Individual Lab Report- 11

By Danendra Singh

Team F: Falcon Eye

Danendra Singh

Yuchi Wang

Pulkit Goyal

Pratibha Tripathi

Rahul Ramakrishnan

17th April 2018

1. Individual Progress:

As my contribution to the MRSD Project for progress review 12, I have worked to correct the drift in the Robot pose that we were experiencing even after EKF localization. I have also worked on trying out various methods of yaw correction for low-cost IMU's. Additionally, I worked with Pratibha, Pulkit, and Rahul to perform outdoor testing and correct the localization issue for the Husky.

1.1 IMU yaw correction using Complementary filter

The filter uses the algorithm proposed by Roberto G. Valenti et al. in the paper "Keeping a Good Attitude: A Quaternion-Based Orientation Filter for IMUs and MARGs" and fuses angular velocities, accelerations, and (optionally) magnetic readings from a generic IMU device into a quaternion to represent the orientation of the device with respect to the global frame.

After implementing the proposed filter for our Razor IMU 9Dof, we achieved faster convergence of Roll, and Pitch values. Although the filter is not able to prevent the yaw drift in presence of an external magnetic field, it provides a certain degree of robustness to the change in roll and pitch values in an external magnetic field.

To correct the yaw values, we incorporated the external magnetic field generated by the motors of the Husky by calculating the hard and soft iron offsets for the magnetometer. We then used these values to correct the magnetometer readings by writing these offset in the Yaml file for the IMU launch file. Figure 1 shows the true magnetic field generated by an IMU when rotated 360 degrees in absence of any magnetic distortion. Figure 2 displays a constant offset generated in presence of a constant field that is additive to the earth's magnetic field values. Figure 3 shows the shift in the magnetic field ellipsoid due to the soft-iron distortions produced by metals like iron, nickel etc.

In addition, since we were receiving robust acceleration and gyroscope values, we also generated a reference yaw value by switching off the magnetometer in the complementary filter and calculating yaw based on accelerometer and gyroscope readings only.

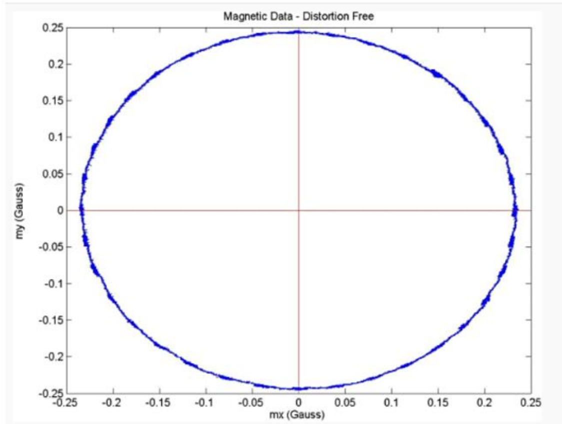

Figure 1: True Magnetometer Readings from a sensor

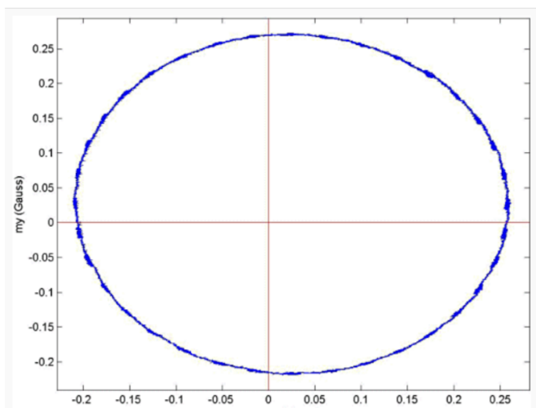

Figure 2: Hard-Iron distortions caused in the magnetometer

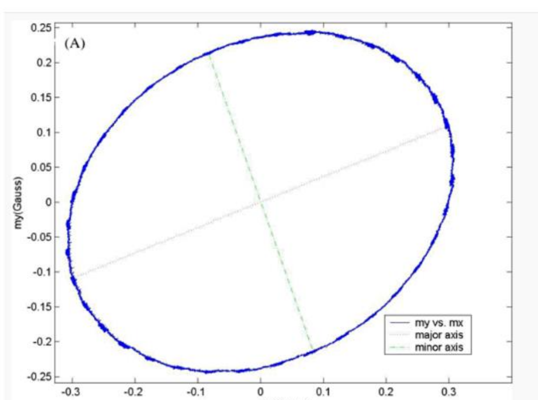

Figure 3: Soft-Iron distortions caused by metallic objects

1.2 Husky navigation stack

After multiple iterations of testing and corrections, we narrowed down the problem of Husky drift to incorrect frame description in the EKF localization of the navigation stack. Hence after few corrections in the frame descriptions and IMU calibration, we were able to perform waypoint navigation with obstacle avoidance. Figure 4 shows husky navigating to the target. Figure 5 shows husky successfully avoiding the obstacle. Figure 6 shows Husky successfully reaching the target.

Figure 4: Husky navigating to the target

Figure 5: Husky avoiding the obstacle

Figure 6: Husky reaching the target

2. Challenges

We were facing a big problem with the EKF localization of the Husky Navigation stack. Due to incorrect sensor frame representations, we were experiencing huge drifts in the robot's current pose. We corrected the frames after which we were receiving a good localization.

One common problem since the starting of the semester has been the bad weather for testing outside. The last part of the project involves the integration of the Husky with the drone which requires a lot of outdoor testing. We are hopeful that because of the carnival holidays, we would be getting sufficient time for outdoor testing and validation.

3. Teamwork

Yuchi worked on changing the bebop's exploration algorithm by incorporating neighborhood exploration and set a fixed flying height for the drone. He performed multiple testing for the exploration algorithm on Bebop.

Rahul, Pratibha, Pulkit and I worked on resolving the above-mentioned issues with the EKF localization of the Husky. I was primarily responsible for correcting the yaw drift with the IMU.

Pulkit, Pratibha and Rahul were working to correct the EKF drift issue and performed multiple testing rounds in the field with various approaches. Rahul also helped Yuchi in testing with the drone.

Thus, by defining each member's goal successfully and working together as a strong team, we could achieve all the tasks for the PR-12.

4. Future plans

Correcting the EKF drift problem solved a major issue for us. The next step involves integrating the waypoint data received from the drone into the navigation stack of the Husky. We already have a pseudocode ready for this but have not tested it outdoors. Hence performing multiple testing rounds before SVE and recoding results will be imperative for good success in SVE.