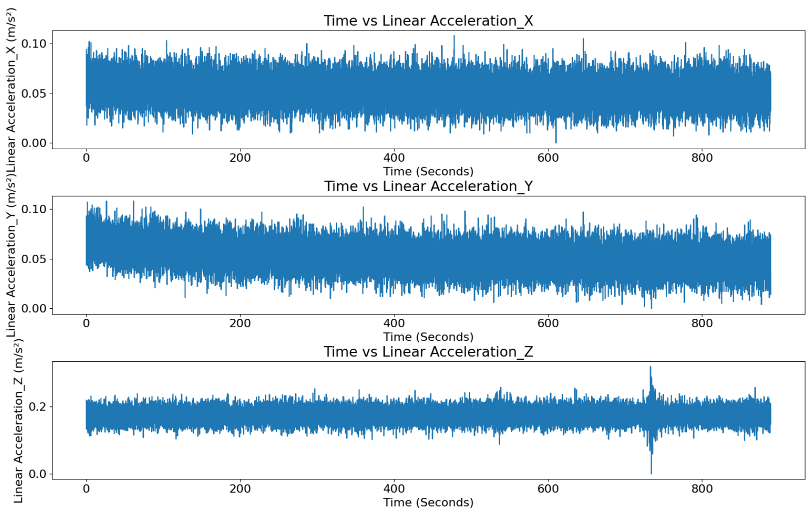
LAB #4 IMU

Part 1:

Collect data individually for 10-15 min at stationary location and here is the data collected



Mean & Standard Deviation of Linear Acceleration:

mean = 0.05318425639583918

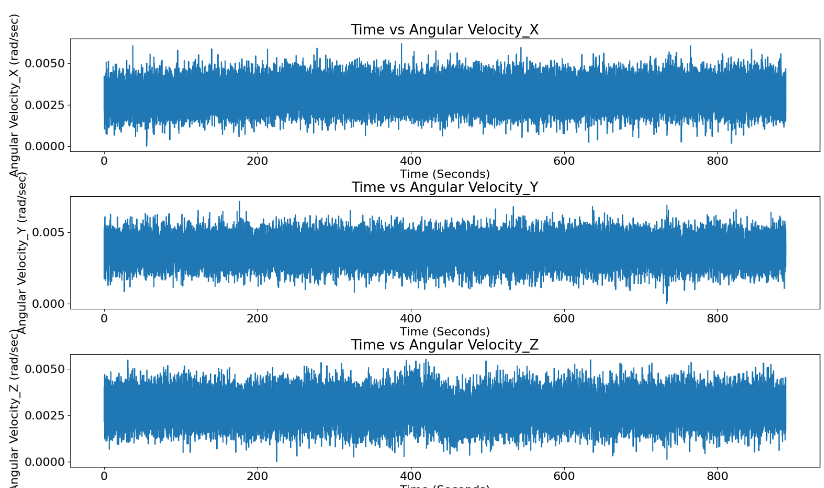
standard deviation = 0.012989928325130 66

mean = 0.052207815574922704

standard deviation = 0.013334105102612594

mean = 0.17498757379814392

standard deviation = 0.019348556164387472



Mean & Standard Deviation of Angular Velocity:

mean = 0.003110412426201856

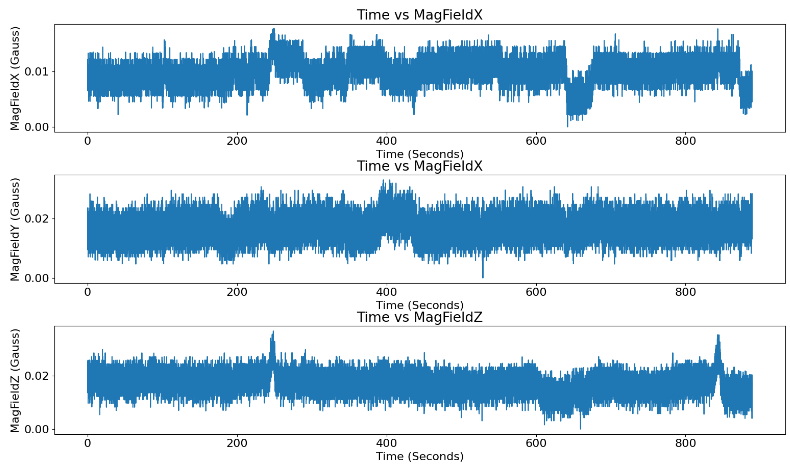
standard deviation = 0.0007410580792924262

mean = 0.0037375095023896546

standard deviation = 0.0008076326350520089

mean = 0.002864389091931403

standard deviation = 0.0007158887650831054



Mean & Standard Deviation of Magnetic Field:

mean = 0.009886598256958092

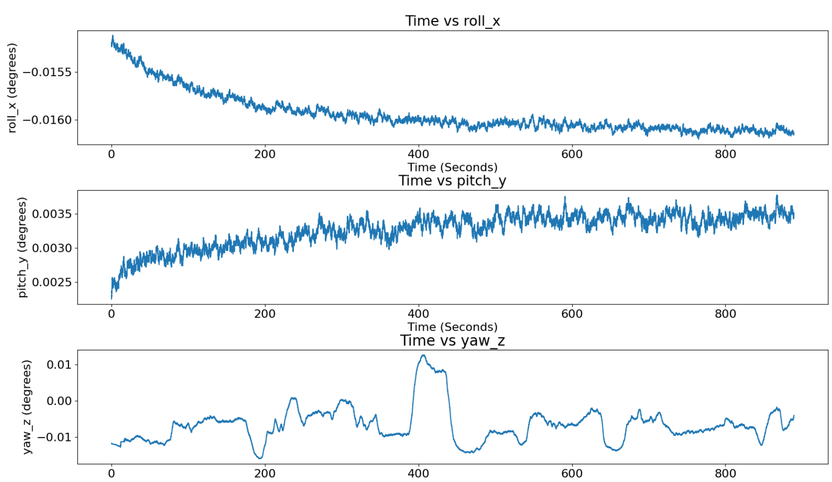
standard deviation = 0.0021589116931615276

mean = 0.016332628619623275

standard deviation = 0.0040158994477277784

mean = 0.017436952488051712

standard deviation = 0.003897265746861367



As observed in the above graph and standard deviation and mean. The noise characteristics of the sensor could be Bias and random walk.

Part 2:

Collect Data in a car for dead-reckoning as a Team:

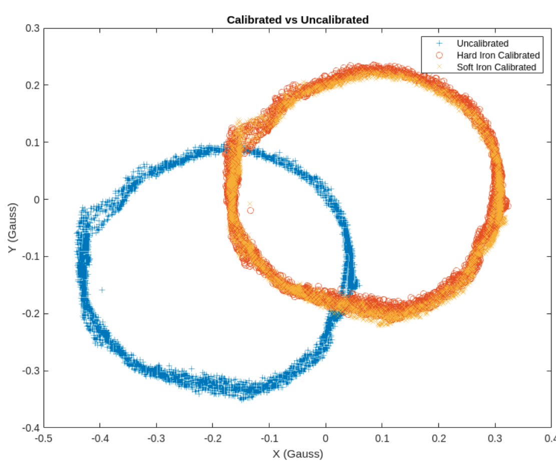
In both the IMU and GPS puck were used to collect data in a preplanned map around the campus and the analysis of the same follows:

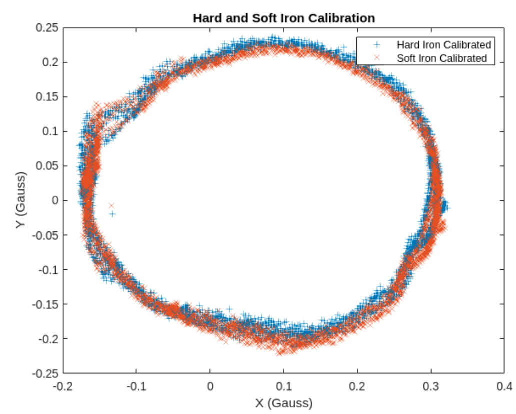
1. Estimate the heading(Yaw)

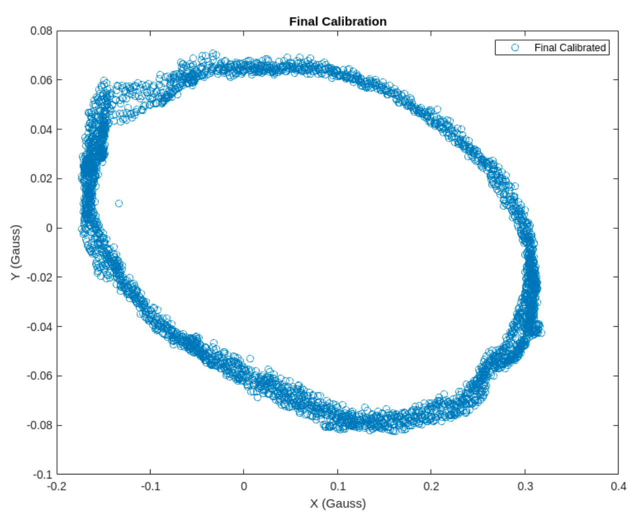
Magnetometer calibration:

- The magnetometer readings for hard iron and soft iron effects were corrected by collecting the data while going in circles.

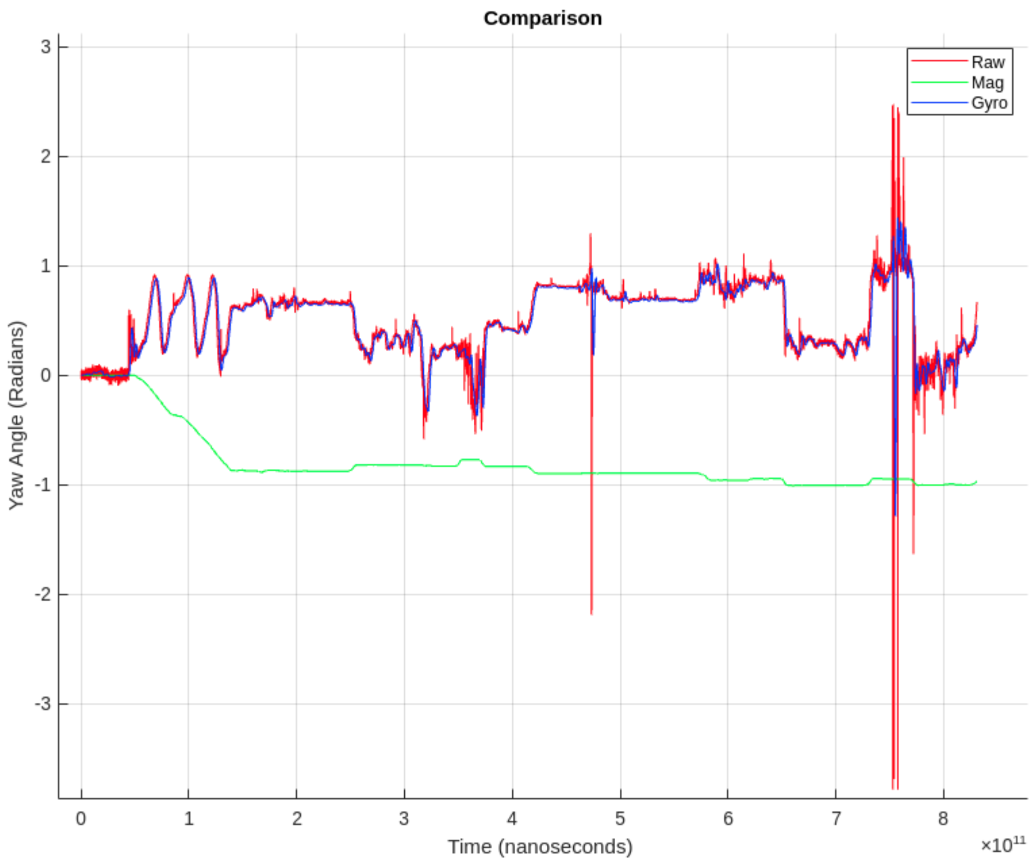
- Hard iron distortions will only shift the center of the circle away from the origin, they will not distort the shape of the circle in any way. Soft iron distortions, on the other hand, distort and warp the existing magnetic fields. When plotting the magnetic output, soft iron distortions are easy to recognize as they will distort the circular output into an elliptical shape.







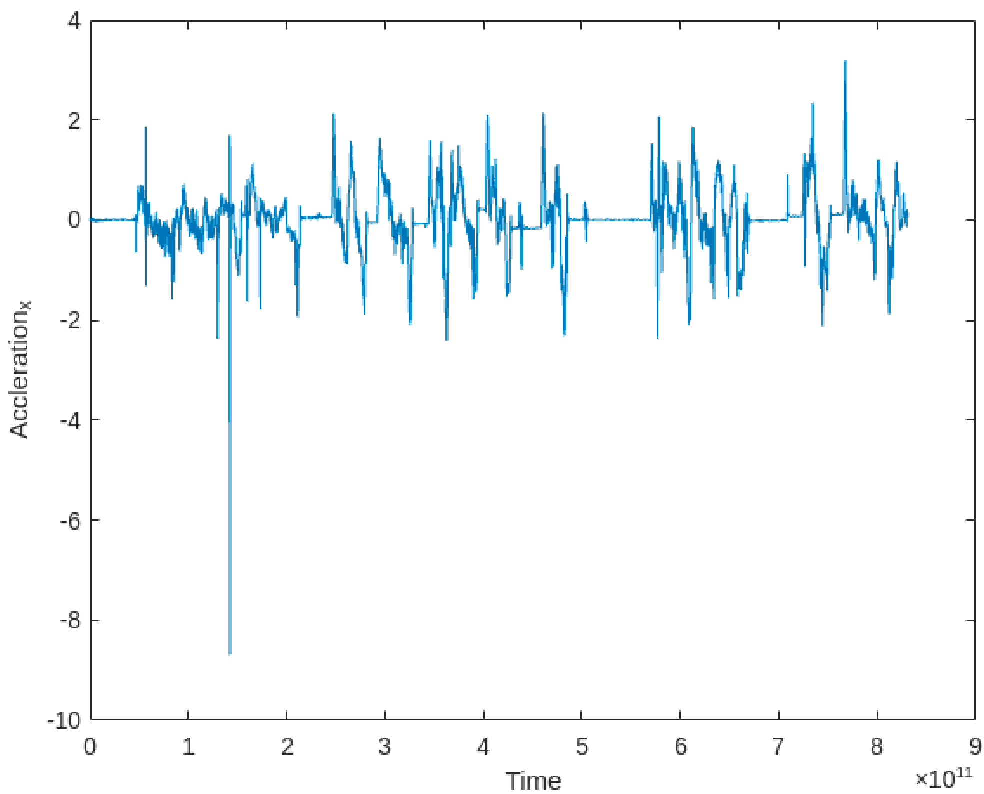
- After the calibration of the magnetometer. The yaw angle was calculated from the magnetometer reading.
- The yaw rate sensor was integrated with time series as a function using the cumtrapz function in matlab to get the yaw angle.



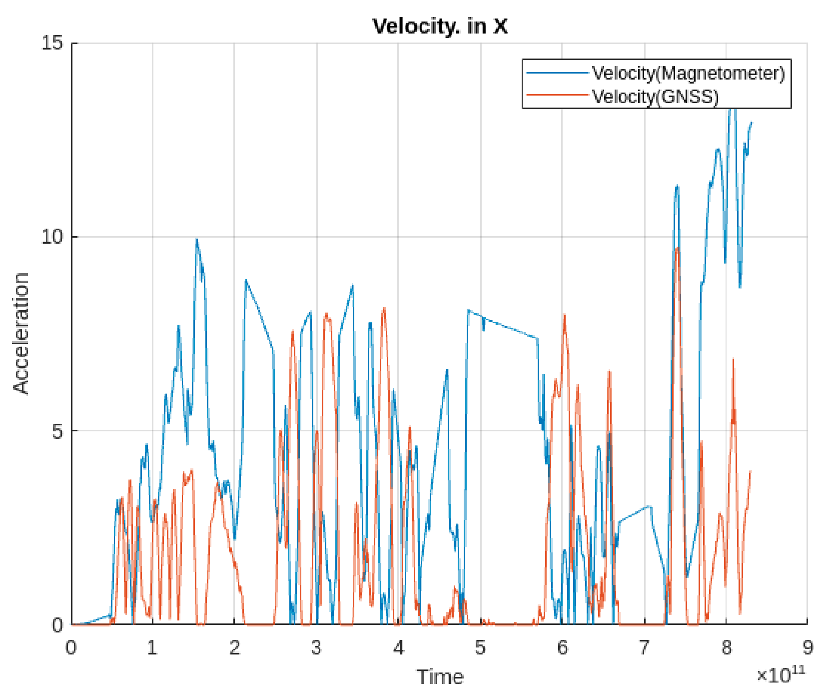
The data from the magnetometer is a little offset from the yaw rate sensor. And also using the complimentary filter the line smooths out without the sudden spike.

2.Estimate the forward velocity:

- We assume that the bias is constant throughout the entire data collection even though it is linear and not constant.
- Will will calculate the offset present in the reading while being still for 10 sec in the car and consider it as the bias and perform the velocity estimation on the basis of that which turned out to be 0.17m/s^2.
- After the stationary bias is removed from the acceleration data. Velocity can be found by taking the integral of acceleration in the direction of x as the imu sensor was mounted in the x direction on the car while moving forward over the time series, and the gps data was also used to calculate the velocity.
- The magnetometer data is varying from the gps data at zero velocity but otherwise the data is comparable to the data of gps.



Acclerationx
Time
×10^11



Velocity. in X
Velocity(Magnetometer)
Velocity(GNSS)
Acceleration
Time
×10^11

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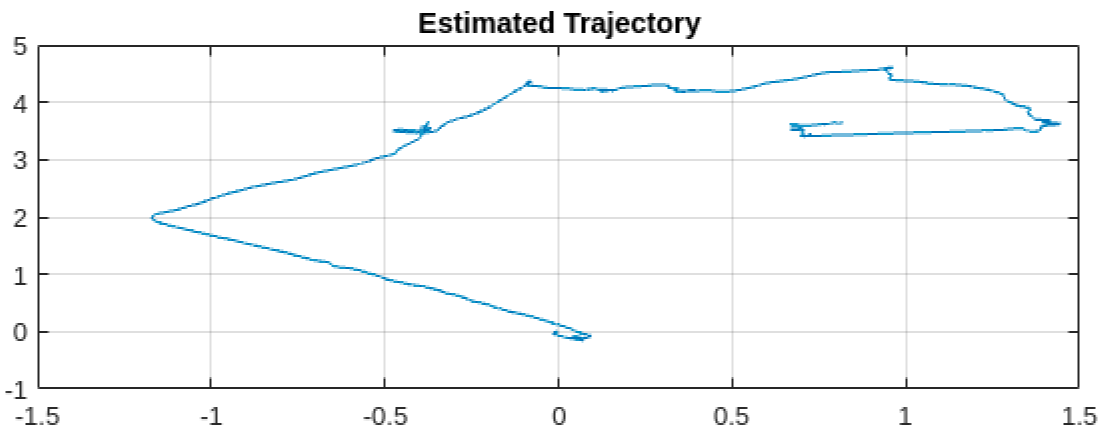
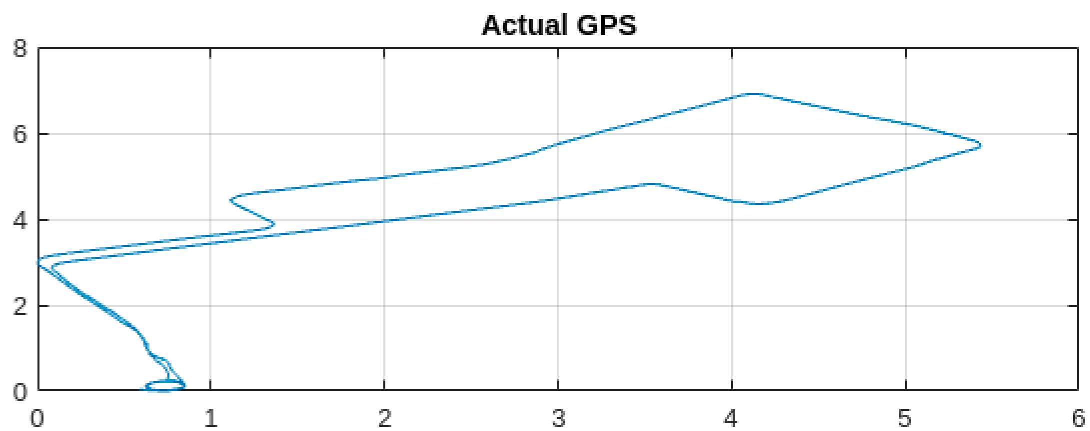
3.Dead Reckoning with IMU:

- The trajectory of the path is calculated by the equation stated in the document by integrating the heading and velocity estimate.
- The second graph shows the gps puck data of northing and easting, this data shows approximately the trajectory taken during the data collection and the estimated trajectory is very much deviated from the path taken.





From the above lab we can conclude that there are some error in the imu data, and this is mainly because of the assumption of constant bias, but in reality the bias is not constant and linear and changes over time.

However we can use sensor fusion to get a better understanding of what is happening.