Inferring 3D Shapes of Unknown Rigid Objects in Clutter through Inverse Physics Reasoning

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Abstract

We present a probabilistic approach for building, on the fly, 3-D models of unknown objects while being manipulated by a robot. We specifically consider manipulation tasks in piles of clutter that contain previously unseen objects. Most manipulation algorithms for performing such tasks require known geometric models of the objects in order to grasp or rearrange them robustly. One of the novel aspects of this work is the utilization of a physics engine for verifying hypothesized geometries in simulation. The evidence provided by physics simulations is used in a probabilistic framework that accounts for the fact that mechanical properties of the objects are uncertain. We present an efficient algorithm for inferring occluded parts of objects based on their observed motions and mutual interactions. Experiments using a robot show that this approach is efficient for constructing physically realistic 3-D models, which can be useful for manipulation planning.

Examination Committee: Prof. Abdeslam Boularias (Chair), Prof. Kostas Bekris, Prof. Jingjin Yu, Prof. Richard Martin.