Carnegie Mellon University

Individual Lab Report #8

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1 Individual Process

The Coborg platform is a wearable robotic arm that can help people hold objects overhead. In this semester, my work in the Coborg project mainly focuses on the Perception (Vision) Subsystem upgrade. From the last progress review, I have generated a few vision upgrade plans and have already done a trade study. For this progress review, I worked on building the upgraded vision system and testing with two YOLO running on each camera.

1.1 Vision System Hardware Upgrade

From the last progress review, I have shown the simulation result on the vision system upgrade plan (See Figure 1 below). It could cover the task space we defined in our requirement. For this progress review, I set up the hardware based on this plan and refined the design based on the final rviz visualization. I also measured the transforms for both of the upgraded cameras with Jason to ensure the frame transforms would work correctly in our motion planning system.

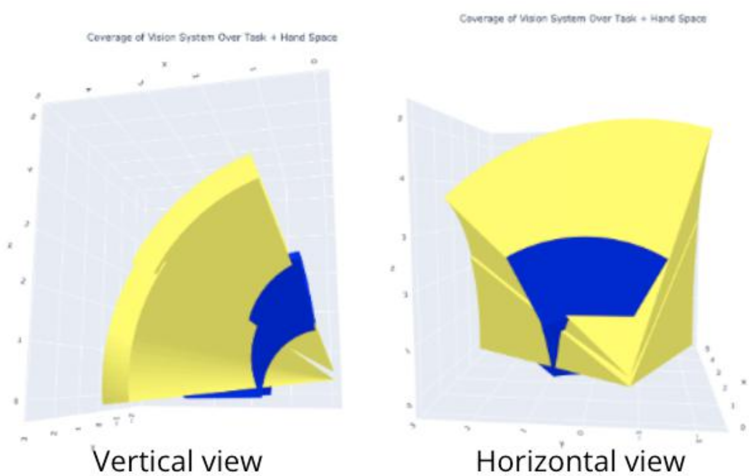

Figure1. Upgraded 2 Cameras FOV (Yellow) vs Hand Space (Blue)

As shown in Figure 1 above, the top camera points up and the bottom camera points straight. I first built our system like the one in Figure 1. When people wear it, I found that people's shoulders would usually block the view of the hands since the bottom camera was mounted at the same height as the human's shoulders. Therefore, we were thinking about moving the bottom camera up to solve the shoulder issue. However, our 3D printed camera holder makes our two cameras fixed in place. I cannot simply move one camera without changing another camera's position. If I move the bottom one up, the top one will also be moved, which makes the top one very close to the hands, and cannot capture both hands clearly. The intuition behind the camera settings is that the top camera should be as lower as possible, and the bottom camera should be as higher as possible. Therefore, I switched the two cameras' settings and made the top one point straight, the bottom one point up.

After setting up the position, I then tuned the angles to achieve a better view. By visualizing the rviz point cloud and image frames, the final sensor system design has been settled down. Figure 2 below shows the final design and the visualization on rviz. The right-hand side image shows that the two camera frames can be stitched together to achieve an extended view in the vertical direction. The overlapping region is also very small (about 1/10 of the frame).

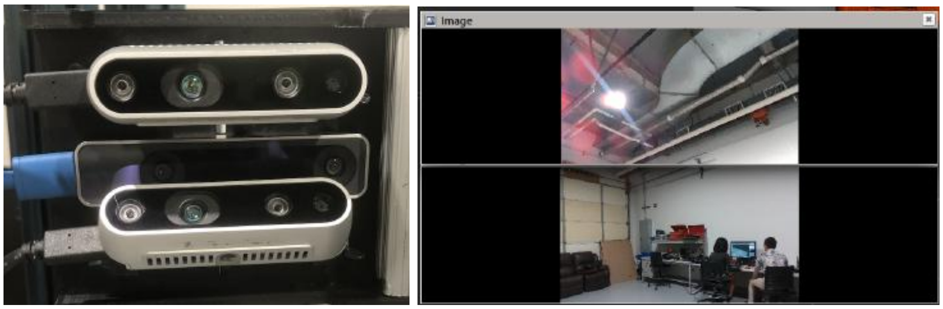

Figure 2. Camera setting (left), Extended view (right)

By measuring the position and angles with Jason, Table 1 below summarizes the parameters for each camera frame. The frame is measured relative to the first motor frame of our robot arm. Figure 3 below shows the side view for both D435i cameras and the T265 camera. We also checked the T265 performance since we were worried about the bottom D435i blocked the view of T265. It turned out that the tracking camera does not influenced by this design.

Camera	x	y	z	roll	pitch	yaw
top	-0.22225	-0.08255	0.19685	0	3 deg	37 deg
bottom	-0.22225	-0.08255	0.23095	0	-42 deg	37 deg

Table 1. Camera frame parameters

Figure 3. Camera side view (from top to bottom: D435i, T265, D435i)

2 Challenges

The main challenges I faced are about the angle measurement. By checking the rviz, we can confirm that the current design will fulfill our requirements. However, it becomes more difficult to measure the position and angles accurately. Jason checked the CAD design for the camera holder so that we can get the relative position of these two cameras. We measured the angles by using the angle measurement tool and also checked the angle markers that Husam made on the camera holder. To further calibrate the camera frames, we also checked the rviz, and tuned the camera angles slightly to make the point could stitch together.

3 Teamwork

Team Member	Teamwork Progress
Feng Xiang	- Worked with me on vision upgrade plan execution - Worked with Gerry on obstacle avoidance
Jonathan Lord-Fonda	- Worked on debugging the smart manipulation code - Software development process
Gerry D’Ascoli	- Worked in obstacle avoidance and goal stabilization node - Integrated the goal stabilization with Jason’s work
Husam Wadi	- Project management work - Cut and assembled the new robot arm - Worked on SolidWorks for the camera URDF

Table 2. Teamwork for Coborg

4 Plans

In the next two weeks, I will mainly focus on the integration of the vision node with the manipulation node. From the last two weeks, we have tested some simple use cases with two cameras running with two YOLO v3. There are still some edge cases that we have a logic discussed already, but have not implemented yet. The implementation of those edge cases will be the next PR goal. We also want to demonstrate some simple cases with the robot off-shelf. From what I saw today when people wear the robot, the cameras are shifted due to the weight of the whole mechanical frame. I will continue iterating on the camera angles and calibration in the later integration testing.