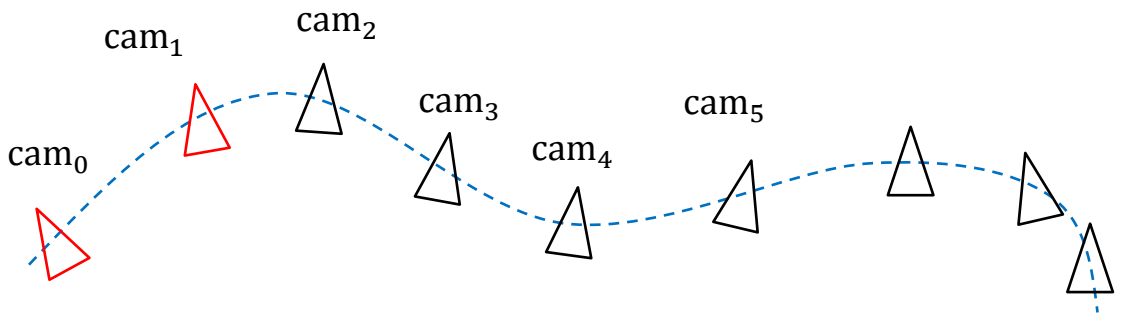
Lab 7 – Visual Odometry

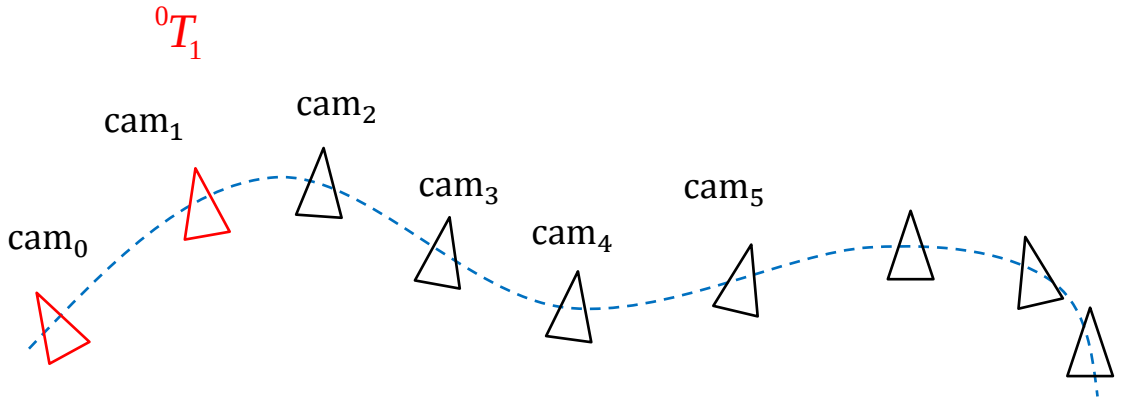
Lab 7 overview

- Camera calibration
- Visual Odometry

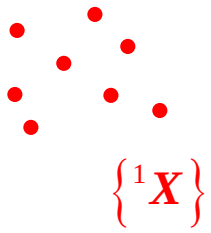
- **Initialize from two-view**
  - Establish 2D-2D correspondences
  - Find inliers using 5-pt algorithm
  - Estimate fundamental matrix F
  - Compute essential matrix E
  - Determine relative pose from E and determine 3D points by triangulation
- **Estimate pose of next frame**
  - PnP relative to existing 3D points

$\{\boldsymbol{u}_0 \leftrightarrow \boldsymbol{u}_1\} \rightarrow E \xrightarrow{\text{decompose cheirality}}$ ${}^{0}T_1$

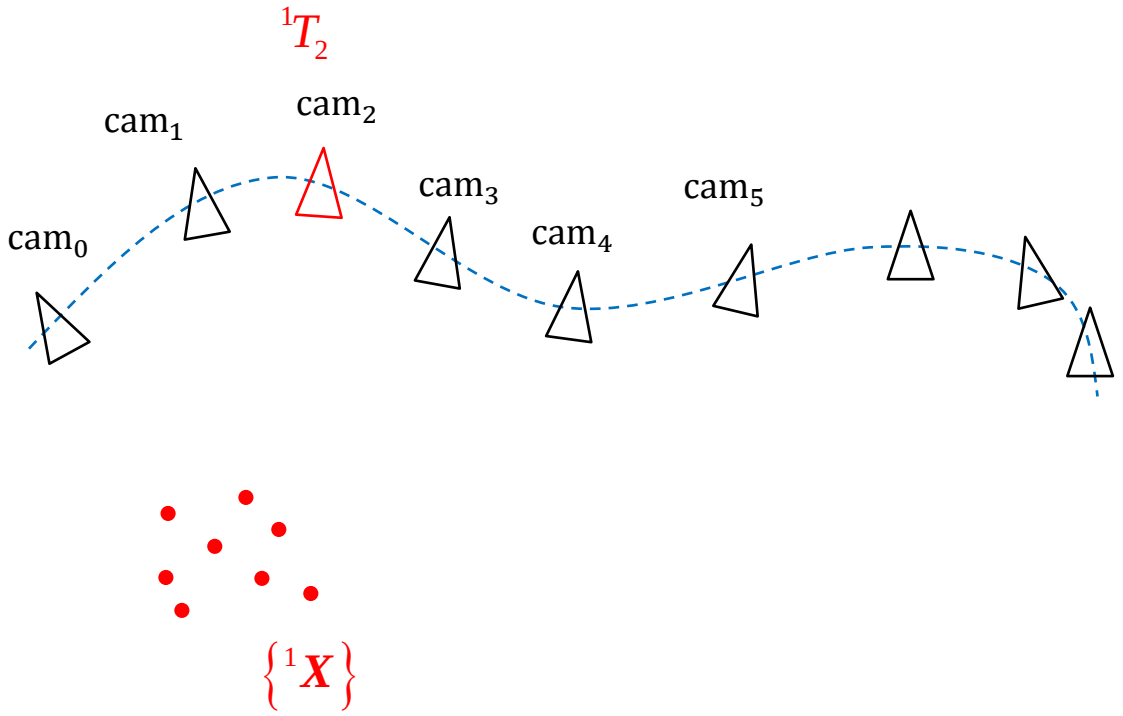


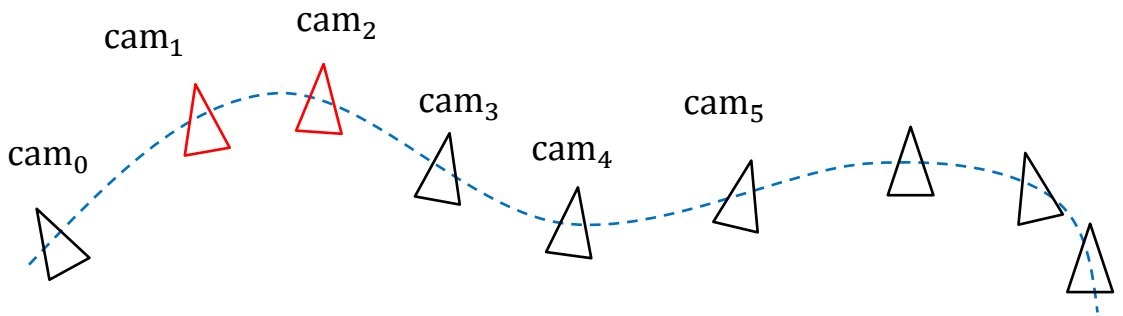


$$\left.\begin{aligned} P_0 &= K\begin{bmatrix} I & \boldsymbol{0} \end{bmatrix} \\ P_1 &= K\begin{bmatrix} R & \boldsymbol{t} \end{bmatrix} \\ \{\boldsymbol{u}_0 &\leftrightarrow \boldsymbol{u}_1\} \end{aligned}\right\} \xrightarrow{\textit{Triangulation}}$$

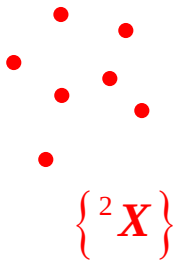


$$\left.\begin{matrix} K \\ \left\{ {}^{1}\boldsymbol{X} \leftrightarrow \boldsymbol{u}_2 \right\} \end{matrix}\right\} \xrightarrow{PnP}$$

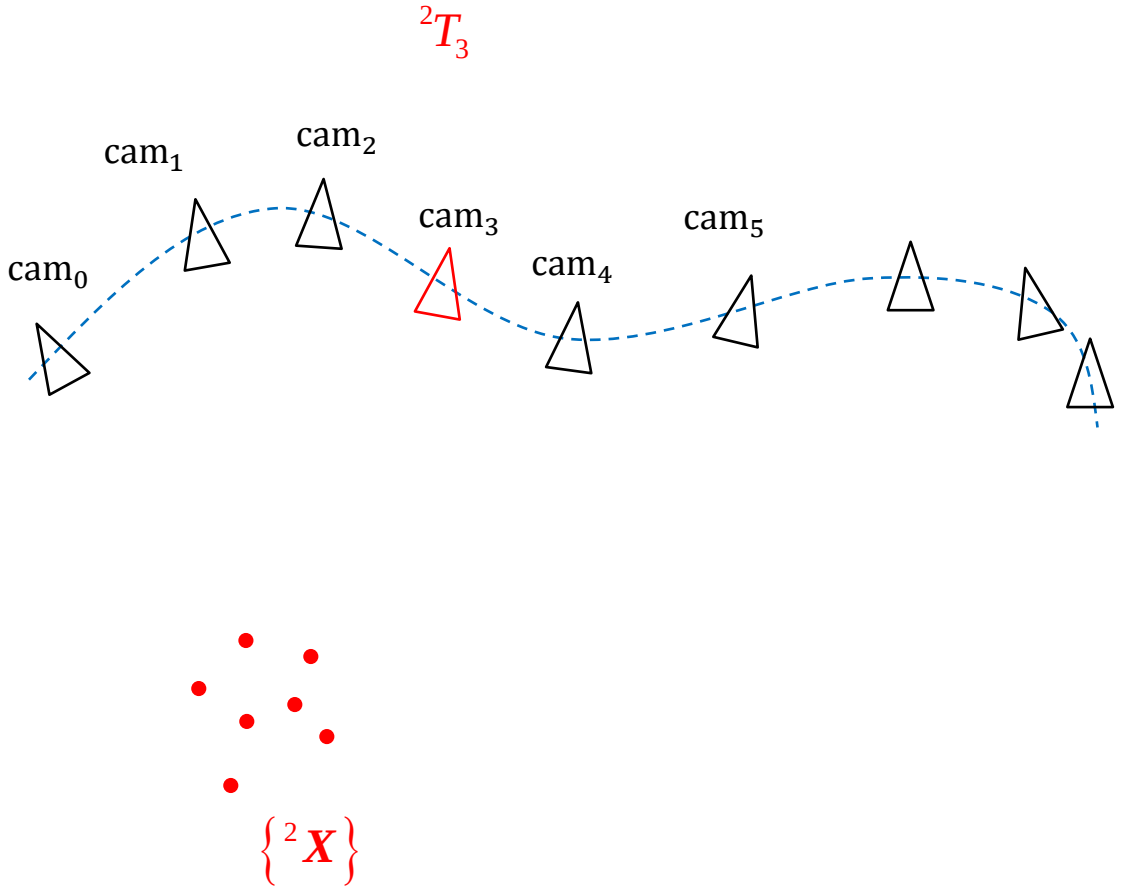




$$\left.\begin{aligned} P_1 &= K\begin{bmatrix} I & \mathbf{0} \end{bmatrix} \\ P_2 &= K\begin{bmatrix} R & \boldsymbol{t} \end{bmatrix} \\ \{\boldsymbol{u}_1 &\leftrightarrow \boldsymbol{u}_2\} \end{aligned}\right\} \xrightarrow{\textit{Triangulation}}$$



$$\left.\begin{matrix} K \\ \left\{ {}^{2}\boldsymbol{X} \leftrightarrow \boldsymbol{u}_3 \right\} \end{matrix}\right\} \xrightarrow{PnP}$$



TODOs

- **TODO 1**: Find inlier 2d-2d correspondences using cv::findEssentialMat()
- **TODO 2**: Compute the fundamental matrix F using cv::findFundamentalMat()
- **TODO 3**: Compute essential matrix from F
- **TODO 4**: Estimate pose from the essential matrix using cv::recoverPose()

Further improvements

- Avoid triangulating points with low disparity
- Compute and visualize epipolar lines for points
- Add colors from the images to the pointcloud
- Improve matching
  - Try using cv::correctMatches() in createMap()
- Use GTSAM to optimize the map