Individual Lab Report

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Team E

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Individual Progress

The most important task I accomplished this week (with the help of Michael) was to constrain the motion of the UR10 such that the end effector will never tangle the vacuum hose. In the past this was avoided by limiting the joint angles of the arm, but that restricts our configuration space too much. Until recently we used trial and error to reduce the incidence of tangling, but this was tedious and unreliable.

The method we employed was a relatively simple formula that transformed a y axis unit vector from the end effector from to the world frame. We took the dot product of this new vector and the z axis from the world frame. This dot product gives us a sense of how aligned the vectors are, and we then reject the states that are too closely aligned, which prevents flipping. After the math was worked out, we made some modifications to our collision checker to reflect the constraints. Based on issues discovered on Tuesday (and then seen during the PR) will we make more constraint adjustments to prevent undershooting items during a picking attempt. Constraints will make our robot considerably more robust, at the cost of some minor configuration space loss.

Figure 1 shows the arm successfully planning to just inside the constraint and Figure 2 shows the arm attempting and failing to plan beyond the constraint (90 degrees in this case).

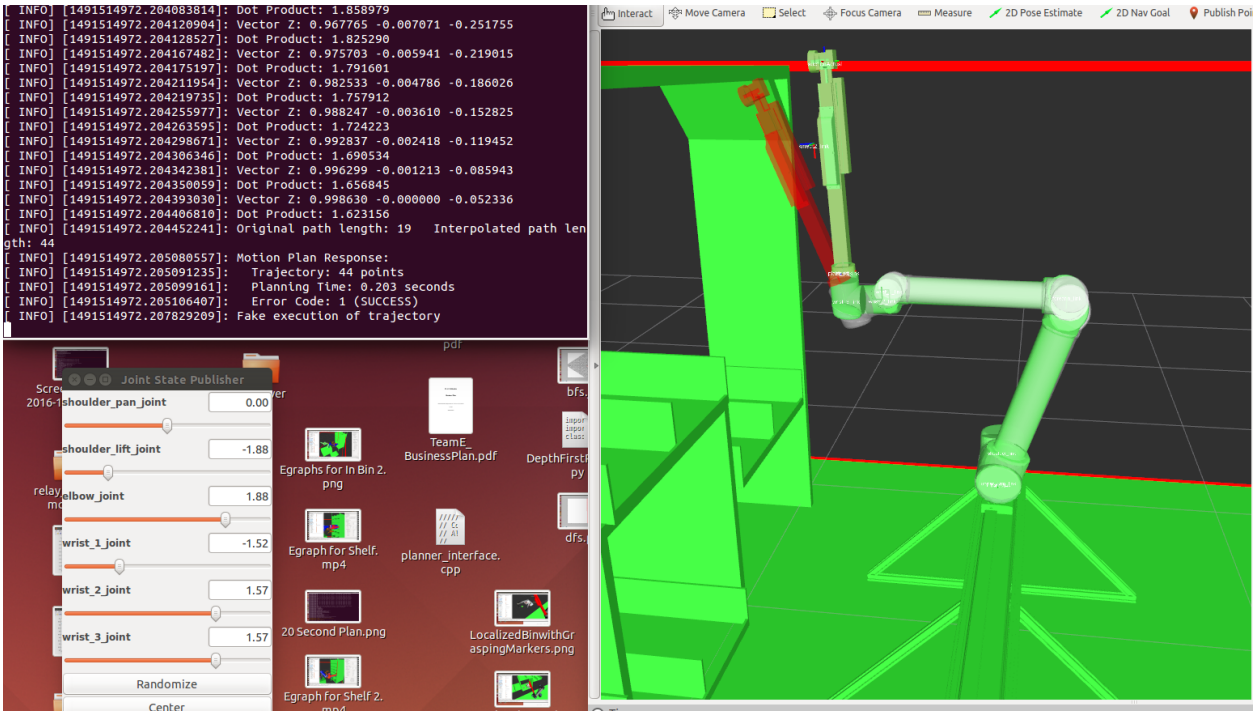

Figure 1. The arm moving to just within its constraint.

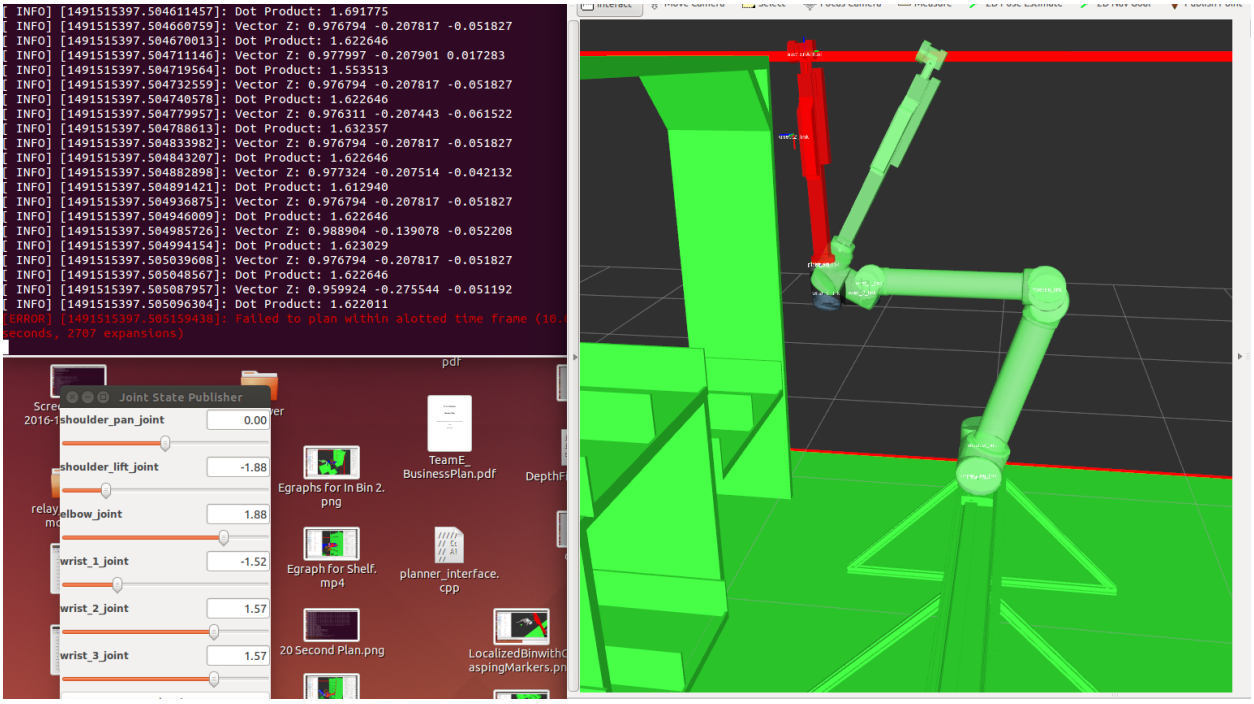

Figure 2. The arm fails to plan beyond the 90 degree constraint.

I also did some work on the slider once we received the new controller on Monday. I was unable to have the slider working for the PR, but I was able to attach a new voltage regulator which should prevent the controller from breaking again (or at least not void the warranty when it does). Figure 3 shows a simple test circuit I used to verify how the regulator would fit onto the board. I also updated the firmware for the controller and did some other housekeeping tasks that for some reason Festo does not.

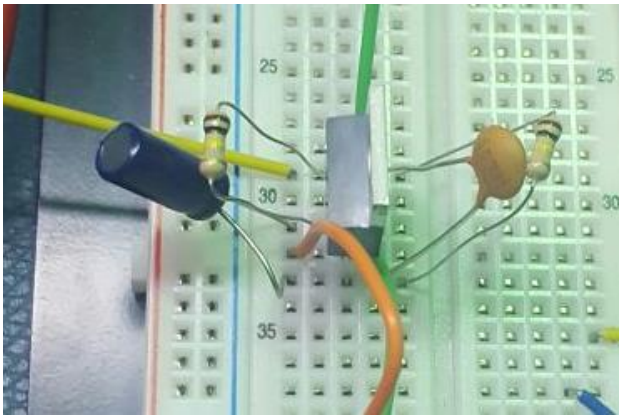

Figure 3. The regulator test circuit.

I also was involved in a lot of integration work for the grasping and Json code that was necessary for the demo. This mostly involved the slight logic changes that need to occur to report items correctly as well as modifying the way that grasping poses were handled.

Challenges

Constraints were a massive challenge for me this last PR. I determined after much trial and error that the built-in ROS and MoveIt functions for constraints are deeply flawed. Most use cases for

constraints are involve constraining things to just a few degrees, but we were seeking a much larger area to be constrained too. I believe that the issue lies with the fact that the constraints in MoveIt are defined as a quaternion with bounds in Euler angles. Unfortunately, Euler angles are not unique and there are always at least two combinations of Euler angles that describe a unique transform. Built-in ROS functions that convert between quaternions and Euler angles will occasionally flip to the other combination type and during gimbal lock vary in complex ways. Michael and I spent a lot of time experimenting with parameters and speaking with Andrew of SBPL to fix this issue, and we slowly decided that we needed to implement this functionality ourselves.

Scheduling was once again a challenge. I wish people felt the same impetus to work on Monday as they do the night before a PR. That would likely save some late nights, but at this point I have used most of my social capital in regards to incentivizing more work.

Teamwork

Michael has finalized his shelf design and has already ordered the necessary material. He has also written the code and made a small demonstration circuit that will control the shelf and end effector.

Akshay has made modifications to the grasping code that has made it more reliable. Particularly, he resolved an issue where the incorrect frame for the point cloud was given. Akshay's code also better interprets point cloud centers.

Leo has created a script that allows us to run our full demo with one command (incredibly useful). He has also added some code that handles Json as well as some general housekeeping for our software architecture. Leo also wrote code that will allow us to fuse point clouds.

Jin has fixed an issue where we were incorrectly determined the accuracy of our perception system. Jin has also worked on masking out the bin from our point clouds, which should help grasping a lot.

Future Work

The linear actuator is still a thorn in my side. I need get that working robustly immediately. I also need to train egraphs, because right now we take too long to plan. We will not meet our SVE goal if planning does not improve in speed considerably.

I need to work with Jin to determine which poses are necessary for image capture so that Leo's point cloud fusion work can be used effectively. We are in the home stretch now.