ILR #3
Amazon Picking Challenge

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Individual Progress

My primary responsibilities for this week were to fabricate a mount for last year's gripping system, to prototype a new mounting system for the 1-DOF gripper, and to continue to research suction generation mechanisms. In addition to that I also ended up working with my teammates to better define task goals for sensor performance evaluation.

New Mount for Last Year's End Effector

It is a goal to try and have all potential end effectors, including last year's model, work in a co-axial manner with the robot wrist in order to simplify planning and have uniformity between primary gripper designs and backups. Last year's end effector mounted with the sensor co-axial to the robot wrist, with the end effector attached underneath. A new mounting plate allows for the end effector to be co-axial.

The new mount was created from PLA using a 3D printer. The mount design is a simple rounded plate, with two four-bolt patterns on each end. One of the patterns attaches to the arm, while the other attaches to the pre-existing extension on the old end effector. The plate length was chosen such that this setup puts the end effector coaxial to the arm, with the sensor mount shifting upward. The plate has extruded cuts on one of the four-bolt patterns in order to allow space for bolt tightening/loosening as the plate is designed to be right up against the surface of the end effector. A picture can be seen of the design in Figure 1.

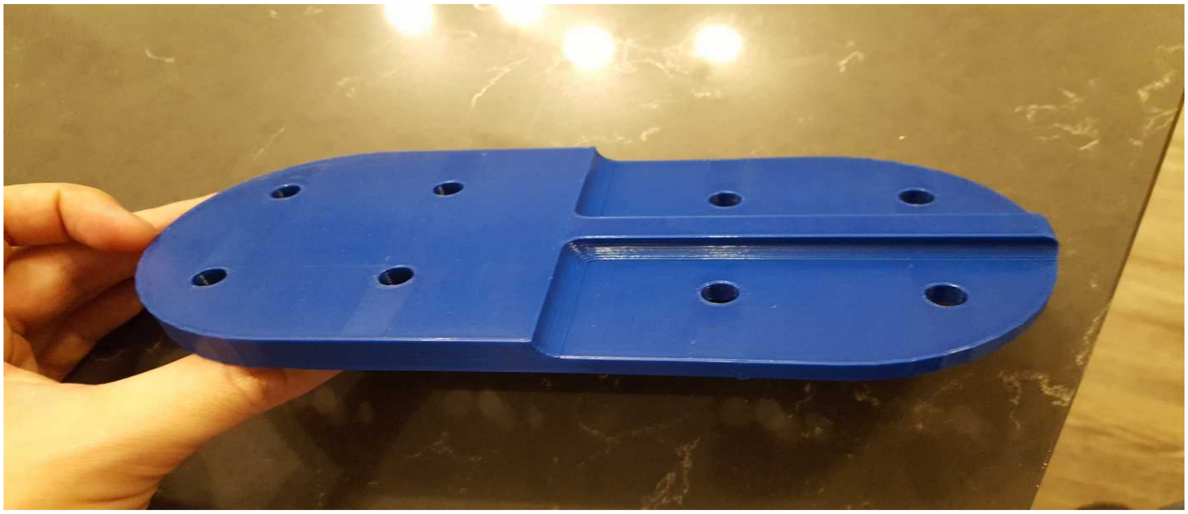

Figure 1: 3D-printed plate design for last year's end effector.

1-DOF Mounting

For the new 1-DOF end effector or any future end effector iterations it is preferable to have a more adaptable and minimal mounting design to the robot arm. The challenge becomes maintaining access to the bolt heads to the arm while still having as continuous and sleek a profile as possible from the arm to across the length of the end effector.

I came up with a simple slotted design for the robot mount and the end effector adapter pair. The mount features the four bolt pattern for the arm, and an additional 3 bolts to secure to the adapter once it is inserted into the slot. The slot pattern resembles a cross, as seen in Figure 2. After printing the design it is likely that the mount piece will be curved along its bottom edges to reduce material need and that the cross slots may be replaced with individual bolts in order to solve 3D print slot tolerance issues.

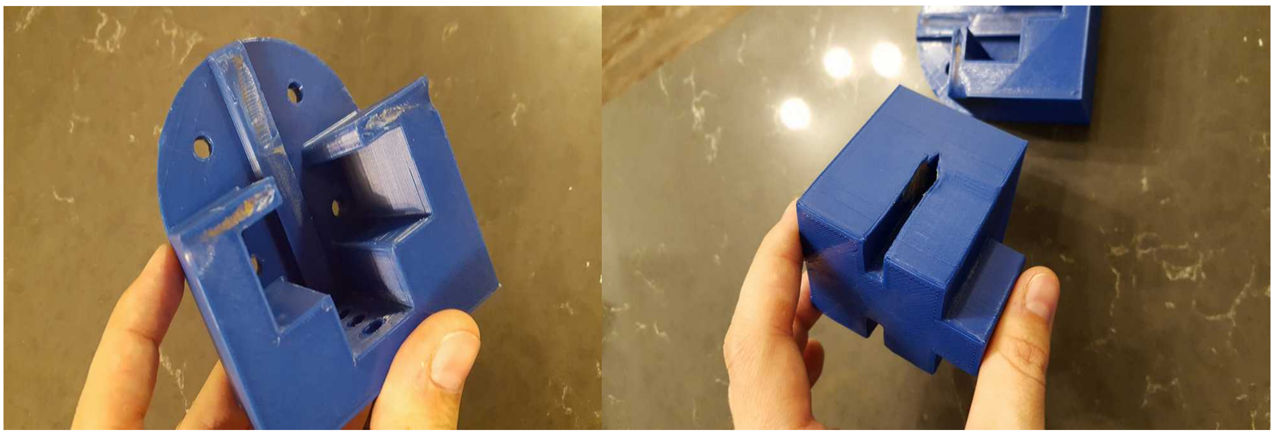

Figure 2: Prototype mounting system for the 1-DOF end effector.

Suction Generation Mechanisms

I am continuing to research suction generation and vacuums. To that end I've scheduled an appointment to meet with a RAF application engineer on campus early next week. I also managed to find a distributor that sells vacuums that match our needs, with vacuums specs at ~20psi, ~120-150CFM, and ~85 decibels (this is roughly 2-2.5 times the psi of the shop vac, and about 20 to 40 CFM less than the shop vac flow rate). In particular I am interested in the Hertell KD-4000 Vacuum/Pressure Pump (1) (2), however I do have concerns about its power requirements and the $1000 price tag before shipping. I still intend to use the Hertell specs as a new benchmark for evaluation, and hope to use it as an effective comparison tool when talking with the RAF engineer and when discussing pricing with any alternatives RAF may propose.

Challenges

3D Print Time and Tolerances

I lost a ton of time this week to my inexperience with 3D printing. First I had challenges with curling and filament dragging, where the outer edges of a larger part weren't staying adhesed to the print bed. I managed to change calibration settings to solve this issue, but only after a handful of canceled prints. I also wasn't sure about what percent infill to use for mechanical purposes, and decided to add a factor of safety of 20% to the 50% recommendation I had seen online. This resulted in a print that took over 18 hours and significantly cut into my design schedule. Further, this print ended up having an incorrect bolt pattern (which must have been something I overlooked in Solidworks), so the print became useless.

I also had an issue with 3D print tolerancing for the slot insert on the 1-DOF mount prototype. I had expected this to be an issue and had created a very small tolerance, but I need to do more testing and check in with others to get a better sense for more suitable tolerance requirements. The tool marks present in Figure 2 are a depiction of the challenge I had with small tolerances, as the two mated parts could only be separated again with a hammer and chisel.

These experiences taught me that item sizes presents different challenges for 3D printing, to first prototype prints at low infill levels before committing to such large print times and specific designs, and to have a better sense of infill requirements in order to save on time and material.

Teamwork

Jin and I worked together this week in order to layout steps for creating a sensor comparison between the Kinect and RealSense. Matt and I also looked over last year's control box for the suction mechanism and brainstormed whether to modify the old system or start from scratch. In addition we attempted to troubleshoot the cause of a blown capacitor that was found inside the box.

Leo worked with most of the group this week, helping Akshay work on his camera localization and Jin on her controls for the Kinect and RealSense. Matt and Leo worked together to have planning simulations run inside of Leo's new code skeleton, and Matt added a mount to the planning scene that includes collision detection features for the arm.

Future Plans

Moving forward this week I have a few goals. I intend to meet with a RAF engineer in order to evaluate vacuum generators, and to keep looking for commercial options that fit our needs, including contacting Vaxteel regarding the Hertell HD vacuum line or similar products. I also plan to get the previous year's end effector mounted and operating on our UR5, with a full CAD model available for planning in the form of an STL file.

References

1. Hertell KD-4000 Vacuum/Pressure Pump. Vaxteel LMT. http://store.vaxteel.com/Vacuum-Pumps/Vacuum-Pumps-by-CFM/100-199-CFM-Vacuum-Pumps/Hertell-KD-4000-Vacuum-Pressure-Pump-120-CFM-p42.html. Accessed Oct 25th, 2016.

2. KD Series User Guide. Hertell Co. http://vaxteel.com/hertellusa/page1/page3/assets/Users_guide%20KD.pdf. Accessed Oct 25th, 2016.