Carnegie Mellon University

16-681

MRSD Project 1

Individual Lab Report 3
Team C - COBORG

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Sponsor:
Biorobotics Lab

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1. Individual Progress

In our project, we have 3 major subsystems that are being developed for the Spring Validation Demonstration (SVD):

- Actuated Manipulation
- Voice Recognition
- Vision Recognition

For this time period, I focused with Yuqing on the vision subsystem validation. With the vision subsystem making substantial progress, we began validation of where the Intel Realsense D435i will be located on the Coborg backpack. After preliminary testing on March 13th, we found that the previous location of the camera assembly may be too close to the overhead panel and may not see both of the users hands. To mitigate this issue, I developed with Gerry an alternative mounting bracket for the camera assembly that would allow us to move the cameras approximately 15 centimeters back from their original location. This allowed the D435i camera enough field of view to sufficiently view and locate both of the operator's hands. Part of this validation process is depicted below in *Figure 1*:

Figure 1. Vision System Distance Validation

I also delved into the PCB design with Gerry to create an automated power switching system that would determine if power was being provided from a battery or a wired power source. Once the appropriate input was determined, it would switch to that power source to supply electricity to the Coborg Backpack. To determine the total power load and how we are to integrate the PCB into the overall Coborg electrical system, I created a sketch of the electrical subsystem as it currently is. With this diagram we were able to estimate the maximum power load our system would draw, which is 358 watts. Our current electrical infrastructure is depicted below in *Figure 2*:

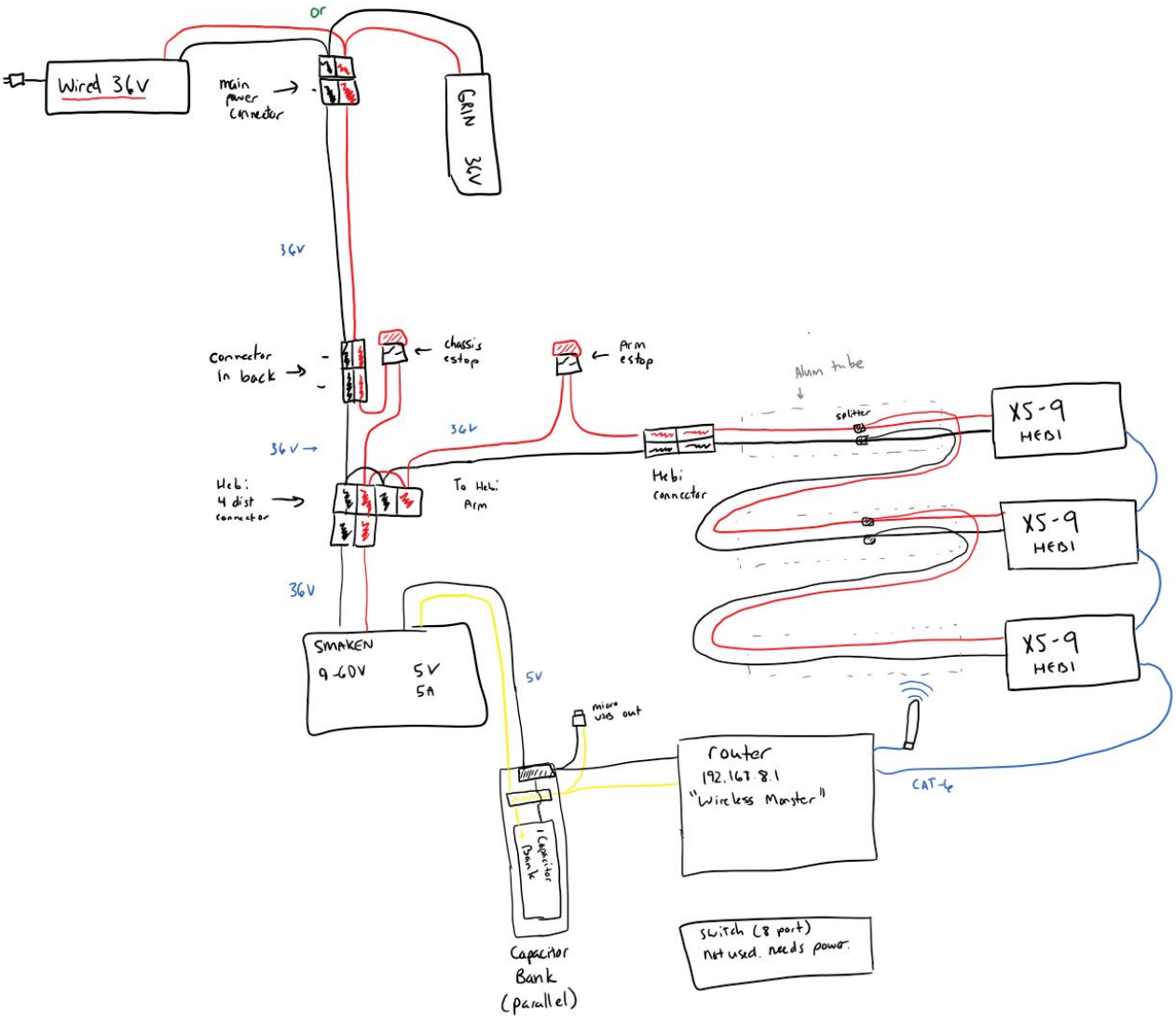

Figure 2. As Is Coborg Electrical System

2. Challenges

We were able to mitigate one of the previous challenges, which was recognizing the correct keyword ("Coborg") to trigger robot commands, by purchasing and installing a directional lavalier microphone instead of the previously tested omnidirectional conference microphone. The new microphone provided an order of magnitude more clarity, and we saw an immediate improvement in keyword voice recognition.

A challenge we are now facing is that the current Unified Robot Description Format (URDF) we are using for the robot arm is out of alignment with the real robot. There is a visible difference between where we instruct the robot arm to go in RVIZ verses where we see it travel to in the real world. This means we have to calibrate the URDF file to match the real robot through a series of measurement tests.

Another challenge we are facing is that the panel that the operator places their hands on is angled relative to the D435i depth camera. While readings from the camera are accurate when orthogonal to a target, we noticed that there is a ~10% inaccuracy when the measurements are reflected from our angled surface. We will have to find a way to mitigate this issue.

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	-Connected and implemented main_state_machine node with voice_recog node -Semantically wrote out all nodes -Updated ROS Node Map with proposal -Worked with Jason on Actuated Manipulation -Read about Elastic Bands -Finished setting up Linux and personal ROS -Met with Kelvin to review ROS Node Map
Gerry D'Ascoli	-Integrated new microphone for improved single user voice recognition -Helped Jonathan develop the main_state_machine node -Developed voice_recog node ROS wrapper for voice recognition to feed commands to main_state_node -Tested successful communication and proper functionality between the voice_recog node and main_state_node -Updated website -Developed conceptual design for CoBorg PCB with Husam
Yuqing Qin	- Implement 3d YOLO in ROS

	- Output the 3d position of multiple hands - Combine d435i and t265 launch file - Postprocess the average 3d position (goal_getter node)
Husam Wadi	-Assisted with ROS main node development -Assisted Jason with T265 tracking camera output -Assisted Yuqing with D435i orientation and location

Table 1. COBORG Teamwork Detailed

4. Plans

We are on track to attempt a full run trial of the SVD. While we are most likely to fall short of our SVD goals, attempting a full run this early will give us insights to which aspects of the project need significant development to meet our SVD requirements. We want to try to do this run on the weekend of March 27-28th as a learning opportunity for the team.

In anticipation of this event, my plans are to assist Feng with the actuated manipulation subsystem, and developing the infrastructure to translate the depth position received from the D435i camera to the planned motion of the robot arm. This is currently (and still) the most involved portion of the project, and to be able to meet our deadlines we must swarm this subsystem with as many resources as we have.

For the third ILR we plan on demonstrating these items, which are critical in our path to conducting a full demonstration of the robot:

Robot Motion <-> Node Publishing:

- Create a ROS node that publishes a point to Move-It.
- Use this point to update the robot arm as it moves towards the goal.

Vision System <-> End Goal Output:

- Publish the center of two translated 3D point cloud hand bounding boxes to a topic.

Voice Command <-> Subsystem Validation:

- Tune and analyze voice commands to confirm accuracy requirements for SVD.

5. Appendix

5.1. Figures

Figure 3. Team C Group Picture