

Individual Lab Report

April 18, 2017

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Team E

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## Individual Progress

There was an issue with the power plug on the linear slider board, so I had to replace it with something that wasn't constantly dropping its connection. After that issue was fixed I could finally use the slider in the complex configuration, which has no lag on feedback, or at least a negligible amount. There was a slight issue involving a two-centimeter offset in positioning, but it just turns out the slider is two centimeters longer than we thought (102 cm total).

I worked the final integration steps for the planning with 7 degrees of freedom (the UR10 plus our end effector joint). Most of this work was adding new STLs to the out of date 7 DOF files and making modifications to the relationship between certain transforms. Once the transforms were updated I made some minor modifications to points of interest (e.g. the home position). Two issues arose that caused us to switch back to 6Dof planning for the PR. The first had to do with camera poses. Since the arm plans for the tip of the robot, there is currently no way to plan for the camera, which resides on the link between joints six and seven. This is an issue we can solve, but it was realized too late for this PR. The second issue was that the SBPL shortcutter does not work on our 7 DOF arm for some reason. This doesn't sound important, but the motions become so jerky the arm will hit its torque limit.

To revert to the 6 DOF arm we decided to angle the end effector at 30 degrees, which would generally allow for picking with fewer collisions. This meant I had to do some math to update the transforms for our suction frames. It also meant I needed to change the orientation of all my prep poses, but that was trivial.

I also had to convert all my poses to be specific for bins as opposed to drawers. This will ease a lot of the work that needs to be done in order to perform a full competition style run.

After that there was a series of a few dozen test runs to verify that things were planning well. Thanks to the work Michael and I completed for last PR, the planner was much more robust and never once tangled the vacuum hose. Figure 1 shows a target pose in green and a starting pose in gray. What is important about this plan is that the arm flips its wrist joints up without tangling, which increases our available workspace by a about 20 cm.

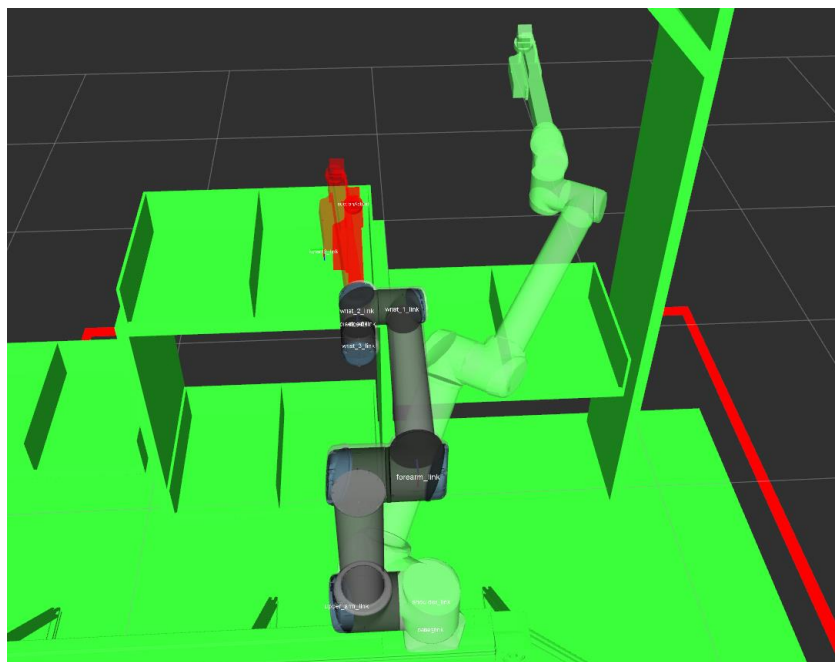


Figure 1. The arm about to plan towards a difficult camera pose.

Figure 2 shows a trajectory of the plan that was made for the start and end in Figure 1. It's a little difficult to make out, but the end effector stays constrained to point forward and not turn over.

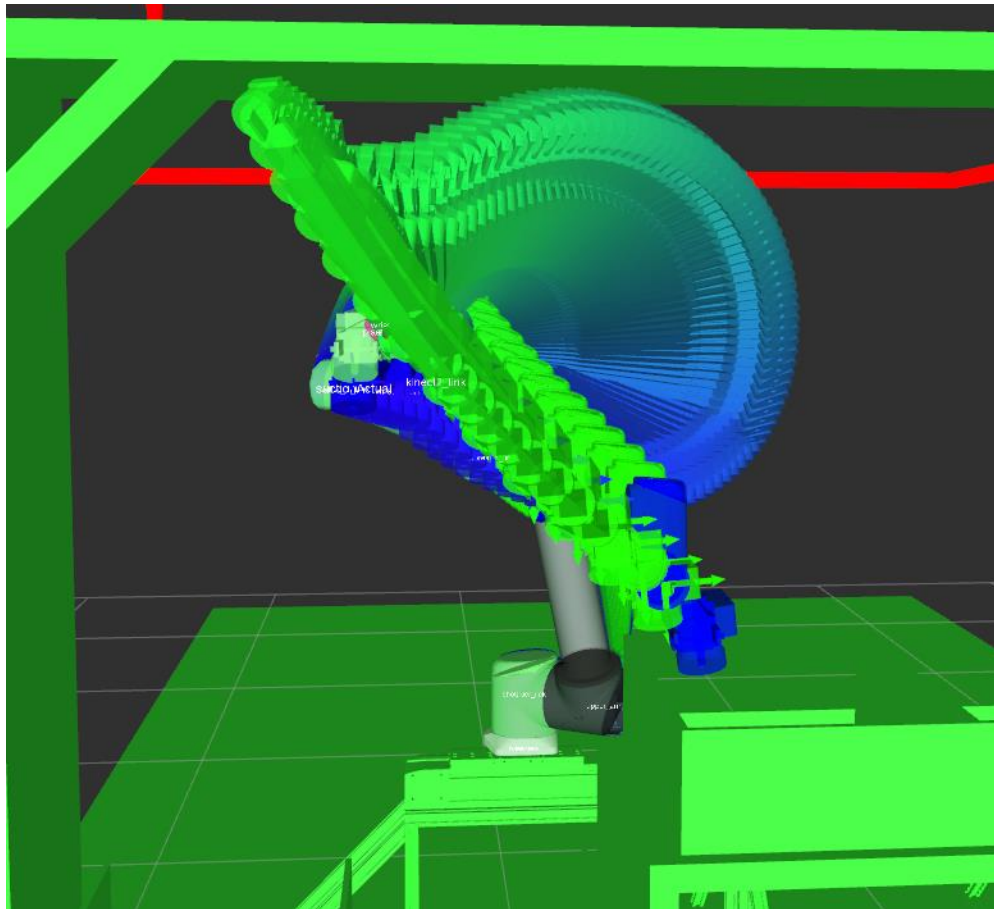


Figure 2. A constrained trajectory that flips the wrist joints up.

This achievement might not seem big, but it was a massive pain point and time sink for last year's team.

I also had to make modifications to the physical workspace to better reflect the planning scene in MoveIt!. Point clouds were not in the correct place in the planning scene, so it was easier to move the real world. I also made modifications to some models that will be used as target boxes for SVE.

To take pictures of the new drawers I validated a new set of camera poses.

I also helped Jin a little with the new lighting.

## Challenges

One large challenge was determining how to position the camera while using the 7 DOF planner. Since the PR, we have found a better way to do this using some built in tools with the SBPL library, but as a stop gap measure we figured out an easy way to directly send desired joint angles to the arm. Essentially, just send a manually found trajectory to the arm. The unfortunate side effect is that there is no collision checking, so it is a sketchy maneuver. The idea would be to set the 6 DOF camera pose as the 7 DOF goal and then sending a manual

trajectory at the end. This would significantly reduce the odds of a collision. Problems with shortcutting function rendered this solution moot, since we ultimately went with the 6 DOF planner.

## Teamwork

Michael fixed the grasping code. He also modified the tip joint control code to better track the trajectories our planner publishes.

Akshay worked with me on the physical workspace and helped with further integration for vision.

Leo modified quite a bit of code to reflect our system wide change from draw based picking to bin based picking. Leo was also an integral part of tracking down many issues that cropped up due to system integration.

Jin has worked to modify our lighting. At this point, there is no glare or shadows, but lighting for the bottom bin is still not complete.

## Future Work

I need to fix issues with 7 DOF planning. I need to project items as collision objects. I need to execute quite a bit of general speed ups as well as train the experience graph to make planning much faster.