

Determination of uncertainty

In the camera pose tracking process of ORB SLAM2, g²o is used to solve the graph optimization problem. In the g²o paper [2], the linear system for the optimization is introduced in equation (24)

$$\begin{pmatrix} H_{pp} & H_{pl} \\ H_{pl}^T & H_{ll} \end{pmatrix} \begin{pmatrix} \Delta \mathbf{x}_p^* \\ \Delta \mathbf{x}_l^* \end{pmatrix} = \begin{pmatrix} -\mathbf{b}_p \\ -\mathbf{b}_l \end{pmatrix},$$

where subscripts p and l represent pose and landmark, H is Hessian, $\Delta \mathbf{x}^*$ is the increment, and \mathbf{b} is the gradient. Hessian regarding the pose increment \mathbf{x}_p^* is formed by taking the Schur complement as

$$(H_{pp} - H_{pl}H_{ll}H_{pl}^{-1})\Delta \mathbf{x}_p^* = -\mathbf{b}_p - H_{pl}H_{ll}^{-1}\mathbf{b}_l.$$

This is equation (25) of the g2o paper. Here, we define H as

$$H \stackrel{\text{def}}{=} H_{pp} - H_{pl}H_{ll}H_{pl}^{-1}.$$

Then, we determine the uncertainty, i.e., covariance matrix, of the estimate by ORB SLAM2 as

$$R = \frac{1}{\sigma^2} H^{-1},$$

where σ^2 is the scale factor and is must be positive.

[1] <https://github.com/RainerKuemmerle/g2o>

[2] https://www.researchgate.net/publication/224252449_G2o_A_general_framework_for_graph_optimization