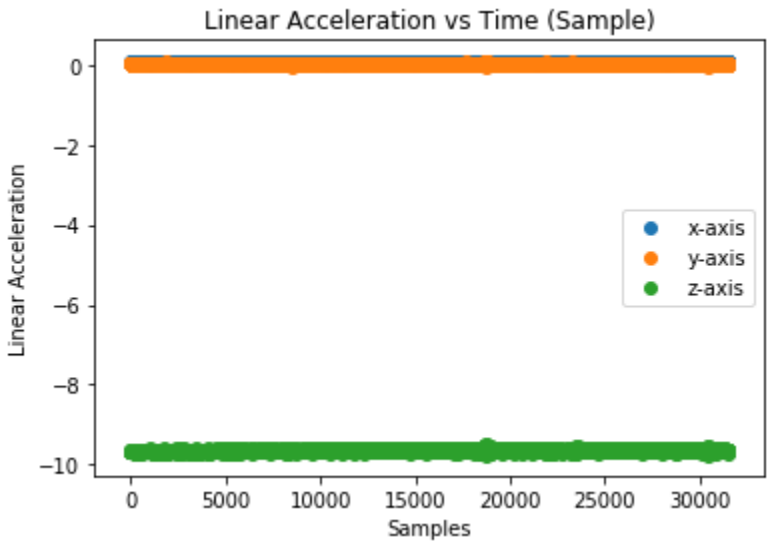
Name: Venkat Prasad Krishnamurthy NUID: 001890724

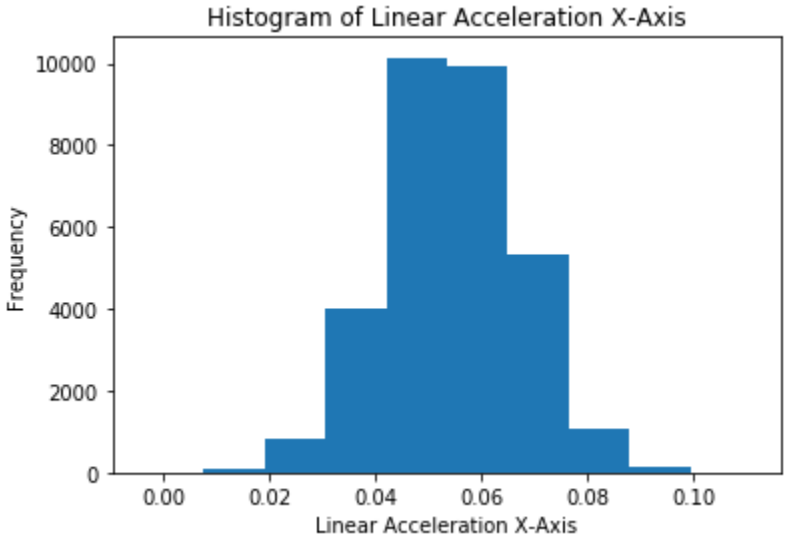
EECE 5554 – Robotic Sensing and Navigation

LAB 2

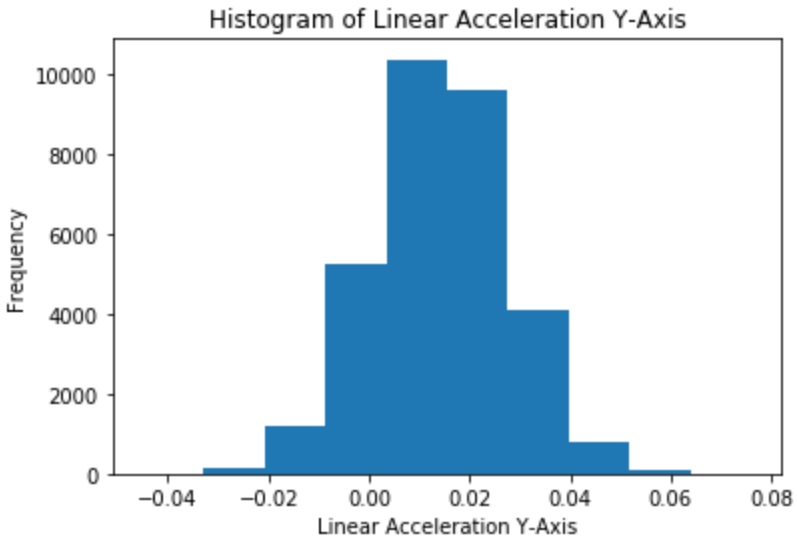
Part 1:
Linear Acceleration:



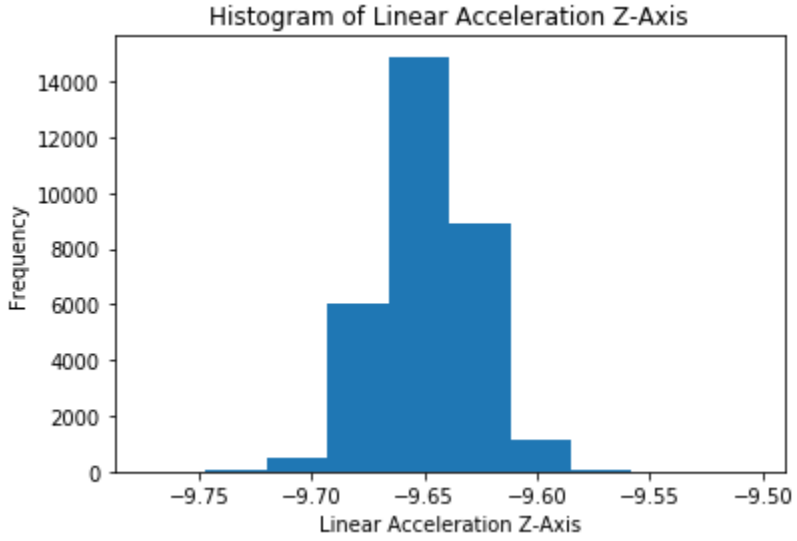
In the above graph, the acceleration in three directions are give where the acceleration in X and Y axis is close to zero whereas the acceleration in Z axis is close to -10. This is because of the presence of gravity which is approx. (9.8m/sec^2). The error in X and Y acceleration is due to the partial presence of gravity in X and Y axis



Mean Linear Acceleration (X- Axis): 0.05421955
Standard Deviation: X-Axis: 0.01259575472711596

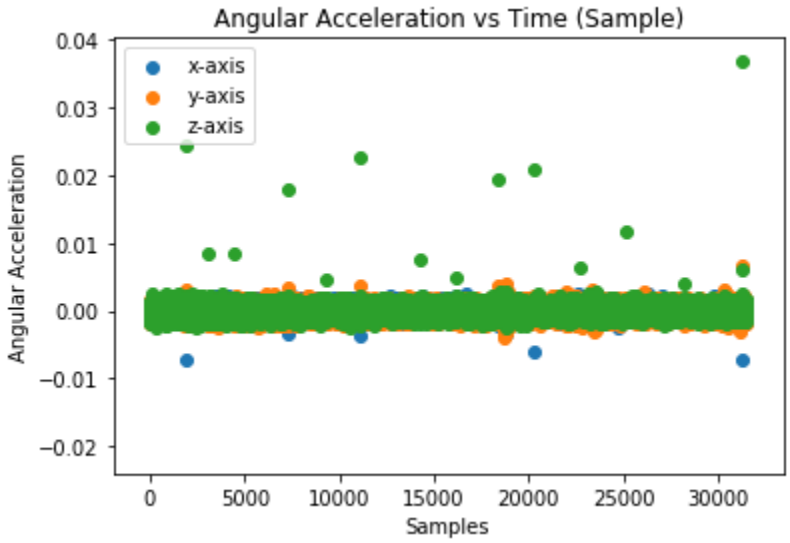


Mean Linear Acceleration (Y-Axis): 0.014213414
Standard Deviation: Y-Axis: 0.013237227795738774

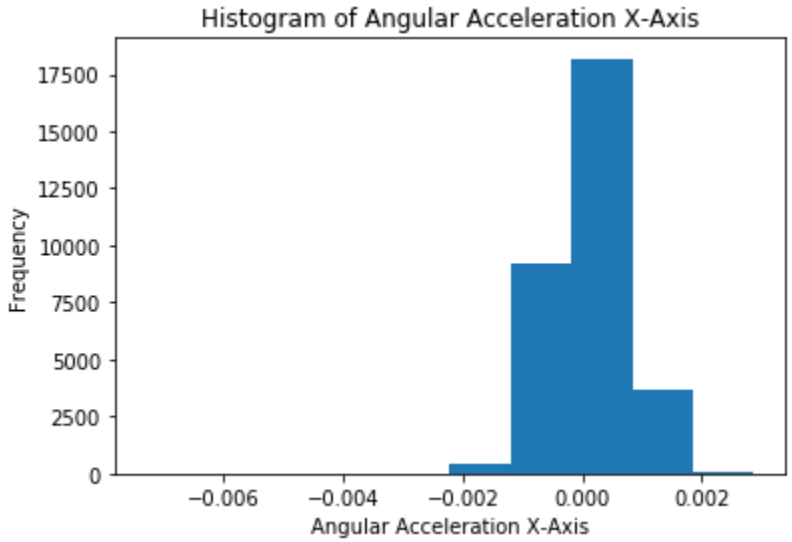


Mean Linear Acceleration (Z-Axis): -9.6489110017
Standard Deviation Z-Axis: 0.02075961227495677

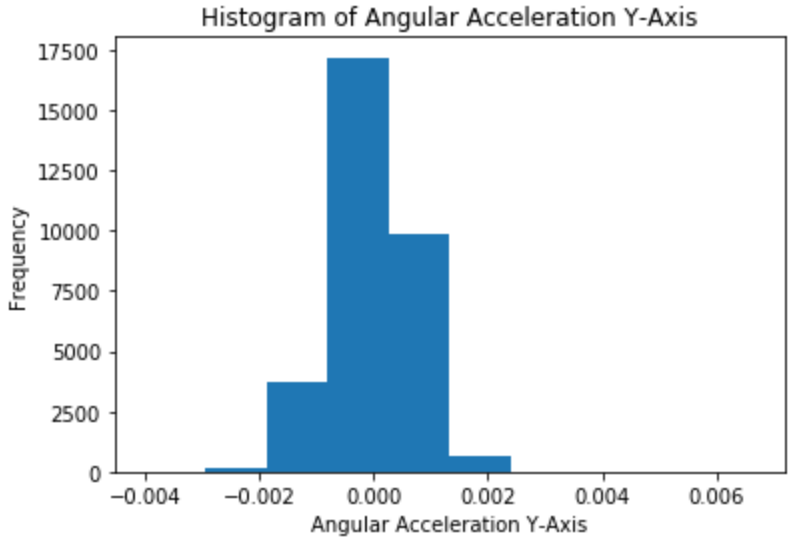
Angular Acceleration:



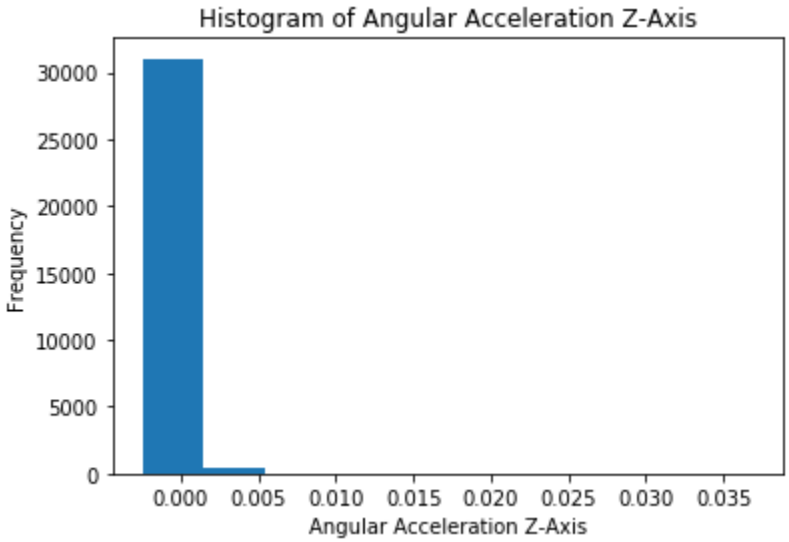
In the above graph, the acceleration in three directions are given where the acceleration in X and Y axis is close to zero whereas the acceleration in Z axis is close to 0.



Mean: X-Axis: 0.00011839765042070238
Standard Deviation: X-Axis: 0.0006024707435380378

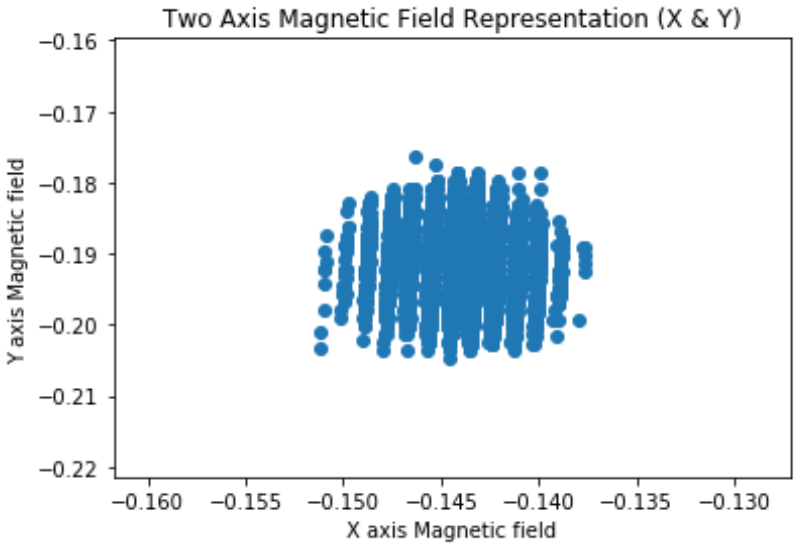


Mean Y-Axis -3.096831243054475e-05
Standard Deviation: Y-Axis 0.0006698855971187549

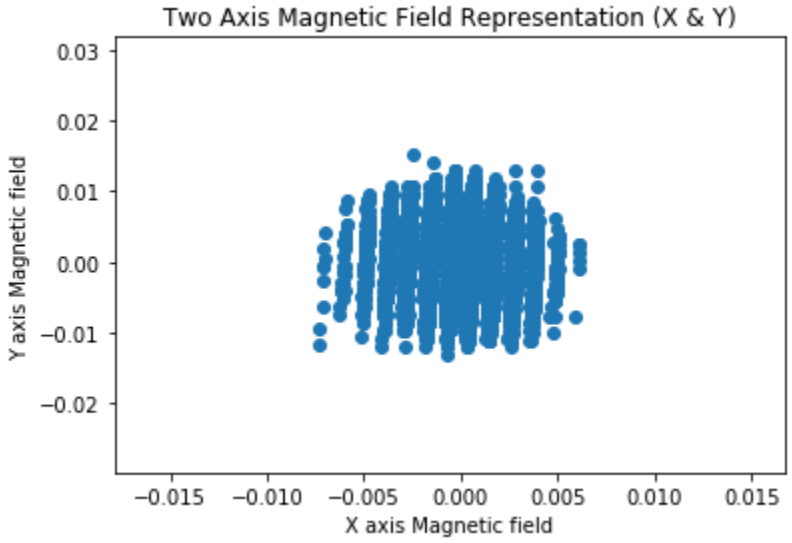


Mean: Z-Axis 4.850319098269541e-05
Standard Deviation: Z-Axis 0.0007354264438687536

Magnetic Field:

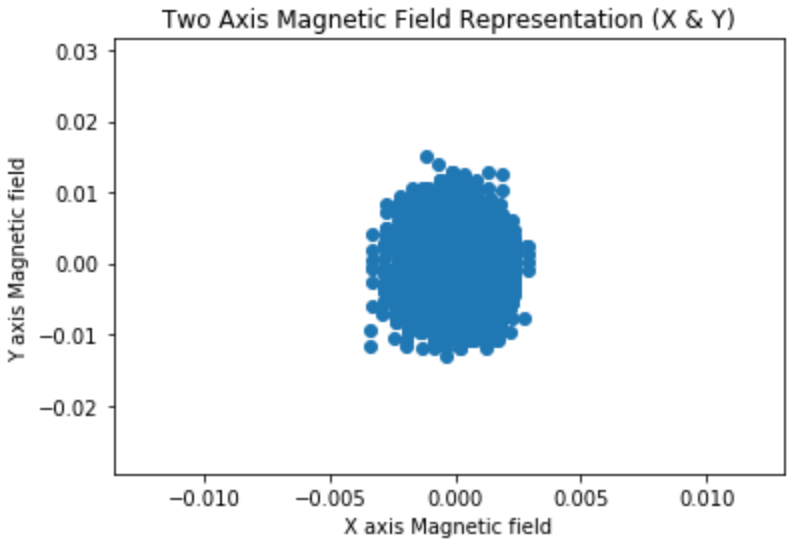


In the above graph between Magnetic field in X and Y axis, the resultant graph is elliptical in shape and mean of both X and Y axis is not zero. This is because of the presence of Hard and Soft Iron distortion. Hard Iron distortion will create a permanent bias whereas soft iron distortions will create deflections based on the orientation of the sensor.
In this graph, to remove the hard iron distortion I subtracted with the mean of respective axes



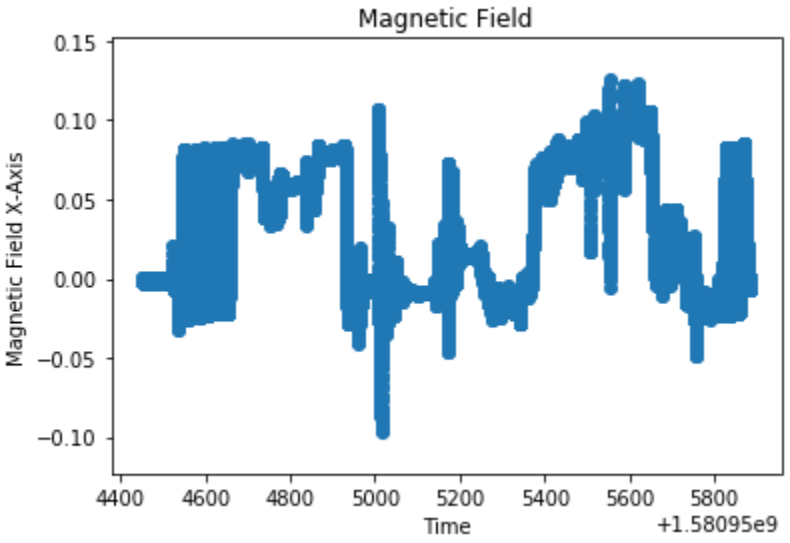
In the above graph, the mean for both X and Y axis is 0 from which we can infer that Hard Iron distortion is removed. For removing the soft iron distortion, I used the below formulae.
sft_cor_x = (magx_max - magx_min)/2.0
magx_lat = sft_cor_x/mag_corr * magx_upd.

After removing the soft iron distortion I got the below graph,

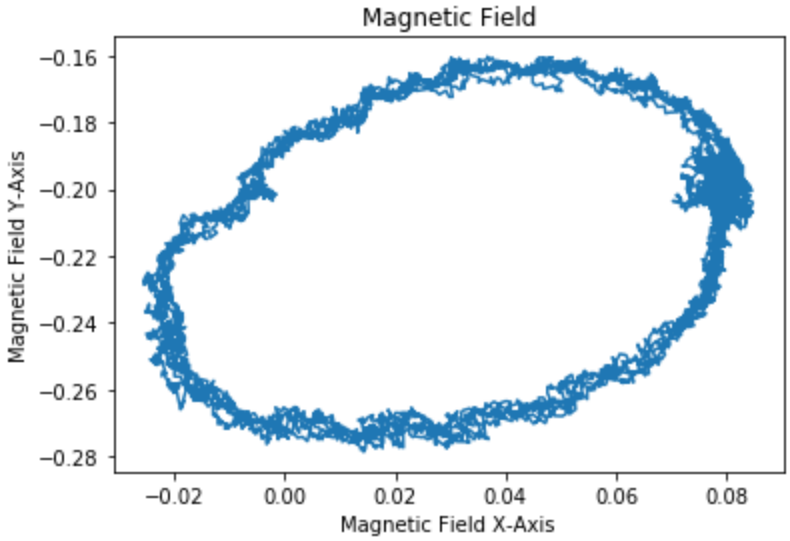


Part 3:

Estimating the Heading:

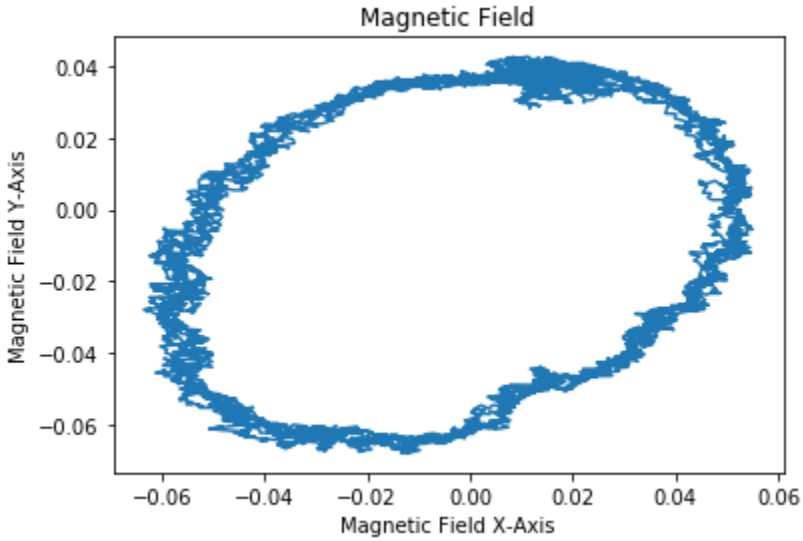


The above graph represents the Magnetic field of Y axis vs X axis when collected in moving car

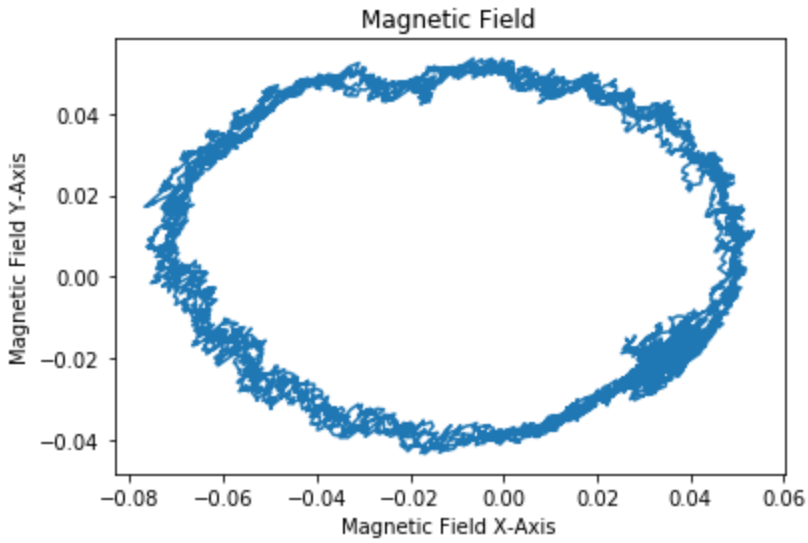


The above graph shows the Magnetic field with Y and X axis which is affected by Hard and Soft Iron distortions.

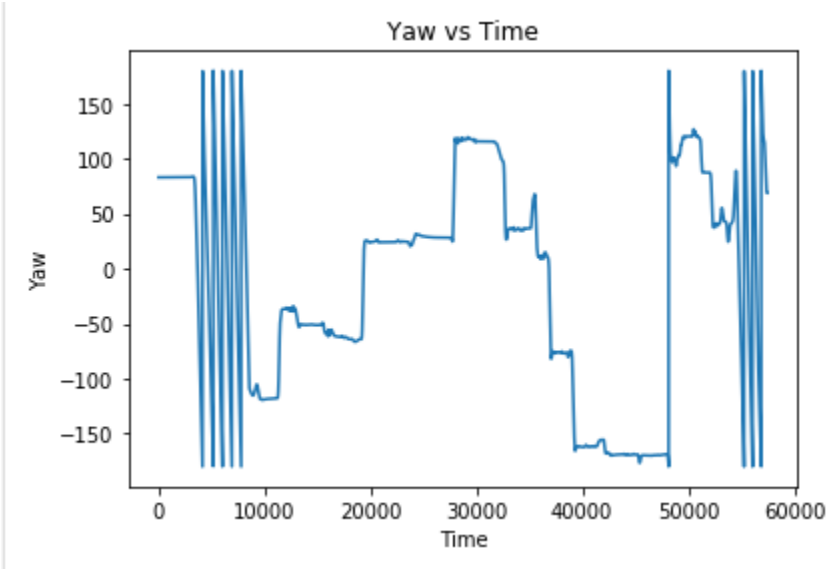
By subtracting by the mean of both the axes I removed the Hard Iron distortions and removed the soft iron distortions using the formula specified above in Part 1



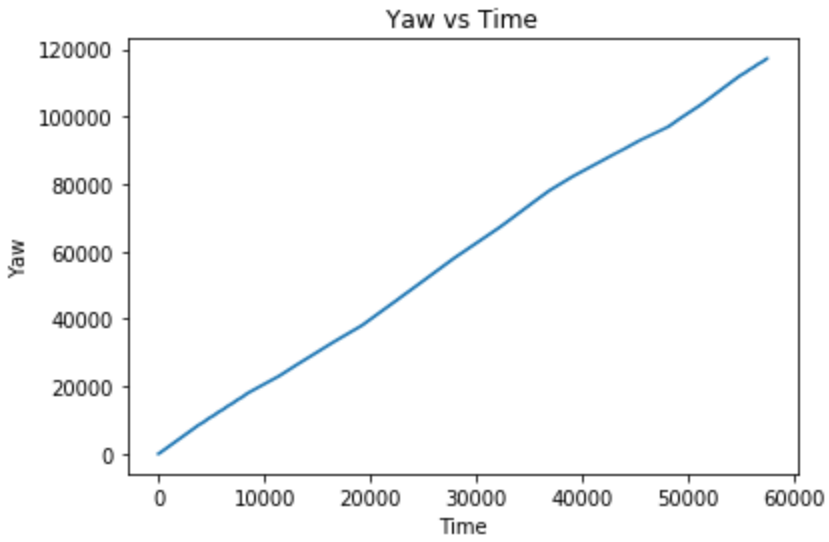
In the graph above, the hard iron distortions has been removed which results in mean value close to zero.



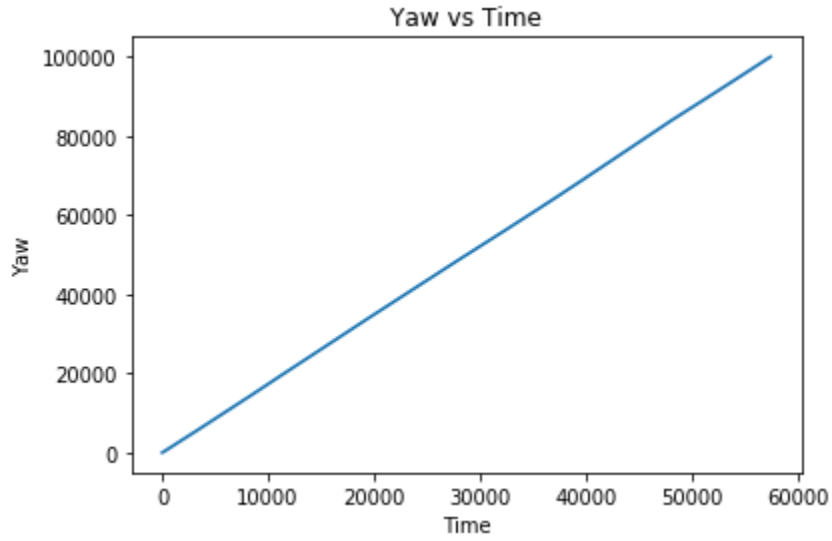
The above graph shows after removing soft distortion, which less elliptical and more circular and mean of magnetic field in both the axes are close to zero



The above graph shows the yaw vs time with corrected magnetic readings.

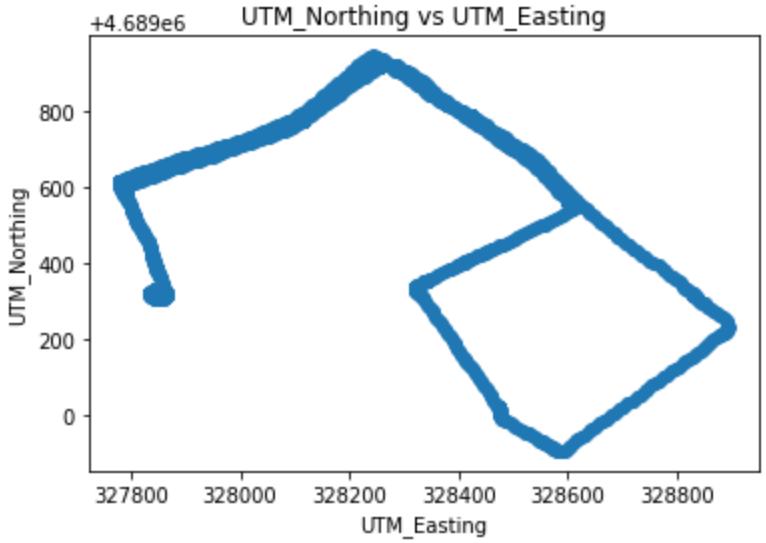


The above graph shows the integrated yaw value from magnetic readings. Which a slanting line with some deviations. After applying complementary filter on yaw calculated form magnetic readings and yaw calculated from imu data we got the below graph

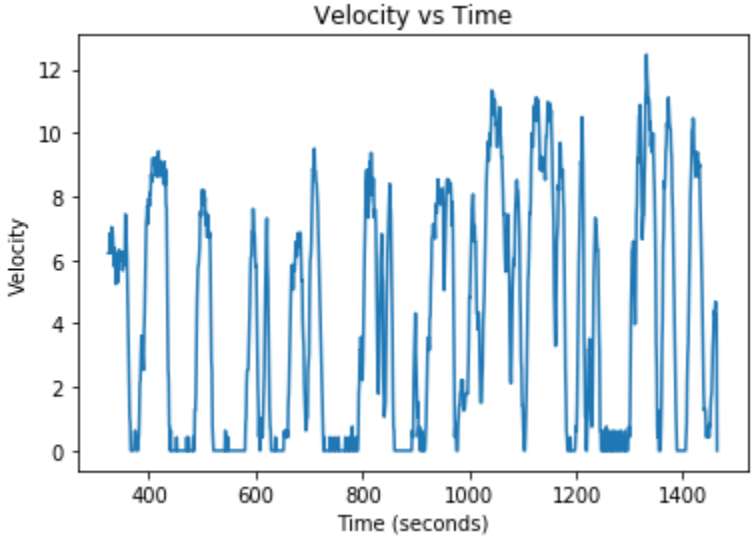


The graph above is straighter when compared to the previous one which infers that by applying complementary filter.

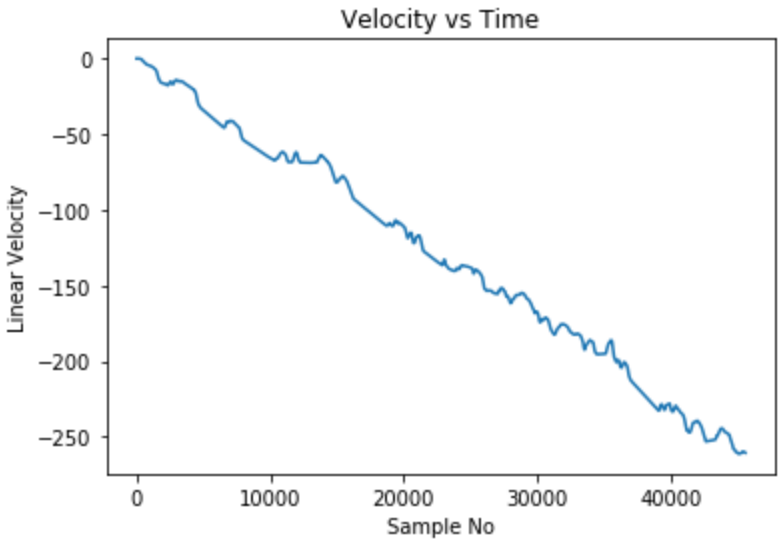
Estimating Velocity:



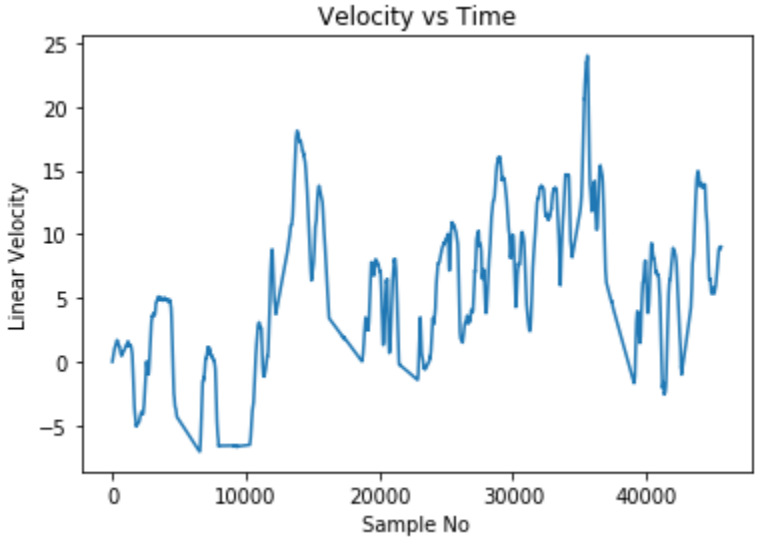
The above graph shows the UTM_Northing vs UTM Easting from the data collected from GPS sensor.



The above graph shows the velocity calculated from data obtained from GPS sensor.
Mean Velocity: 4.009 m/sec
Distance Covered: 4572 meters



The above graph shows the velocity vs time graph with errors obtained from imu sensor. These errors are corrected by subtracting mean error when the vehicle is stationary and reducing a very small manual bias



The above graph gives a errored but slightly similar when compared the data received from GPS sensor.
Mean Velocity: 4.702 m/sec
Distance: 5360 meters.

From the two values, mean velocity and distance are almost equal with few 100 meters error in distance

Reference:

1. https://math.stackexchange.com/questions/2975109/how-to-convert-euler-angles-to-quaternions-and-get-the-same-euler-angles-back-fr
2. http://students.iitk.ac.in/roboclub/2017/12/21/Beginners-Guide-to-IMU.html
3. https://github.com/kriswiner/MPU6050/wiki/Simple-and-Effective-Magnetometer-Calibration

4. https://www.fierceelectronics.com/components/compensating-for-tilt-hard-iron-and-soft-iron-effects