Aero 2 Lab Procedure

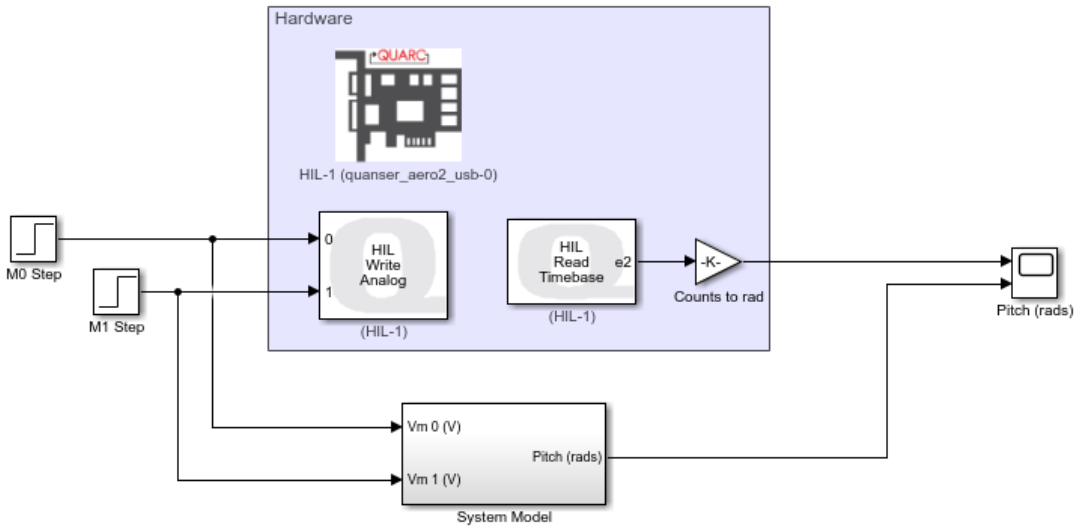
System Block Diagram Modelling

Setup

1. Make sure the Aero 2 has been tested as instructed in the Quick Start Guide.
2. Launch MATLAB and browse to the working directory that includes the Simulink models for this lab.
3. Make sure the Aero 2 is configured as the 1 DOF pitch-only system:
    a. Unlock the pitch axis and lock the yaw axis.
    b. Both rotors are horizontal.
    c. Adjust thruster weights so the Aero sits close to level at rest.
4. Connect the USB cable to your PC/laptop.
5. Connect the power and turn the power switch ON. The Aero 2 base LED should be red.

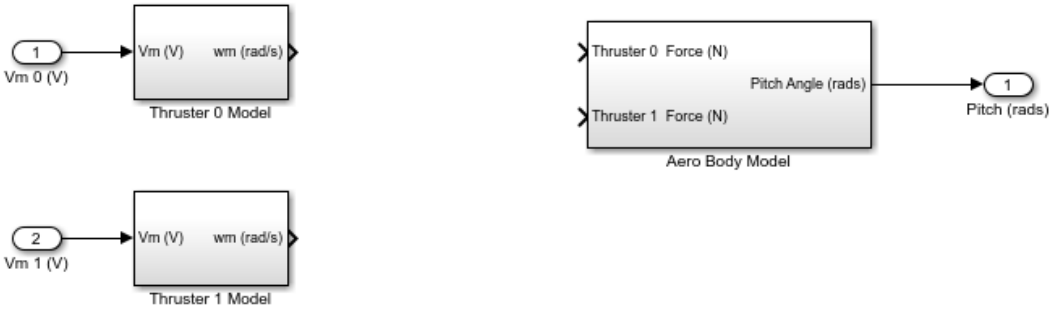
Completing the Block Diagram

The Simulink model as given in the student resources is shown here



Follow the instructions below to complete and validate the block diagram:

1. Open the the **q_aero2_system_block_diagram.slx** Simulink model.
2. Open the System Model subsystem
3. Connect the thruster subsystem blocks to the pitch dynamics block by adding a gain to convert from propeller velocity to force using the propeller thrust constant **kt_p** as shown below



4. Open the Aero Body Model subsystem. The model has been preconfigured with inputs, as well as the blocks required to calculate the angular position from the total applied torque. There are four inputs for torques applied to the body of the Aero. These correspond to the two thrust torques, the damping in the pitch axis, and the effect of gravity.
5. Connect the thruster force inputs using the thruster displacement to calculate the applied torques
6. Connect a feedback loop from the simulated velocity using the pitch damping constant to calculate the damping torque
7. Using the free body diagram Using the free body diagram given in the System Block Diagram Modelling Application Guide, calculate the torque due to gravity as a function of the sine of the simulated angle, as well as the body mass Mb, the mass displacement, Dm, and the gravity constant g.
8. Connect a feedback loop from the simulated position using the formula from step 7 to calculate the gravity torque.
9. Capture an image of the Aero Body Model subsystem with the completed feedback loops.

Model Validation and Tuning

Now that the block diagram is complete, we will validate how well it models the behaviour of the hardware. The model applies a 5V step to motor 0 after one second, followed by a 5V step on motor 1 after five seconds. The result should be a damped oscillation in the pitch axis which settles toward a pitch of zero.

10. Return to the top level of the Simulink model and open the Pitch (rads) scope.
11. Build and run the **q_aero2_system_block_diagram** Simulink model in QUARC.
12. Export a MATLAB figure showing the response of the pitch angle of both the hardware and model.
13. Does the model with the parameters you found match the hardware response? Identify one reason why there could be a mistmatch, i.e., why the model does not represent the system.
14. Try adjusting the variables for mass dispacement (Dm), propeller thrust (K_tp), and damping (Dp) to try and more closely match the hardware response.
15. Make a note of the final values used, and capture a figure showing the model and hardware responses.
16. Close the Simulink model
17. Turn off the power on the Aero 2.