6.7 Design Project

In this assignment you will use simplified linear design models to tune the gains of the control loops for the lateral and longitudinal autopilot. To do this, you will need to create some auxiliary Simulink scripts that implement the linear design models. The final step will be to implement the control loops on the full 6-DOF MAV nonlinear model (developed before).

6.1. Check the Matlab script file compute_control_gains.m that computes the gains for the roll attitude hold loop. It is assumed that the maximum aileron deflection is $\delta_a^{\max}$ = 45 degrees, the saturation limit is achieved for a step size of $\phi^{\max}$ = 60 degrees, and the nominal airspeed is V_a = 35 m/s.

Use the Simulink file mavsim_chap6.slx and autopilot.m to check if the values of ζ_ϕ and k_{i_ϕ} result in acceptable performance in the full 6-DOF MAV model (Read the problem 6.8).

6.2. Augment the above Matlab script (compute_control_gains.m) to compute the gains for the course hold loop. Tune the bandwidth separation and the damping ratio ζ_χ to get acceptable performance for step inputs in course angle by using the Simulink model mavsim_chap6.slx.

6.3. Augment the Matlab script to compute the gains for sideslip hold. Assume that the maximum rudder deflection is 20 degrees, the saturation limit is achieved for a step size of 3 degrees.

6.4. Augment the Matlab script to compute the gains for the pitch attitude hold loop. Assume that the maximum elevator deflection is $\delta_e^{\max}$ = 45 degrees, and that the saturation limit is achieved for a step size of $e_\theta^{\max}$ = 20 degrees. Use the Simulink file mavsim_chap6.slx and autopilot.m to check if selected gains result in acceptable performance.

6.5. Augment the Matlab script to compute the gains for altitude hold using pitch as an input. Use the Simulink file mavsim_chap6.slx and autopilot.m to check if the value of ζ_h and the bandwidth separation results in suitable performance.

6.6. Augment the Matlab script to compute the gains for airspeed hold using pitch as an input. Use the Simulink file mavsim_chap6.slx and autopilot.m to check if the value of ζ and the bandwidth separation results in suitable performance.

6.7. Augment the Matlab script to compute the gains for airspeed hold using throttle as an input. Use the Simulink file mavsim_chap6.slx and autopilot.m to check if the value of ζ and w_n results in suitable performance.

6.8. The final step of the design is to implement the lateral-directional and longitudinal autopilot on the full 6-DOF MAV simulation model. An example of how to organize your simulation is given in the Simulink model mavsim_chap6.slx. In particular, to implement the longitudinal autopilot, you will need to implement a state machine using the 'switch' statement.

Tip

- Check if your P.mass is 13.5 (not 35)
- In this assignment, you need to amend compute_control_gains.m, autopilot.m, param_chap6.m files.