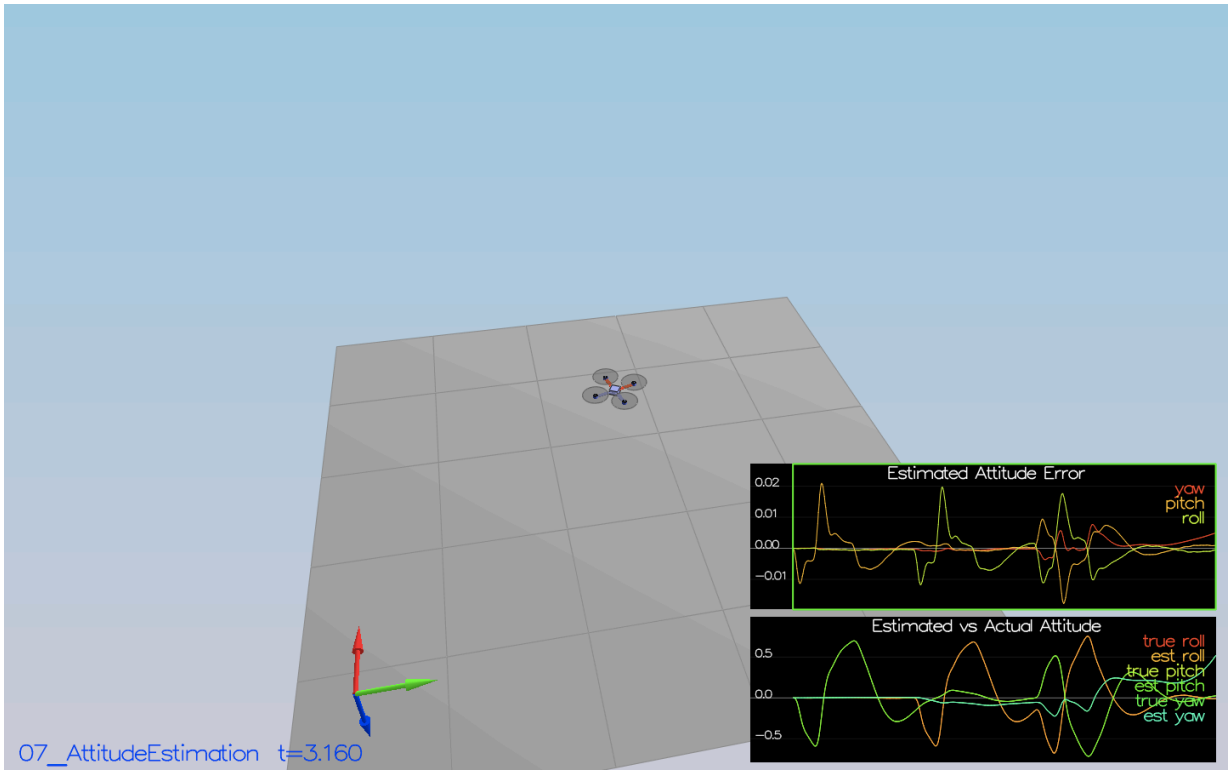
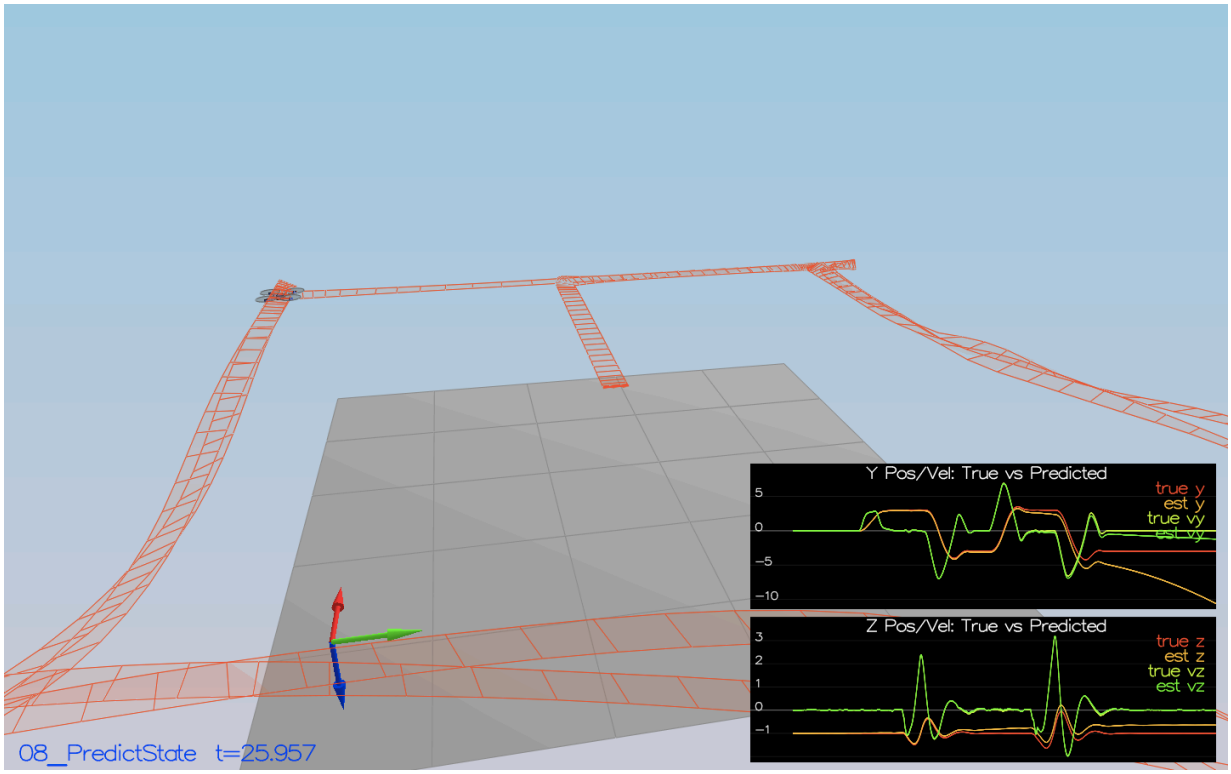
# ESTIMATION PROJECT FCND

To determine the standard deviation of the measurement noise I wrote a python program that follows a four part algorithm; 1 Take the average (Mean) of the data. 2 For each number in the data, subtract the Mean and square the result. 3 Take the average of those numbers (the squared differences). 4 Take the square root of the last found average, and that is the std.
The python program is called Std_calculation and the notebook can be found in the project folder. The program calculates the std of the GPS X data to be 0.6957689986214529, and the std of the Accelerometer X data 0.5037454331606036.

To implement a better attitude integration scheme in UpdateFromIMU I use a simple non-linear complementary filter using the theory from section 7.1.2 from the paper "Estimation for Quadrotors", using quaternions to improve performance;



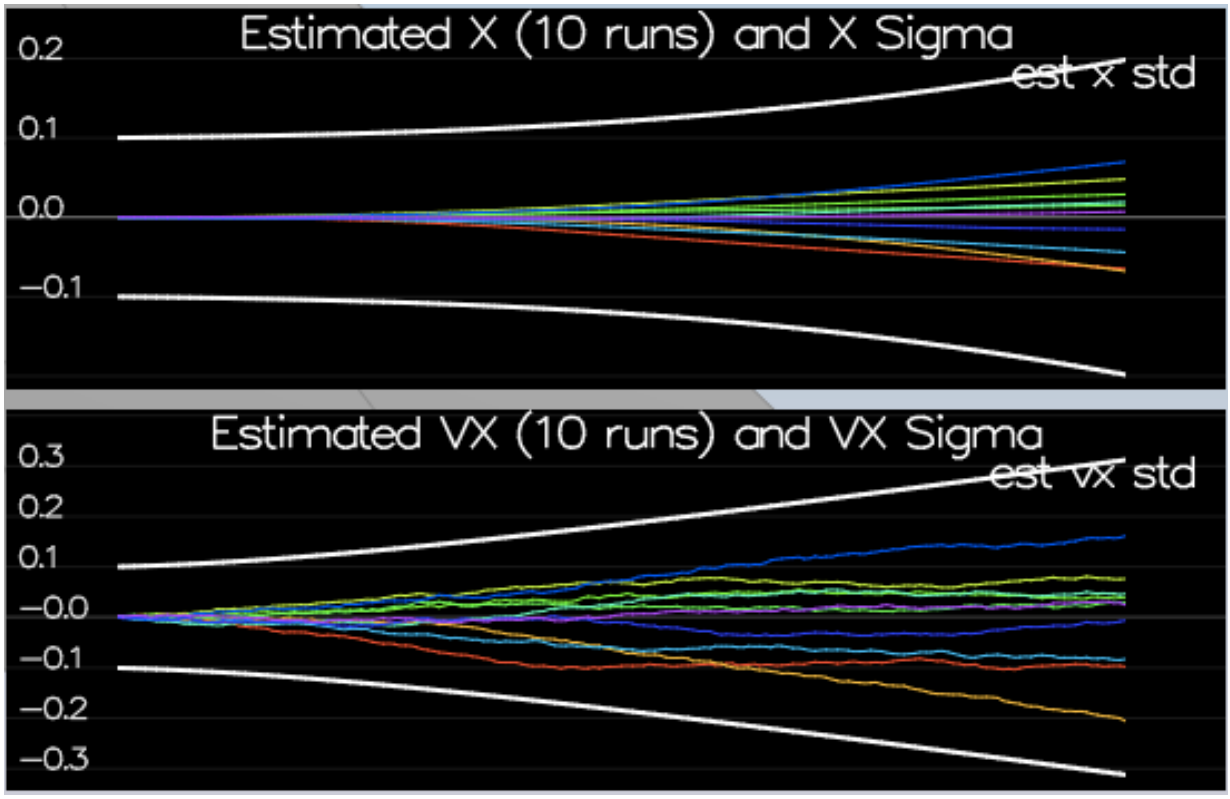

In the prediction step I first implement a PredictState() function, as a result the estimated state tracks the actual state with only reasonably slow drift, as shown in the screenshot below:




The partial derivative of the Rbg rotation matrix, is given in the paper “Estimation for Quadroters” in 7.2, and the equations for the update of the state covariance;

$$\bar{\Sigma}_t = G_t \Sigma_{t-1} G_t^T + Q_t$$

Result:

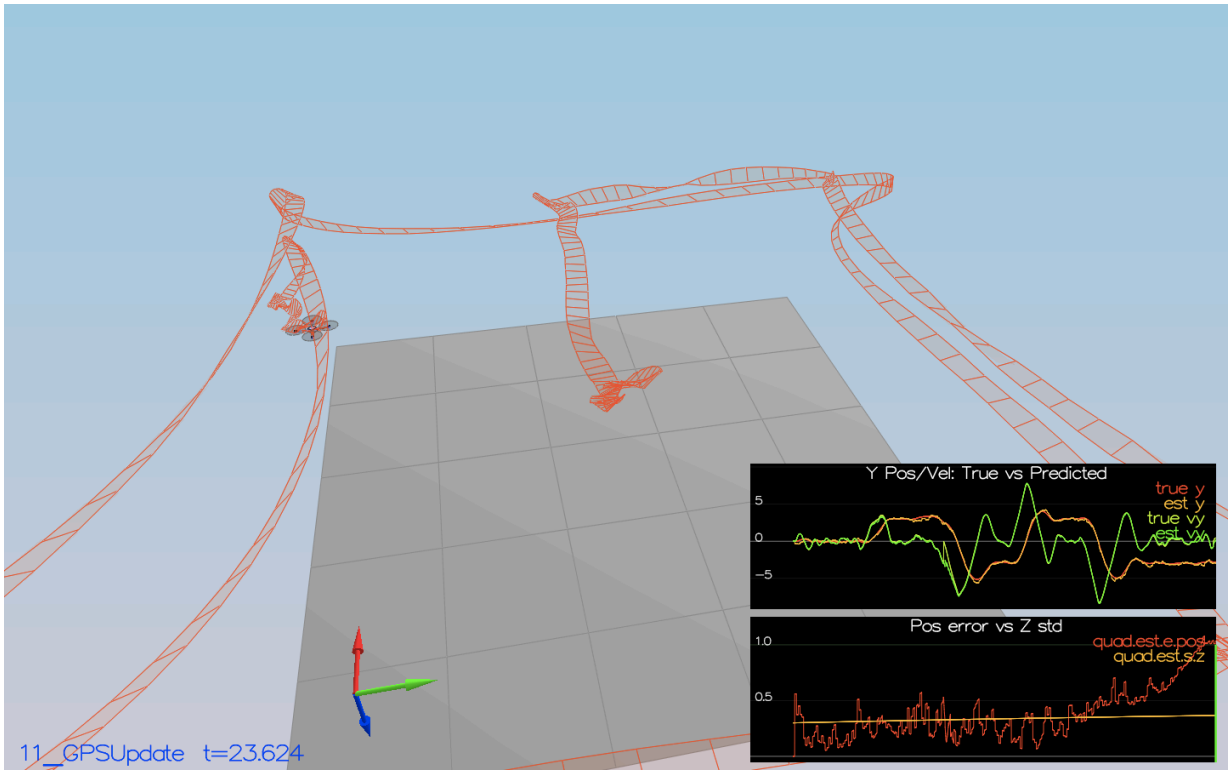



The acceleration is accounted for in gPrime as the whole algorithm the code uses is ;

$$\textbf{function } \textsc{Predict}(\mu_{t-1}, \Sigma_{t-1}, u_t, \Delta t)$$
$$\bar{\mu}_t = g(u_t, \mu_{t-1})$$
$$G_t = g'(u_t, x_t, \Delta t)$$
$$\bar{\Sigma}_t = G_t \Sigma_{t-1} G_t^T + Q_t$$
$$\textbf{return } \bar{\mu}_t, \bar{\Sigma}_t$$

The magnetometer update simply takes the measurement directly. The angle error between the current state and the magnetometer is taken the short way around (not the long angle).
Result;


And I Also incorporate GPS information by taking the measurements directly. Result;



Please note that all screenshot are taken after implementing my controller from previous project. All tests return a pass :)