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Comparison of Simulink and Realflight 9.5

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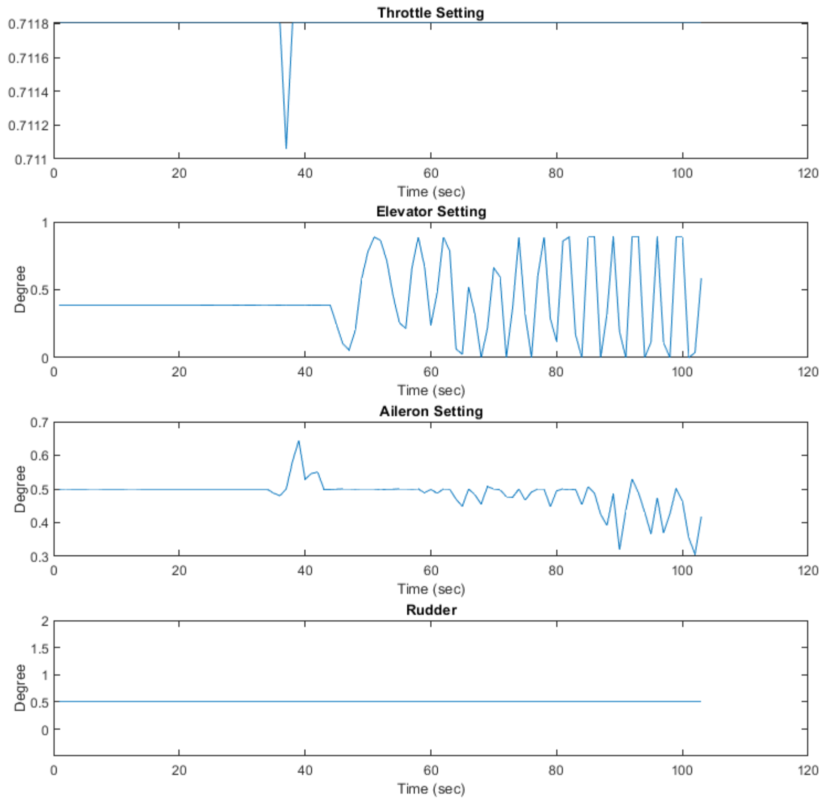

Figure 1 Control Inputs into Mathematical Model

The frequency sweep from the Mat file, Elev_Clipped_1, is shown in Figure 1. This data is the normalized RC controller inputs and does not accurately describe the angle in degrees the elevator has been set to. This is true for the elevator, aileron, and rudder. The Throttle setting is normalized between 0 and 1 and is true to the input of the Mathematical Model. Data integrity is lost if the data is attempted to be denormalized. In Figure 1, 0.5 “degrees” is actually 0 degrees across all control surfaces.

We can only look at the trends from the state output and cannot look at the actual values to give a rough estimation of if the mathematical model matches the Realflight 9.5 Simulator. Further, some of the states are not output in the data collected from the Realflight 9.5. Inclination angle will loosely be looked at in comparison to the angle of attack.

Figure 2 shows the state outputs of the Mathematical Model with respect to the control inputs in figure 1. Because this is in response to a frequency sweep on the elevator, special attention should be shown towards the pitch angle, theta, and the pitch rate, q.

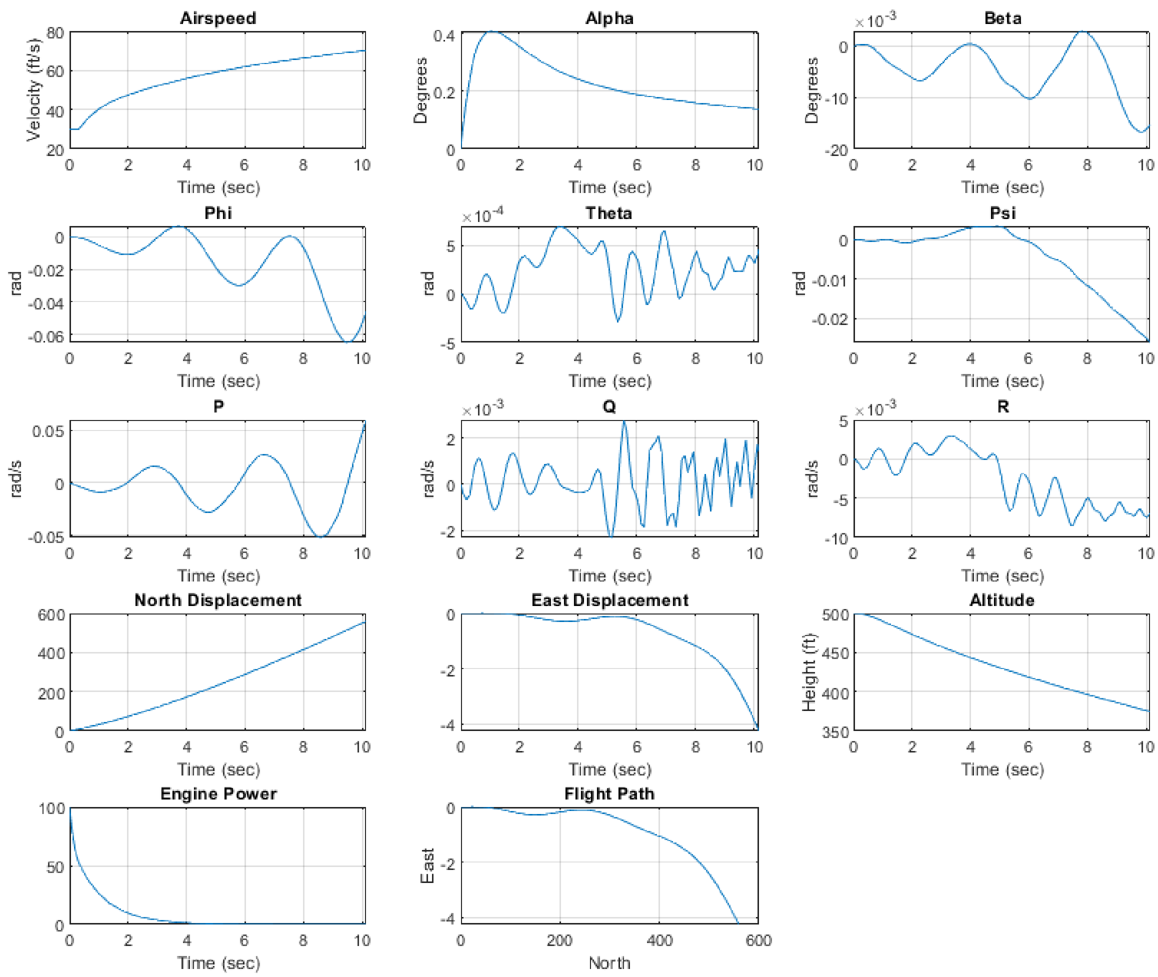

Figure 2 State Outputs Mathematical Model

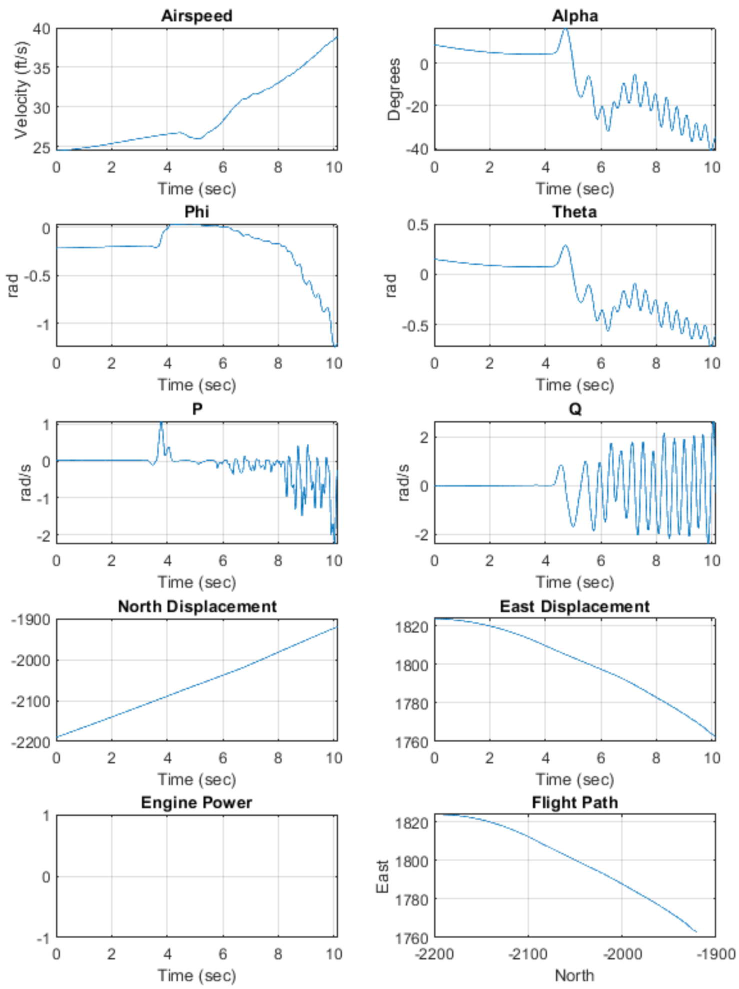

Figure 3 State Outputs Realflight Simulator

In figure 3, the angle of attack has been estimated as the inclination angle and beta has been estimated as the yaw rate, which is why the second plot is the same as the fifth and the third is the same as the ninth plot. Again, remembering the inputs are not the same, we do see similar plots between the two figures. In the mathematical model, the airspeed, almost doubles in magnitude, but appears to taper off as it reaches the end of the time range. In the Realflight simulator, the airspeed increases by about 60% but does not appear to taper off. The trend of the two is similar, but the Mathematical model increases much more with a smaller elevator input. In the second plot of the angle of attack and the inclination angle, again there are similar trends. However, in this instance, the angle of attack drops significantly in the Realflight simulator, but in the Mathematical Model, the angle of attack slowly decreases. This can be compared to the altitude, the Realflight altitude drops 60 ft within the last 4 seconds, whereas the in the Mathematical Model, the altitude drops at a slower rate. The metrics that have the best trends are the Flight Paths, the models have very similar flight paths. Both models are veering west. The Realflight simulator does not output the engine power, so the engine power cannot be analyzed. However, if it could, I would be interested to see if the altitude follows more of a similar route, where the plane is flying at constant altitude for a couple seconds and then starts to lose altitude rapidly. After about four seconds, the models have opposite trends in the yaw and the yaw rate. For the first four seconds, both models trend positively, but then deviate in opposite directions. The roll angle trended in a negative direction in both the Realflight simulator and the Mathematical Model. However, the magnitudes of the two models are not very similar. Interestingly, the roll rates are trending in opposite directions and the Mathematical Model is much more oscillatory than the Realflight simulator. Finally, the pitch angle, theta, in the Realflight simulator, trends in a negative direction and oscillates and it pitches down. Theta in the Mathematical model oscillates as it pitches up. The Mathematical Model has smaller oscillations in the first 4 seconds and then an increase of amplitude of oscillations after that in its pitch rate. We are expecting no initial oscillations as the Realflight Simulator displays. However, after the first four seconds we have similar behavior. It is also important to remember the loss of fidelity between the two models. The Mathematical Model has an output space of 119 timestamps and the Simulink has over 1000. Overall, the Mathematical Model is similar to the Realflight simulator but is quite different in several places. I think a good next step in tuning the Mathematical Model is scaling the aerodynamic coefficients according to the xflr5 outputs.