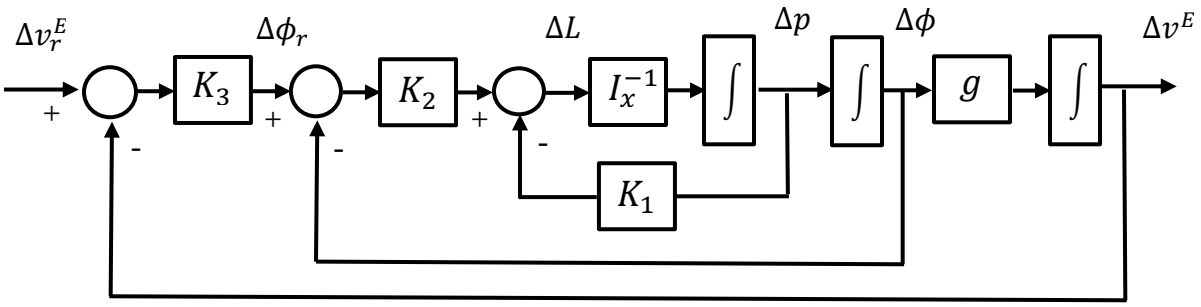
ASEN 3128 Assignment 5

Due: Thursday, October 10 at 11:59 PM on Canvas

1) Using the feedback control gains K_1 and K_2 designed in Assignment 4 for the linearized lateral and longitudinal rotation dynamics of the quad copter as an "inner loop" control law, arranged so that the bank and elevation angles track their corresponding reference angles, design an "outer loop" tracking control law with gain K_3 to cause the translational inertial velocity components to track corresponding reference commands, as shown in the block diagram below for the linearized lateral set.



Design K_3 so that the closed loop three-state systems (lateral and longitudinal) have real eigenvalues, with corresponding modal time constants no larger than 1.25 sec. Use Matlab's `eig` function to find the eigenvalues of the system for a range of gains K_3 and plot the locus of these eigenvalues in the complex plane. Use this locus to determine gain values that satisfy the design objectives. Pay careful attention to the sign of K_3 in the longitudinal set.

2) Design "open loop" or "feedforward" commands Δv_r^E and Δu_r^E to cause the corresponding inertial displacements Δy_E and Δx_E (assuming $\psi_o = 0$) to change by 1.0 m in 2.0 sec. Assume that the copter will maintain altitude (an existing altitude controller will be active---you do not need to design this). Also assume that the velocity commands can be set to non-zero constants over a specified time, after which they will return to zero. Simulate this system in Matlab, for both

longitudinal and lateral translation, one at a time, and verify that the simulation behaves as desired.

3) Implement your design on the Mambo copter, and record the motions to compare with the simulation above. Discuss the differences between your predicted and measured behavior. Provide engineering reasoning for the differences where you can, but no wild guesses please!

Be aware that your first design for the guidance commands may not work as expected, so it will be better if you come to the lab period prepared with an initial design. This will leave more time to alter the design based on the performance you observe on the copter.