

Paper Review

Extrinsic Dexterity: In-Hand Manipulation with External Forces

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1 Paper Summary

This paper exploits a particular type of robotic in-hand manipulation that utilizes resources outside of the capability of the grasp actuators themselves. This type of manipulation is then named “extrinsic dexterity manipulation.” This paper specifically categorizes extrinsic dexterity manipulation into three different types. This work then performed experiments, based on some proposed grasp graph, on a few primitive shapes for the different types of extrinsic dexterity. Some qualitative and quantitative results are reported for the successfulness of hand-tuned open loop control on those different objects and different situations.

2 What I Learned

When we are manipulating objects with robotic grippers, it is crucial to be aware of the dynamics of both the objects and its surrounding environments. Simple design of the fingers, like the one used in this paper, can introduce limited level of manipulation themselves. However, if we takes factors such as gravity and external obstacles into account, we may be able to do much more than using just the fingers.

3 Opinions

3.1 Up Votes

I agree with the idea that extrinsic resources can affect the manipulated object in much more diverse way then the fingers themselves can. Even thinking about how human manipulate objects with hands, we take advantage of factors such as weight distributions and fixed platforms all the time.

3.2 Down Votes

- All experiments conducted in this paper is hand-coded with open loop control. Even though they analyze the sensitivity in initial condition error, it is still quite far away from being deployed to real-world situations where uncertainties are a major factor in pick-and-place tasks.

- This paper only reveals the fact that the tuned control is from trial and error but does not discuss the process of their tuning. The reported success on the different scenarios might come with the cost of excessive number of failing trials.

4 Evaluations

The goal of this paper is to exploit the effect of extrinsic dexterity for in-hand manipulation. This is a perfectly valid goal and it is also quite significant since most studies on grasp manipulations by that time is focusing on the control of the gripping actuators themselves. Extrinsic dexterity brings in much more possibilities for what a simple gripper can achieve.

However, I think the overall quality of this work is not so great. There are rarely any theoretical analysis on their proposed types of grasp. Most importantly, all the experiments are done with hand-coded open loop controller, meaning that there is almost certainly no tolerance to any disturbances or changes to the systems. Although they did some quantitative analysis on how much of an initial condition variation can be tolerated for certain type of grasp, the tolerance is quite low (sub centimeter level). Any new object, new gripper configuration, will require excessive re-tuning for it to work not so reliably. That said, given this was an early-stage work on the area of extrinsic dexterity, I do want to give them the credit for bringing the importance of this concept up to the public.

5 Questions

1. how is Fig. 12 obtained? Are the samples interpolated and then visualized with contours?
2. I am wondering how many trials failed before coming up with an controller that can succeed in consecutive 50 tries.