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LEARNING 3D RECONSTRUCTIONS FOR GEOMETRICALLY AWARE ROBOTIC GRASPING

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Robotic grasping is a crucial subtask of many important robotic applications, such as in-home robotic assistance, emergency response robots, and industrial robotics. Deep learning has enabled remarkable improvements in robotic grasp synthesis for previously unseen objects from partial object views. However, existing approaches lack the ability to explicitly reason about the full 3D geometry of the object when selecting a grasp, relying on indirect geometric reasoning derived when learning grasp success neural networks. This abandons explicit geometric reasoning, such as avoiding undesired robot object collisions.

In this work, we propose to utilize a novel, learned 3D reconstruction to enable geometric awareness in a grasping system. Our 3D reconstruction learning architecture, PointSDF, learns to predict the signed distance from a given query location in space to the surface of the reconstructed object. This yields high-quality geometric understanding – our method outperformed existing voxel-based reconstruction algorithms previously utilized in robotic grasping.

We leverage the structure of the reconstruction network to learn a grasp success classifier which serves as the objective function for a continuous grasp optimization. We perform several comparisons on this architecture, including comparisons between point cloud and voxel embedding architectures as well as utilizing reconstruction pretraining.

Finally, we explicitly constrain the optimization to avoid undesired contact, directly using the reconstruction network to perform collision detection. We test our approach in 96 physical robot grasping trials. Our results indicate that while the added reconstruction constraints make the grasp synthesis problem more difficult to solve, our method exhibits desirable properties, avoiding clear collisions that methods that do not utilize reconstruction exhibit.