



VISUAL NAVIGATION

Annex A

Estimation of rotation and translation

Problem formulation

- First set of data points (3 x n matrix): \mathbf{X}
- Second set of data points (3 x n matrix): \mathbf{X}'
- The two sets are related as

$$\mathbf{X}'_i = \mathbf{R}\mathbf{X}_i + \mathbf{t}$$

where \mathbf{R} is an orthonormal matrix (rotation) and \mathbf{t} a real-valued translation vector

- How to estimate both rotation and translation?

Estimation

- Compute centroids $\mathbf{c} = \frac{1}{n} \sum_{i=1}^n \mathbf{X}_i$ and $\mathbf{c}' = \frac{1}{n} \sum_{i=1}^n \mathbf{X}'_i$
- Compute matrix $\mathbf{H} = \sum_{i=1}^n (\mathbf{X}_i - \mathbf{c})(\mathbf{X}'_i - \mathbf{c}')^T$
- Compute SVD decomposition $\mathbf{H} = \mathbf{U}\mathbf{S}\mathbf{V}^T$
- Estimation of rotation: $\mathbf{R} = \mathbf{V}\mathbf{U}^T$
- Estimation of translation: $\mathbf{t} = \mathbf{c}' - \mathbf{R}\mathbf{c}$