ILR #9
Amazon Picking Challenge

Michael Beck
March 23rd, 2016

Team E
Michael Beck
Akshay Bhagat
Matthew Lauer
Che-Yen Lu
Jin Zhu

Individual Progress

My duties for the last two weeks primarily involved spec'ing and procuring hardware for our system. In addition I spent time with SBPL members and teammates to outline goals and troubleshoot other system components, and worked with the team to integrate new software and hardware components for our PR demonstration.

Project Management

Management tasks for the past couple weeks involved coordinating all members' tasks such that we could have a system integration using the new item list, gripper, and arm stand for our PR demonstration. This also involved coordinating with team members as to their Spring Break plans in order to make sure all tasks would be completed on time.

Shelf Hardware

My primary task for the last week, and for the next 3-4 weeks, is to create and final design for and fabricate our system shelving. I am anticipating using 80/20 framing to hold the system drawers and rail/slider systems. For the drawer design I am currently creating several iterations based off of different mounting mechanisms and april tag sizes. I am anticipating using 1/4” aluminum plate for the drawer materials, and to cut and weld the drawers in the RI machine shop with the use of the TIG welder (I received instructions from Chuck on how to use this particular welder and have enough welding experience to perform the task). The 80/20 framing will be a joint effort with Joe Harkiewicz at Intek, and we are looking into attempting to create a rigid shelving frame that can support the drawers without having front end legs (this is a structural challenge but would hold great benefits for the planning environment).

The biggest challenge currently is procuring the sliding/rail mechanism which will enable the drawers to fold in and out of the system shelf. The running assumption has been that telescoping sliders would be appropriate for this application, but after talking to different hardware vendors it seems this assumption may be flawed. Slides of this type are designed to be mounted as pairs on opposing sides of objects, instead of on the same side of the object in a cantilever loaded fashion. I drafted up models of our design to Chambrelan, a high-end telescopic slide vendor that makes over-extension slides which would be ideal for our application, but unfortunately received disheartening feedback as to the feasibility, cost, and shipping time of such an installation. The CAD models can be seen in Figures 1 and 2.

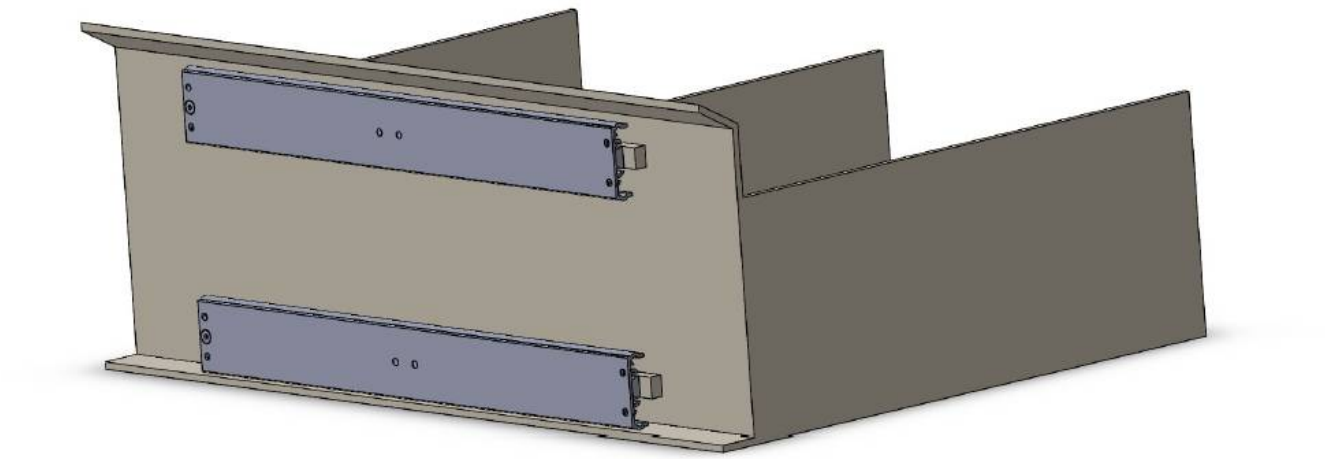

Figure 1: CAD mockup of Chambrelan over-extension telescopic slides attached to our current drawer design in the closed position.

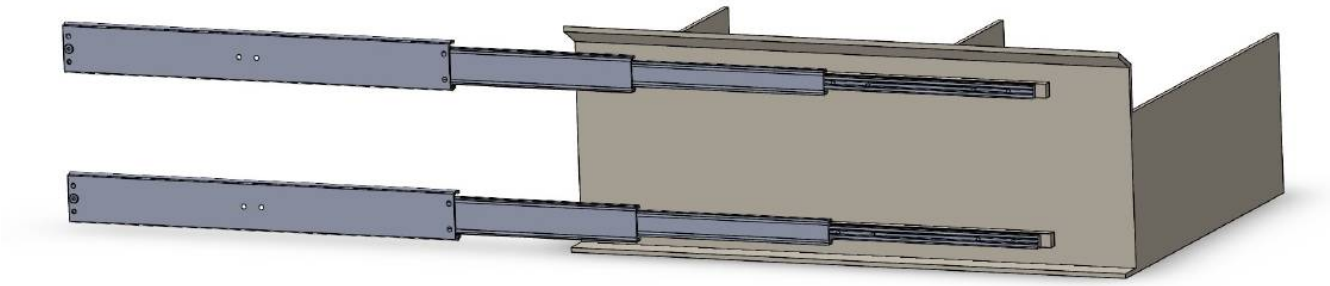

Figure 2: CAD mockup of Chambrelan over-extension telescopic slides in the open position. Over-extension means that the slide's open length is greater than its length in the closed position.

Despite my best efforts I have been unable to find other vendors besides Chambrelan that sell over-extension slides that fit our application. I am working with Joe at Intek to see if caster rails may be feasible, and am currently waiting to hear back from him on that front. I have also purchased some cheaper heavy duty OVIS 30” full-extension telescopic sliders that are less ideal for our application but may still work fairly robustly, pending cantilever load testing that I will be performing this weekend.

Vacuum Hardware and Magnets

Our current system vacuum is able to lift all known items for the competition

which our magnet will be unable to handle, with the exception of the epsom bag of salts. I spent some time with Joe going over Piab vacuum types to see if we could lift the bag of salts, however we were unable to do so with the vacuum generators and cups he brought to test. We are hoping Joe will be able to acquire a foam multi-channel suction gripper for us to test, as research suggests this is the most optimal for our application. I am also having Anver perform testing with different foam suction cups to see if they can lift the epsom salts, and am discussing a similar foam multi-channel gripper design with them as the one we are looking at with Intek.

So far we have purchased two small inexpensive electromagnets to test for our gripper needs. The magnets were able to lift all the items except for the dumbbell, which is the heaviest item and also provides additional resistance to lifting due to its neoprene coating. Two more stronger magnets will be arriving by this weekend for testing, and Shawn suggested a magnet within the lab that will be tested as well. Any magnet which can lift the dumbbell and still fit within our gripper design will be deemed suitable for installation.

Challenges

Spec'ing Hardware w/out Testing

For the shelf and vacuum system it is challenging to know what components will and will not work for our application, since our project has so many novel properties. I am continually struggling with this issue, and attempting to get hardware distributors to test things for us in a way that mimics our system and to send us their results. These distributors are generally not open or able to perform such tests. Ideally we could purchase or otherwise procure these systems and test them ourselves to know their viability, but that simply is impossible due to budget limitations.

SBPL Planner Pose Generation

The SBPL planner is the desired planner for our system due to its high repeatability of plans. Unfortunately, the planner is also slow to act, and has a tendency to want to unnecessarily rotate joints when developing poses. We are intending to work with the SBPL lab in order to set working restraints on some joints during plan executions to prevent these rotations, which would greatly speed up our ability to execute new actions with our arm.

Teamwork

Robotic Arm 80/20 Stand

The original 80/20 materials Intek sent us had a flaw in their design (the Intek software created fasteners which were in collision in impossible configurations). This set back our ability to mount the arm by about a week, and took some significant troubleshooting on behalf of myself, Akshay, and Joe from Intek. Eventually we were able to find the mistake and correct it through the use of additional fasteners which were provided by Intek at no charge. The mounted arm can be seen in Figure 3.

Figure 3: Our project arm mounted on the new 80/20 stand. The stand provides the necessary reach to all system bins.

Vision Training: New Items and New Camera

Jin and Sharon (our MSCV teammate) worked to train FCN and Faster-RCNN on the new item set. Jin worked on Faster-RCNN specifically, and also tested both networks

on data from the ASUS camera to verify that the models still functioned appropriately (both had originally been trained with data from the Kinect).

Camera Calibration

Akshay attempted to internally calibrate our ASUS camera using an online package which utilizes a large checkerboard and taking images of that checkerboard from several poses in order to generate the calibration file. The calibration seems to have failed, and we will be attempting a different package moving forward.

PERCH

Leo integrated PERCH into our ROS system. He created models for two new competition items and tested PERCH's ability to generate a 6 DOF pose for both items using a point cloud taken on our system shelving. The results looked excellent, and more models will be added for all non-deformable competition items once SBPL has updated the algorithm to fit our needs more specifically.

Arm Slider

Matt worked to install a new circuit which would allow for more robust control over our arm slider. There were apparent bugs in the circuit I attempted to help him troubleshoot, but unfortunately during troubleshooting our motor controller for the slider was damaged. We discovered from our vendor that we were powering the controller in an incorrect manner, which likely caused the damage to the controller and may also have been the source of the issue with Matt's circuit. We will resume this task when we receive our new controller next week.

System Integration

Matt, Akshay, Leo, and myself all worked long hours to integrate all the system components for the new vision, planning, and hardware aspects of our project. After 15+ hours of work we managed to develop minimal successful system integration and delivered our intended goals for the PR.

Future Plans

My personal goals for the next 2-3 weeks involve procuring and installing our final system shelving that we will use for the competition, and installing our electromagnet gripper component. Akshay, Jin, and Sharon will continue working to refine our vision system from its current state, including improving our identification

accuracy and system vision calibration aspects. Leo will be taking some time to refactor and organize our system software, as well as develop backup strategies for our system in the event of a failure. Matt will be working with SBPL to make the SBPL planner more robust for our application, and will also work with Sharon and Jin in order to develop poses for our system that can quickly take training data. Matt and myself will also work to troubleshoot our slider issues once the new motor controller arrives, and to integrate our 1-DOF suction gripper.