Carnegie Mellon University

16-681

MRSD Project 1

Individual Lab Report 4
Team C - COBORG

Husam Wadi

Teammates:
Feng Xiang, Jonathan Lord-Fonda, Yuqing Qin, Gerry D'ascoli

Sponsor:
Biorobotics Lab

April 1, 2021

Table of Contents

1. Individual Progress

For this time period, I focused with Gerry on the voice subsystem validation. With the voice subsystem making substantial progress, we began validation of the voice command accuracy. After preliminary testing on March 20th, we found that the voice subsystem was really susceptible to false positives. By our measurements, we found that background noise over a long enough period of time could toggle the “Coborg” main keyword, or even worse, the emergency “stop stop stop” command. To mitigate this issue, I worked with Gerry on identifying the source of the problem and correcting it. We found after several days of testing that there was no threshold on how long a keyword could be triggered. This meant that if the Coborg heard the word “stop” then 1000 words, then another “stop” then 1000 words then a third “stop” it would count that as “stop stop stop” and emergency abort the robot. To correct this, we used a thresholding feature in PocketSphinx that only allows keywords to be recognized within a certain amount of syllables, otherwise it rejects the command. We found 5 syllables to be optimal for the keyword “Coborg” and 50 optimal for “stop stop stop” .

I also assisted Gerry with the PCB schematic and board design for the project. My task was to design libraries for parts that did not natively have a package in Eagle CAD, doing a detailed dive on all the components, and ensuring that the board layout made sense with the selected components. This process took many hours and was quite tedious, but was necessary in creating a PCB that is fully functional. *Figure 1* depicts the layout we created to distribute power to all of the components in the Coborg backpack:

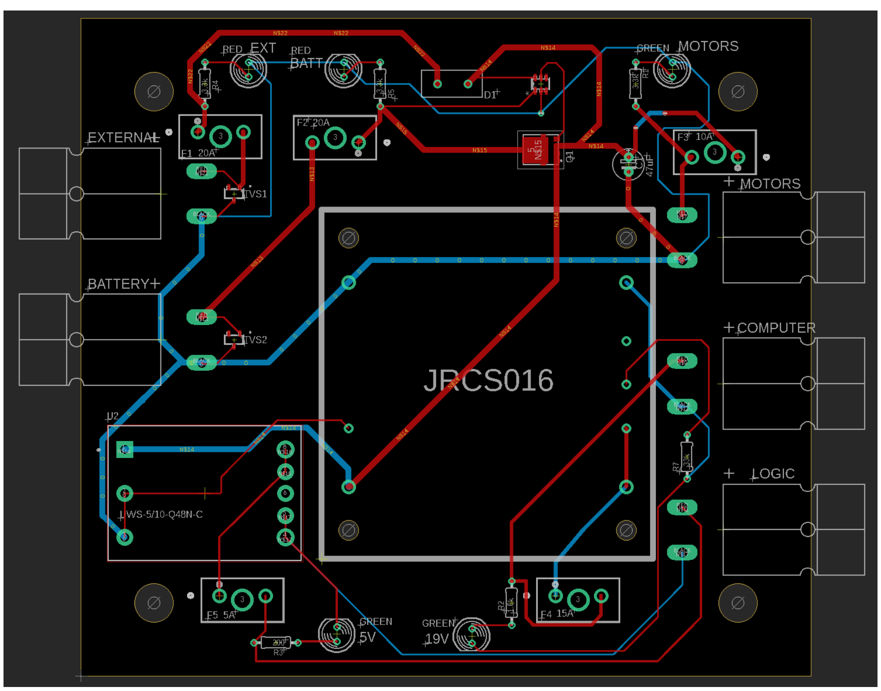

Figure 1. Coborg Power Distribution V3

2. Challenges

A challenge that we are facing is that the robot arm cannot meet our mandatory performance requirement PM 3.2: *Will lift at least 2 lbs to full horizontal extension*. We found out about this challenge when we did requirement validation over the previous weekend. To mitigate this challenge, we started discussing the original scope of PM 3.2, and how we could modify it to be more relevant to our use case. The requirement of lifting at least 2 lbs to full extension primarily demonstrates the torque output of the shoulder/base motor, but does not demonstrate holding force above the robot. We are looking into changing the validation to demonstrate vertical holding force rather than a rotational full arm extended lift.

We also found out through testing that YOLOv3 does not run on the computer we received from the Biorobotics lab. This risk was documented as a potential problem in our risk analysis, and to mitigate it we had budgeted $1300 to cover the expense of a new computer. I recently put in an order for a Nvidia Jetson Xavier AGX computer that arrived on Wednesday. A challenge we will face is migrating the current code base onto the new computer, and since my job is the software framework, installing the version of Ubuntu we need, setting up the computer, and loading all the files relevant to our project is my responsibility.

In the Fall, we will be expanding our project's use case to include other tasks. The field of view (FOV) of the D435i camera is 69.4° × 42.5° × 77° (±3°). This FOV is fairly small, and we have to decide which direction to face the camera for the appropriate task. If we are doing overhead tasks, the camera must be angled at 45° up from the horizontal axis. So what happens when we want to do a task out in front of the user? To solve this problem, I proposed adding a second D435i camera that faces forward, and would be hard mounted to the frame's other shoulder. This would allow us to expand on the codebase we currently have, and give us flexibility for future tasks. *Figure 2* shows a rough mock up of where the second camera would be relative to the first:

Figure 2. Second D435i Prototype Location

3. Teamwork

In *Table 1* below, we detail the progress of each individual team member as the project progresses:

Team Member	**Teamwork Progress**
Feng Xiang	-Tied T265 and D435 cameras to URDF model -Able to move URDF model live relative to global odom frame in RViz simulator
Jonathan Lord-Fonda (Updated for PR3)	-Wrote SVD/FVD 1-pagers -Added the speaker to requirements and validation plans -Checked in with Gerry, Jason, and Yuqing to ensure validation plans still matched voice, actuated manipulation, and vision subsystems and updated validation plans -Began setting up validation testing -Ran through voice validation with Gerry -Ran through strength test -Started writing impedance controller for stabilization
Gerry D'Ascoli	- Designed power distribution PCB layout - Re-evaluated parts with Husam based on system requirements and Luis's recommendations - Ran trial runs of Jonathan's validation tests for the voice subsystem.

	- Fixed major issue with Voice Subsystem having too many false positives
Yuqing Qin (PR3)	- Implemented the post processing node (goal_getter) - Implemented the surface normal - Set up the validation environment
Husam Wadi	-Created launch files for main node and voice node -Assisted Gerry with removing false positives in voice subsystem -Assisted Gerry with PCB design and refinement

Table 1. COBORG Teamwork Detailed

4. Plans

We are on track to attempt a full run trial of the SVD in Progress Review 4. Since we are slightly ahead of schedule, we also want to start integration steps to see how our subsystems interact with each other. Our first goal is to have the vision subsystem interact with the actuated manipulation by sending it a position goal to reach. We anticipate challenges in implementing this, but we think it is better to start integration this semester than waiting until the Fall. We also want to tighten up our robot arm actuated manipulation accuracy by calibrating it, and validate the D435i depth perception accuracy before the SVD.

For the fourth ILR we plan on demonstrating these items, in addition to conducting a partial SVD demonstration of the robot:

Robot Motion <-> Node Publishing:

- Validate Robot Arm Accuracy

Vision System <-> End Goal Output:

- Validate D435i Vision System Accuracy.

System Integration:

- Publish D435i point to robot arm through Move-It.

SVD pre-test:

- Conduct a preliminary overview of the SVD if there is time after demonstrating the other items