LAB#4

Navigation with IMU and Magnetometer

MAGNETOMETER CALIBRATION

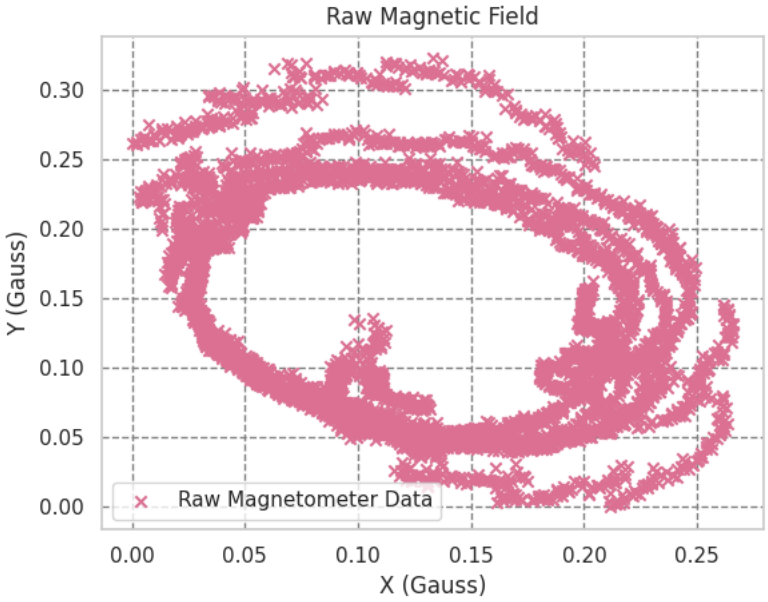

Fig. 1: Raw Magnetometer data

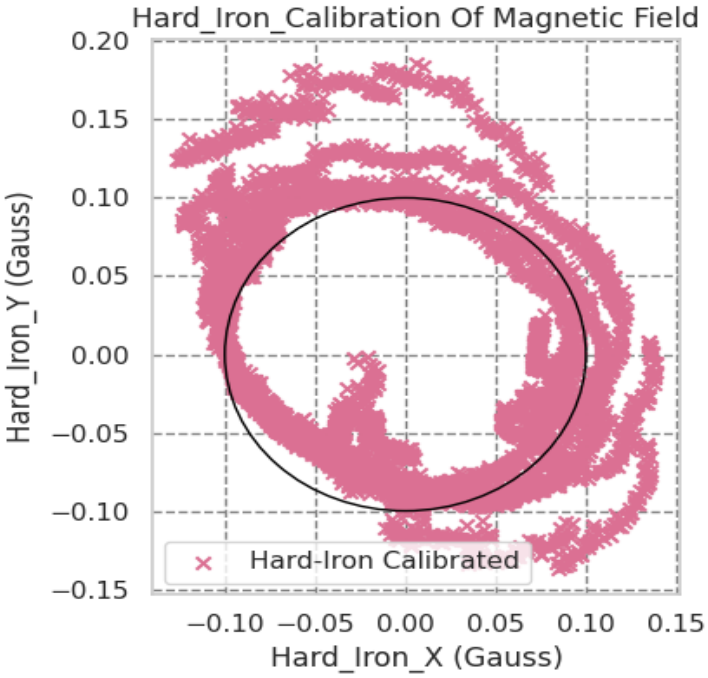

Fig. 2: Hard Iron calibrated Magnetic Field

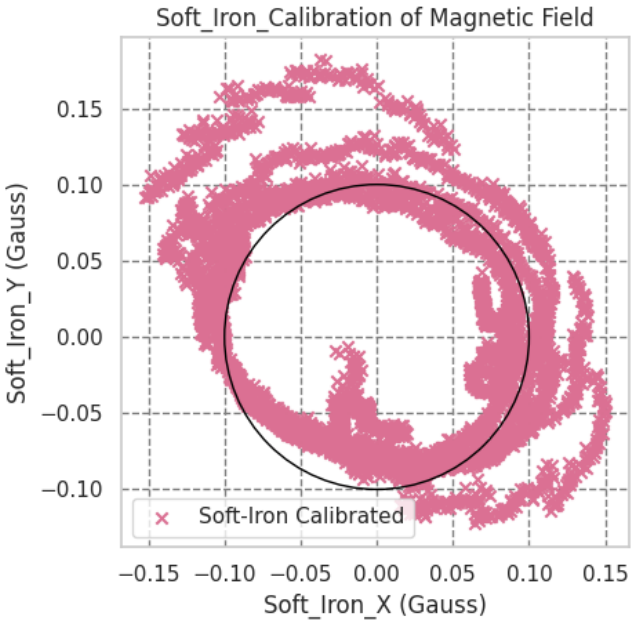

Fig. 3: Soft Iron calibrated Magnetic Field

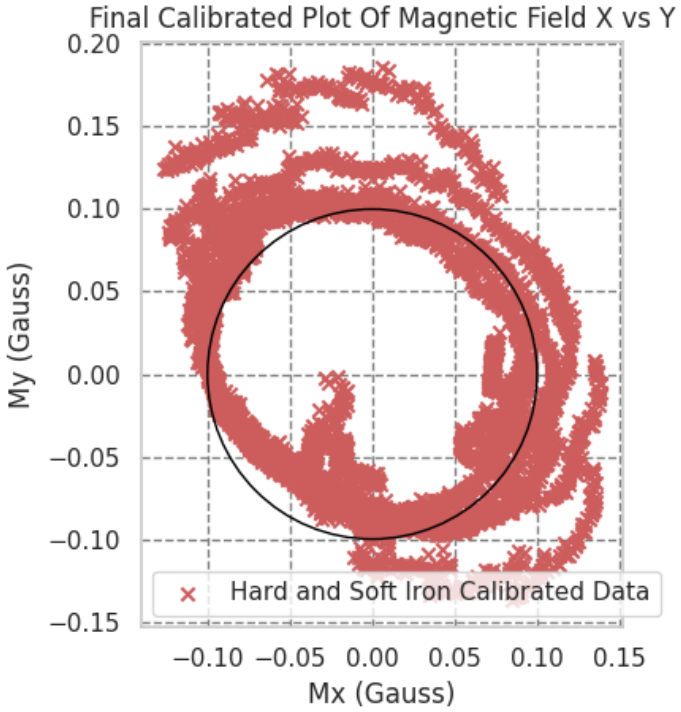

Fig. 4: Hard & Soft Iron calibrated Magnetic Field

Hard Iron Correction involves the subtraction of the mean of the data from each datapoint in the dataset. Soft-Iron Correction involves fitting the circular trajectory data to a circle and estimating the rotation of the whole dataset as per the fit circle.

SENSOR FUSION

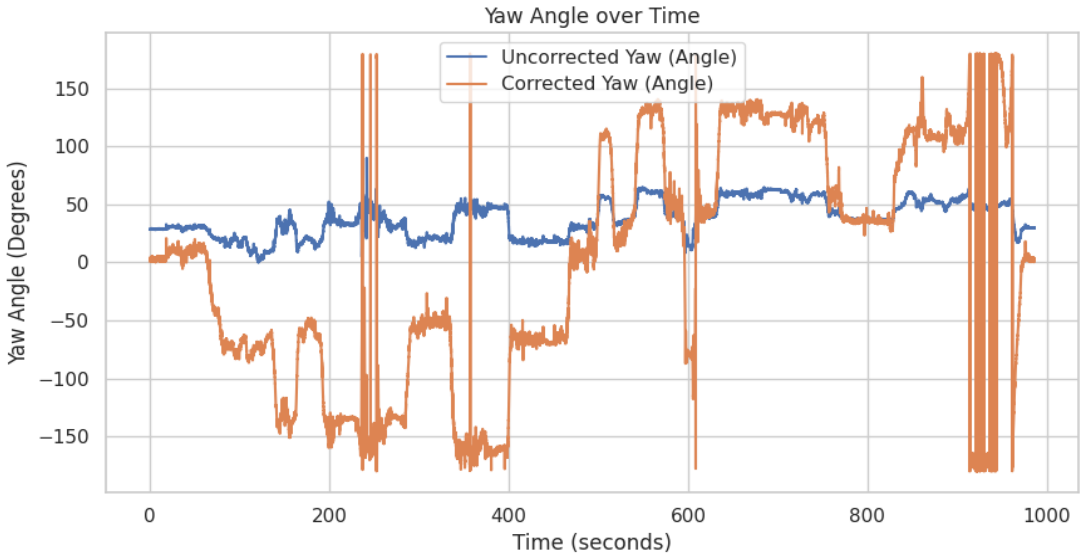

Fig. 5: Raw Magnetometer Yaw (Degrees) and Corrected Magnetometer Yaw (Degrees)

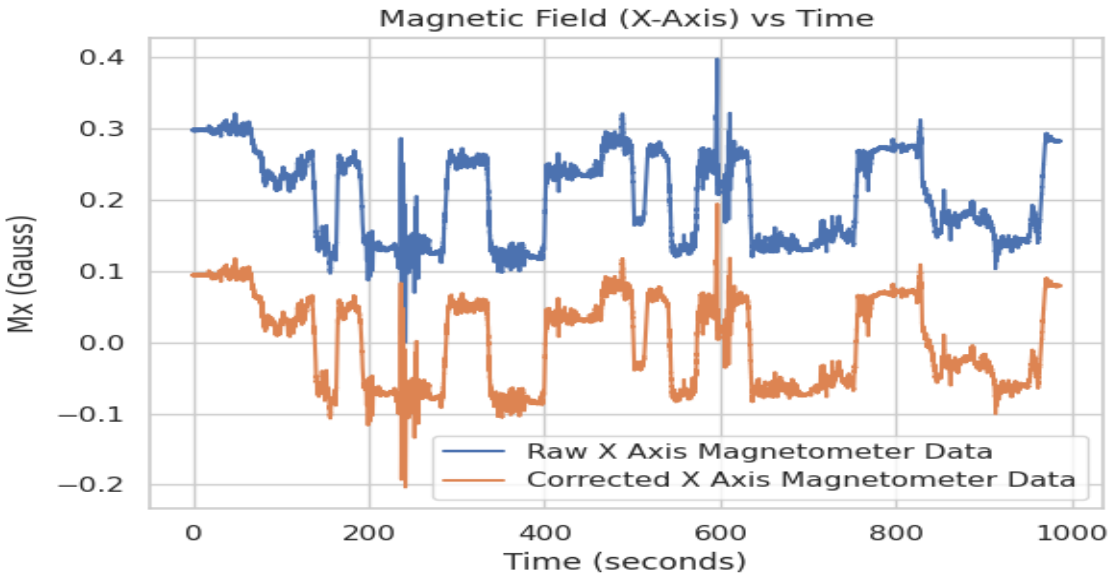

Fig. 6: Comparison of Raw & Corrected Magnetic Field in X-Axis

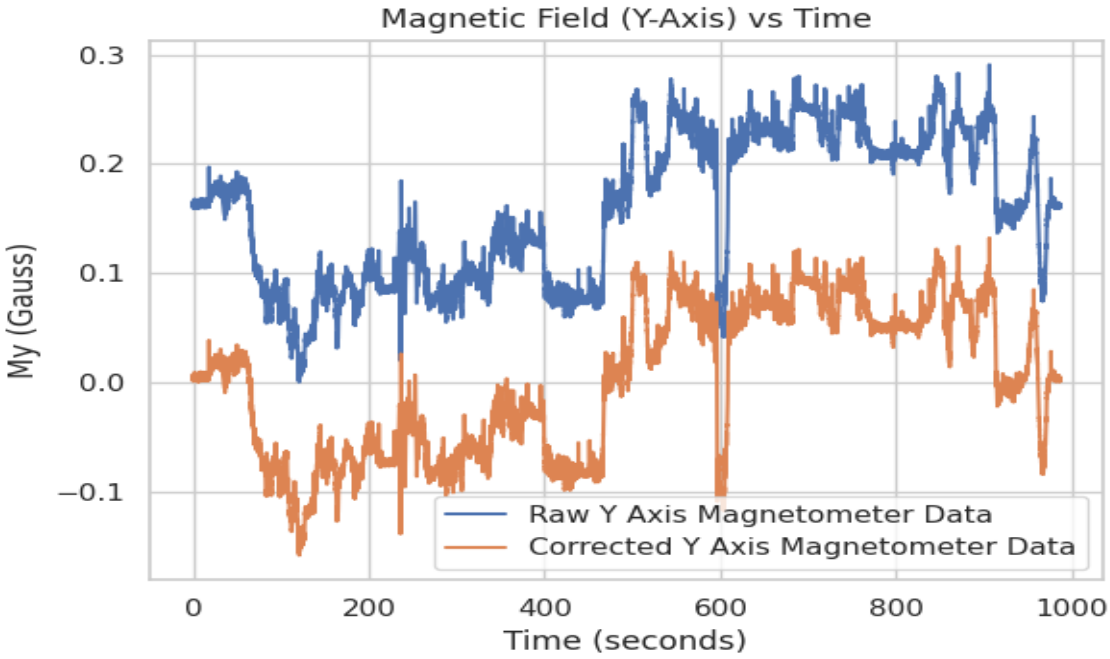

Fig. 7: Comparison of Raw & Corrected Magnetic Field in Y-Axis

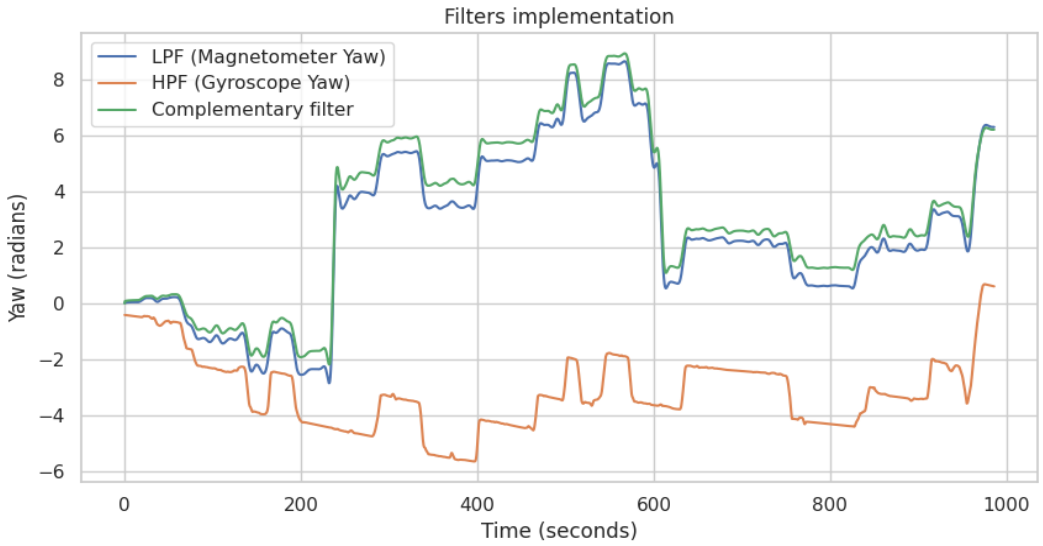

Fig. 8: Low Pass Filter (Magnetometer), High Pass Filter (Gyroscope) & Complementary Filter

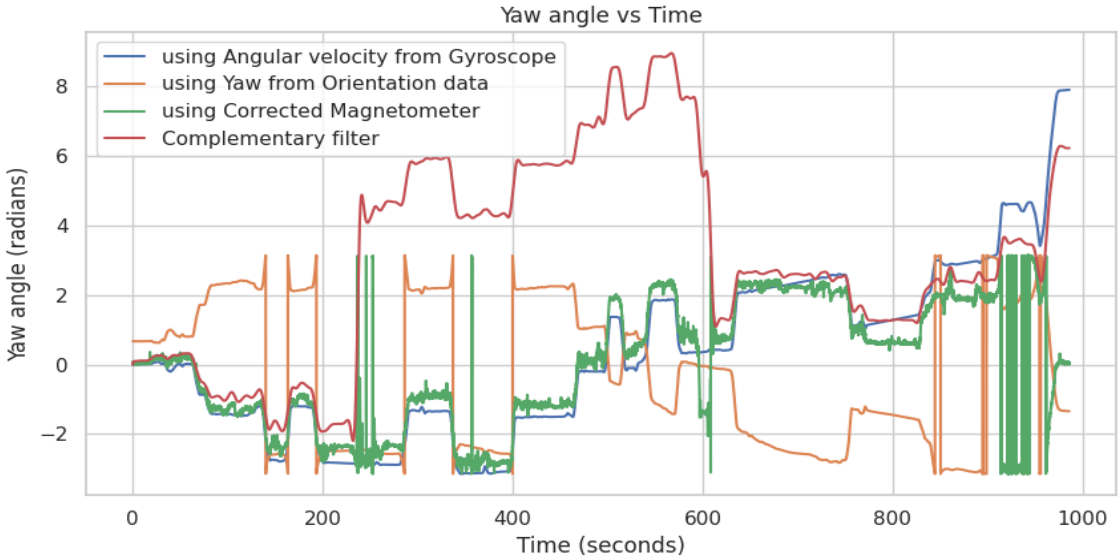

Fig. 9: Comparison of Yaw angle from Gyroscope, Orientation (by IMU), Magnetometer, and Complementary Filter

The yaw calculated using the magnetometer is passed onto a Low Pass Filter (LPF) and the yaw estimated using the Gyroscope is passed onto a High Pass Filter (HPF). The outputs of these two filters are combined to form a singular component as the Complementary Filter. The cut-off frequencies were chosen as 0.1 and 0.0001 for the LPF and HPF.

The yaw estimate resulting from the complementary filter would be preferred for use in a system with complex functionalities which has requirements for very accurate estimation.

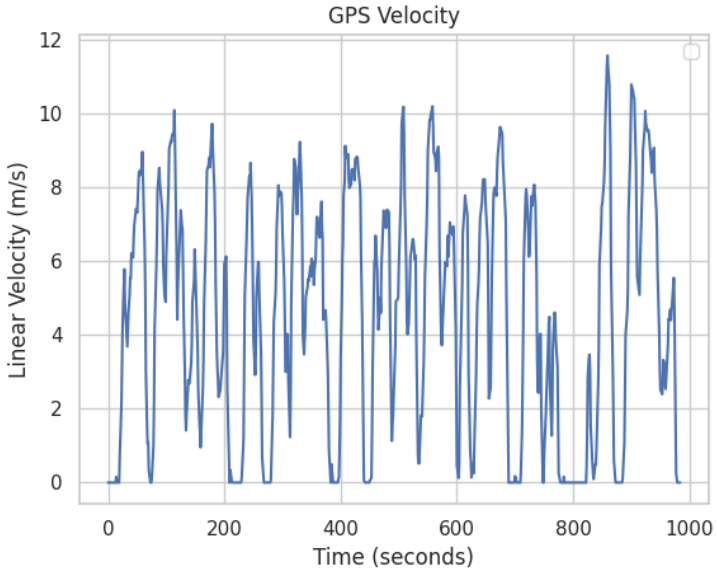

Fig. 10: Velocity estimation using GPS

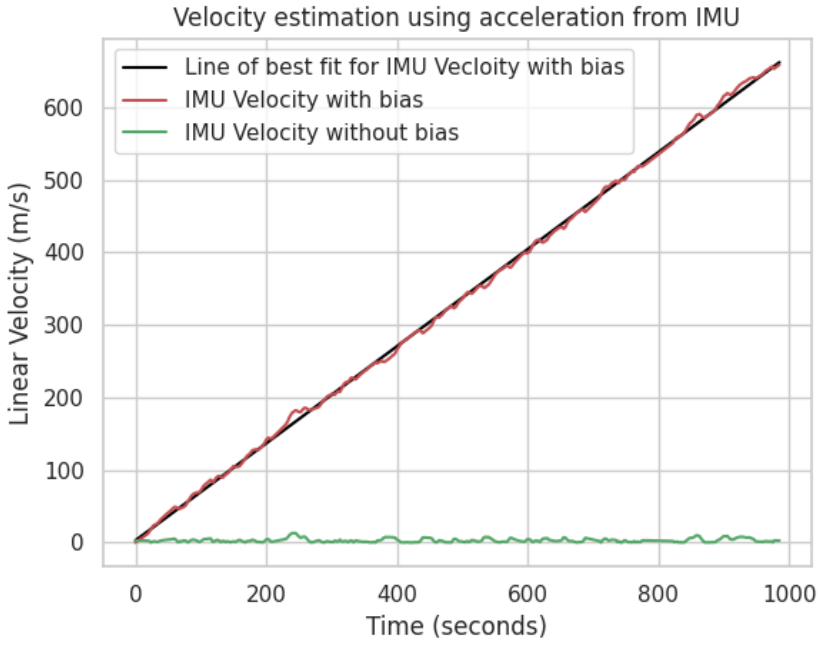

Fig. 11: Velocity Estimation using IMU

The adjustments included fitting the raw data into a linear line and using this fit line as the new dataset for further calculations. Moreover, the absolute values of the points from this new fit line were considered. The discrepancies present in the velocity estimate between accel and GPS are primarily that the one from IMU being a cumulative sum as it is obtained by integration of acceleration values over the complete duration of driving.

DEAD RECKONING

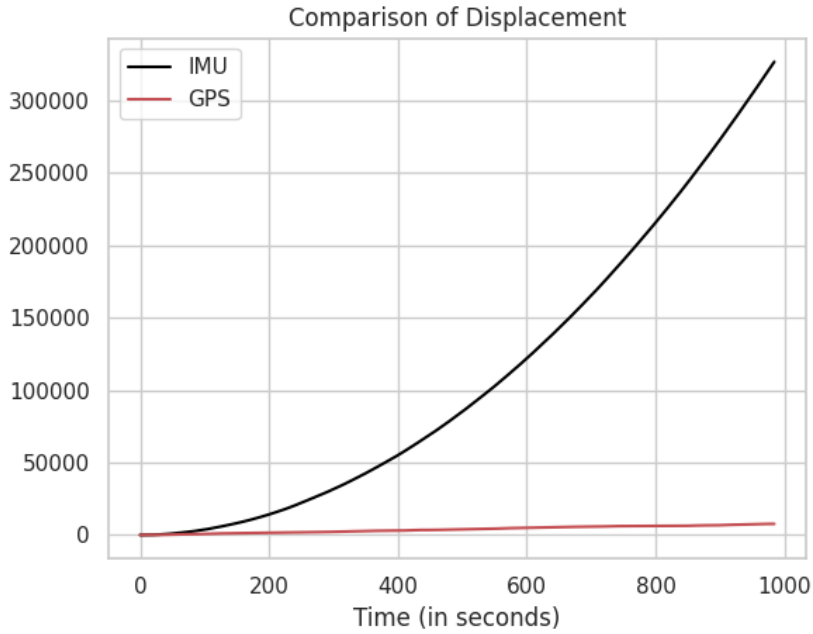

Fig. 12: Comparison of Displacement calculated from IMU and GPS

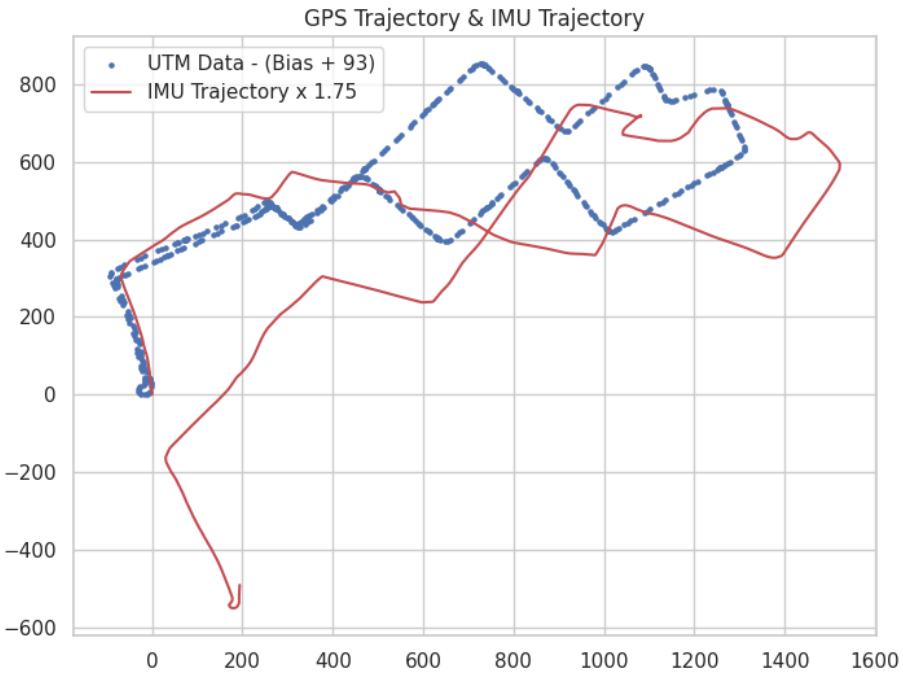

Fig. 13: Comparison of Trajectory calculated using GPS & IMU (Complementary Filter)

A scaling factor of 1.75 has been used to enlarge the trajectory calculated using the complementary filter from the IMU. Based on the trajectory comparison, I would say that the GPS and IMU estimate of position matched for about $1/4^{th}$ of the whole drive starting from the initial position.