Lab 03 Data Analysis

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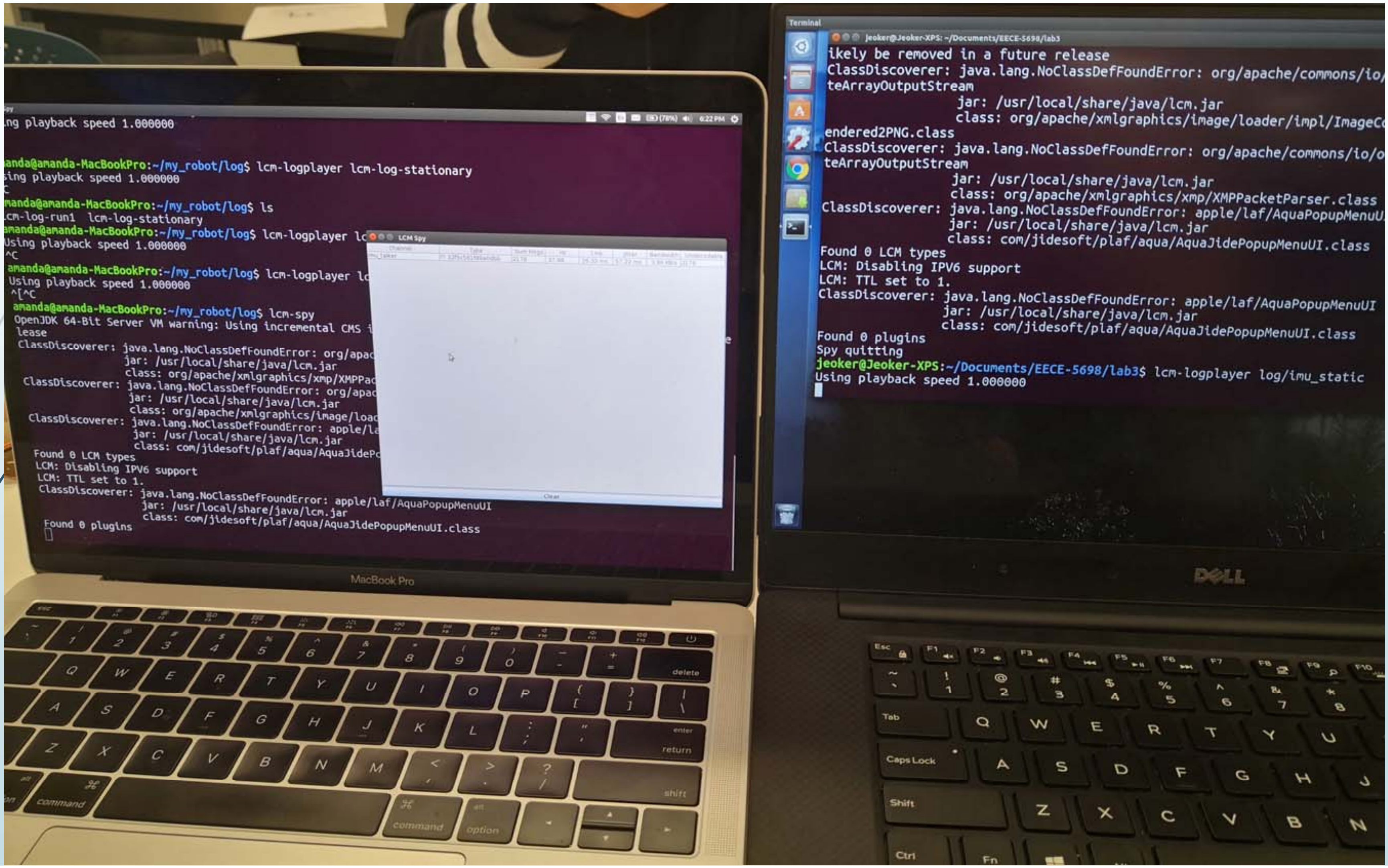
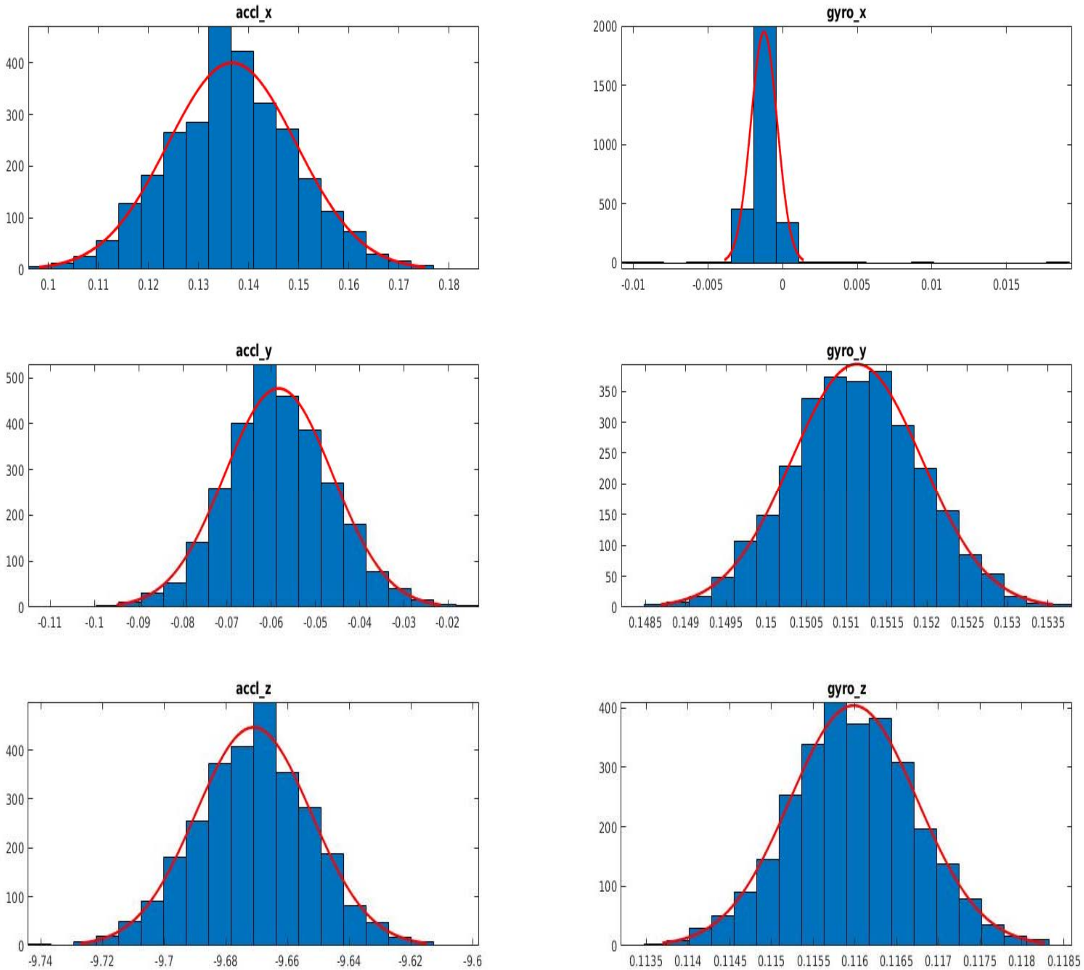
Gitlab Link: https://gitlab.com/liu.yang12/EECE-5698

LCM Working Over Network

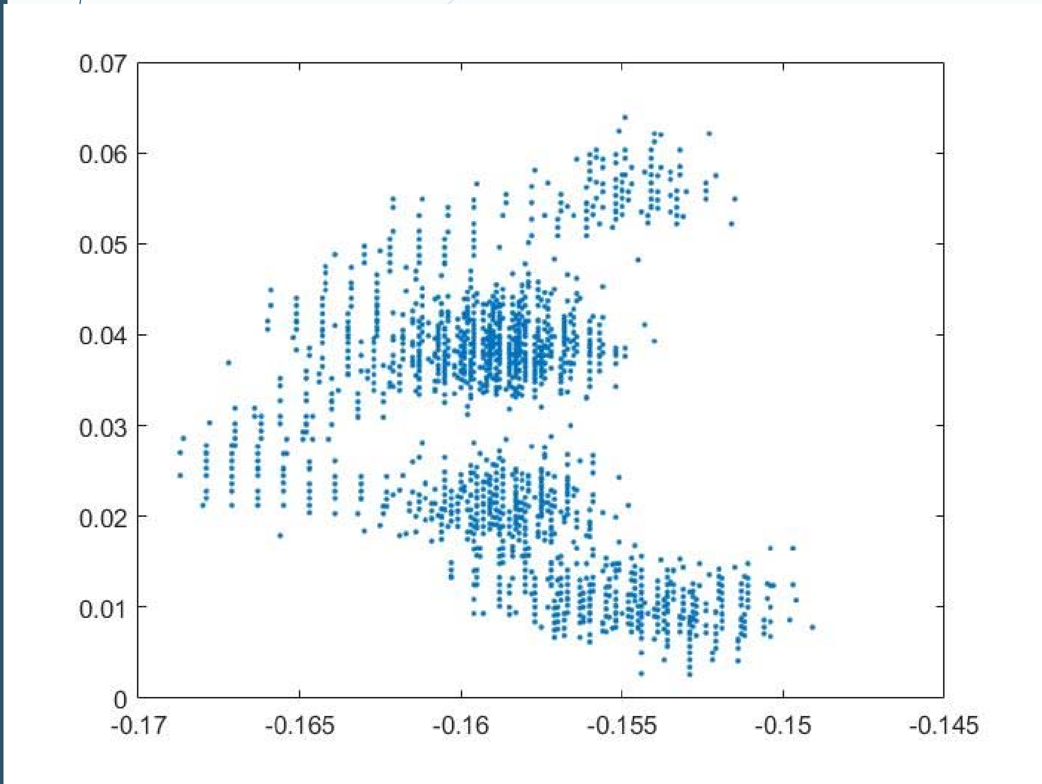


Static Data Analysis



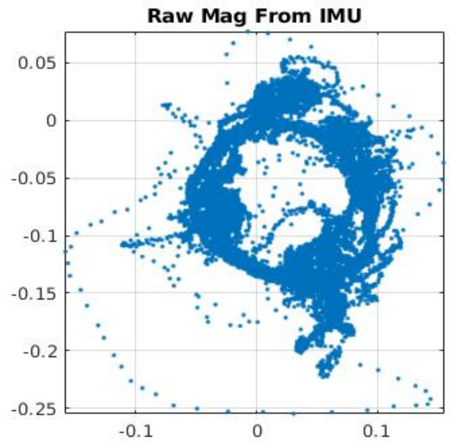
- The data is taken on a desk in Snell Library
- We can see that when kept stationary, the gyro data from three axis and acceleration from three directions follows gaussian distribution pretty well
- The scatter ranges of data from six degree of freedom are similar, which are around 0.15 m/s^2 and 0.05 rad/s.
- We can see that the mean value of all data are not at zeros. For accelerations, this is partly because that the desk is not perfectly horizontal, partly because that the sensor itself has bias. Meanwhile, for gyros, this is mainly caused by the bias of the sensor.

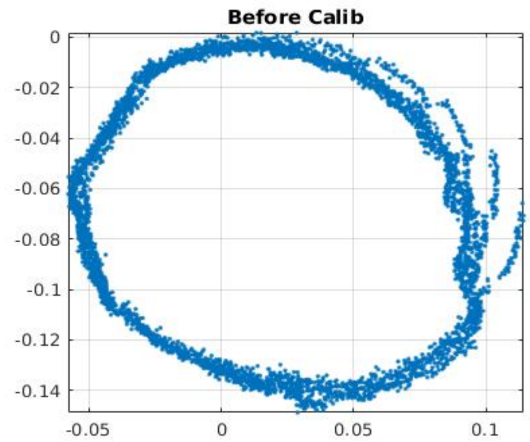
Static Data Analysis

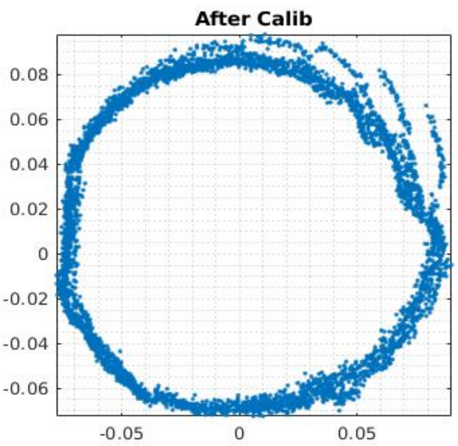


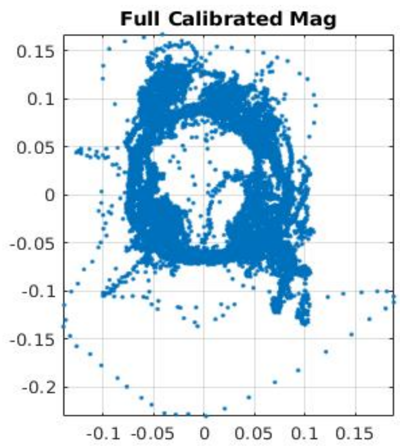
- The static data of magnetometer distribute in a very strange way in all three axis.
- I believe this is because the data is affected by environment magnetic field.
- Hence, static data of magnetometer should not be used for calibration.
- For magnetometer calibration, we need to use data gathered during driving period.

Driving Data Analysis: Calibration of Magnetometer



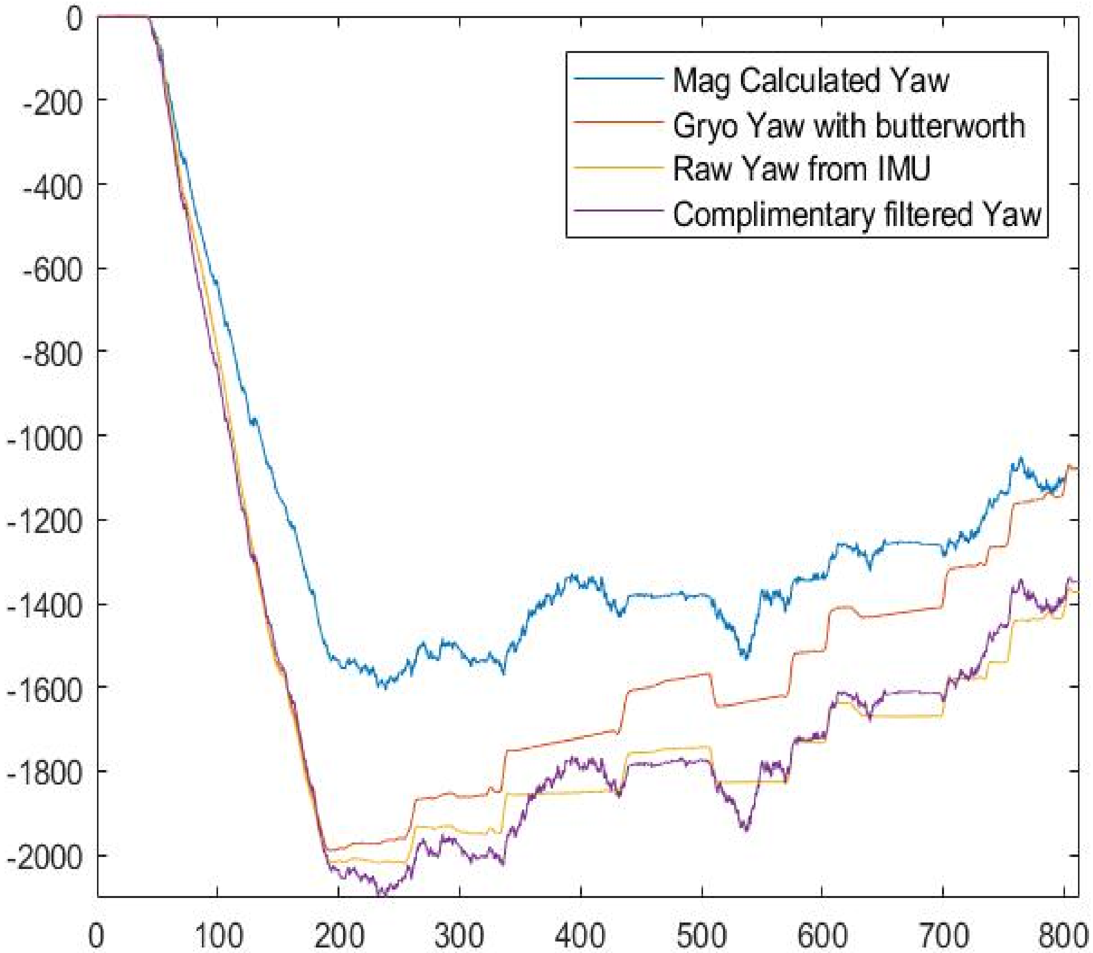






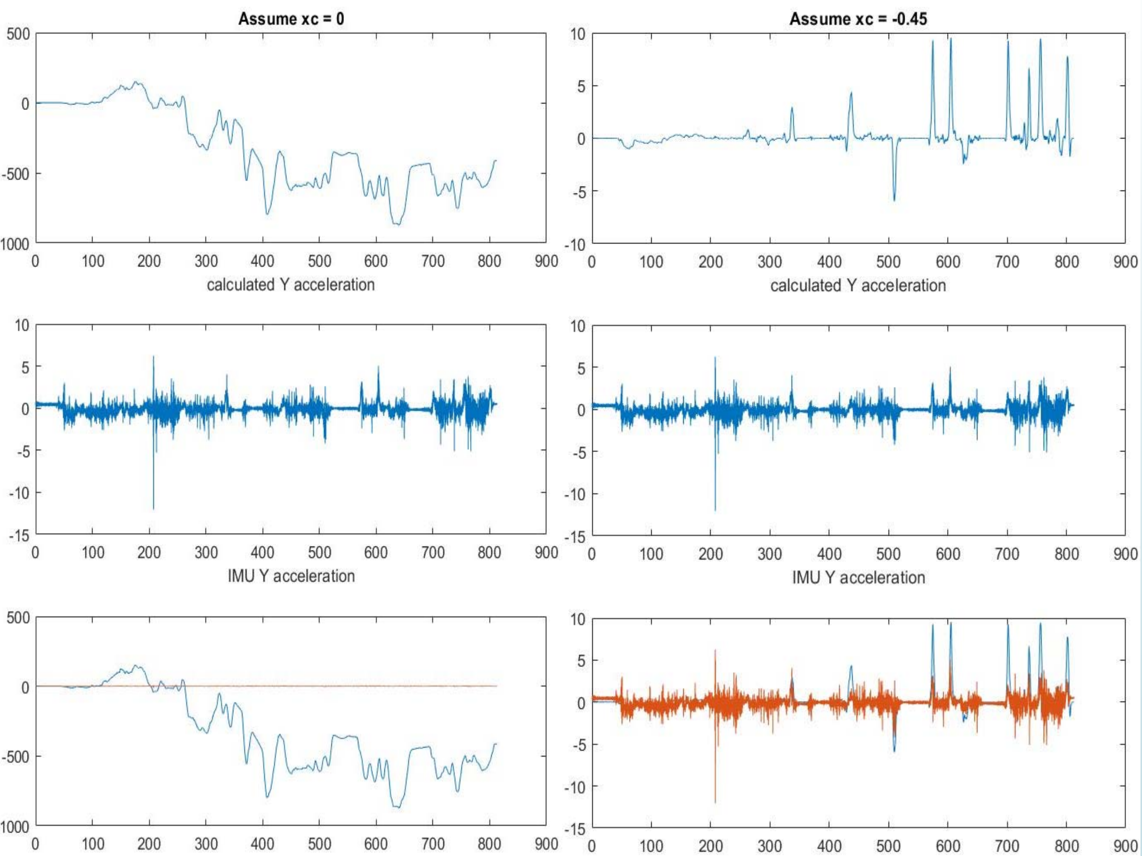
- These plots show the data read from magnetometer while driving along x and y axis.
- The first plot is data from whole driving part. Due to the limited scale of Earth magnetic field, the data is strongly affected by noises.
- Hence, to calibrate the magnetometer, we grasp the data we get when driving in circles at Ruggles for calibration.
- In plot3, we move the ellipsoid to origin, then rotate it to make its axis same to x and y axis and finally expand the x axis to make it more a sphere.
- In the end, we apply the calibration parameters to all data, and get plot 4.

Driving Data Analysis: Calculation of Yaw angle



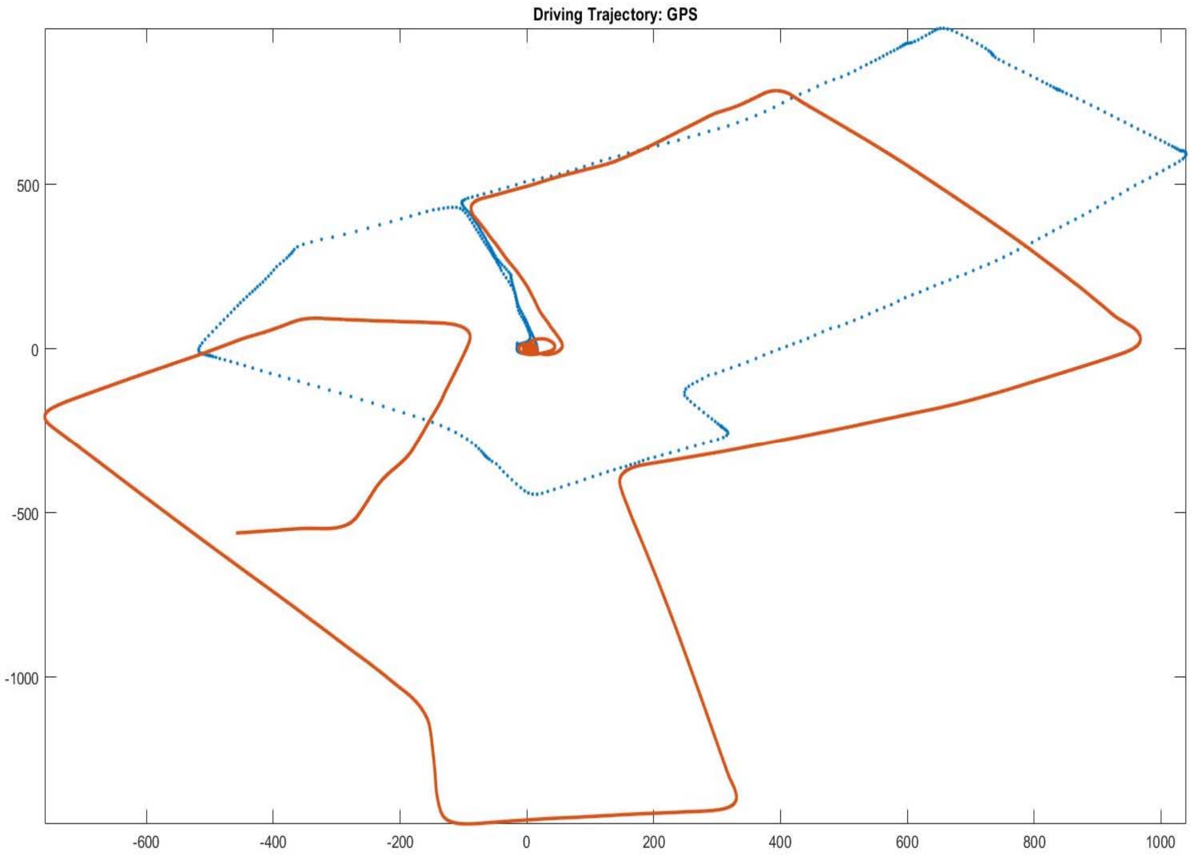
- This figure shows four different yaw we can get from IMU
- The initial value of all four data are reset to zero manually to make them more comparable.
- For high-pass filter of gyro-integrated yaw, I used 1 pole butterworth filter with Wn=0.0005
- For low-pass filter of magnetometer yaw, I used 1 pole butterworth filter with Wn=0.05
- As we can see from the graph, the result given by imu (yellow line) and result given by complimentary filter (purple line) roughly match to each other.
- The yaw angle from mag looks wild even after filter. I tried to do filtering before or after calculating yaw angle, and tried different samples for calibration, but it didn't help. I believe this is because the magnetic environment in our car wasn't good. We took data three times and got every electronic devices away from imu, but it didn't work. I don't have enough time to do more test, so I used the best data I can get.

Driving Data Analysis: Comparation of acceleration in Y axis



- These plots compare the acceleration in y-axis given by imu and calculated data
- The plots in left column show results when xc=0. They are calculated acceleration, observed acceleration and their combination respectively.
- The plots on the right column are results with an estimation of xc = 0.35. The main criteria of doing this is making the first 200 seconds data as flat as possible. Because that part of data was samples taken when we were stopped or driving in circle in front of Ruggles.
- By comparing the result, we can see that the calculated acceleration match to the observed data pretty well when xc = 0.35.

Driving Data Analysis: Calibration of Magnetometer



- Figure on the left shows the trajectory given by GPS (blue line) and integrated by imu (orange line).
- I shrinked the original orange line by a scalar 0.16.
- I rotated the graph by 105 degree to let the first line of two routines meet.
- I set X velocity to zero when GPS position is not moving to soothe the accumulated error.
- The starting point at last didn't meet the ending point in my case. Obviously, the errors are from acceleration and yaw angle. I don't really know how to reduce the error when driving on a ramped road.