

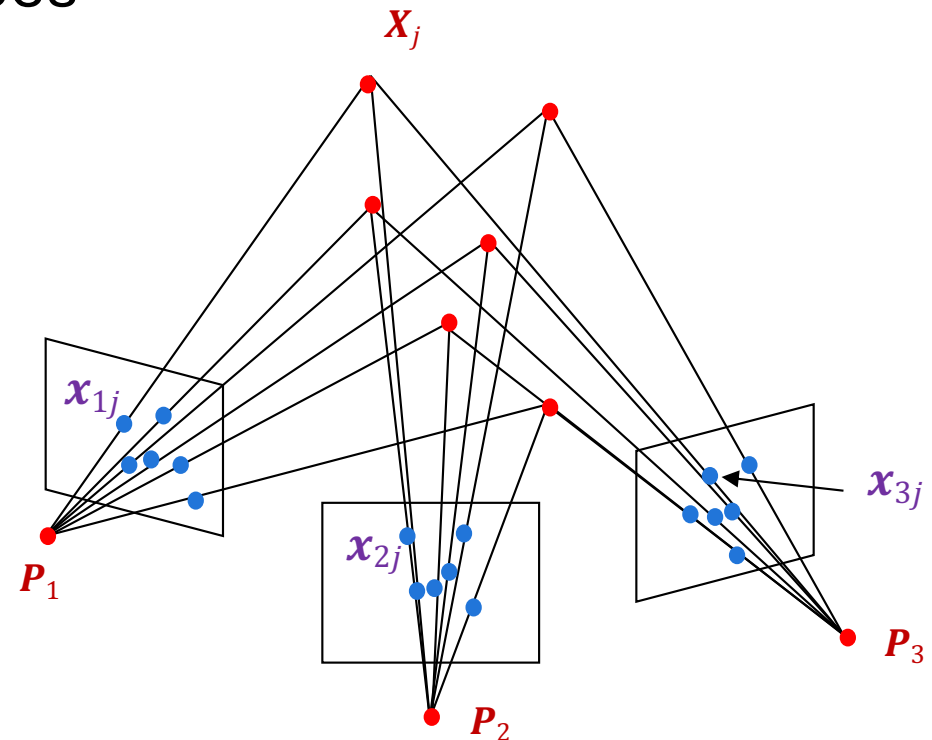
Structure and motion

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Core problem

- Given:
 - m images of n fixed 3D points
 - $\mathbf{x}_{ij} \cong \mathbf{P}_i \mathbf{X}_j, \quad i = 1, \dots, m, \quad j = 1, \dots, n$
 - with known correspondences
- Estimate:
 - m projection matrices \mathbf{P}_i
 - n 3D points \mathbf{X}_j



Cases:

- Offline
 - work with all images
 - structure from motion
 - underlying Q:
 - how to make best use of all information
 - roughly familiar structure
 - set up huge optimization problem by constructing start point
 - efficiency is now a serious issue
- Online
 - build best estimate available up to time t
 - SLAM
 - simultaneous localization and mapping
 - build a map at the same time as determining where you are
 - new Q:
 - how do you make best use of all information up to now
 - efficiency often crucial
- Hybrids are quite usual, and important

Applications

- Enable inspection in hard to reach areas with drone photos and 3D reconstruction
- Create 3D model from images
- Provide tools to inspect on images and map interactions to 3D

Source: D. Hoiem



Project


Secure <https://dev.reconstructinc.com/project>

PROJECT: MLIT.LUCHE_BRIDGE

2 day(s) left in trial

Reconstruct: Inspect aging infrastructure

Derek Hoiem



Point Cloud

Opacity

Size

Images

Opacity

Frustum Size

Show All Cameras

File Name

Schedule

Fri Feb 24 2017

Luche Bridge, Ministry of Land, Transport, and Infrastructure, Japan

Point Cloud

RECONSTRUCT

Applications: where is my drone?

- Highly relevant
- Taste prevents the use of news pictures...

Structure from motion ambiguity

- Transform the scene using a transformation Q
- Apply inverse to the camera matrices
- The image observations do not change:

$$x \cong PX = (PQ^{-1})(QX)$$

Structure from motion ambiguity

- Cases:
 - nothing is known about cameras – Q is projective tx
 - camera calibrations known – Q is scaled Euclidean

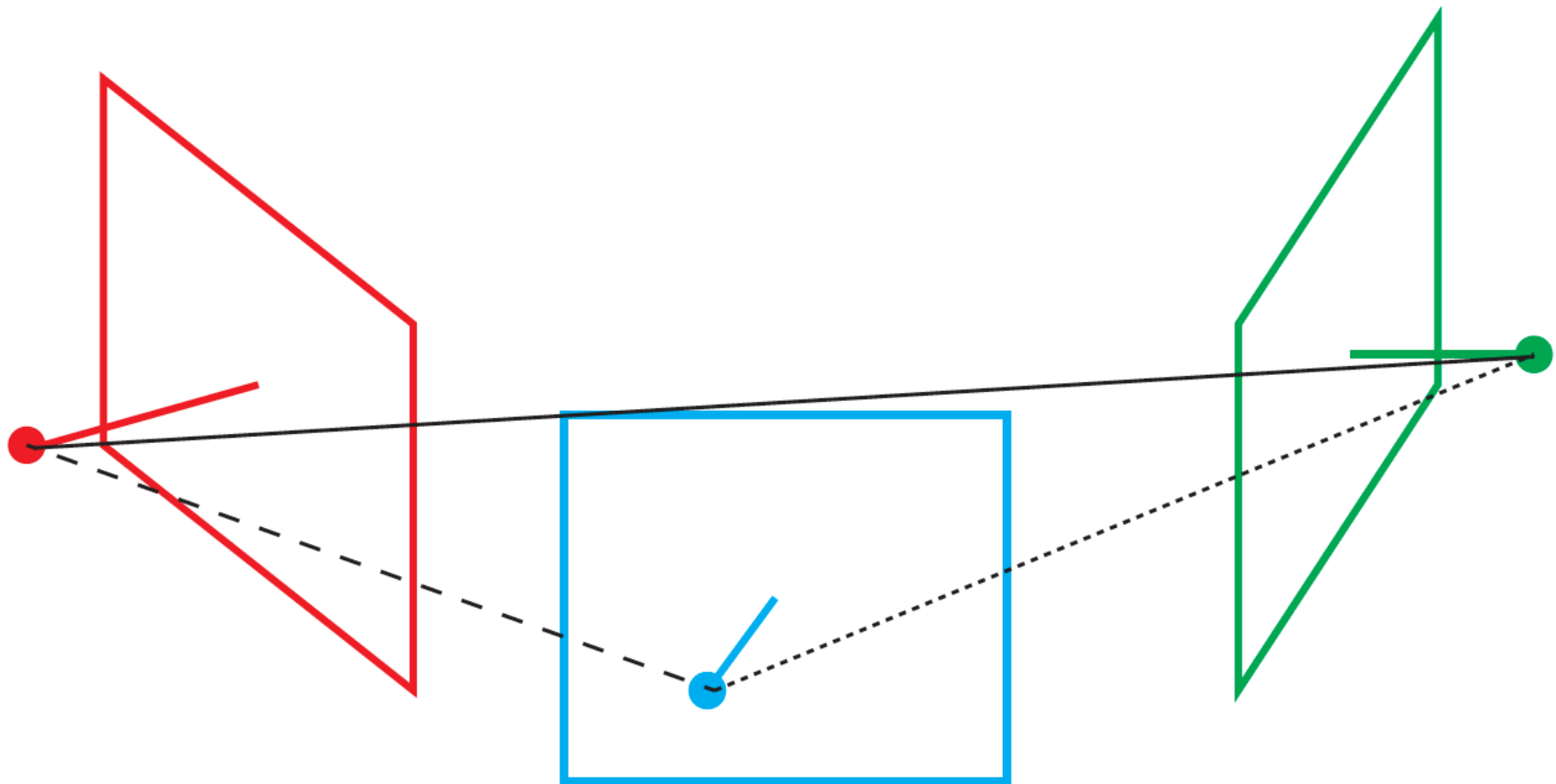
Recall: Two calibrated cameras

- Obtain interest points and some matches
- Obtain fundamental matrix
 - as before, using matches
- Obtain essential matrix
 - as before, using calibration
- Obtain rotation, translation up to scale
 - as before, using odometry
- Triangulate

Three calibrated cameras

- Do two cameras for c_1, c_2
 - reconstruct all points in both c_1 and c_2
- Now figure out c_3
 - using reconstructions - calibration
 - There is only one missing scale!
- You can now insert more points into 3D!
 - anything in c_1 and c_3 but not c_2
 - anything in c_2 and c_3 but not c_1
 - just more triangulation

There is only one missing scale...



Three calibrated cameras

- You can now insert more points into 3D!
 - anything in c1 and c3 but not c2
 - anything in c2 and c3 but not c1
 - just more triangulation

3 or more calibrated cameras

- Issue:
 - in what order should you insert cameras?
- Online:
 - no issue
 - in the order you get them, BUT
 - how do you get best estimate of points, cameras from data?
- Offline
 - major issue