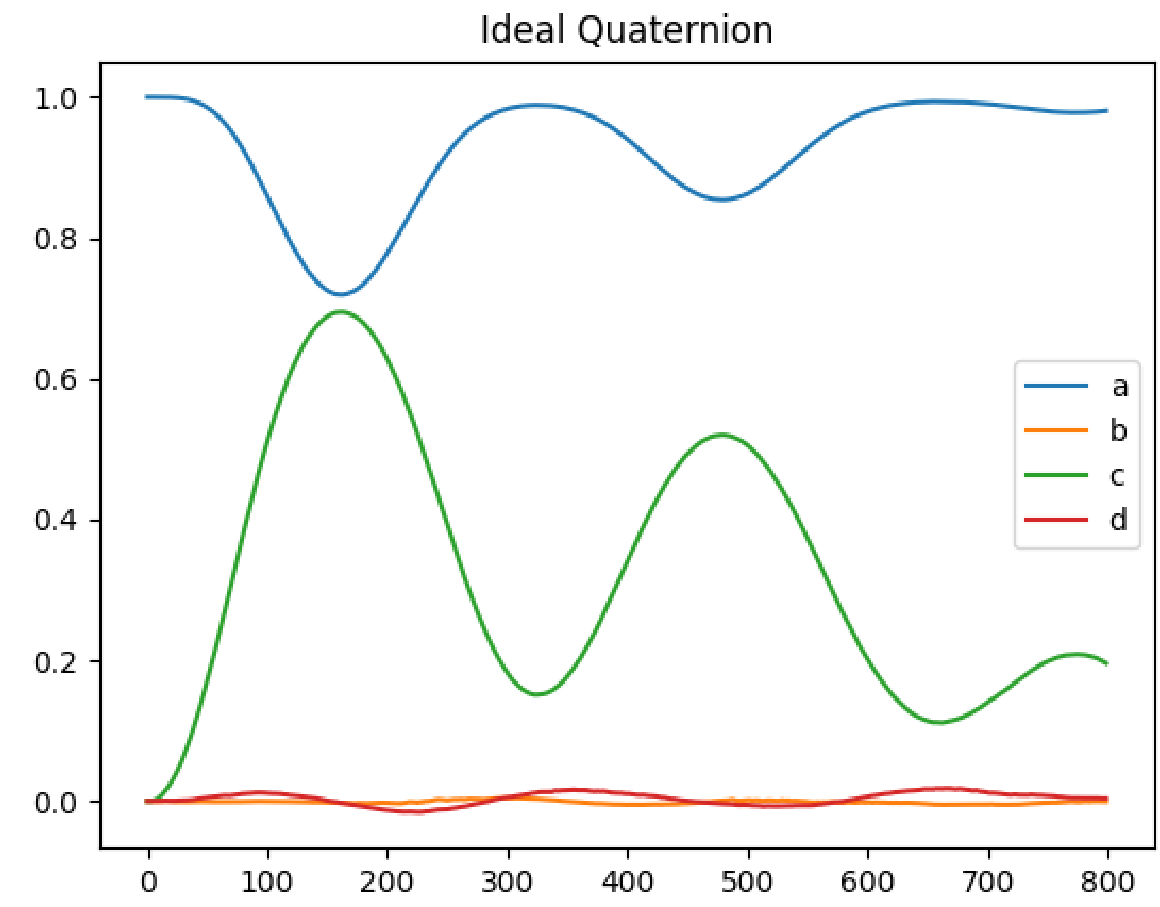
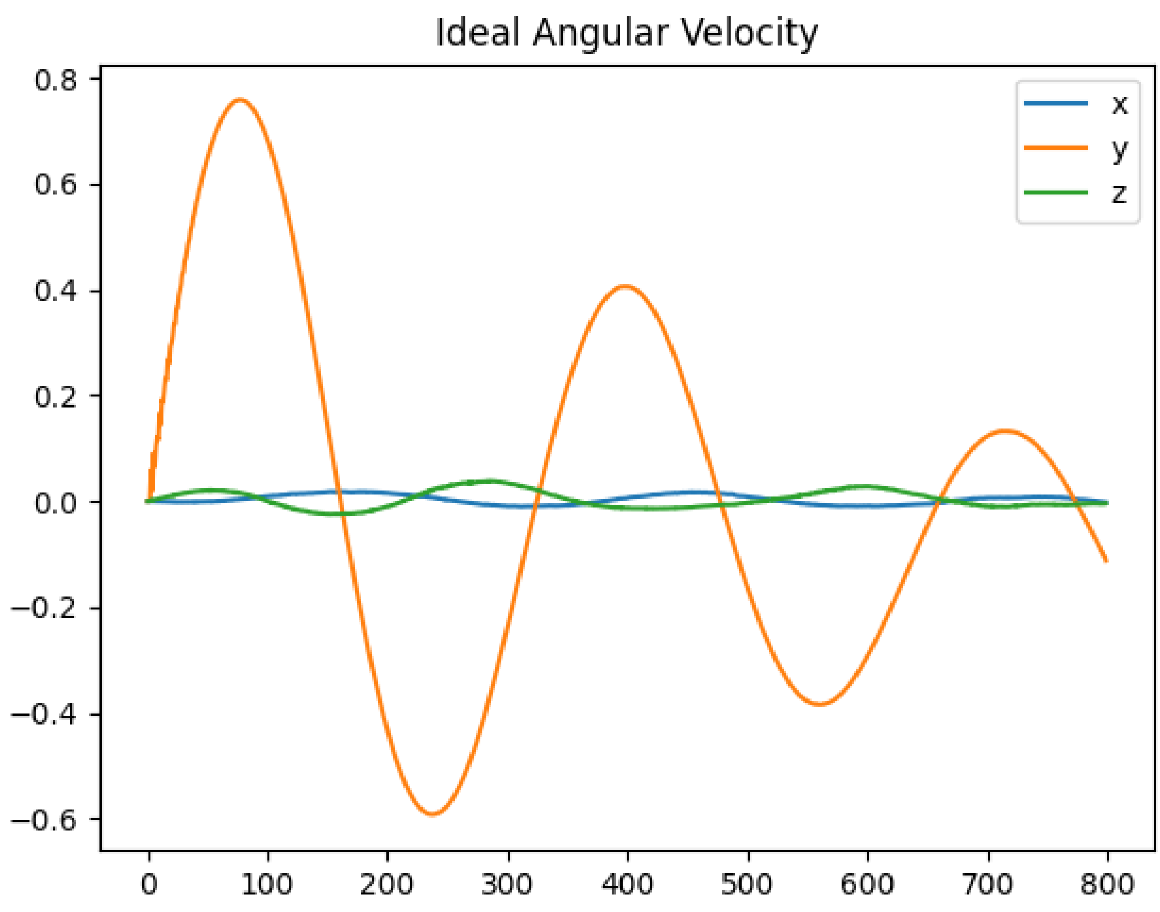
Kalman-Testing Simulation Report

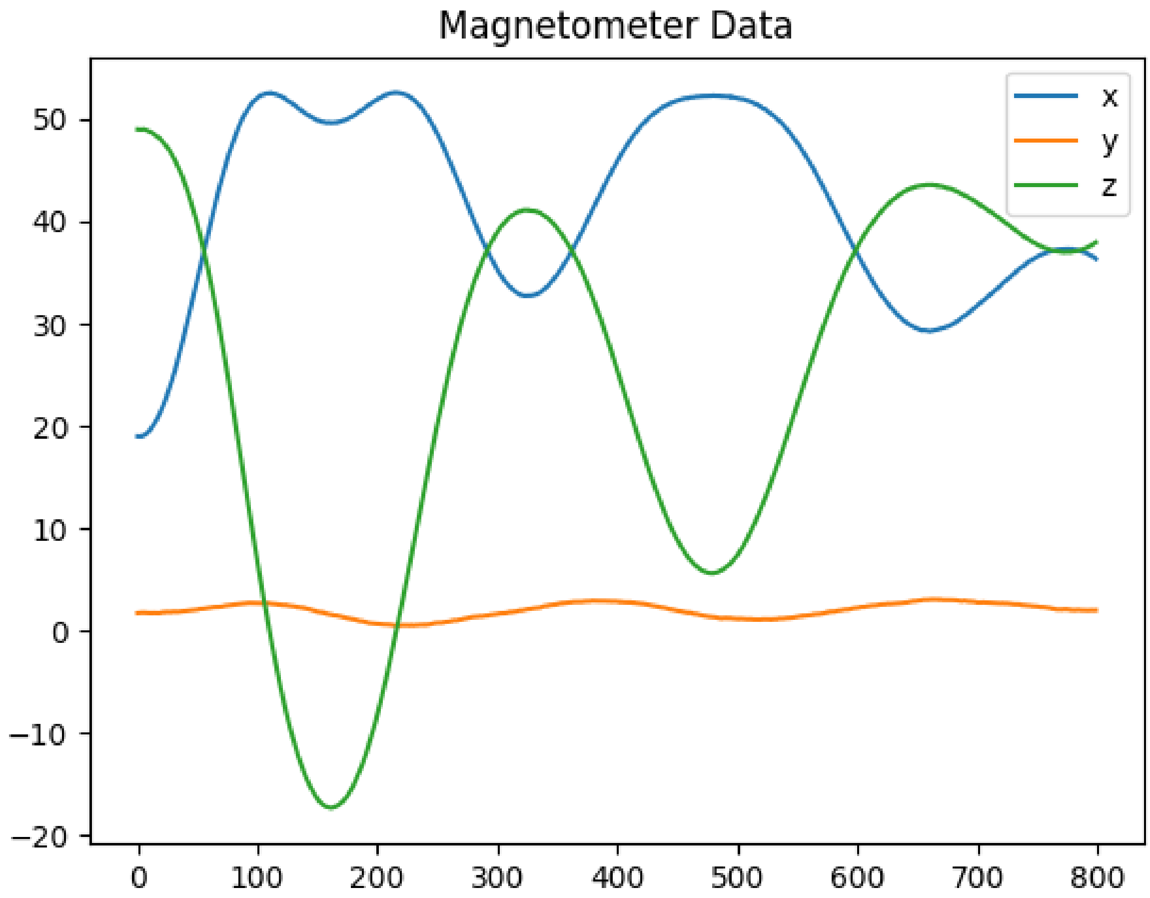
Ideal behavior is dictated by our propogating initial state and reaction wheel info for each step through our Equations of Motion (EOMs) and the true magnetic field (19.0, 1.7, 49.0 microteslas).

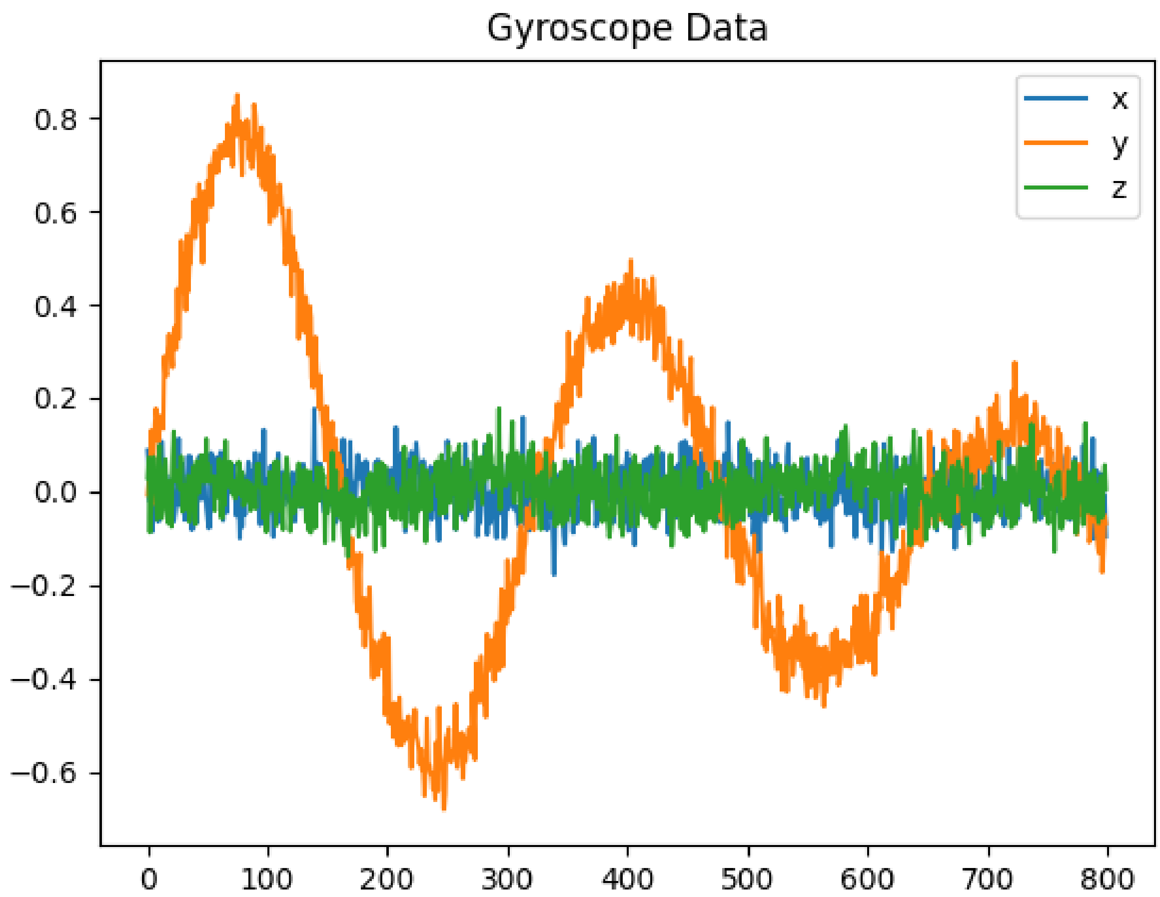




Data

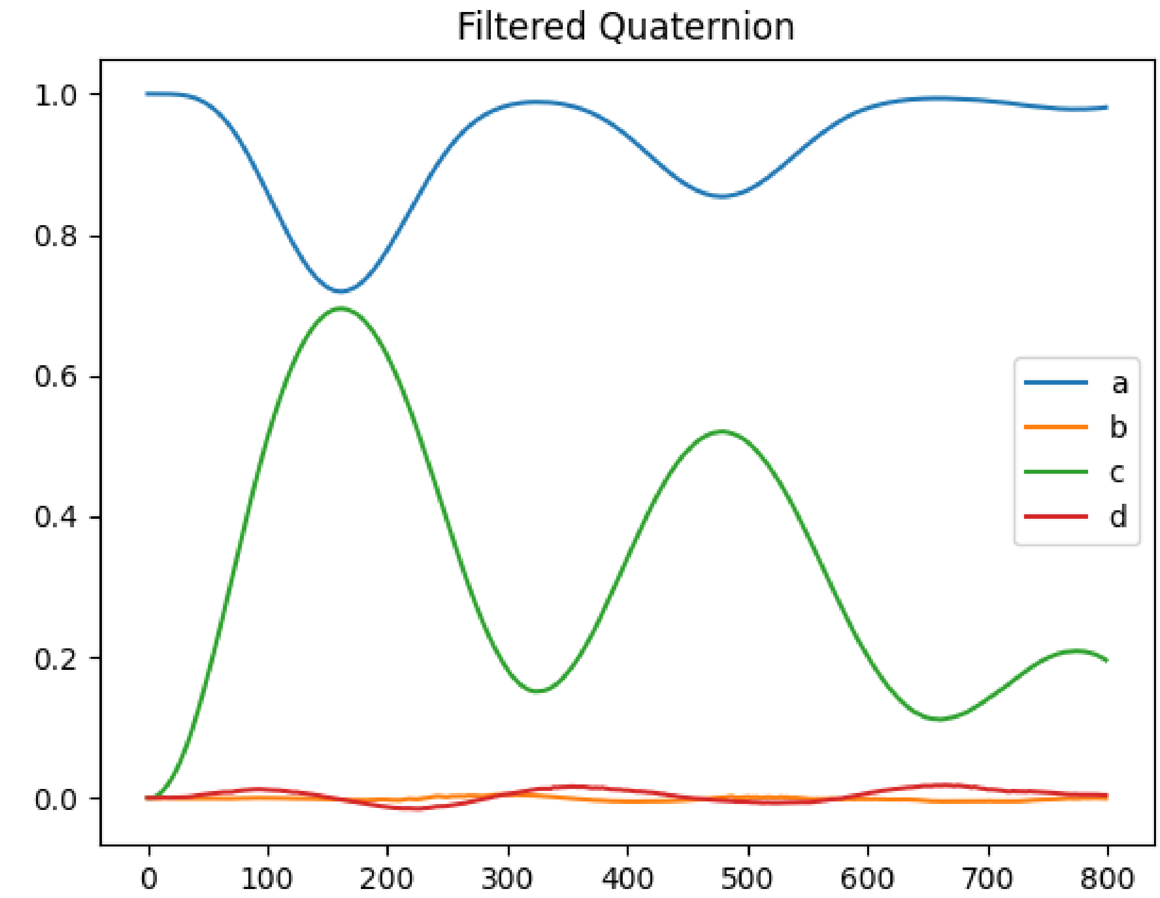
Simulate IMU data by adding noise to our ideal states in measurement space. For vn100, magnetometer noise = 0.019798989873223333 and gyroscope noise = 0.04949747468305833.

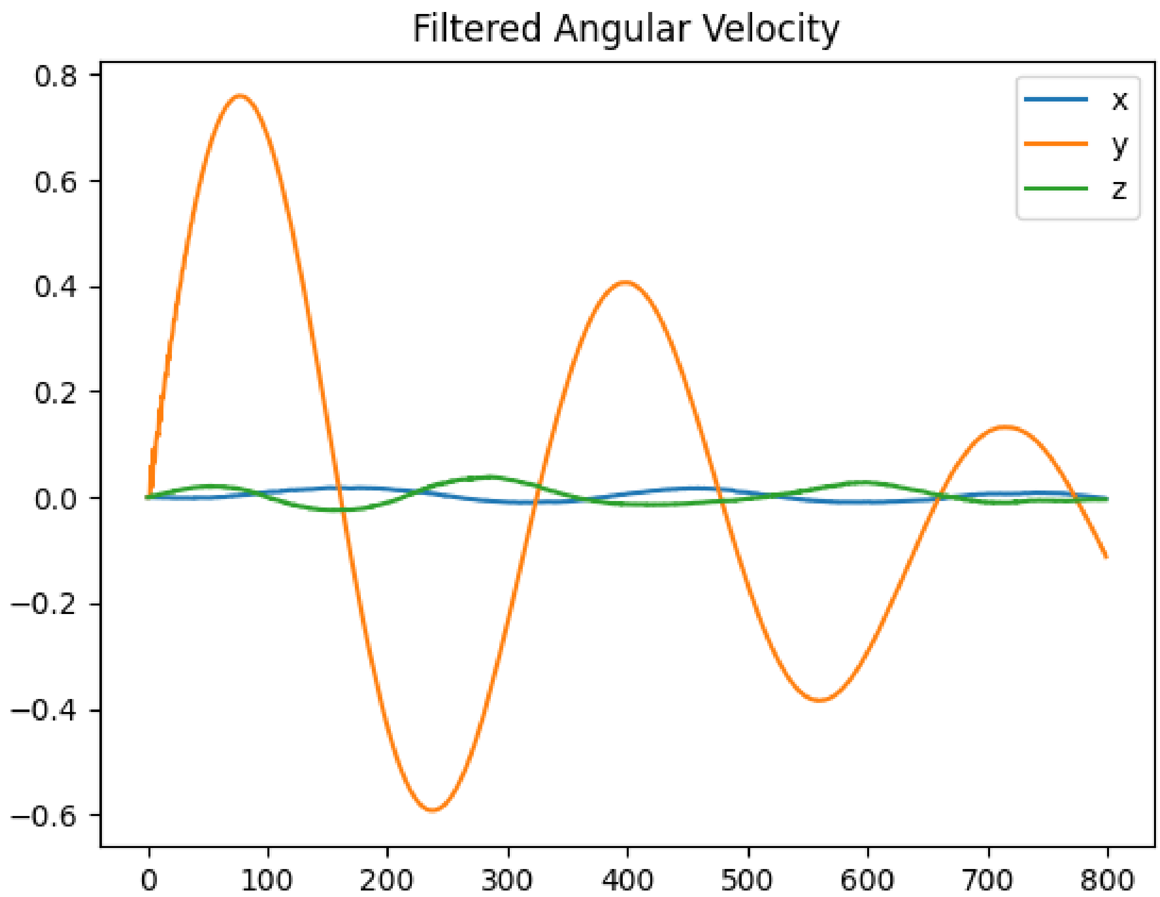




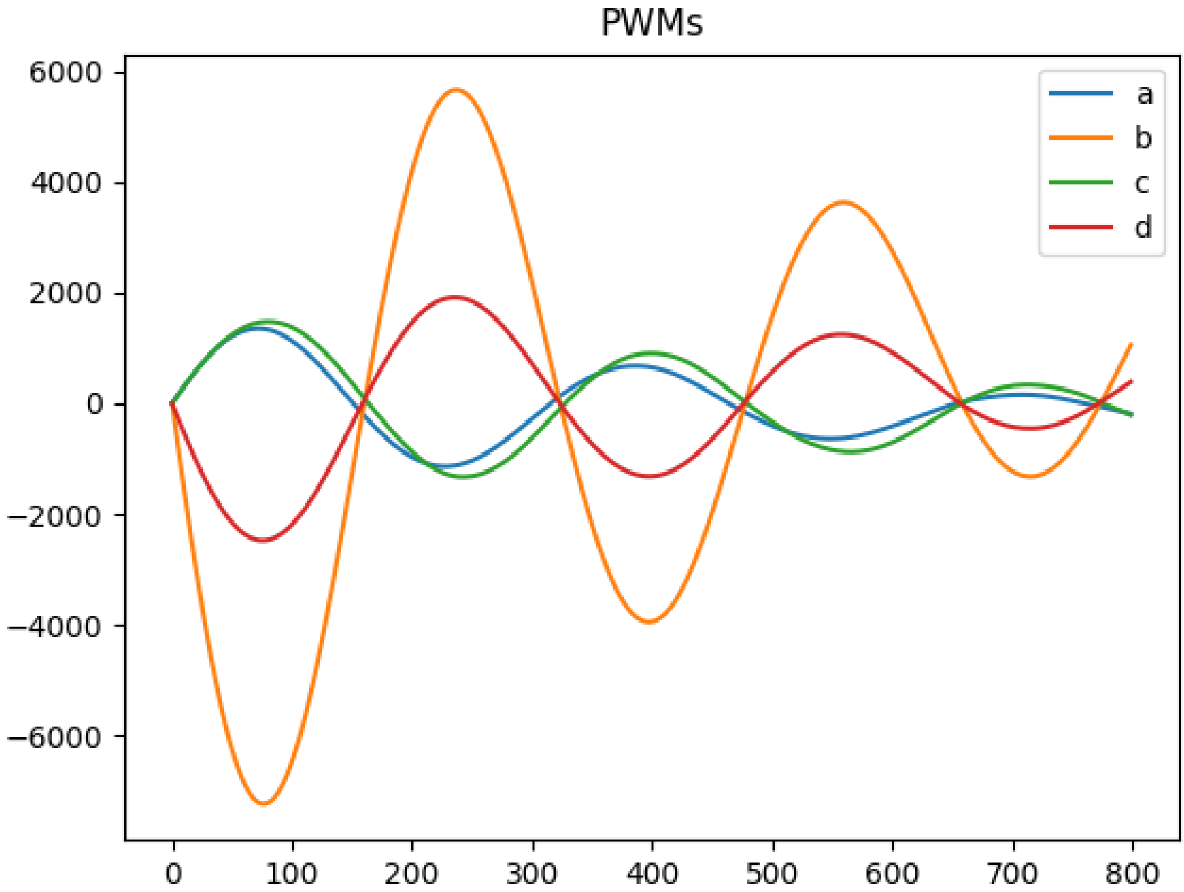
Filter Results

Kalman filter estimates our state for each time step by combining the noisy data and physics EOMs.



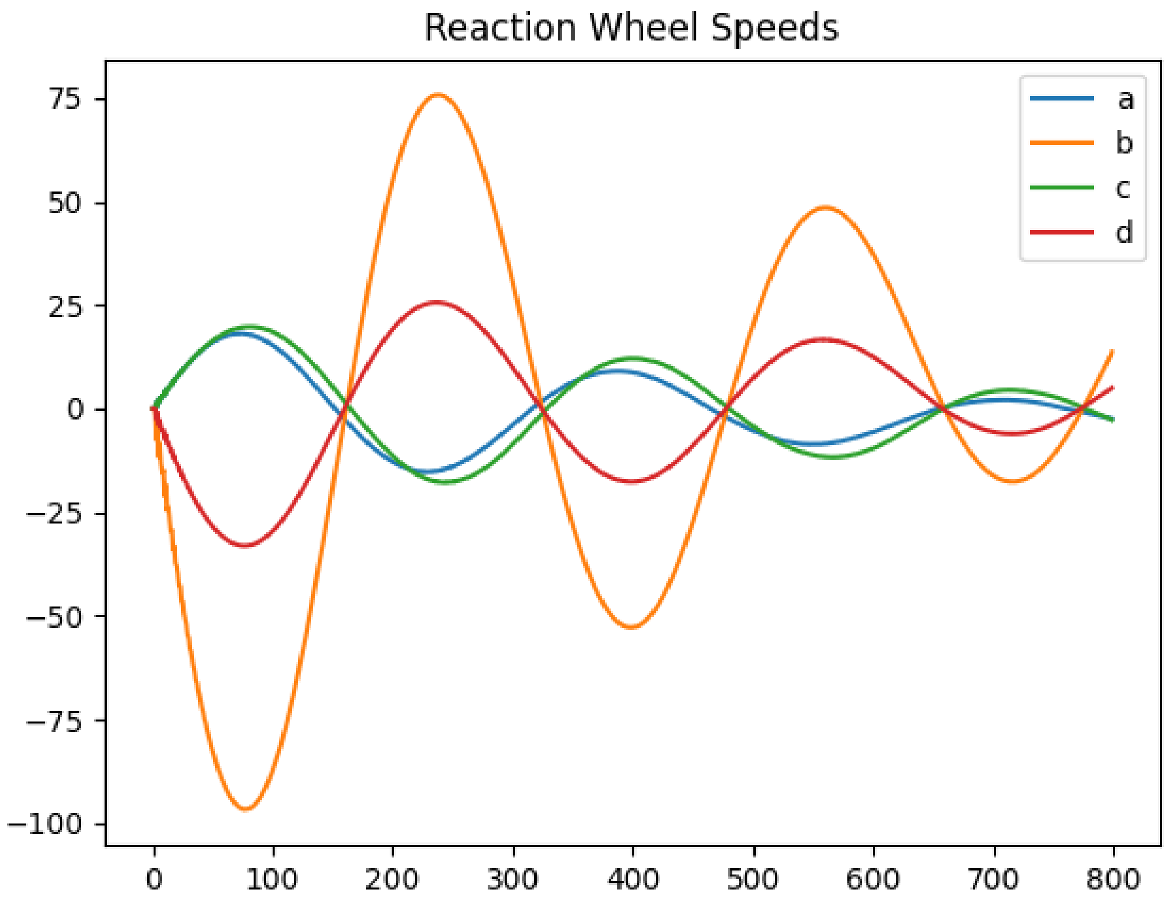


PWM

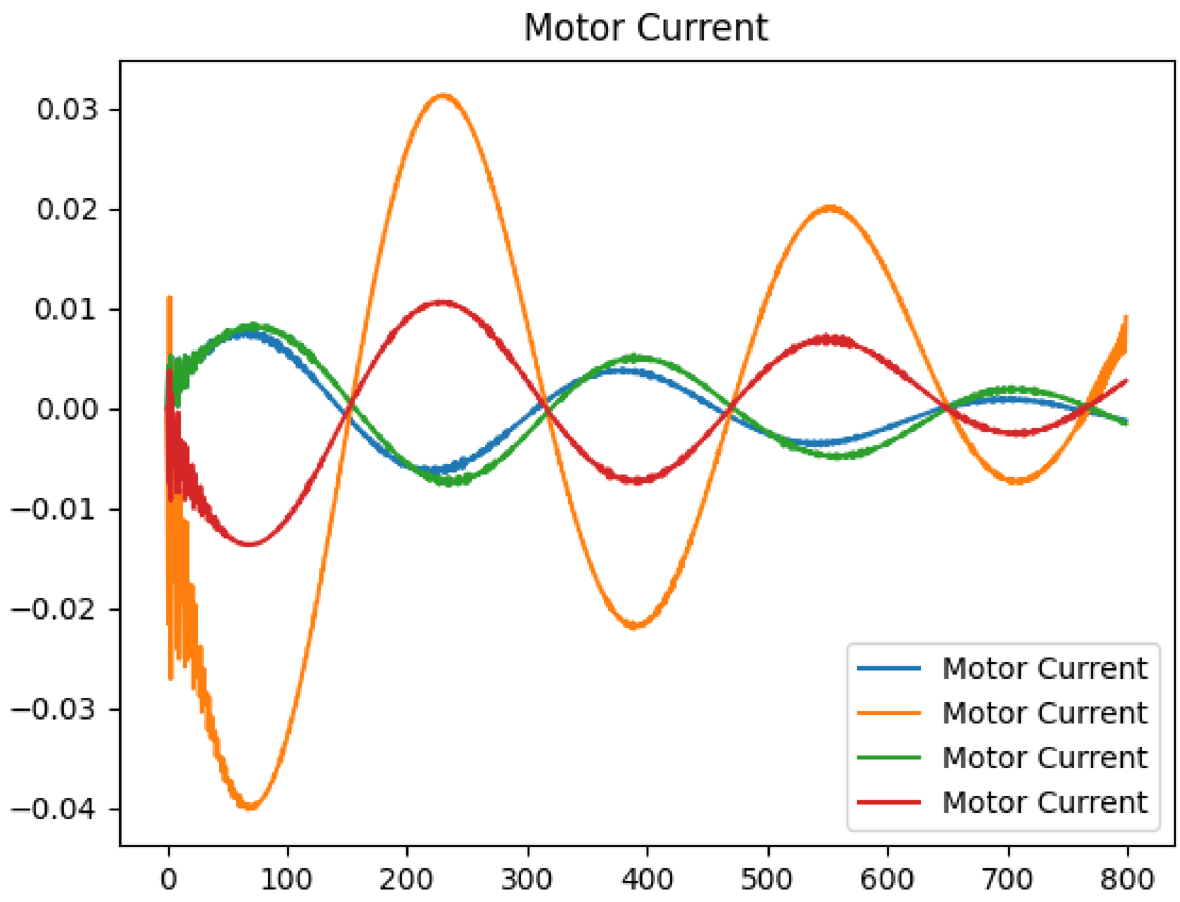


PWMs
6000
4000
2000
0
−2000
−4000
−6000
0
100
200
300
400
500
600
700
800
a
b
c
d

Reaction wheel speeds



Motor Current



Tests

We have two metrics for examining our filter: statistical and speed tests.

Speed tests:

800 iterations were completed in 3261.0 milliseconds. This kalman filter took 4.08 ms per iteration.

The statistical tests are based on Estimation II by Ian Reid. He outlines 3 tests that examine the innovation (or residual) of the filter, which is the difference betwee a measurement and the filter's prediction.

1) Consistency: the innovations should be randomly distributed about 0 and fall within its covariance bounds.

2) Unbiasedness: the sum of the normalised innovations squared should fall within a 95% chi square confidence interval.

If distribution sums are too small (fall below interval), then measurement/process noise is overestimated (too large). Therefore, the combined magnitude of the noises must be decreased.

Conversely, measurement/process noise can be increased to lower the sums of the normalized innovations squared.

3) Whiteness: autocorrelation should be distributed around 0 with no time dependecy.