Robot Mapping

Least Squares Approach to SLAM – Additional Remarks

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Global Reference Frame

- We saw that the matrix $H$ has not full rank (after adding the constraints)
- The global frame had not been fixed
The constraint specifies a relative constraint between both nodes.

Any poses for the nodes would be fine as long as their relative coordinates fit.

One node needs to be fixed.

\[
H = \begin{pmatrix}
2 & -2 \\
-2 & 2
\end{pmatrix} + \begin{pmatrix}
1 & 0 \\
0 & 0
\end{pmatrix}
\]

\[
\Delta x = -H^{-1}b_{12}
\]

\[
\Delta x = (0 \ 1)^T
\]

Constraint that sets \(dx_1 = 0\)

Chap. 15 error
Role of the Prior

- Fixing the global reference frame is strongly related to the prior $p(x_0)$
- A Gaussian estimate about $x_0$ results in an additional constraint
- E.g., first pose in the origin:
  \[ e(x_0) = t2v(X_0) \]
Fixing a Subset of Variables

- 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?
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Fixing a Subset of Variables

- 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

- $H$ represents the information matrix given the linearization point
- Inverting $H$ 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 \( x_i \) and \( x_j \):

- Construct the full matrix \( H \)
- Suppress the rows and the columns of \( x_i \) (=fix it)
- Compute the \( j,j \) block of the inverse
- This block will contain the covariance matrix of \( x_j \) w.r.t. \( x_i \), 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