Individual Lab Report - 2

Lunar ROADSTER

Team I

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1 Individual Progress

1.1 VectorNav IMU

After finishing the IMU interfacing the previous week, I found a pre-built ROS2 wrapper that integrates the VectorNav SDK. This ROS2 Wrapper takes the data that are read by the SDK and publishes them to ROS2 Topics, as seen in Figure 1. This allows us to run the IMU directly inside the ROADSTER's docker container and use the data for localization.

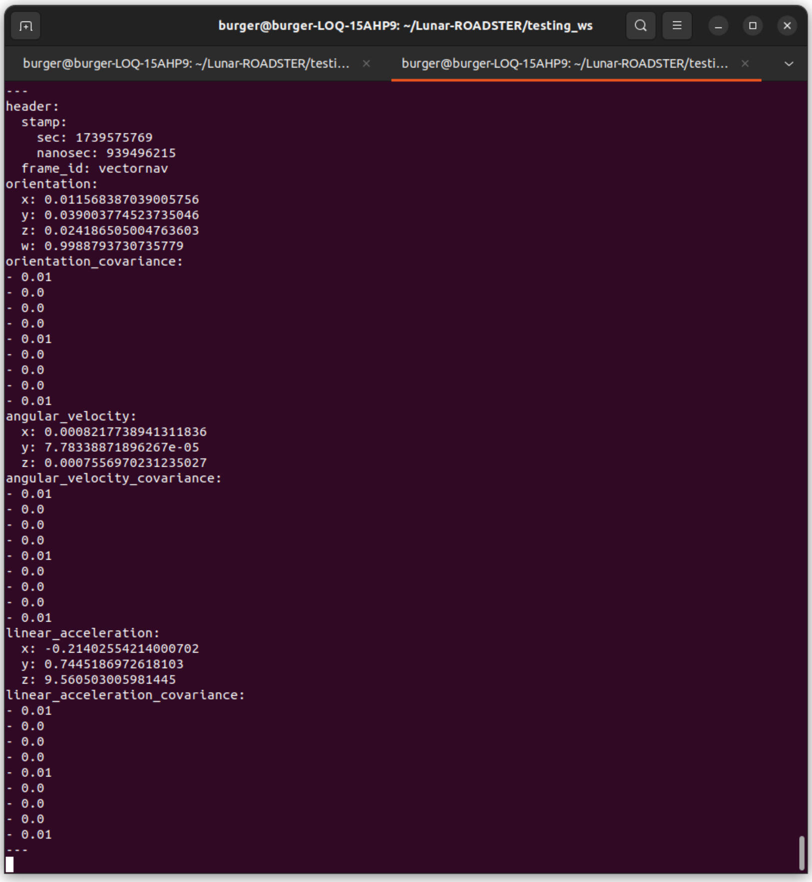

Figure 1: IMU publishing data to a ROS2 Topic - /vectornav/imu

1.2 Electronics Structure

Iterating over the circuit diagram for the previous week, we created a map of all electrical connections to the rover, shown in Figure 2. We identified weak points, such as jumper connections between the Arduino and motor drivers, and reinforced the connections using tape (for now) to allow us to test without experiencing potential electrical failure.

Based on this, we were able to identify the need for a better power distribution board for the system. In addition to this, we plan to create a single stack of motor drivers to minimize the space used by the electronic components. We also plan to eliminate components such as fans and the boost converter as we are not using any motors over 12V on the rover.

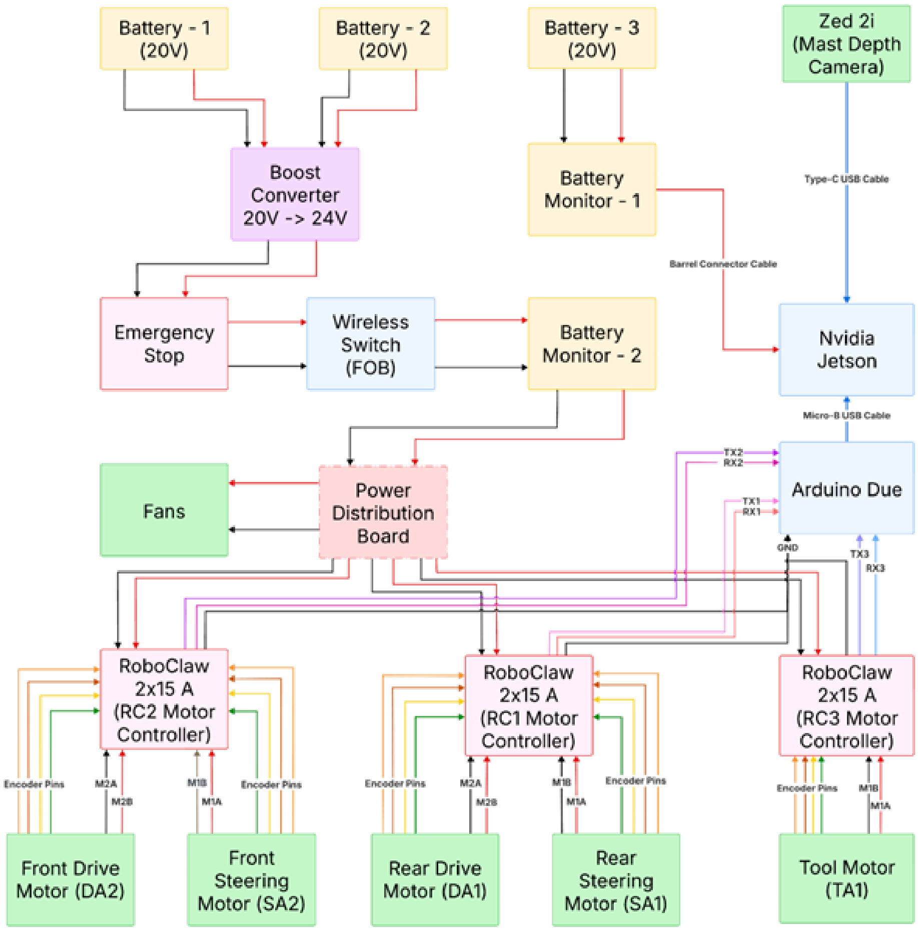

Figure 2: Complete electrical diagram of the rover

1.3 Rover Maintenance

During testing in the previous week, the rear steering mechanism was disconnected due to the decoupling of the pinion and shaft. The connection relies on a friction-based grub screw that may have degraded due to usage and contact with sand. To repair, I replaced all components of the assembly. In addition, if this issue persists, I will replace the friction hold with a through bolt to ensure permanent engagement. This is an active issue being tracked through our risk management matrix and we are on track with our mitigation plan.

Further, we added a task of adding limit switches to the steering mechanism to ensure that the rack is not pushed out of operating limits, which could cause disengagement of the shaft and pinion.

To accommodate our increased traction requirements for dozing sand, I replaced the drive motors with higher torque motors (118 rpm -> 60 rpm). To do this, I had to machine down the motor shafts using an angle grinder to fit the required rectangular shape of the drive gearbox. We will be testing performance with these motors and quantifying results by creating a wheel-slip v/s dozing depth graph.

The 3D printed wheel has been mounted on the rover, as shown in Figure 3. However, we were unable to test performance due to the above-mentioned steering problems. Tests are planned for next week, and I will design further iterations of the wheel post-testing.

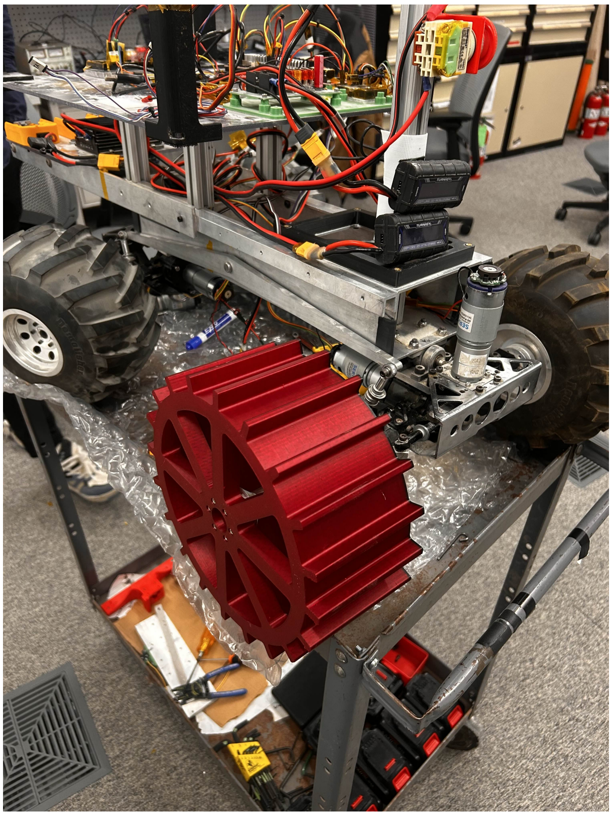

Figure 3: 3D printed wheel mounted on the ROADSTER

1.4 Power Distribution Board PCB

I took ownership of the PCB task to allow the team to prioritize rover tasks. I spent some time going through Eagle tutorials and learning protection circuits. In addition, I also learned PCB design rules, such as clearances and proper naming conventions. The complete CAD design of the Power Distribution Board is shown in Figure 4.

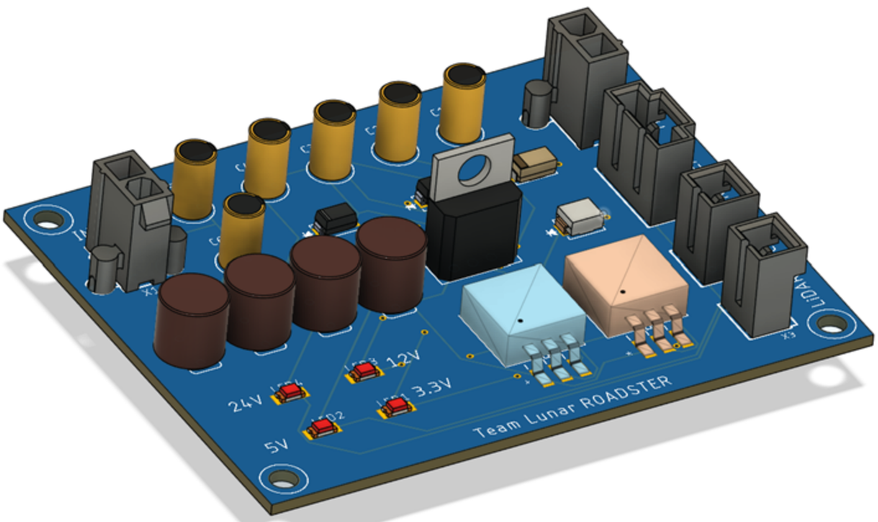

Figure 4: PDB Printed Circuit Board

I used the recommended voltage regulators (MIC29300) to step-down the voltages to the required inputs. I created reverse voltage protection using diodes and overvoltage protection using the recommended fuses.

2 Challenges

My original plan for this PR cycle was to test the wheel and design more iterations; however, the steering mechanism failure was a big challenge. I spent a great deal of time coming up with both short-term and long-term fixes, as this is now a risk with very high consequences.

During the drafting of the electrical circuit, due to lack of documentation, we manually checked every connection using a multimeter. This was challenging as closely placed pins caused issues. However, the wiring on CraterGrader's rover is well-labeled, which allowed us to successfully complete the circuit diagram.

As I do not have much prior experience in designing PCBs, creating the assignment was a difficult task. It took me much longer than planned as I needed to learn the basics of Eagle again. However, the assignment has set us up well for the upcoming PCB assignments, and I believe we will be much more efficient from now on.

3 Teamwork

I worked on fixing the Rover drive system to allow the team to resume testing. My work on the steering system involved creating a secure assembly and I collaborated with Bhaswanth to introduce limit switches for robustness. I collaborated with Deepam to discuss design iterations of the dozer blade. I interfaced the IMU with ROS2, which enabled Bhaswanth and William to take forth their work on localization. I took ownership of the PCB assignment, which facilitated the team to prioritize tasks on the project. The team also collaborated on devising the Spring test plan together.

The following are my team mates' contribution to the project:

Bhaswanth Ayapilla: Bhaswanth's work was in collaboration with William's in setting up the total station and working on the localization stack. He has also been working on visualizing the rover's pose on Rviz. He tried to get the existing limit switches working, and this relates to my work on fixing the steering mechanism. His work also relates to Simson in the interfacing of the ZED camera with ROS, which will be used in navigation.

Simson D'Souza: He processed point cloud data from the FARO scanner, set up ZED 2i and Intel RealSense D435i cameras, and tested mapping using RealSense to generate a 2D costmap, which relates to Bhaswanth and William's work on localization, as the map will be used for robot localization. He designed the electrical circuitry diagram in collaboration with me, which will aid Deepam in integrating the linear actuator, and collaborated with him on fabricating the dozer blade.

Deepam Ameria: He worked on finalizing the design of the dozer assembly (dozer blade, dozer arms, mounting brackets, lifting mechanism, linear actuator). I collaborated with him to discuss iterations and ideas on the lifting mechanism, and with Simson to manufacture the dozer blade.

Boxiang (William) Fu: William's work was in collaboration with Bhaswanth in setting up the external infrastructure for localization. This includes setting up the total station, the TX2 relay that's connected to the total station, and the LAN network for the total station data to be transmitted to the rover. His work also relates to Simson's since the map he is producing is used in localization as the world frame.

4 Plans

Our goal by the next PR is to have the preliminary hardware design and dozer design manufactured. Additionally, we will also target finishing mapping the MoonYard and finalizing the localization stack. My individual goals will be:

- Designing more wheel iterations based on our tests (carry-over from previous week)
- Joining Simson on Navigation tasks - creating occupancy grids and corresponding cost maps
- Manufacturing the new electronics design of the rover and plan the integration of a new PCB
- As PM, ensure the team stays on track, conduct meetings and conflict resolution