Individual Lab Report- 6

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Team F: Falcon Eye

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Individual Progress:

As my contribution to the MRSD Project for progress review 7, I have successfully integrated an Inertial Measurement Unit(IMU) to our Autonomous Ground Vehicle(AGV). I have also solved the common networking issue by shifting the entire system on multiple Access Point(AP) mesh network. Additionally, I have also started developing the ROS software update to incorporate the new IMU for the AGV.

AP Mesh Networking:

One major problem the team was facing using the COTS drone in a client mode (default mode is host) with ROS was that the signal strength from the ASUS 2.4 Ghz WIFI Router was not strong enough to cover the entire stipulated area with the 3dbi antenna being used.

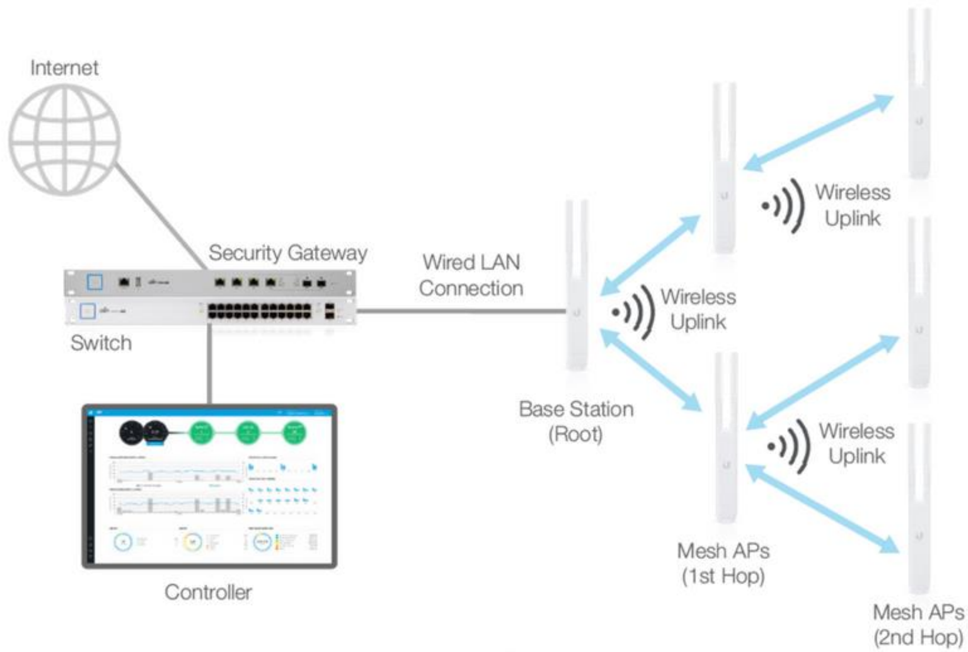
Even if we used a higher dbi patch antenna, connectivity to the control PC on the AGV and the user laptop cannot be guaranteed because of the directional nature of the patch antenna.

One approach to solve this problem was to configure a mesh network involving multiple access points. Now, Seamless roaming as described by IEEE 802.11r (fast BSS transition) is AP-assisted client roaming where is zero-time delay between switching from one AP to another. However, the drone and most WIFI modules in PC's don't support the IEEE 802.11r standard.

The second solution was to use the Zero-Handoff (ZHO) Roaming technology available in the Ubiquity AP's. While it allows clients to roam without any added latency, ZHO does have some limitations. When enabled, all APs in the network use the same radio channel, effectively converting the entire network into a single AP. While this completely eliminates roaming latency, all wireless traffic must compete for airtime on a single channel. The result is a more sluggish network, especially with several clients online. Since, we will be transferring live video from the drone, all devices running on single channel is not the best stratergy.

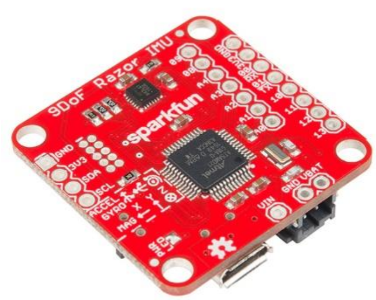
The best solution seemed to use the Ubiquity Fast Roaming technology inspired from the IEEE 802.11r standard. Fast roaming allows negligible roaming delay times while supporting the drone's IEEE 802.11a/b/g/n/ac standard.

So, we decided to test the system on a single AP device and the results were more than satisfying. We were getting faster ping rates and superior imagery data from the drone even in closed surroundings. Although single AP claims to provide 183m of Range, we will be using 2 AP's in Mesh topology to improve the safety and robustness of the system. Initial tests are promising, and we hope to achieve good results.



Example of Multi-hop Mesh Topology with UAP-AC-M

<u>Razor M0 IMU:</u>



Razor M0 IMU-Sen-14001

During the FVE, due to faulty hardware and outdated hardware of UM7 IMU, we were not able to acquire accurate inertial measurements for the AGV. We decided to shift to another low cost IMU form UM7 and procured Razor M0 IMU. One big issue with this new IMU was that it supported raw serial data communication to Arduino. This meant we needed to convert the raw gyroscope, magnetometer and accelerometer data to roll-yaw-pitch values and then send it to ROS serial.

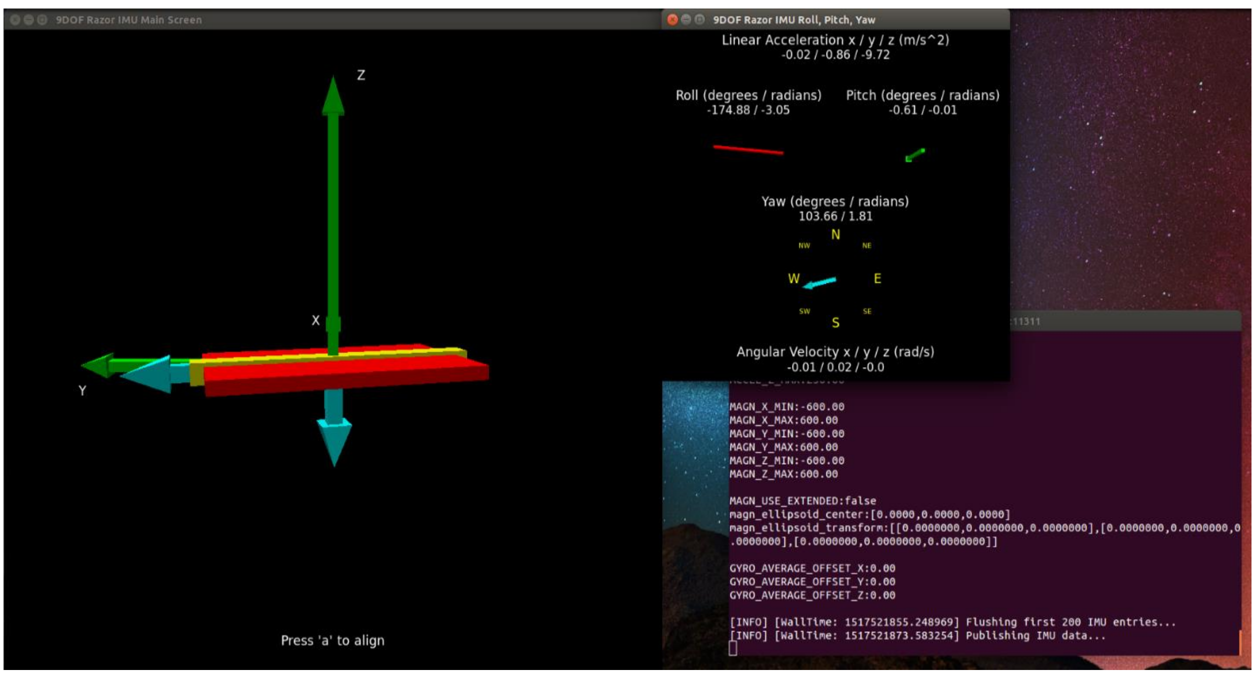
So, we flashed a new firmware using a bootloader on the IMU's SAMD21 microprocessor which allowed us to directly convert raw values to useful quaternions and directly access the IMU's data over USB in ROS. This was imperative as the "razor_imu_9dof" ROS package only supports older variants of the hardware and we had to make necessary changes in the firmware file.

We used configuration yaml file to publish the IMU RPY data with a launch file as /imu topic.

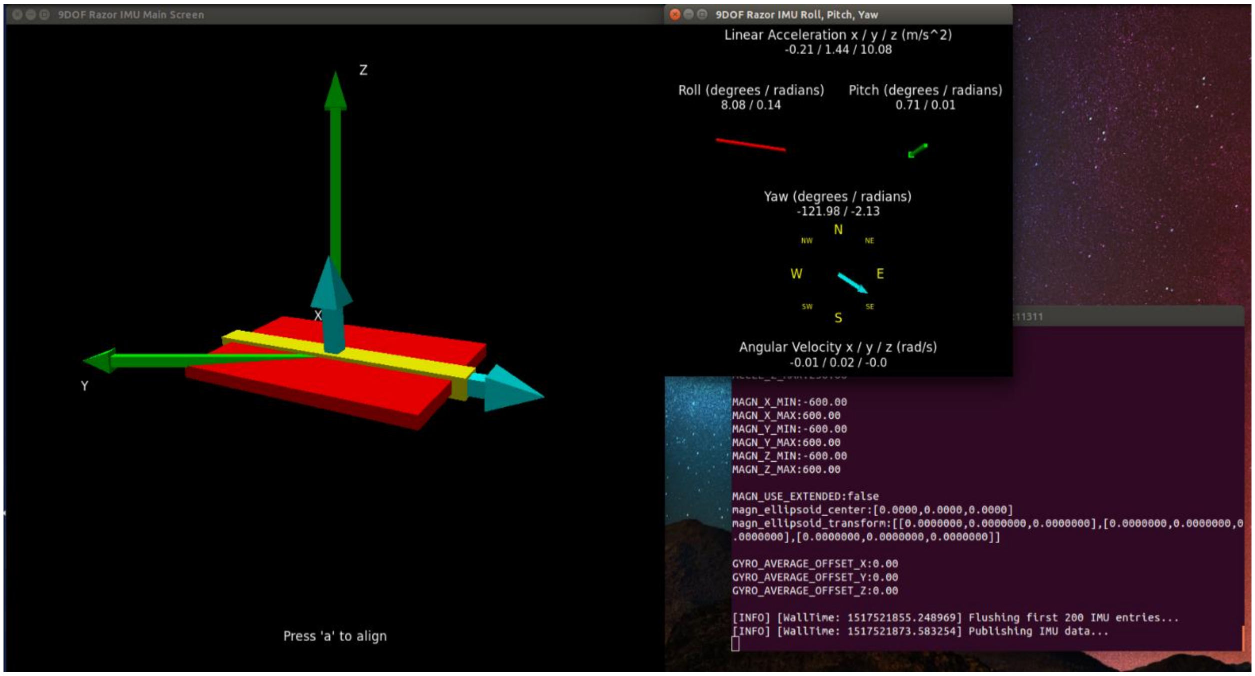
To find IMU usb port ID to be updated on configuration file: $ ls -la /dev

To change port accessibility setting (wont be able to read IMU values without this):

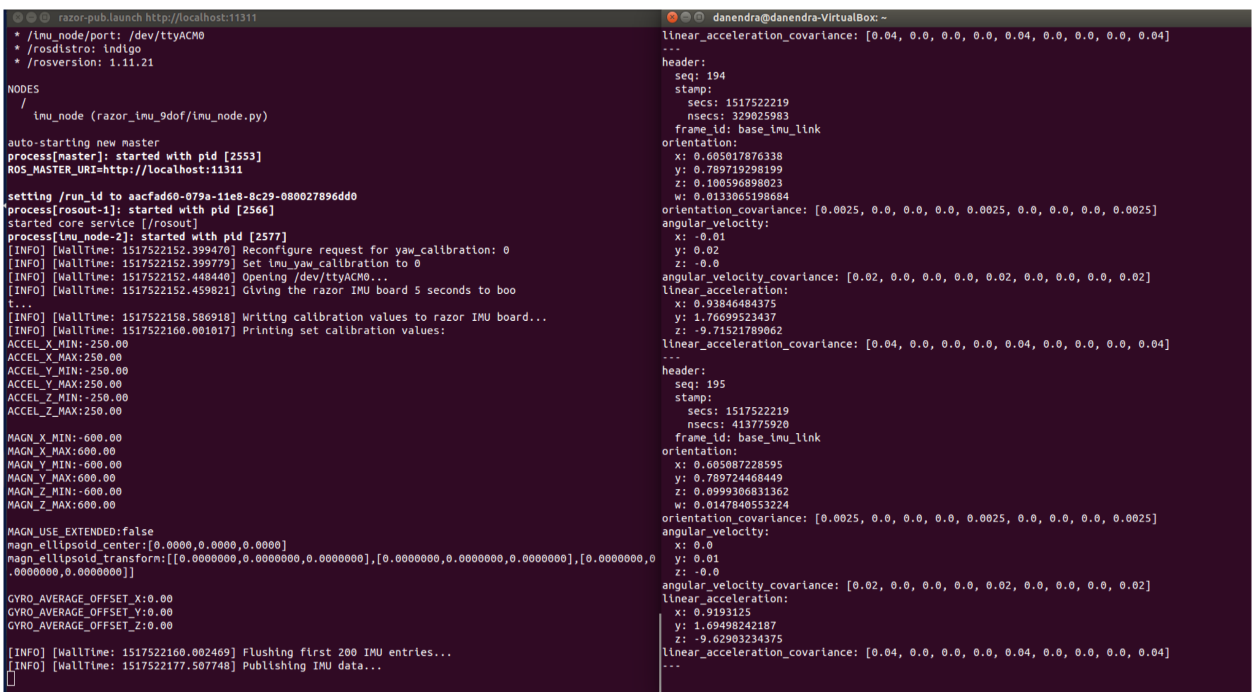
$ sudo chome user_name:user_name dev/Port_name



Interface to verify IMU reading



Changed values of IMU



Publishing IMU RPY data as a /imu topic

Challenges

For this PR, the biggest challenge we faced was the unaccommodating climate for outdoor testing of the drone and the husky outside. We were able to manage indoor testing of the april tag mapping, but we are yet to test the IMU operation integrated with the AGV.

The mesh network depends on a DHCP enabled router to assign IP addresses to various devices. Since, this increases components used and hence failure modes. We decided to let go of the router and directly switch the AP to a static IP mode with IP's preassigned to each individual component (Laptop's, PC, Drone etc). This however will not allow any other device to connect to the network unless it is pre-configured with the network. This has its own pros (increases security and decreases interference) and cons (new devices can't be connected on the go).

Teamwork

Yuchi worked on developing a map of the path traversed by the UAV by registering the april tags detected by the UAV and registering the distance from one april tag to another.

Pratibha worked with me to solve the IMU data transfer to the ROS node and publish the data on a node. She also worked with Pulkit to upgrade the mini PC for needs of LIDAR point cloud data processing.

Rahul and Pulkit worked on the Velodyne LIDAR's point cloud data to find obstacles on husky's path and localize the found obstacles.

Thus, by defining each member's goal successfully and working together as a strong team, we could achieve all the tasks for the PR-7.

Future plans

I am planning to work on testing the navigation code on the AGV by incorporating the new IMU and develop initial path planning algorithm for deployment on the AGV. I also will help Yuchi with developing software to send commands to Husky for navigation.