EECE5554: Robotic Sensing and Navigation

LAB 5: NUance Navigation

1. **How did you calibrate the magnetometer from the data you collected? What were the sources of distortion present, and how do you know?**
   Calibration of magnetometer data was carried out by first calculating the offset for both x and y components by taking the average of maximum and minimum values. Then scale was calculated using maximum and minimum values of both x and y components, then calibrated values were calculated using the offset and the scale values.
   Sources of distortion in the circle_data was that there was concentrated disturbance at on point of the circular plot, and it was because when the nodes were running collecting data, the car was stationary at the start position for 10 to 15 seconds, hence there were higher distortions at that area.

2. **How did you use a complementary filter to develop a combined estimate of yaw? What components of the filter were present, and what cutoff frequency(ies) did you use?**
   Complementary filter was designed using a low-pass filter used for magnetometer data filtering and a high-pass filter used for gyroscope data filtering, combining giving a complimentary filter. This complimentary filter was used to combine the yaw data from magnetometer and yaw data from integrated gyro data, providing efficient yaw data. The cutoff frequency for low-pass filter used was 0.1Hz and for high-pass filter was also 0.1Hz. Alpha the tunning parameter used was 0.1.

3. **Which estimate or estimates for yaw would you trust for navigation? Why?**
   I would trust the estimates of yaw from the gyroscope data, as it has a much clearer and less fluctuating data. On the other hand, the magnetometer data has a lot of fluctuations even after calibration. Even though gyro data had to be wrapped in between pi and negative pi, it provides much clearer data.

4. **What adjustments did you make to the forward velocity estimate, and why?**

   The initial plot of forward velocity estimate values was dropping towards negative values. To make the data more understandable, all values were subtracted from the mean of all the velocity values calculated from acceleration data. This provided a positive value graph that showed zero values whenever the car was stopped at a red light for velocity.

5. **What discrepancies are present in the velocity estimate between accel and GPS. Why?**
   The GPS data provides a much more accurate data about when the car was stationary at a stop sign, indicating an absolute zero velocity value, whereas the velocity values from accelerometer data had few points that wasn't completely zero even if it was a situation where the car was at a stop sign.

6. **Compute omega_x_prime and compare it to y_obs_double_prime. How well do they agree? If there is a difference, what is it due to?**
   Acceleration along y direction observed has lesser distortions compared to omega as seen in the graph plotted between acceleration and time. Omega shows higher value acceleration distortion at certain time points which has to be an error.

7. **Estimate the trajectory of the vehicle (xe,xn) from inertial data and compare it with GPS. (adjust heading so that the first straight line from both is oriented in the same direction). Report any scaling factor used for comparing the tracks.**
   The trajectory of GPS exactly matches the path we took while collecting the data, but my IMU data doesn't match much with the actual path we took. It is as if the path was inverted, and the errors were very much accumulated that results had a very big deviation. The scale was also calculated to bring the IMU data graph to the same level as that of GPS data.

8. **For what period did your GPS and IMU estimates of position match closely? (within 2 m) Given this performance, how long do you think your navigation approach could work without another position fix?**
   Unfortunately, my analysis didn't show any match of paths for a significant period of time, this much has been due to the errors accumulated in the analysis and leading to a higher difference in the output values.