

Paper Review of Lessons from the Amazon Picking Challenge

Four Aspects of Building Robotic Systems

Alvin Sun

November 11, 2021

1 Paper Summary

This paper discussed four spectrum of robotic system building under the context of the Amazon Picking Challenge. The four aspects are Modularity vs. Integration, Computation vs. Embodiment, Planning vs. Feedback, and Generality vs. Assumptions. The authors first introduces the overall algorithms for their first-place solution, where they uses feedback guided control of a suction-cup based manipulator, in combination with their perception module that segments visual information to determine object locations. They also showed quantitative evaluation of their grasping success rate both in the contest and in a replayed setting. Failure cases are thoroughly analyzed and improvements are proposed with the discussion for the four trade-off spectrum of design choices.

2 What I Learned

1. Modularity insures a smooth development cycle but imposes difficulties for evaluating the robotic systems as a whole. Tightly integrated solutions are harder to develop but may yield higher overall performance.
2. Feedback guided control are really powerful that it might completely replace the need for a motion planner as in the case of this Amazon Picking Challenge.

3 Opinions

3.1 Up Votes

1. I agree about this author's claim that few researchers in the robotic community has tried to explicitly characterize robotic system building. This is true especially in the academia where people usually focuses on performance of a single module within a robotic system rather than the combined system as a whole.
2. I also strongly agree with their choice with a holonomic mobile base which reduces quite a lot of complexity in planning motion with the manipulator. This seems like a perfect example for the spectrum between software and hardware, and this is just simple hardware that dramatically reduces software complexity.

3.2 Down Votes

I don't quite agree one of the four aspects they proposed, which is planning vs. feedback. Even though they show-case that with good feedback, a need for planner might be completely eliminated as in their case. However, I don't think these two things are necessarily trade-off, but rather could be complement of each other. A good feedback should be able to enhance planning but not replace it.

4 Evaluations

This paper aims at discussing multiple aspects of robotics system building and how design choices can affect the overall system complexity and performance. This is a perfectly valid objective as few prior work has focused on evaluating robotic applications from a system level, but they rather put more focus on the individual sub-problem they are trying to solve. I also agree that the system level design choices greatly impacts the overall performance, so it is definitely worth looking into these system building spectrum. The author also delivers their goal such that they also discussed their proposed findings under a concrete robotic contest setting with quantitative evaluation metric.

The overall quality of this paper is excellent, as it not only proposed the four trade-off spectrum in robotic system building, but also evaluated their own award winning design choices within those spectrum. The assumption they made for this specific picking challenge is that objects are placed in a known shelf, which is quite reasonable given such controlled contest environment. What matters is their achieved generality under such assumption, which is their robot's capabilities of handling a variety of uncertainties in the actual challenge. They have also thoroughly analyzed their failure cases by replaying the challenge in a lab environment. One slight short coming is that even though they proposed future improvements within the guidelines of the four aspects, they did not show any results for the proposed improvements. This might be what's saved for future directions.

5 Questions

1. How do they exploit the force feedback to activate the suction cup? Is it when some force detected is over a pre-determined threshold?

2. Why other teams rarely chose to use a holonomic base?