IE 6500 Human Performance
Lab Report

Lab 4: gps and imu

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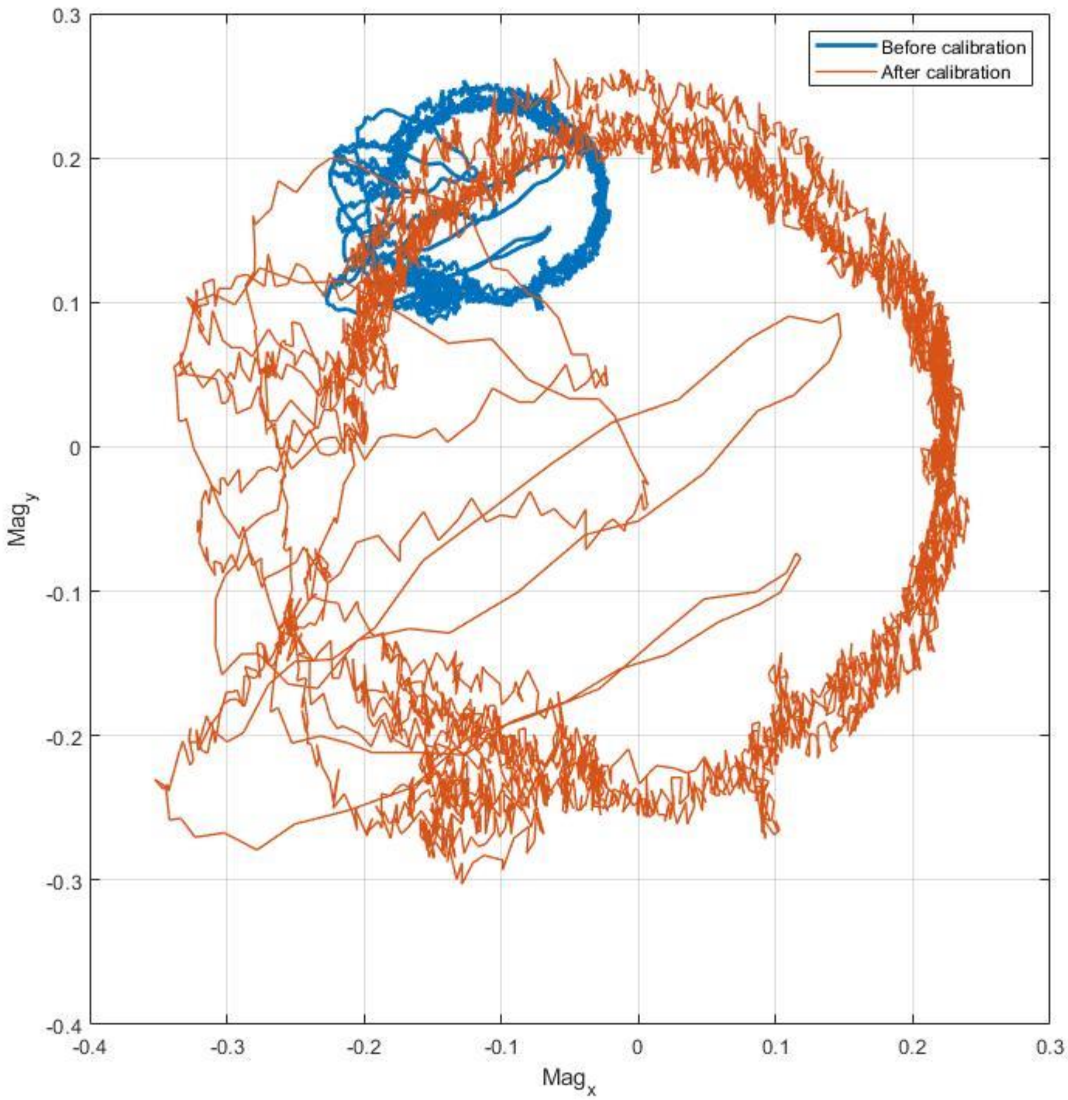
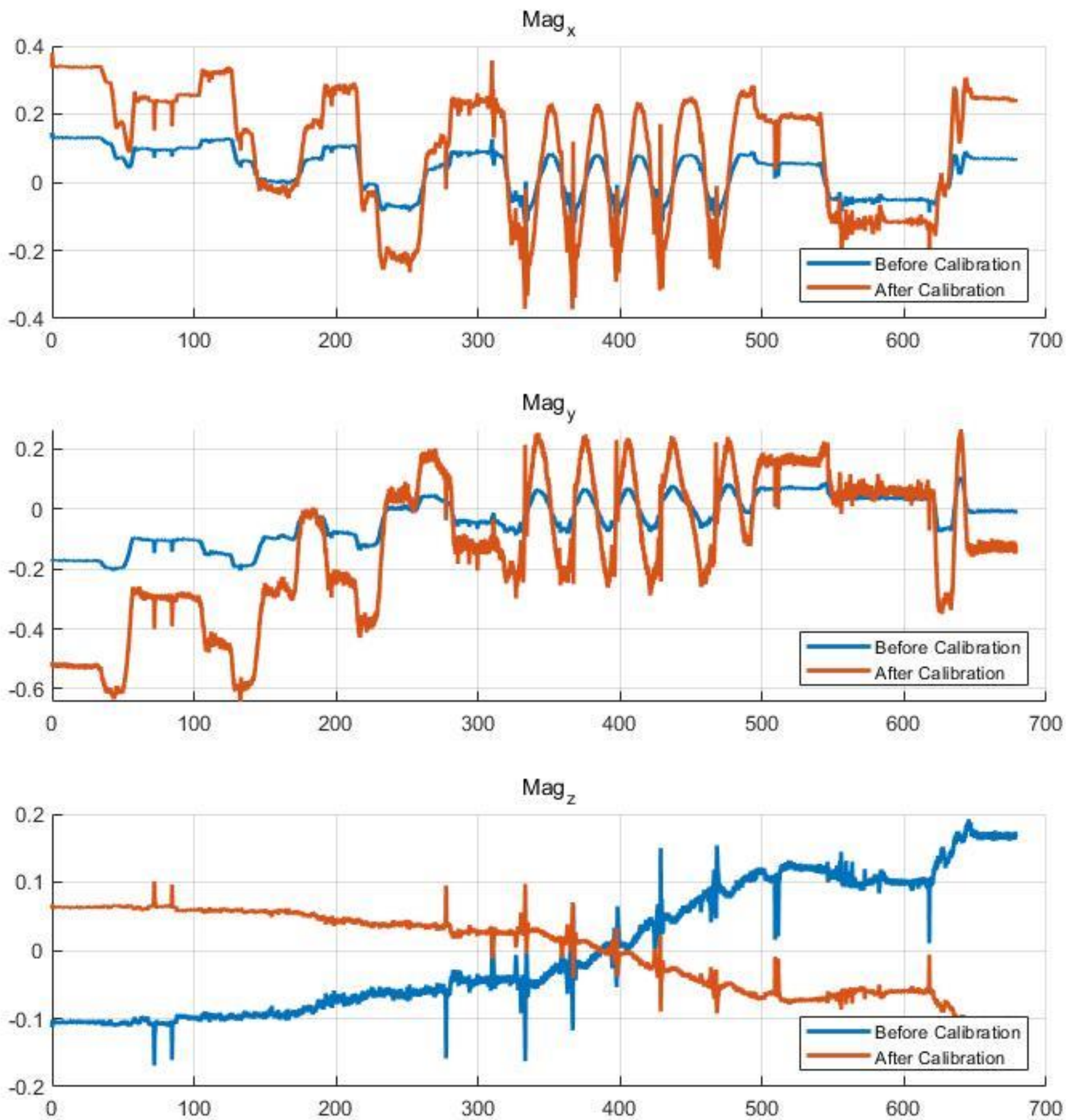
1. Estimate the heading(yaw)

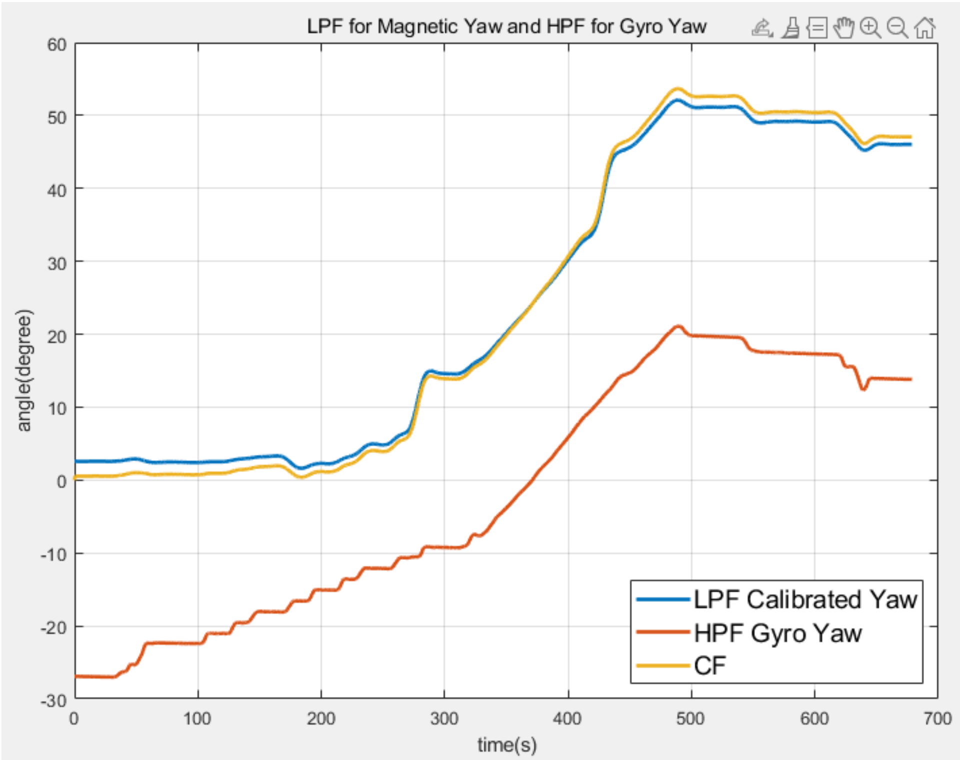
The magnetometer X-Y plot before and after hard and soft iron calibration



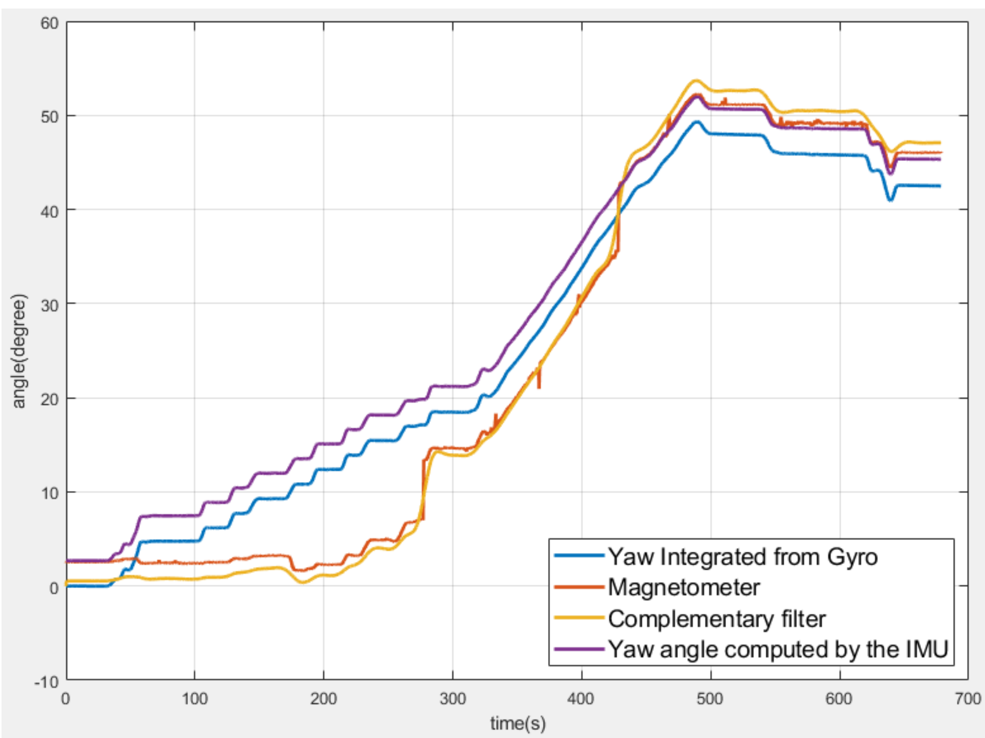
The time series magnetometer data before and after the correction



LPF, HPF, and CF plots

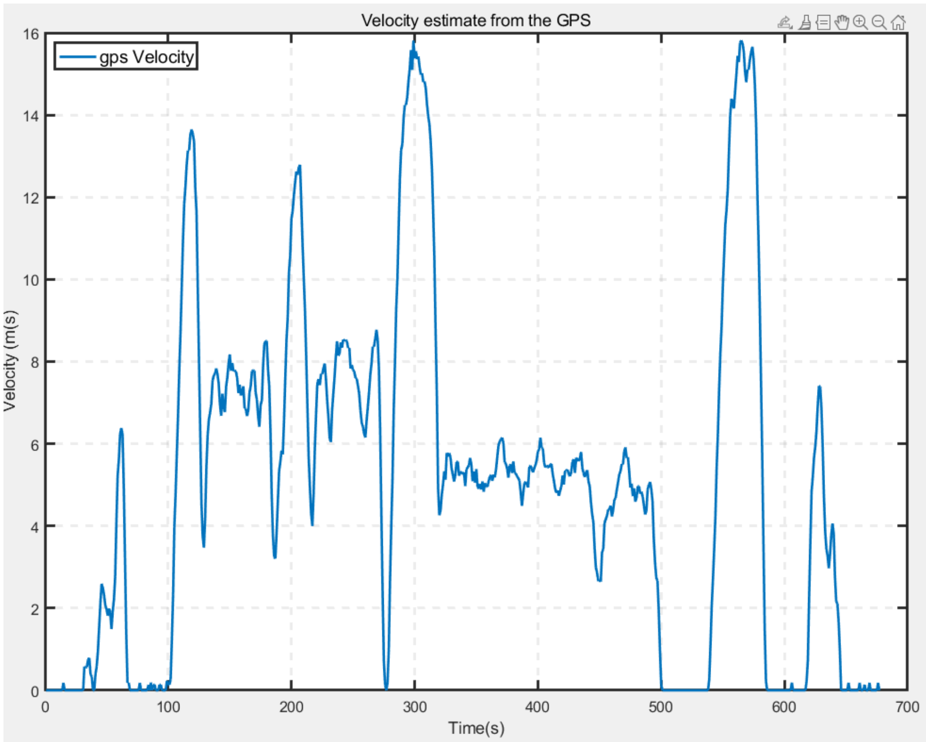


Compare the yaw angle between four methods: Magnetometer, Yaw Integrated from Gyro, Complementary filter, Yaw angle computed by the IMU

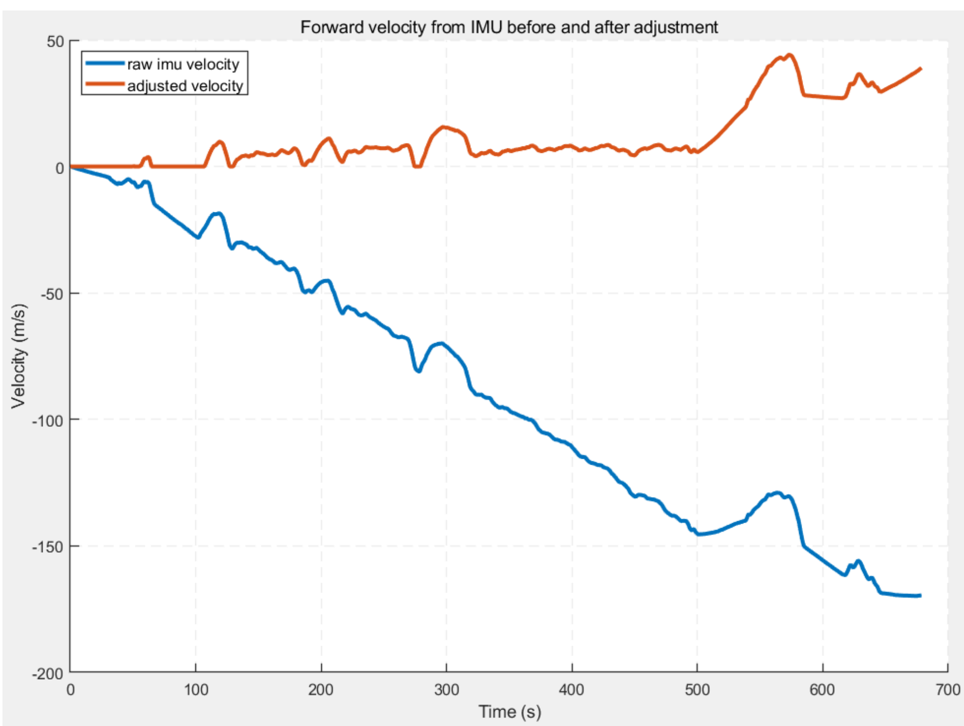


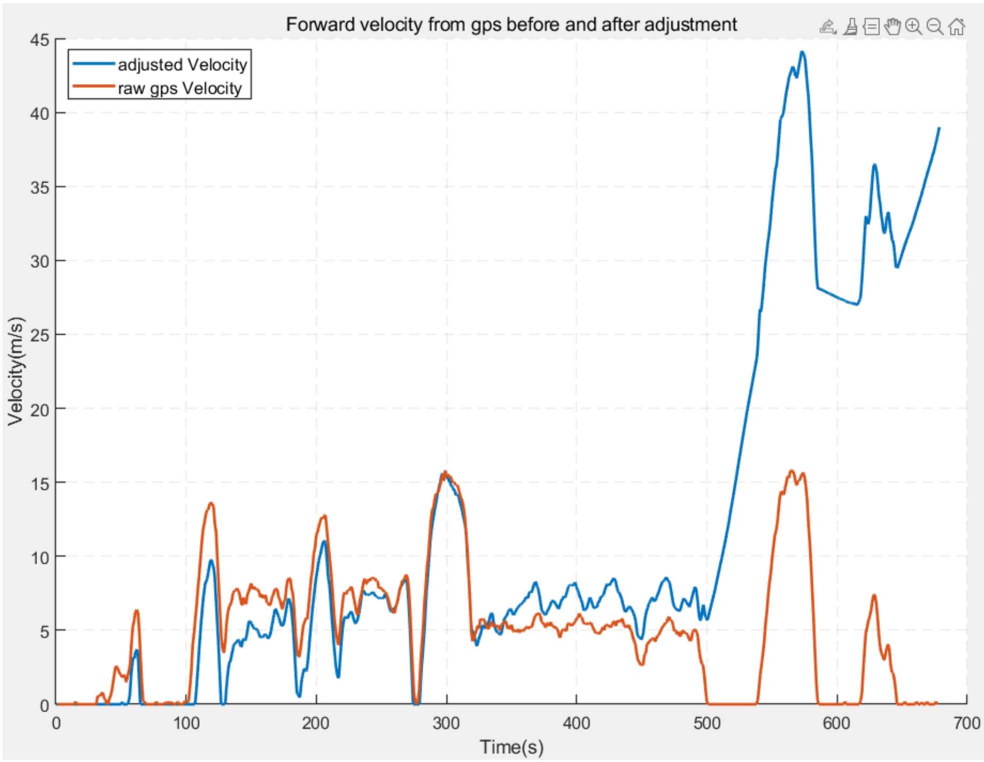
2. Estimate the forward velocity!

Velocity estimate from the GPS



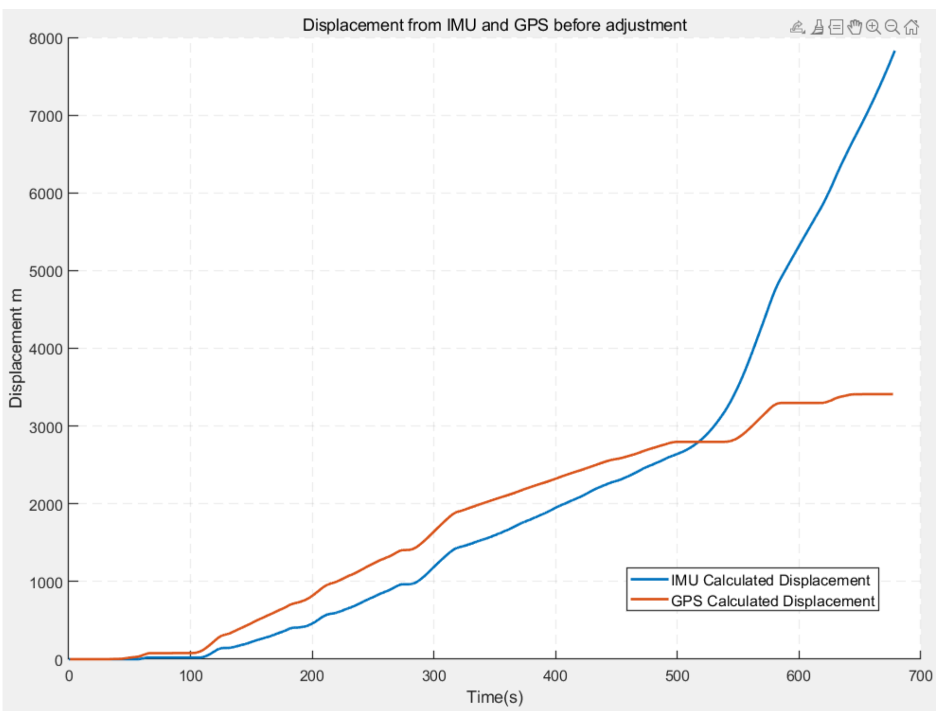
Velocity estimate from accelerometer before and after adjustment



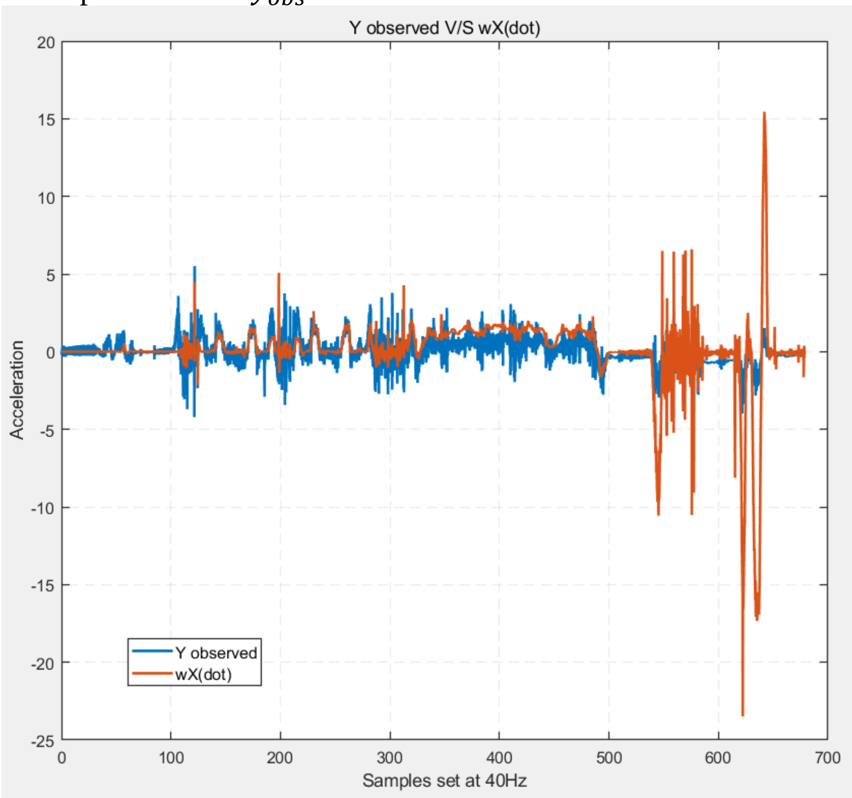


3. Dead Reckoning with IMU

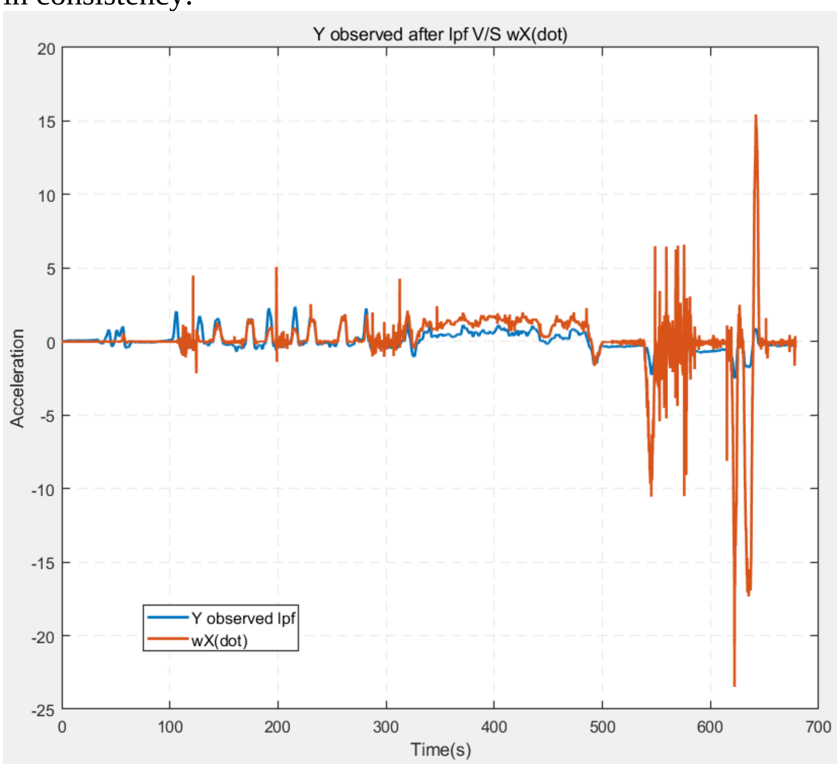
Integrate the forward velocity to obtain displacement and compare with GPS displacement

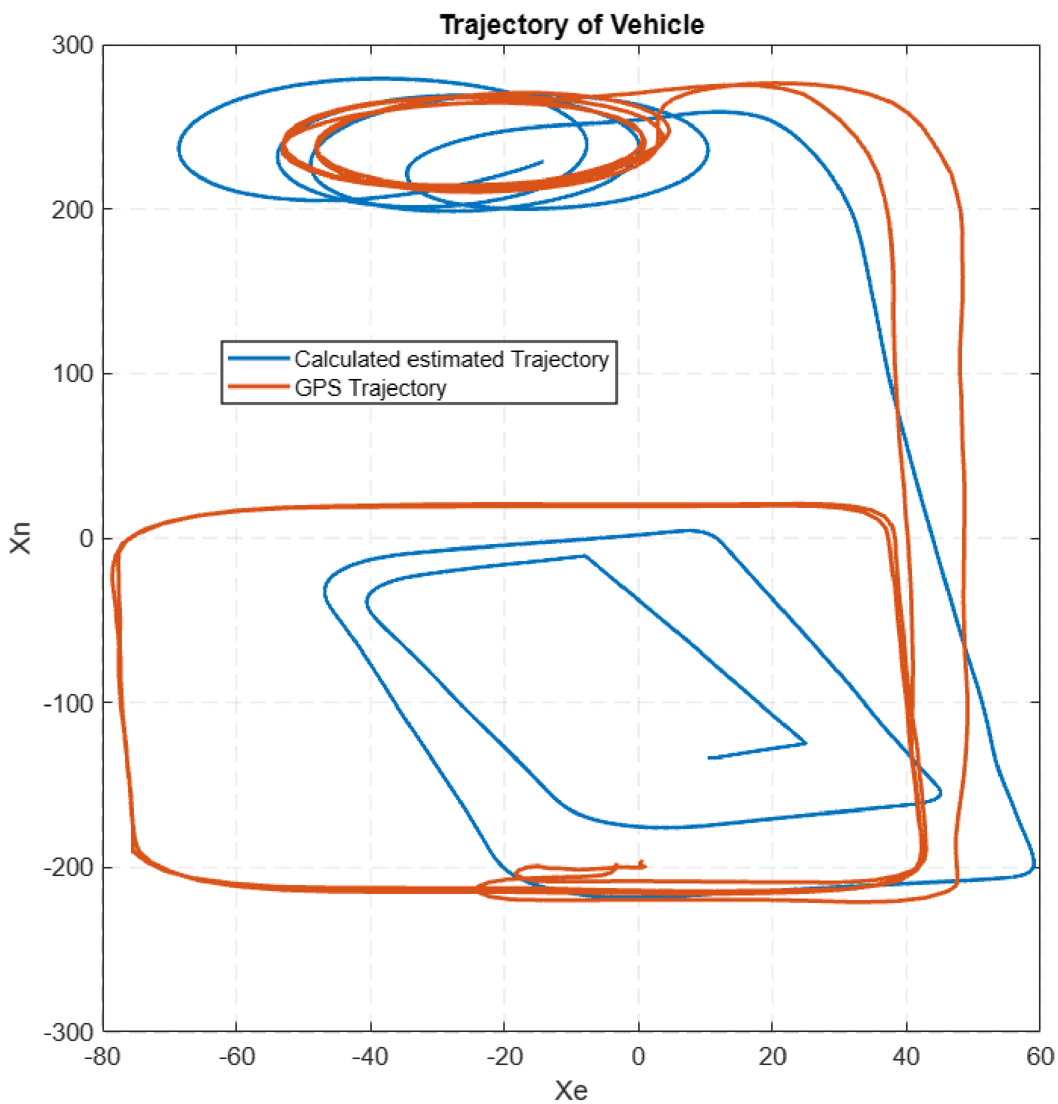


Compare $\omega\dot{X}$ and $\ddot{y}_{obs}$



The ωX˙ is calculated using the adjusted velocity from the IMU, and there is good agreement between them. Additionally, applying a low-pass filter to the y¨_obs resulted in an improvement in consistency.





4. Bonus Question

According to $\ddot{y}_{obs} = \ddot{Y} + \omega\dot{X} + \dot{\omega}x_c$, then $x_c = -11.4258$

5. Question to answer

1. To calibrate, the MAG data was collected during circling. The process involved computing the average for each axis and the radius of the circle for each sample. The maximum radius and scale factors were then determined for each axis. Using the scale factors and average values for each axis, a rotation matrix was computed, and the magnetometer readings were corrected by applying the rotation matrix.

hard-iron distortion, which occurs due to ferromagnetic materials near the sensor, and soft-iron distortion, caused by the presence of other magnetic fields that can be influenced by nearby magnetic materials or structures.

2. The complementary filter utilized a combination of low-pass filtered data and high-pass filtered data, with a weighted averaging approach. The low-pass filter had a cutoff frequency of 0.1 Hz, while the high-pass filter had a cutoff frequency of 0.00001 Hz.

3. The YAW was determined using angular velocity as it provided the closest match to the yaw provided by the IMU itself.

4. Maintaining a constant speed during circling data collection ensures mean acceleration is zero. The mean value of collected acceleration data is used as an offset, subtracted from all readings. Initial speed of the car is adjusted to remain constant, ensuring accurate orientation estimation from the resulting data.

5. GPS and IMU speed calculations are typically similar, but after 500 seconds, a significant difference can arise, potentially due to drift in the IMU over time.

6. There is a high level of consistency between $\omega\dot{X}$ and $\ddot{y}_{obs}$, which was further improved after applying a low-pass filter.

7. The heading of the IMU trajectory is reversed in both directions, and scaling factors of 0.5192 and 0.7042 are utilized in the x and y directions.

8. The device is capable of navigating without a position fix for around 500 seconds, as indicated by the results. The highest degree of overlap between the two trajectories is observed during circling.

The stated performance for dead reckoning doesn't match actual measurements. Due to significant noise and the potential for IMU sensor misalignment, there can be significant changes in the z-axis during circling, resulting in poor accuracy of the trajectory obtained from dead reckoning. Also, velocity and displacement integrated from imu can drift largely as time goes on.