Lab3

- Stationary data analysis
- Estimate heading
- Estimate the forward velocity
- Integrate IMU data to obtain displacement and compare with GPS

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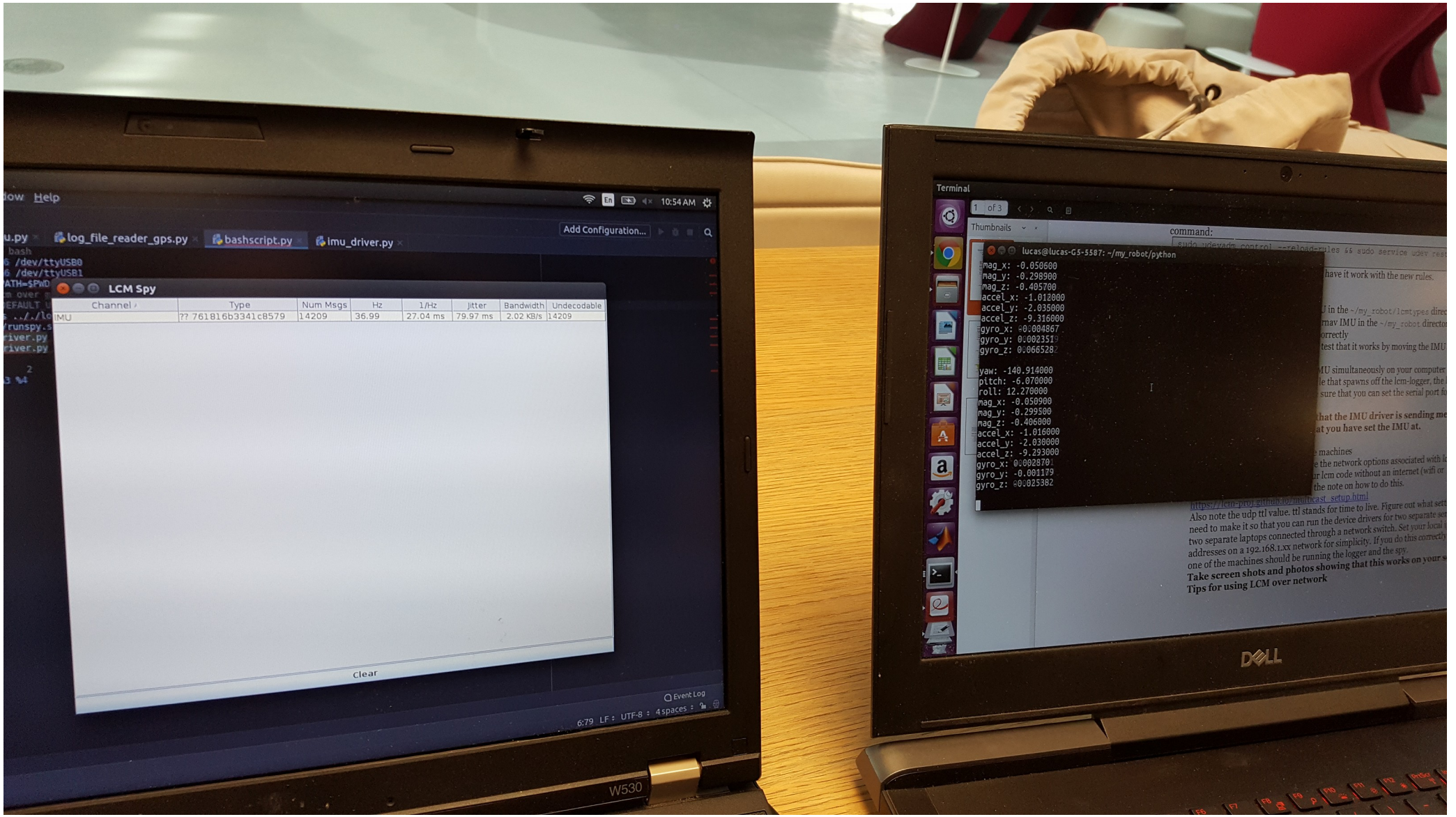
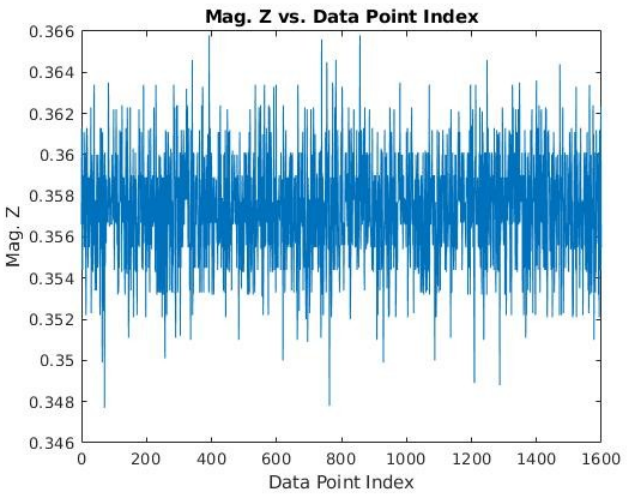
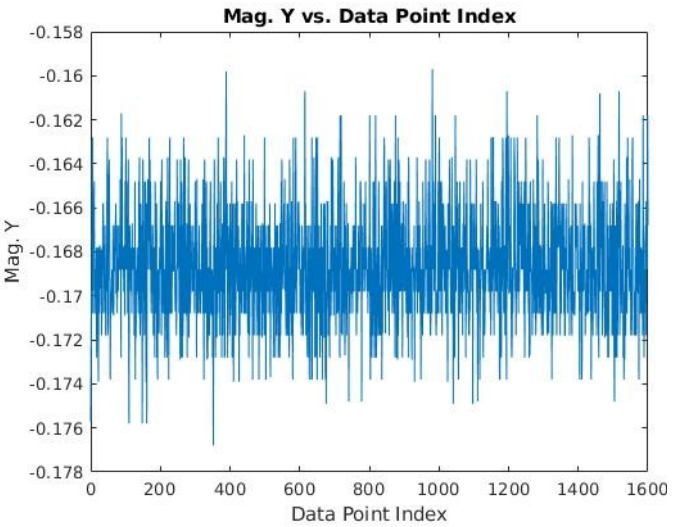
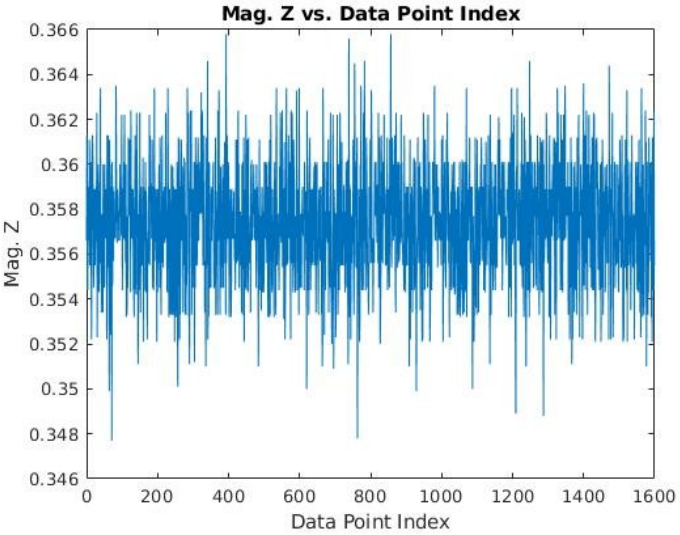
LCM working over the Internet



Stationary Data on Magnetometers







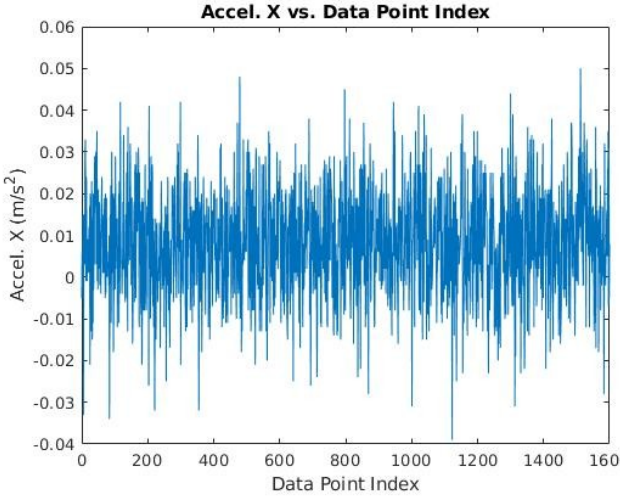
Errors source:

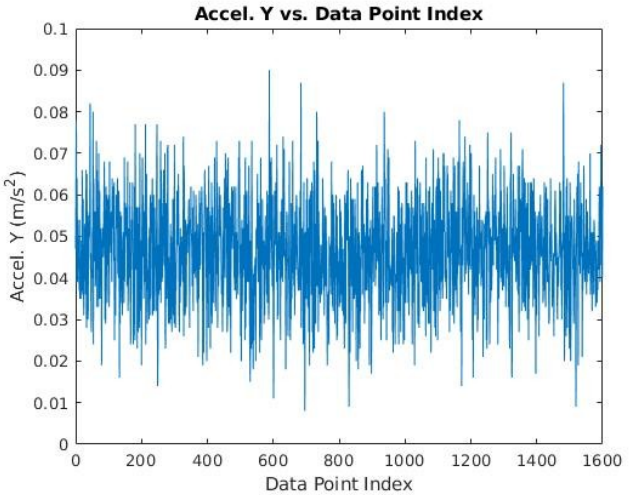
1 Bias: the magnetometers may have initial bias.

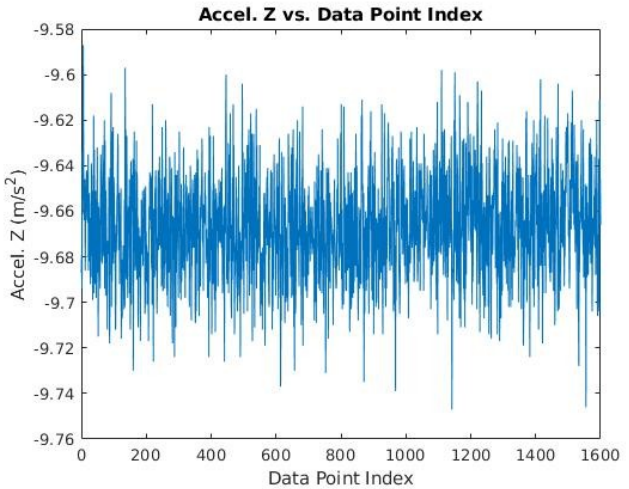
2 In-run bias: After powerup, initial bias changes over time.

3 Hard-iron and soft-iron: There are magnetic field sources, such as computer, running cars and trains. For hard-iron: the magnetic field add to or subtract from the earth's magnetic field. For soft-iron: the ferromagnetic objects changes the direction and magnitude of earth magnetic field.

Stationary data on Accelerometers

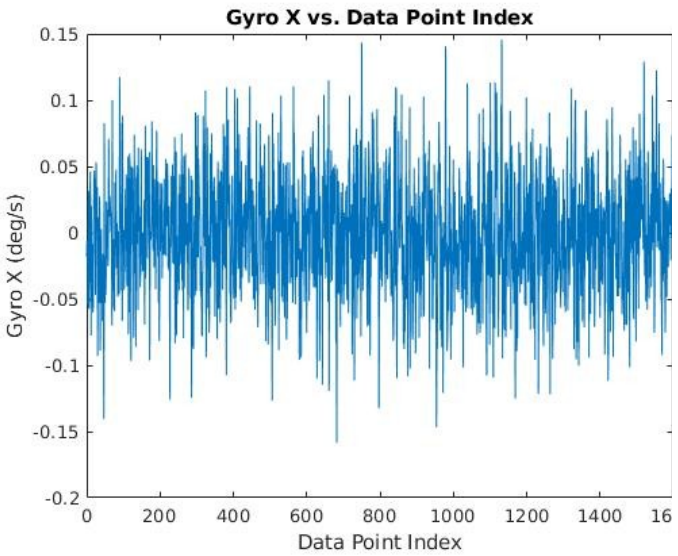


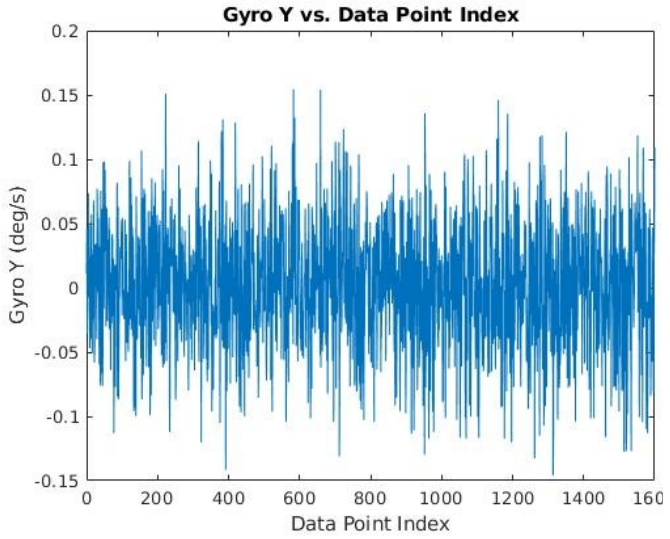


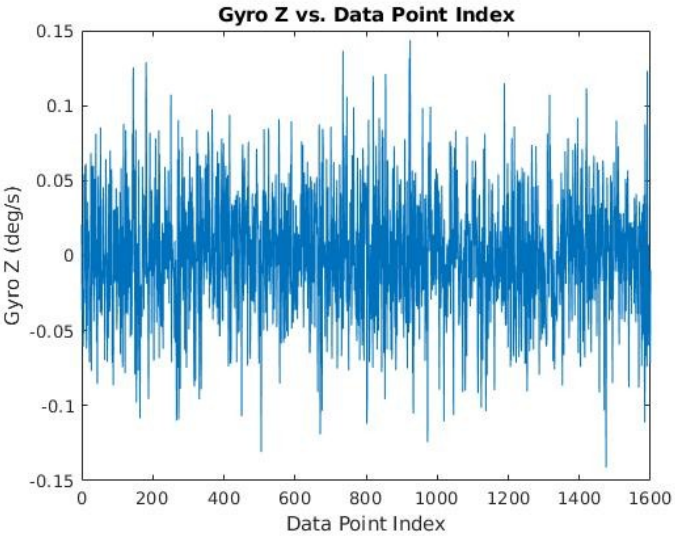


1 Bias: Accel z should be -9.81, there exists about 0.2 initial bias.
2 In run bias: The initial bias changes over time.
3 Misalignment: We can see accle.x and accle.y are nonzero, so the accelerometers are not orthogonal to each other.

Stationary data on gyroscope

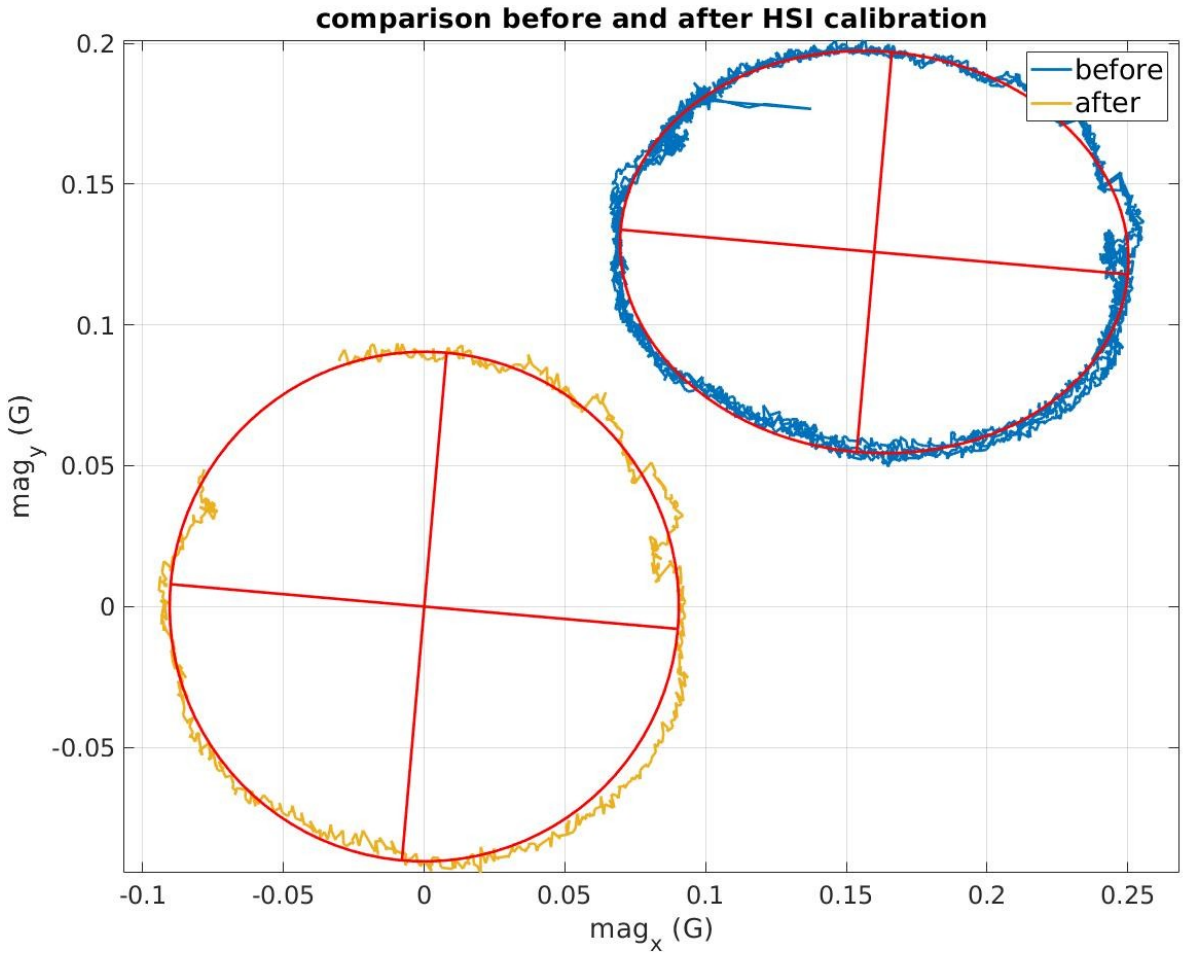






There exists bias and in-run bias.

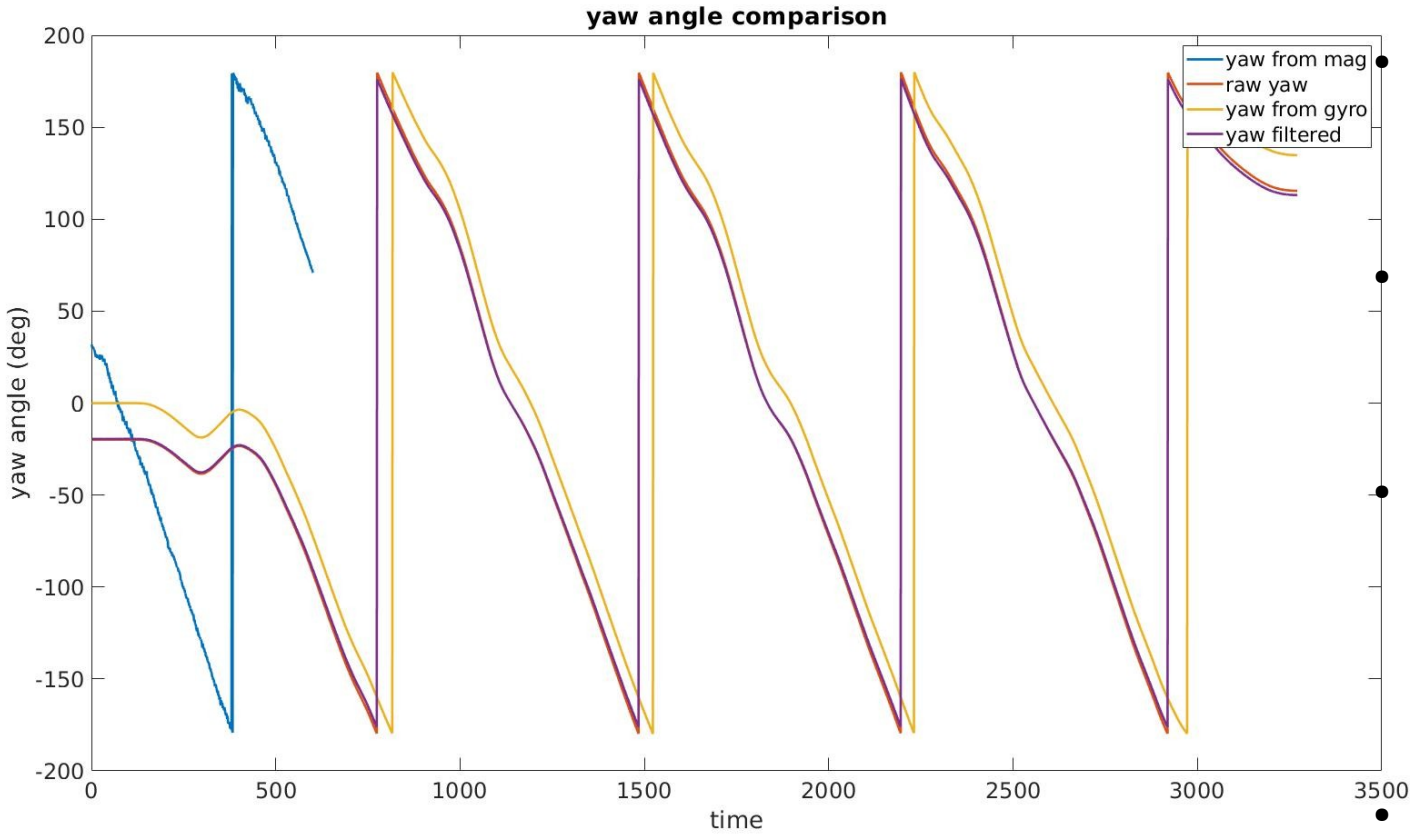
Estimate the heading(yaw)



- These plots from the only circle driving.
- After hard iron correction and soft iron correction, we can see the trajectory is close to a circle.

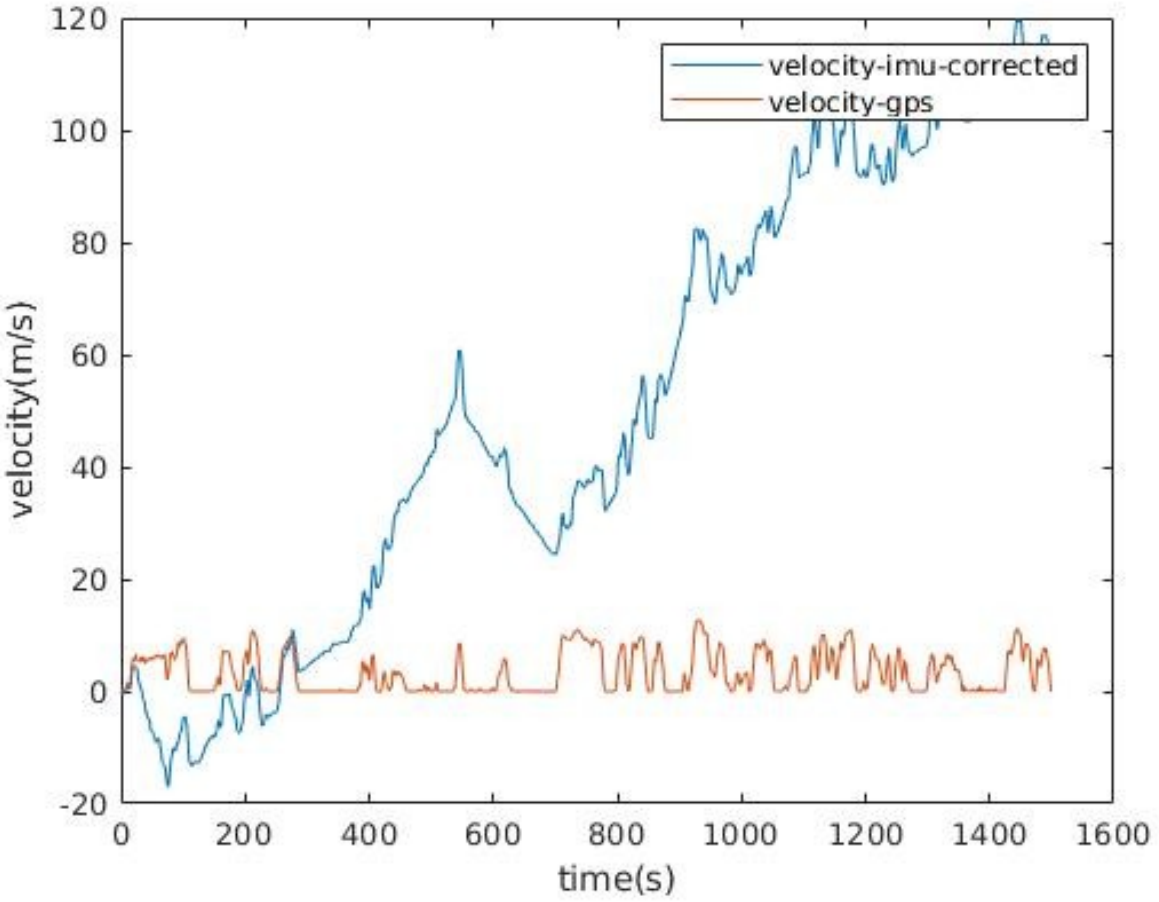
Estimate the heading(yaw)

Comparison of yaw from gryo, mag, and yaw sensor of imu.



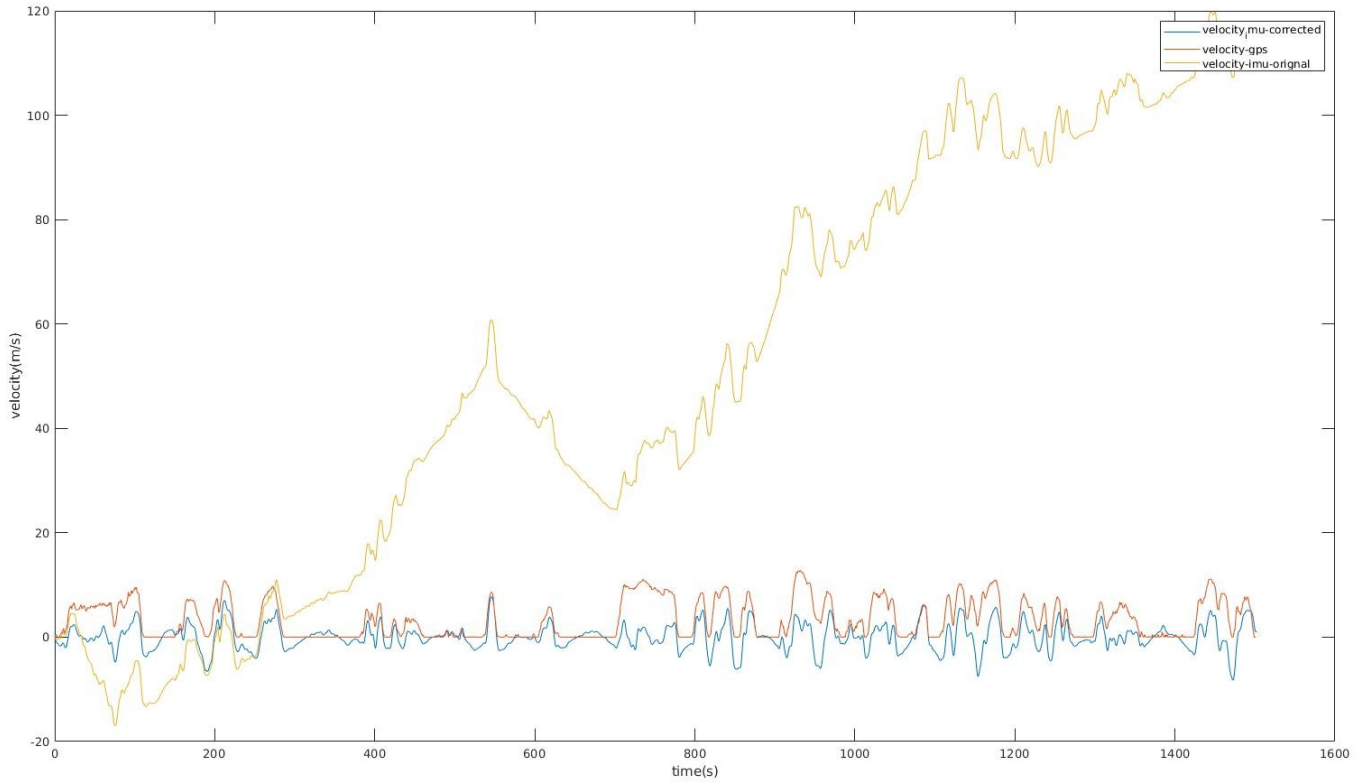
- The figure shows four different yaw we can get from imu and the complementary filter
- We can see the result given by imu and the filter one roughly match to each other
- We found that the mag one is strange and cut-off. I think it should be interfaced by magnetic field especially earth magnetic filed.
- Also, the yaw angle calculated from gyro with initial yaw 24.98 deg, which means the data from gyro is perfectly agree with yaw from yaw censors.

Estimate the forward velocity



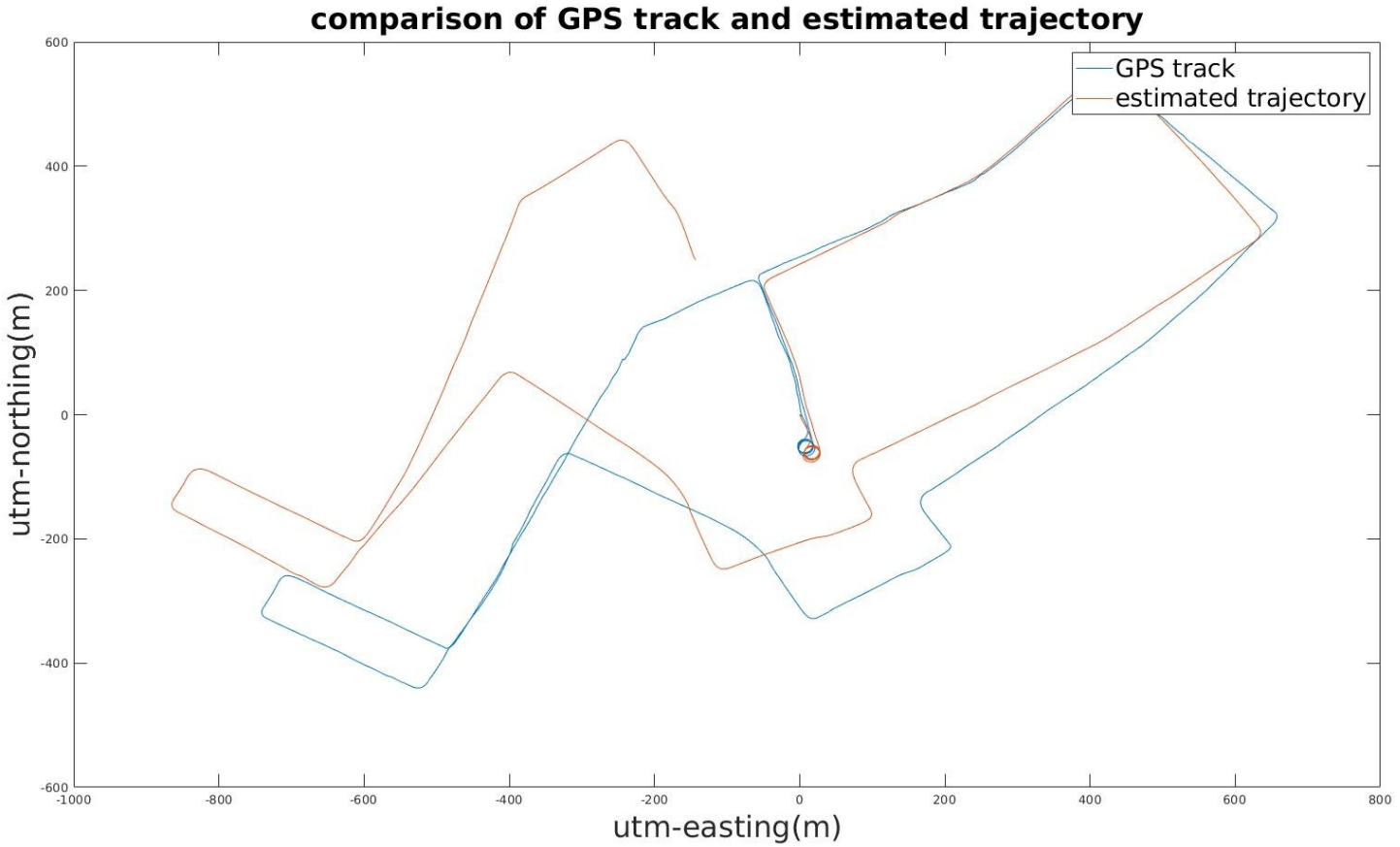
- Because IMU works on 40HZ as gps works on 1HZ. The first thing I did is rescale the imu data.
- After calibrated the scale of axis, there exits strange velocity data from imu.
- The imu will drifted over long time running. Also if the accelerometers are not orthogonal to each other, gravity will make big effect on the forward direction. That’s why the integrated velocity from accelerators doesn’t make sense. We should filter these noise to get a better data by using bandpass filter.

Estimate the forward velocity



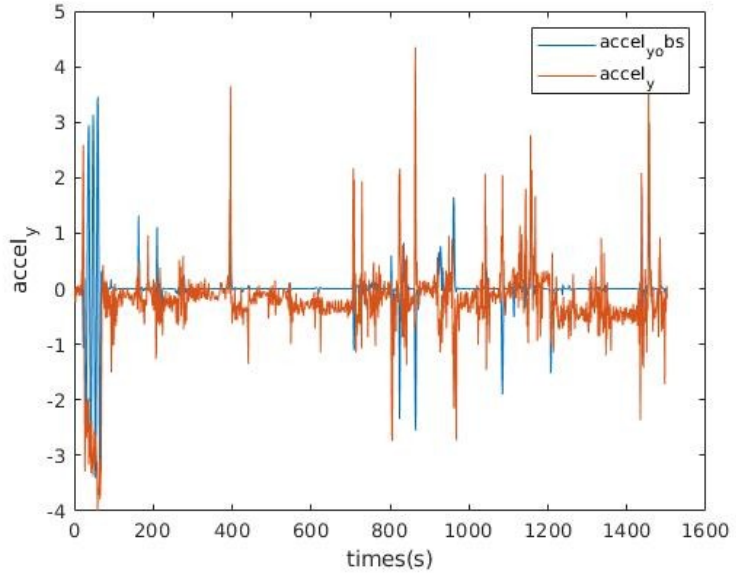
- We can see the data after bandpass filter and the data from gps are roughly match.

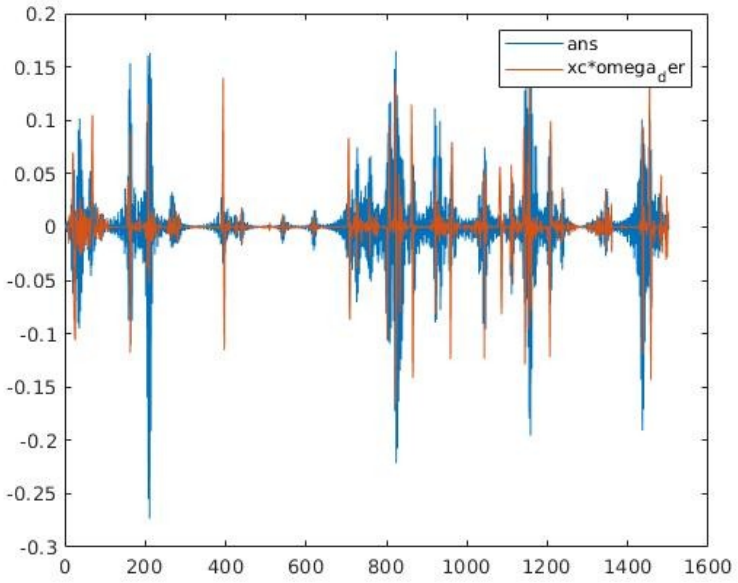
Displacement comparison between IMU and gps



- We see the trajectory given by gps(blue line) and estimated trajectory calculated from IMU data.
- I rotated the graph by 200 degree to let the first line of two routines meet.
- We can see the starting point at didn’t meet the end point in this case. Obviously, these errors are from accelerometer and yaw angle.

Acceleration comparison and estimate Xc





- When Xc = 0, I got the observed acceleration and calculated acceleration in the first figure.
- Because of Xc is not equal zero, there exists difference in these two acceleration.
- We can estimate Xc from the following relationship between parameters:
  accel_y_obs - vel_x(i) * gyro_z(i) = xc.*omega_der
- I got Xc =0.5 when these two data in the second figure are roughly match.
- The value of Xc is close to the distance between GPS and IMU during the driving test.