Progress Review

In order to test the simulator in MATLAB, the code has to be broken down to smaller parts. The main issue revolves around the calculation of angular acceleration of the body frame. In order to test the angular acceleration of the body frame, besides using an actual drone with IMU, the best way is to use an imported CAD model and do analysis of the dynamics of the model.

Quadcopter simulations generally do not consider the effect of the moment of inertia of propellers because near hover, the angular acceleration of the propellers is small, and combined with small moment of inertia of the propeller relative to the body, the effect is negligible. The assumption does not hold for a single-motor flyer.

The hover solution has been verified by calculation through Symbolic toolbox. The non-hover solution, however, is not easy to verify. Importing a CAD model would be the most straight forward way of investigating the validity of the model. It will be constructed in the following ways if necessary.

The block test approach is difficult to implement. From the linearization matrix A, we can see that the current implementation has $\frac{\partial f_{\omega z}}{\partial \omega_x} = \frac{\partial f_{\omega z}}{\partial \omega_y} = \frac{\partial f_{\omega x}}{\partial \omega_z} = \frac{\partial f_{\omega y}}{\partial \omega_z} = 0$ where

$$\dot{s} = f(s, u)$$

$$s = \begin{bmatrix} \eta_1 \\ \eta_2 \\ \omega_x \\ \omega_y \\ \omega_z \\ f_P \end{bmatrix}$$

ω is equal to $C^{CB}\omega^B_{BE}$ (angular velocity of the body in the control frame). C^{CB} is constant (dependent on the hover solution). In the current implementation, z component of angular acceleration of the body is independent of the x and y component of the angular velocity of the body in the current implementation. Given the original equation to calculate the angular acceleration of the body,

$$I^B_B \dot{\omega}^B_{BE} = r^B_P \times e^B_P f_B + e^B_P \tau_P + \tau^B_d - \omega^B_{BE} \times (I^B_B \omega^B_{BE} + I^B_P \omega^B_{PE}) - I^B_P \dot{\omega}^B_{PE}$$

The term $\omega^B_{BE} \times (I^B_B \omega^B_{BE} + I^B_P \omega^B_{PE})$ has a cross product and shows that z component of $\dot{\omega}^B_{BE}$ has to depend on x and y component of the angular velocity. Therefore, the linearization result does not reflect the qualitative relation it is built on.