Fast Global Optimality Verification in 3D SLAM

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Abstract

Graph-based SLAM has proved to be one of the most effective solutions to the Simultaneous Localization and Mapping problem. This approach relies on nonlinear iterative optimization methods that in practice perform both accurately and efficiently. However, due to the non-convexity of the problem, the obtained solutions come with no guarantee of global optimality and may get stuck in local minima. The application of SLAM to many real-world applications cannot be conceived without additional control tools that detect possible suboptimalities *as soon as possible* in order to take corrective action and avoid catastrophic failure of the entire system.

This paper builds upon the Maximum Likelihood Estimator with quadratic objective proposed by [1] and introduces a novel superior parameterization of the problem. Then the *Lagrangian dual problem* and well-established duality theory results are leveraged to provide verification techniques that certify the optimality of candidate solutions.

Our proposal retains the same high effectiveness that the state-of-the-art method [1], whereas verification times are reduced up to >50x, paving the way for faster verification in critical real applications or in embedded low-power systems. We support our claims with extensive experiments with real and simulated data.

References

[1] L. Carlone, D. M. Rosen, G. Calafiore, J. J. Leonard, and F. Dellaert, "Lagrangian duality in 3D SLAM: Verification techniques and optimal solutions," in *Intelligent Robots and Systems (IROS), 2015 IEEE/RSJ International Conference on*, pp. 125–132, sep 2015.