

Project Proposal

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Project Introduction: Train the Robot to Screw a Screw

With the prosperous development of Deep Reinforcement Learning in recent years, Deep Reinforcement Learning is researched and applied on a big variety of areas like playing games, robot manipulation etc. Due to the difficulty to have access to real robots, the need of doing research and experiments on the real entity in the real world is replaced by the simulation with computers. For example, when we tried to do some research on Grasping problems of a robot hand, GraspIt can be used, and when we want to find out a policy for the robot to follow in some special situations and environments, we can use MuJoCo to simulate them. However, these kind of simulators can be only used for some relatively simple scenarios, say, the number of contacts and force constraints is very limited, or the simulator can lead to catastrophic failure with lots of contacts, frictional forces and all other forces. If a very simple task in our life but with lots of contacts and frictions, like screwing the bolt into a nut, needs to be simulated in the computer for the robot to learn a policy, none of the simulators in the world can do this properly. The contacts and the frictions between the threads on the bolt and the nut make the mission almost impossible for Mujoco or GraspIt kind simulation system, which leads to my question: Can we really not do it? The answer is YES. With the paper of Incremental Contact Potential(IPC) method comes to the world, this kind of simulation can be done with high accuracy and a relatively short running time. Thus the goal of my project is to utilize IPC simulation in the world of Deep Reinforcement Learning, and in this project, I will try to train a robot particularly to screw a screw into a nut.

Project Pipeline

This project mainly consists of three parts. The first part is to build the triangle mesh model of the screw and the nut in computer. My plan is to buy some toys of the screws and its corresponding nuts, then I can scan it to have the point cloud and reconstruct it, or I can directly build it with CAD with its actual size. Then the second part is to simulate the whole process in the cluster with IPC and the robot hand. If the simulation works, then I can step into the last part: to apply the policy to the real robot hand and the real screws and nuts. There are a lot of difficulties, like the accuracy of the reconstruction of the model, the running time of the simulation, and more importantly, what kind of RL algorithm to use for this project. Thus there's a lot of work to do. Let's get started first!