2-view Alignment and RANSAC

CSE P576

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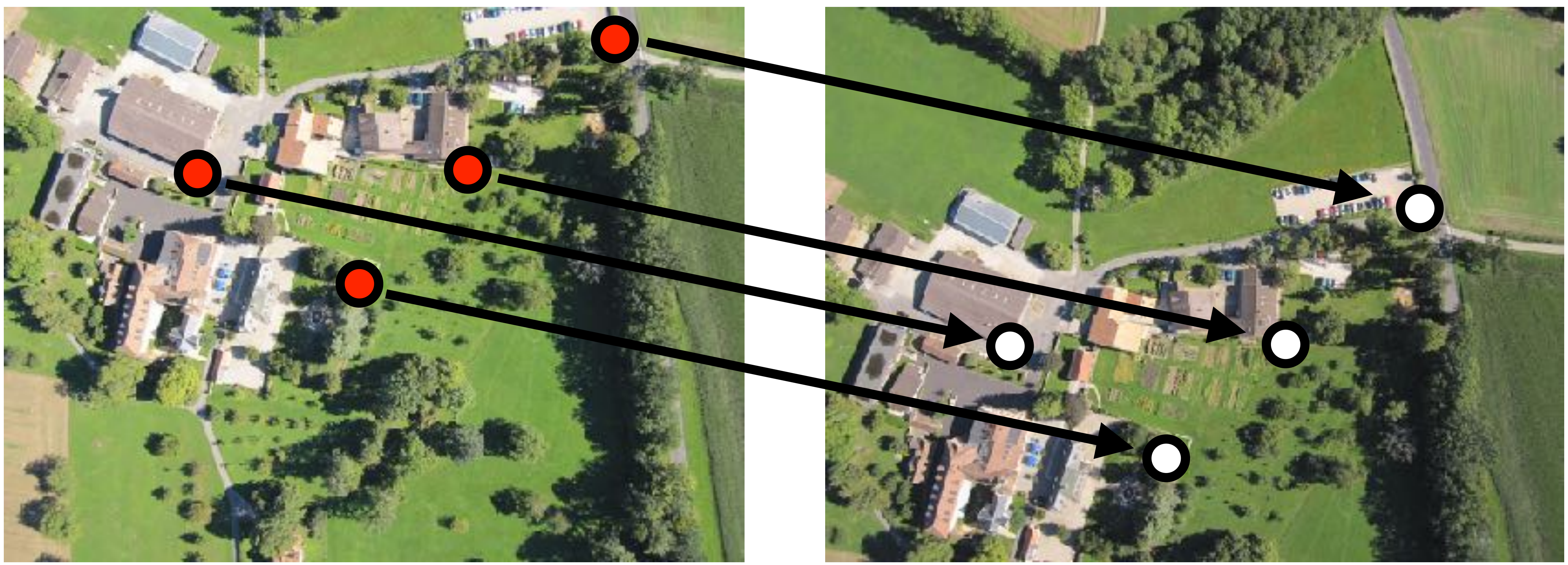
2-view Alignment + RANSAC

- 2-view alignment: linear equations
- Least squares and outliers
- Robust estimation via sampling

[Szeliski 6.1]

Image Alignment

- Find corresponding (matching) points between the images

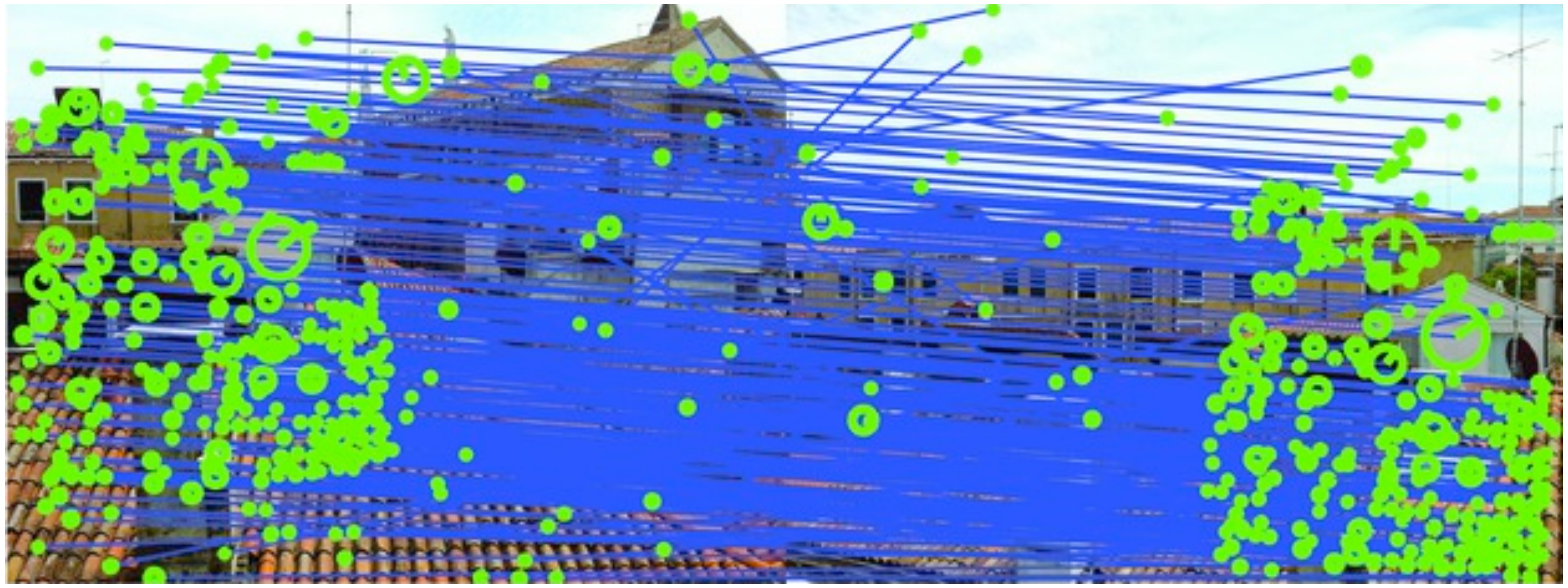


$$\mathbf{u} = \mathbf{H}\mathbf{x}$$

2 points for Similarity
3 for Affine
4 for Homography

Image Alignment

- In practice we have many noisy correspondences + **outliers**



Linear Equations

- e.g., for an affine transform we have a linear system in the unknown parameters **a**:

$$\begin{bmatrix} x_1 & y_1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & x_1 & y_1 & 1 \\ x_2 & y_2 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & x_2 & y_2 & 1 \\ x_3 & y_3 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & x_3 & y_3 & 1 \end{bmatrix} \begin{bmatrix} a_{11} \\ a_{12} \\ a_{13} \\ a_{21} \\ a_{22} \\ a_{23} \end{bmatrix} = \begin{bmatrix} x'_1 \\ y'_1 \\ x'_2 \\ y'_2 \\ x'_3 \\ y'_3 \end{bmatrix}$$

$$\vdots \qquad\qquad\qquad\qquad \vdots$$

- It is **overconstrained** (more equations than unknowns)
- and subject to **outliers** (some rows are completely wrong)

Let's deal with these problems in a simpler context..

Robust Line Fitting

- Consider fitting a line to noisy points

3.8

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

4 inliers (red, yellow, orange, brown),

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

4 outliers (blue, light blue, purple, pink)

RANSAC Example

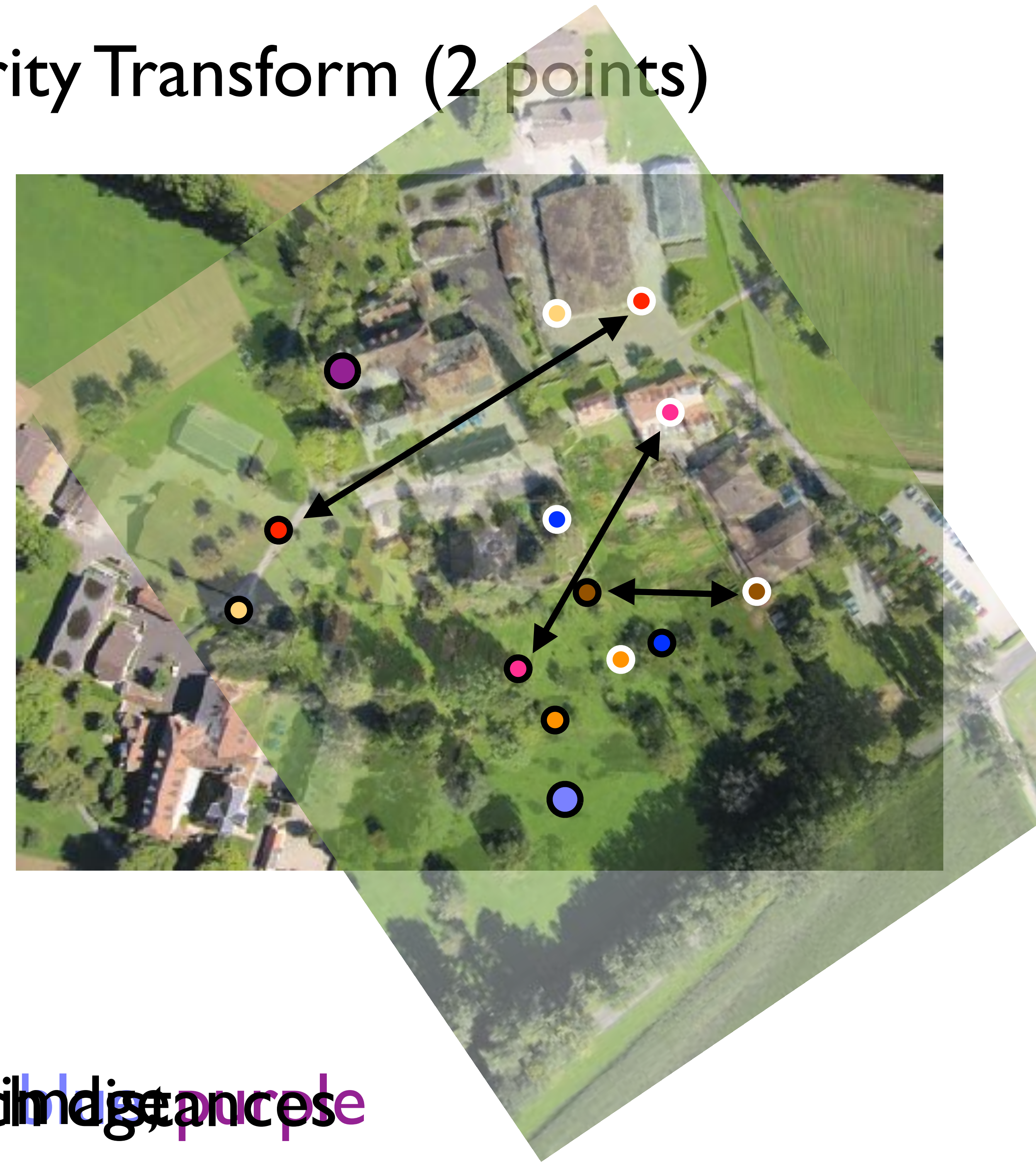
- RANSAC solution for Similarity Transform (2 points)


4 inliers (red, yellow, orange, brown),

4 outliers (blue, light blue, purple, pink)

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)



choose light blue, purple
warp image
check match distances

#inliers = 2

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

choose pink blue
warp image
check match distances

#inliers = 2

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

choose red, orange
warp image
check match distances

#inliers = 4

RANSAC Example

- RANSAC solution for Similarity Transform (2 points)

RANSAC recap

1. Select minimal subset of points
2. Compute transformation T using minimal subset
3. Check consistency of all points with T, count #inliers
4. Repeat steps 1-3 to maximise #inliers

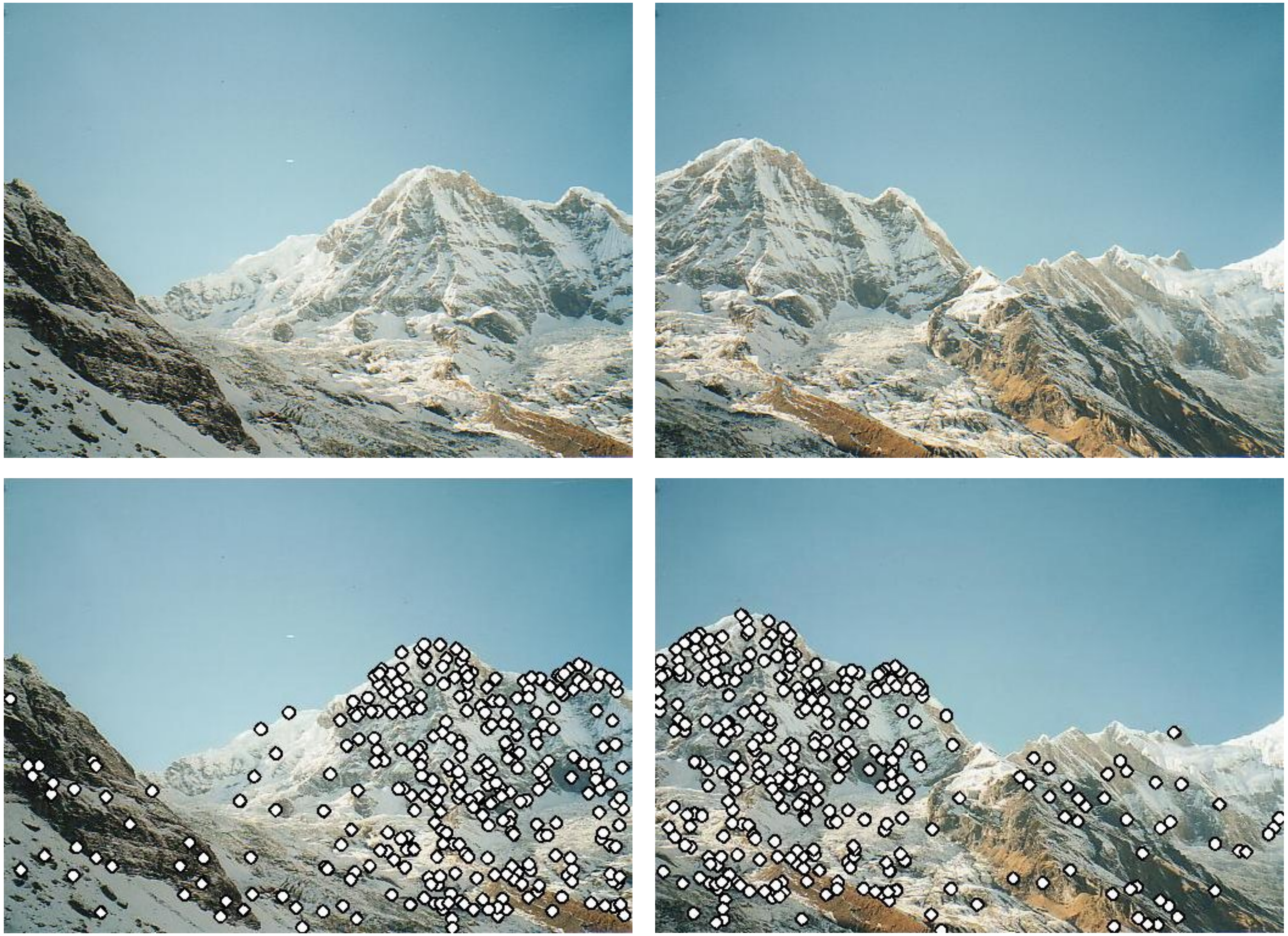
Project 2

P2

- Try out the **RANSAC Implementation** section in Project 2.

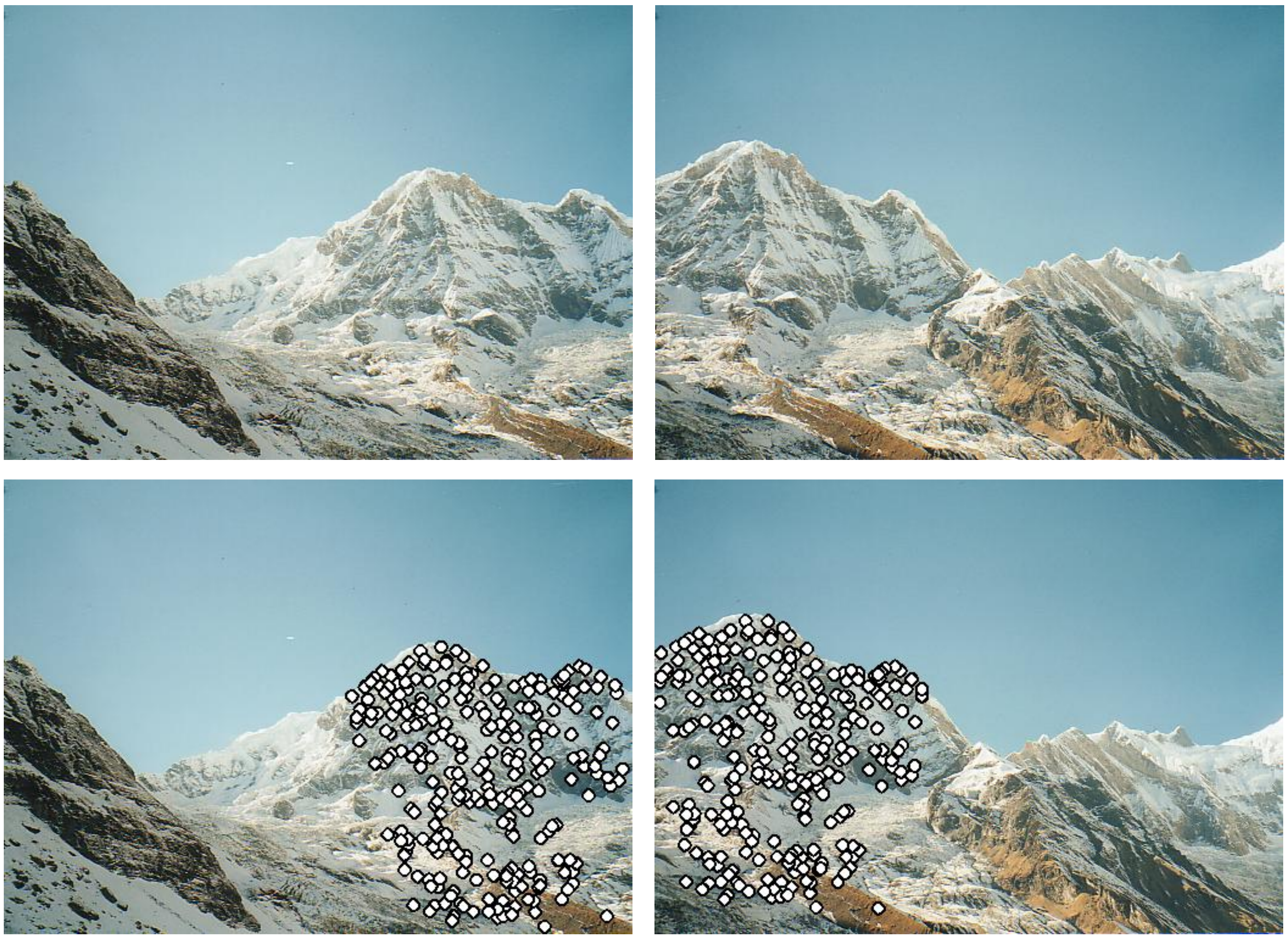
2-view Rotation Estimation

- Find features + raw matches, use RANSAC to find Similarity



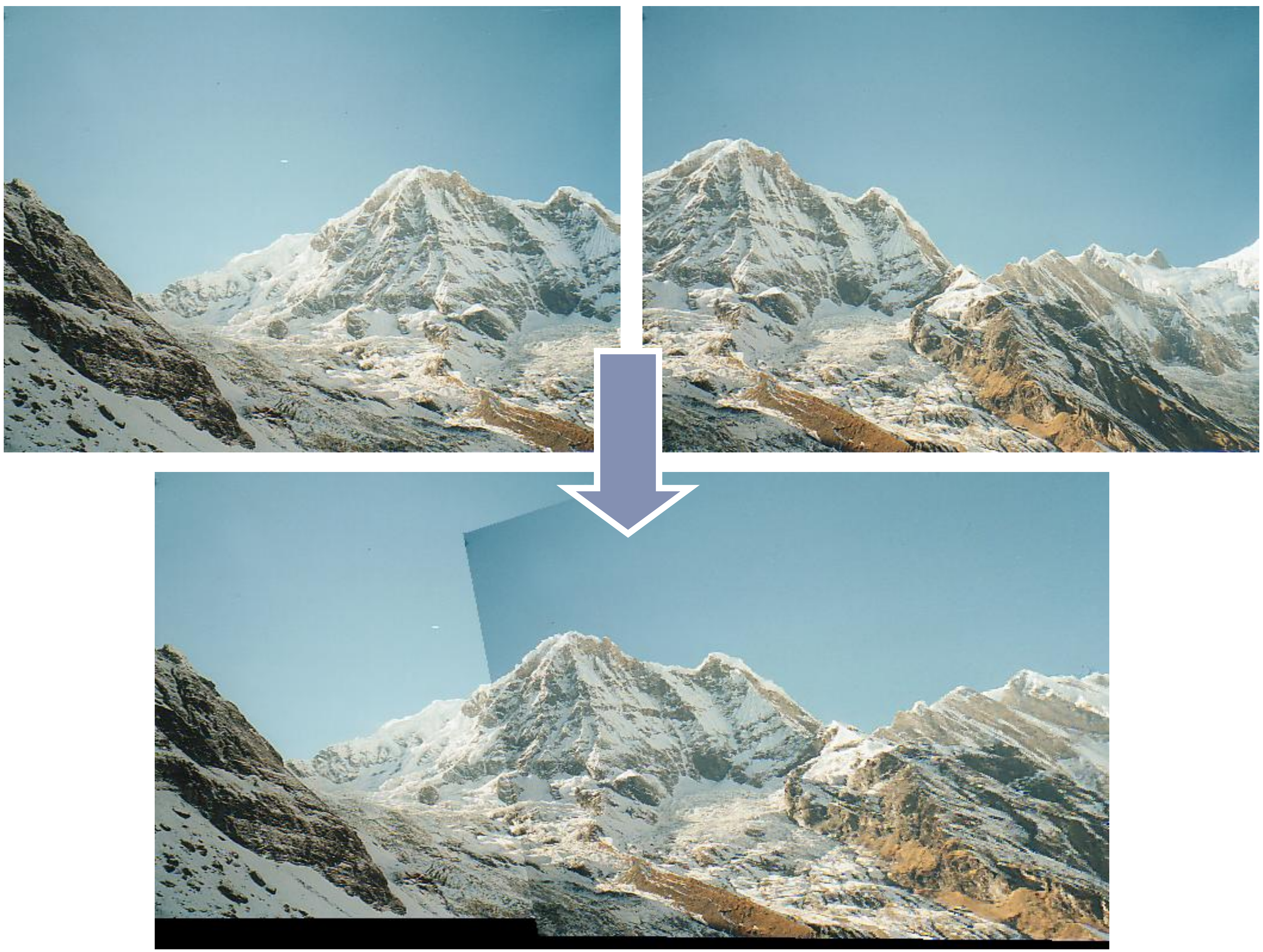
2-view Rotation Estimation

- Remove outliers, can now solve for R using least squares



2-view Rotation Estimation

- Final rotation estimation



Rotation Estimation

- Least squares estimate of rotation from corresponding rays

3.9

$$C = \sum_i \hat{\boldsymbol{x}}' \hat{\boldsymbol{x}}^T = \boldsymbol{U}\boldsymbol{\Sigma}\boldsymbol{V}^T$$

$$\boldsymbol{R} = \boldsymbol{U}\boldsymbol{V}^T$$

[Szeliski p321]

[Arun et al 1987, “Kabsch Algorithm” 1976, Orthog. Procrustes]

Next Lecture

- Epipolar Geometry