Individual Lab Report- 8

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Team F: Falcon Eye

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1. Individual Progress:

As my contribution to the MRSD Project for progress review 8, I have successfully performed field testing of the AGV by integrating the new IMU. This involved flashing new ROS compatible firmware on the Razor IMU and then performing calibration for the Gyroscope, Accelerometer and Magnetometer. Additionally, I have also helped Yuchi in developing and performing the field testing of the Bebop exploration algorithm.

1.1 IMU Calibration:

We initially tried using the IMU without calibrating the sensor data and received unacceptable drifts in the yaw values which lead to incorrect movement of the Husky.

The calibration solved the drift in the IMU and gave much stable, usable values. We were able to correct the max and min ranges of the accelerometer, magnetometer and gyroscope and zero offset for the gyroscope.

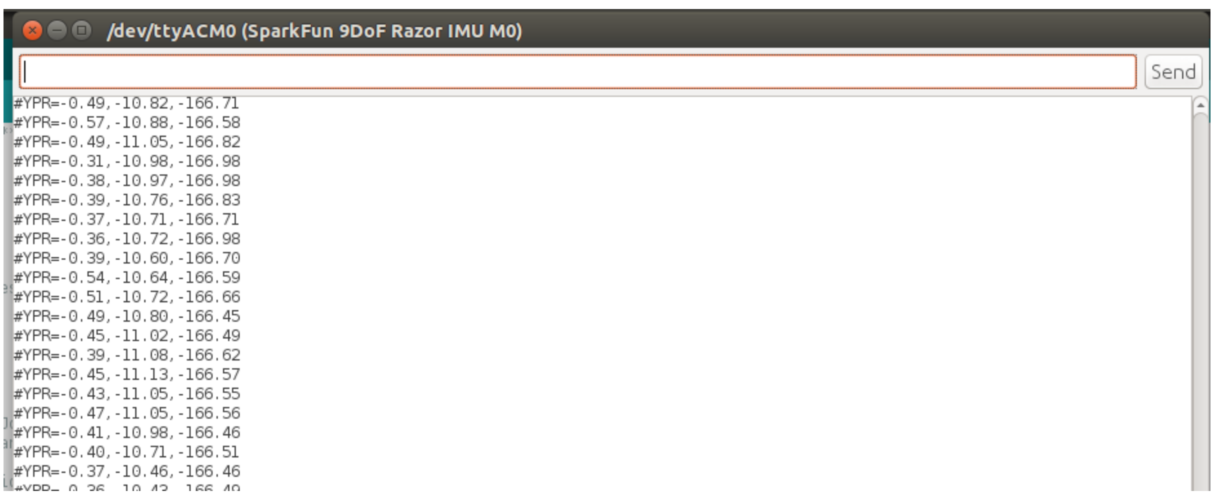

Figure 1: Shows Yaw-Pitch-Roll from IMU (Yaw=0)

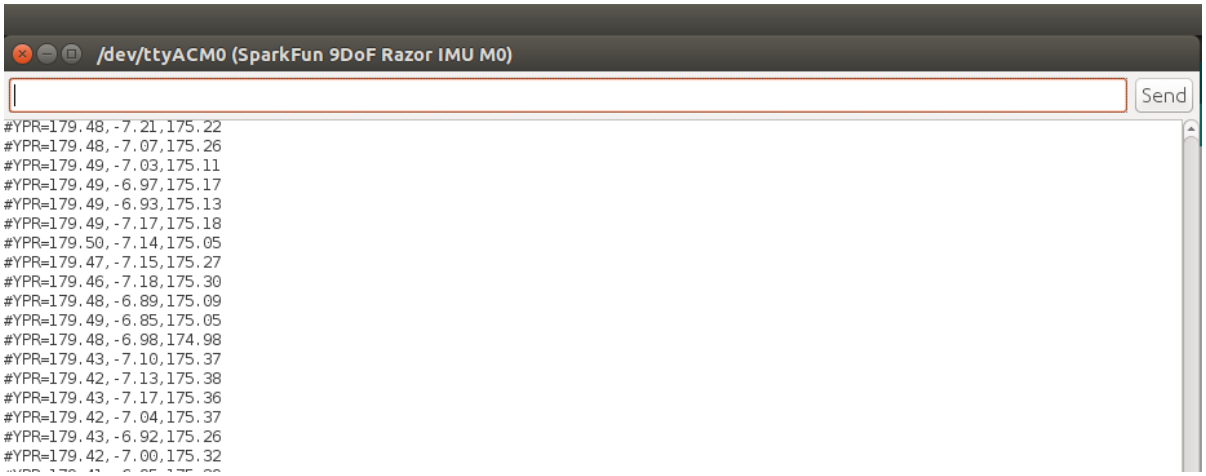

Figure 2: Shows Yaw-Pitch-Roll from IMU (Yaw=180)

Since the calibration values generated can't be adapted in real time, we flashed the firmware initially with the values calibrated in the lab. Later, on going to field, we performed a second calibration and stored the updated matrices in the ".yaml" file of the IMU's ROS source. This yaml file is invoked every time we launch the node of the IMU and loads these values into the IMU. Figure 1 and 2 shows the values read from IMU. Here yaw value of 0 denotes true North and 180 denotes South.

We observed that the most difficult to calibrate was the magnetometer as it is effected by external magnetic fields as well.

To calibrate we plugged in the IMU via USB to a PC and immediately started reading the Yaw-Pitch-Roll values published by the IMU via Serial Bus. To find out the maximum range of the magnetometer, accelerometer and gyroscope , we sent '#oc' command via serial monitor.

For accelerometer, we fixed IMU on 1 axis and then rotated around that axis very slowly to read the range of accelerometer in that axis. Repeated the same for all axes. Figure 3 shows the range of accelerometer.

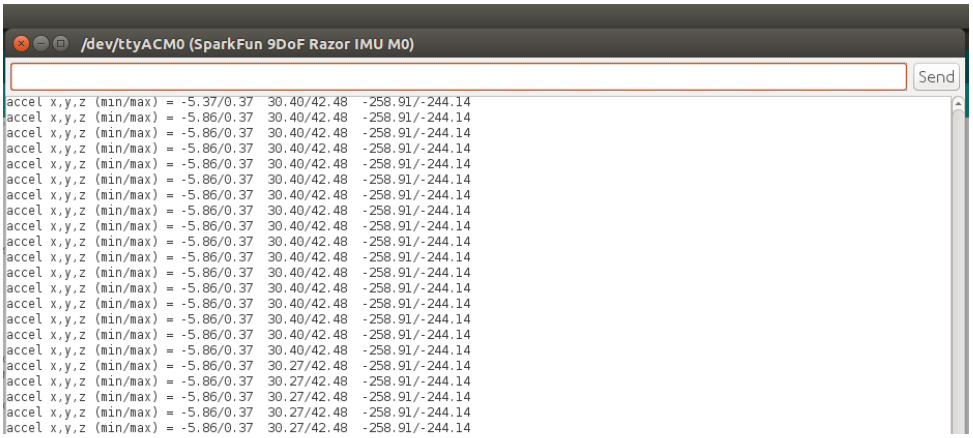

Figure 3: Min-Max of Accelerometer

For gyroscope, we placed the IMU still on a table and recorded the stable values after 10 seconds. Figure 4 shows the range of gyroscope.

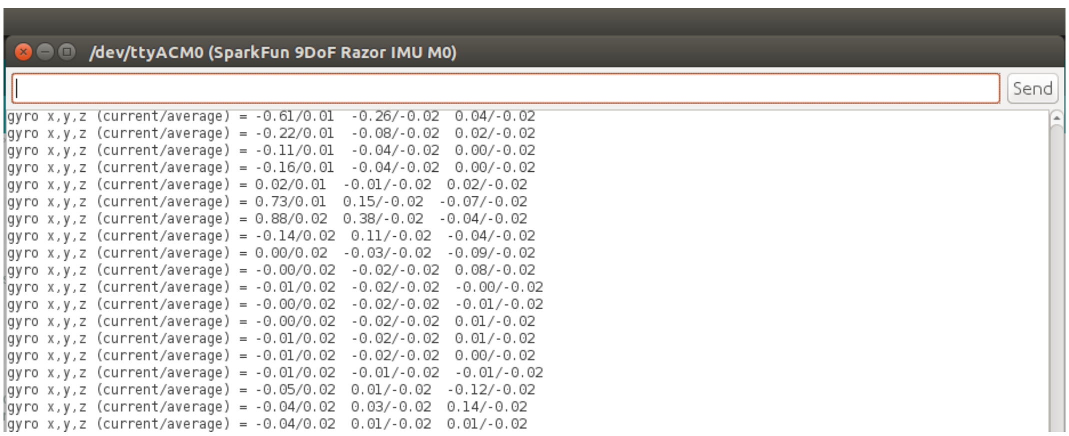

Figure 4: Min-Max of Gyroscope

For magnetometer we used the Processing software to visualize the IMU magnetic field in all directions and obtained a near sphere that was distorted to the visualized earth in center. Figure 5 shows the range of magnetometer. Figure 6 shows the calibration in process and Figure 7 shows calibration values.

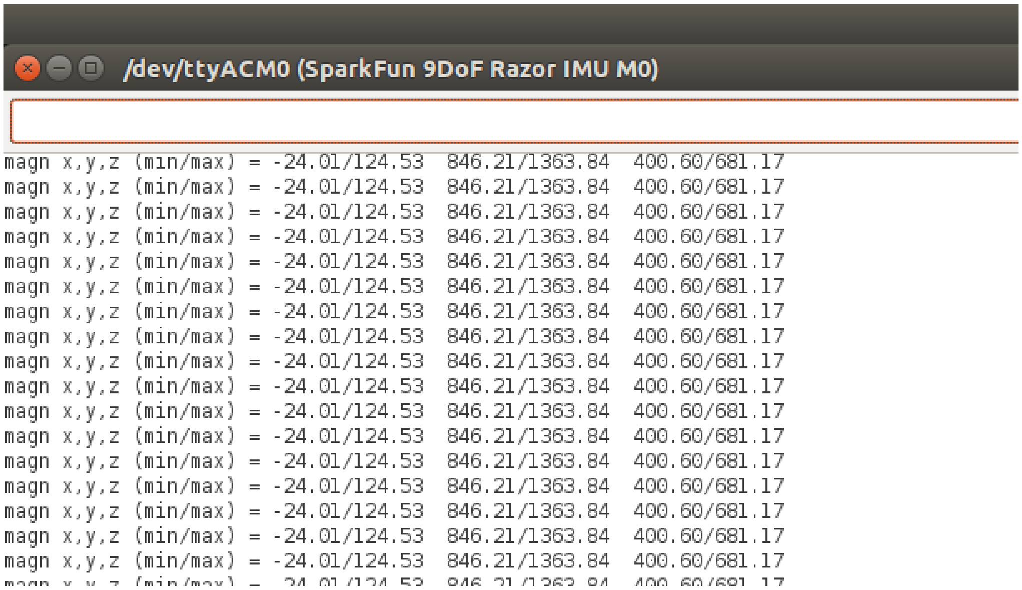

Figure 5: Min-Max of Magnetometer

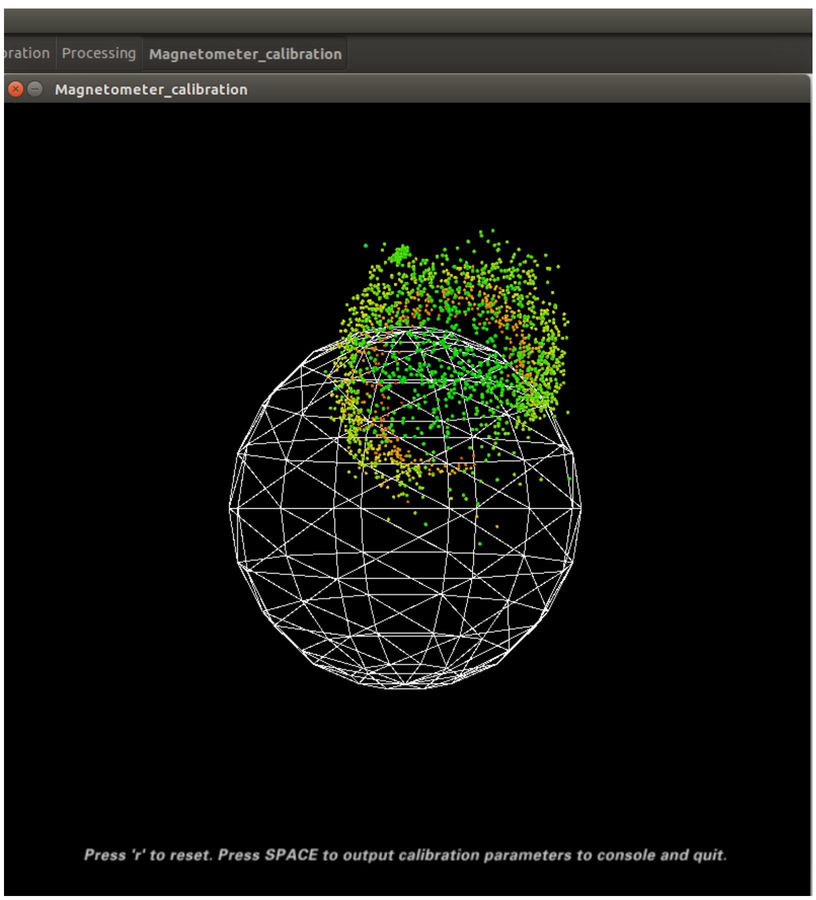

Figure 6: Magnetometer calibration from Processing software

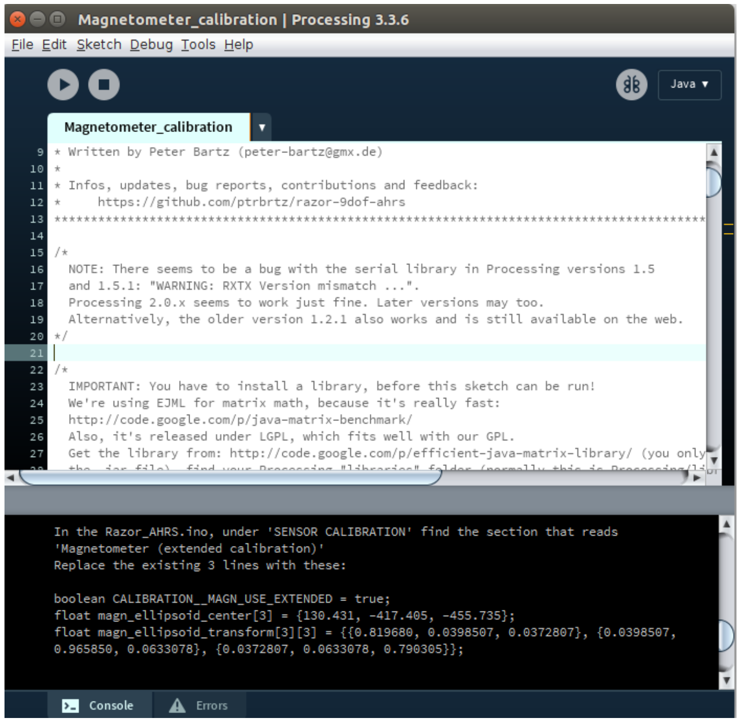

Figure 7: Magnetometer calibration result from Processing software

1.2 IMU Field Testing and Evaluation

To verify the correct calibration, placement and accurate readings from the IMU we tested the real system outside on a sunny day. We calibrated the IMU on the field before running and wrote the sensor values on the yaml file.

We sent two waypoints to the husky and it was able to navigate to both with fair accuracy. Thus we were able to achieve a successful new IMU verification for our system. Figure 8 shows the outdoor testing of Husky. It is moving towards a target location.

Figure 8: Husky moving towards a target with new IMU readings

2. Challenges

For this PR, the biggest challenge we faced was the unavailability of good weather for testing the system outside. We tried testing in the night outside but the low light conditions render the recognition of April Tags by Bebop impossible.

Another major loss we incurred was that we lost one of our backup drones. It got stuck on a very high branch of a tree. We tried various tricks to try to get it down but were not successful. However, we were fortunate to have a backup drone ready for deployment and hence were able to test our software development with the other drone.

3. Teamwork

Yuchi worked on developing a method to explore the mission area using the drone and to relay the information back to the Husky. We were able to record GPS locations for the April Tag fiducials and navigate to them individually in a sequential manner.

Pratibha worked we me to calibrate IMU and perform field testing. Pulkit and Rahul worked on Lidar's point cloud data processing for obstacle avoidance.

Thus, by defining each member's goal successfully and working together as a strong team, we could achieve all the tasks for the PR-9.

4. Future plans

I am planning to work on developing an integrated software stack for the Husky and Bebop so that they are able to communicate directly to each other and share intelligence. Yuchi will continue working on improving the path exploration algorithm for the Bebop. Pulkit and Rahul will work to improve the reactive approach for the obstacle detection on the Husky.