Bringing geometric methods to robot learning, optimization and control

IROS 2020 Workshop

Talk title:
Certifiable 3D Perception: from Geometry to Global Optimization and back

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Abstract:
Abstract: 3D Perception problems in robotics and computer vision are concerned with the estimation of a world model from data. As such, they include a broad set of inverse problems, ranging from object pose estimation to robot localization and mapping. These inverse problems are typically formulated as a nonconvex or combinatorial optimization, and are solved using local solvers or heuristics. The resulting techniques are brittle, due to the non-convexity of the problem. While many applications can afford occasional failures (e.g., AR/VR for entertainment), safety-critical applications of robotics in the wild (e.g., self-driving vehicles) demand a new generation of algorithms.

In this talk, I present recent advances in the design of *certifiable* perception algorithms that find globally optimal estimates in the face of extreme noise and outliers. The key insight behind these algorithms is the design of *tight* semidefinite and sum-of-squares relaxations, combined with fast verification methods based on Lagrangian duality. These algorithms are "hard to break" and work in regimes where all related techniques fail, while providing performance guarantees. I discuss applications to a variety of perception problems, including mesh registration, image-based object localization, and robot pose estimation. For instance, I show that our algorithms can solve registration problems where 99% of the measurements are outliers and succeed in localizing objects where an average human would fail.

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