INDIVIDUAL LAB REPORT 6

Progress Review - 7

Shubham Garg

TEAM H (PHOENIX)

Teammates:

Akshit, Parv, Steve

September 13, 2019

Individual Contribution:

1. Understanding the inertial sensor (3DM-GX5-45 GNSS/INS) ROS package
2. Indoor and Outdoor navigation test for husky using inertial sensor
3. Working with other team members on designing/building the window for opening detection testing and mounting stereo cameras on the husky

Understanding the inertial sensor (3DM-GX5-45 GNSS/INS) ROS package:

In last semester we were using UM7 IMU on husky but even after fusing with the wheel odometry the localization was drifting a lot with the distance. In the mid-spring semester, we switched to the Intel Tracking T265 camera for the localization which worked accurately in the indoor environment but it was drifting significantly in the outdoor environment. So, we decided to use a highly accurate inertial sensor (3DM-GX5-45). This sensor has adjustable sampling rates up to 500Hz, 34 state auto-adaptive EKF, Independently configurable IMU, GNSS, EKF outputs. This sensor also has high-performance accelerometer with the sensitivity of 25 $\mu g/(Hz)^{1/2}$ along with it the accelerometer resolution is less than 0.1 mg & gyroscope resolution is less than 0.003 deg/sec.
ROS package for this sensor publishes the IMU data (AHRS stream), EKF filtered output and the navigation status message. Navigation status message is of size 2 byte which returns the filter state. In the indoor environment when there is no GPS lock the navigation message returns 0x8003. Based on the sensor manual, this message means there is high covariance in the position and there is soft iron correction estimate high warning. And if the sensor is in the outside environment, the navigation status 0x2 which means the filter is running and there is a valid solution. So, we use this information to change the mode of the sensor. I wrote a new ROS node to switch the communication mode to and from "Estimation Filter" mode to "IMU only" mode. This command responds with an ACK/NACK just prior to switching to the new protocol which me to verify if the mode is changed successfully or not.

Indoor and Outdoor navigation test for husky using inertial sensor:

As mentioned in the previous section that the sensor can be operated in different modes like "IMU only" and EKF output mode. So, based on the navigation status published by the sensor, we switch the mode of the sensor. If we are in the outdoor environment, state estimation is directly taken from the 3DM GX-5 sensor which runs on board while in the

indoor environment, AHRS stream from the IMU goes in the robot localization node (EKF filter) which fuses with the wheel odometry.
We did indoor to outdoor navigation test and the localization with the 3DM GX-5 sensor worked accurately throughout. For measuring the accuracy of the sensor, we collected the ROS bag of the odometry output and the static tf information. Figure 1 shows the rviz odometry/trajectory visualization of the outdoor navigation test.

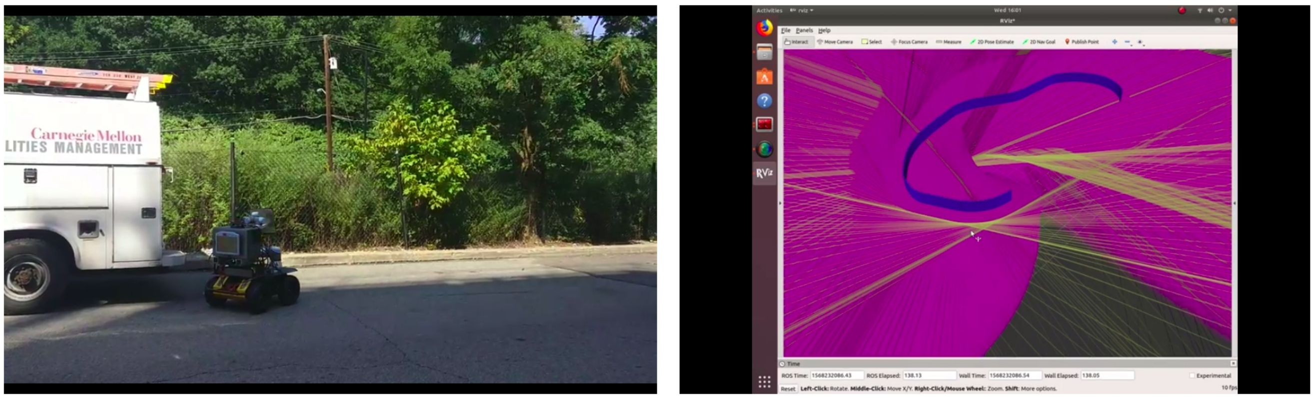

Figure 1: Outdoor navigation test for the husky with rviz odometry visualization

Stereo camera mount on Husky and window design for testing opening detection algorithm:

I coordinated with Akshit & Parv to design/built the window from the cardboards and foams available on the B-level which helped us to test the opening detection algorithm.
I worked with Oliver's student (Kevin) on mounting the stereo camera and mounting UR5 arm electronics. As of now, all the required electronics, sensors, mechanical assembly is available on the husky as shown in Figure 2.

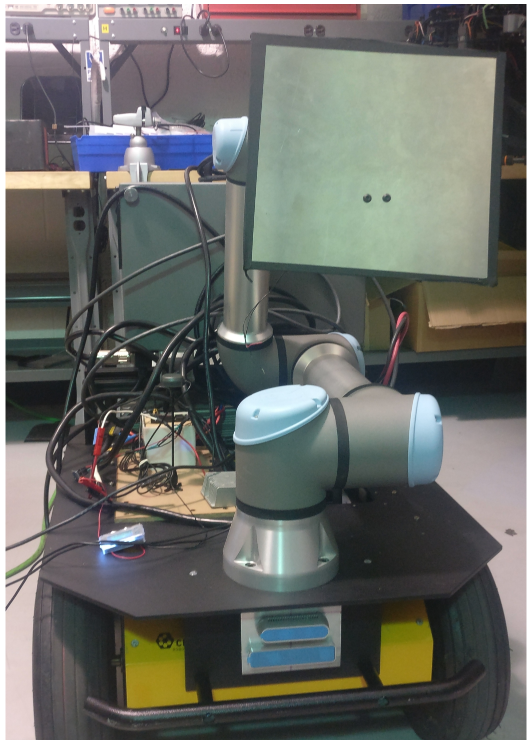

Figure 2: Current status of AGV (Husky) with Stereo cameras and UR5 assembly kit

Challenges:

Challenges faced in the last two weeks are discussed below:

1. I haven't worked with the 3DM GX5 sensor before. So, it took me some time to understand the capabilities of the sensor and understanding the associated ROS package where I did the changes to run the sensor in the different configuration like "IMU only" mode, EKF output mode.

2. We also faced a challenge in fine-tuning the different threshold parameters in the opening detection algorithm.

3. Another major challenge was writing Opencv code on C++ instead of python for higher performance.

Teamwork

Initially, we all brainstormed the opening detection algorithm and came up with an algorithm which can be implemented by classical computer vision algorithms.

Parv wrote the code for the opening detection and I helped him in finding different OpenCV functions which can be used for the algorithms.

Akshit coordinated with Parv in writing the opening detection algorithm/debugging the code and fine-tuning different threshold parameters in the algorithm. He also helped in

collecting the ROS bag of the depth images from a handheld Intel real sense camera for testing the algorithm.
Shubham helped Akshit and Parv in brainstorming the opening detection algorithm, suggesting OpenCV APIs and writing the
Steve helped me in understanding the inertial sensor's ROS package and coordinated with me in the outdoor and indoor navigation test for husky.

Future plans

1. **Shubham** and **Steve** will be working on integrating the local path planner and controller for the Husky.
2. We are also planning to write the code for visual servoing for UAV such that it can align itself to the opening.
3. **Parv** and **Akshit** will be responsible for implementing/testing the code for UAV to enter the window/opening.
4. **Shubham** and **Steve** will be responsible for implementing/testing the code for Husky to enter the door/opening.