Robot Mapping

Least Squares Approach to SLAM – Additional Remarks

Cyrill Stachniss

UNI FREIBURG

AIS Autonomous Intelligent Systems

Global Reference Frame

- We saw that the matrix $\mathbf{H}$ has not full rank (after adding the constraints)
- The global frame had not been fixed

Chap. 15: What Went Wrong?

- The constraint specifies a **relative constraint** between both nodes
- Any poses for the nodes would be fine as long a their relative coordinates fit
- **One node needs to be fixed**

$$\begin{aligned} \mathbf{H} &= \begin{pmatrix} 2 & -2 \\ -2 & 2 \end{pmatrix} + \boxed{\begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}} \\ \Delta\mathbf{x} &= -\mathbf{H}^{-1} b_{12} \\ \Delta\mathbf{x} &= (0\,1)^T \end{aligned}$$

constraint that sets ***dx₁=0***

Chap. 15 error

Role of the Prior

- Fixing the global reference frame is strongly related to the prior $p(\mathbf{x}_0)$
- A Gaussian estimate about $\mathbf{x}_0$ results in an additional constraint
- E.g., first pose in the origin:

$$\mathbf{e}(\mathbf{x}_0) = \mathrm{t2v}(\mathbf{X}_0)$$

Fixing a Subset of Variables

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- Assume that the value of certain variables during the optimization is known a priori
- We may want to optimize all others and keep these fixed
- How?
- If a variable is not optimized, it should "disappears" from the linear system
- Construct the full system
- Suppress the rows and the columns corresponding to the variables to fix

Uncertainty

- $\mathbf{H}$ represents the information matrix given the linearization point
- Inverting $\mathbf{H}$ gives the covariance matrix (which is dense)
- The diagonal blocks of the covariance matrix represent the (absolute) uncertainties of the corresponding variables

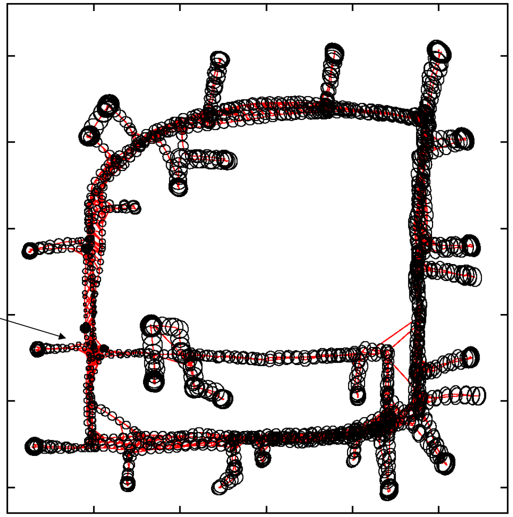
Relative Uncertainty

To determine the relative uncertainty between $\mathbf{x}_i$ and $\mathbf{x}_j$:

- Construct the full matrix $\mathbf{H}$
- Suppress the rows and the columns of $\mathbf{x}_i$ (=fix it)
- Compute the *j,j* block of the inverse
- This block will contain the covariance matrix of $\mathbf{x}_j$ w.r.t. $\mathbf{x}_i$, which has been fixed

Example

robot



Summary

- Prior knowledge about a pose results in an additional constraint
- Embedding prior knowledge about the position of some parts of the map
- Computing the relative uncertainties