ASEN 5519 Small UAS Guidance and Control

Homework 7 Assignment

Assigned: Thursday March 23, 2023

Due: 11:59 PM, Thursday, April 6, 2023

Submit all plots and code and through the course web site as a single pdf. Unlike past assignments, this assignment does not specify the exact form or decomposition of all additional functions you may create, nor is a specific control objective given.

Students are given several new functions as well as two sets of gains (one for the SLC autopilot and one for the new SLC with Feedforward autopilot) as .mat and .ascii files. The file `RunHW7.m` is set to run either autopilot by setting a control flag near the top of the script.

Problem 1

Implement a guidance algorithm to track a specified circle at a given height. Use any approach that was discussed in class. The guidance algorithm takes as input the aircraft state and returns a vector $\mathbf{g}_c = [\dot{h}_c \quad h_c \quad \chi_c \quad \dot{\chi}_c \quad V_{a,c}]^T$. The parameters defining the desired circle are the position of the center, the radius of the circle, the speed the aircraft follows the circle, and a flag to indicate the direction of the orbit. For this assignment you can pass the center height and speed directly through, i.e. they are constants, and hard-code $\dot{h}_c = 0$.

Using the standard SLC autopilot (`CONTROL_FLAG = SLC`), demonstrate that your code works by initializing the aircraft with the trim state with the exception of the initial height of 1655 m, and showing it converge to a circle with center $\mathbf{c} = [1000 \quad 1000 \quad -1805]^T$ m, radius $R = 200$ m, and speed $V_a = 18$ m/s. Do not expect to track the circle perfectly.

Problem 2

Look through the code for the new autopilot function `SLCWithFeedForwardAutopilot.m`, which can be implemented with (`CONTROL_FLAG = FEED`). This autopilot takes as input both

commanded course rate $\dot{\chi}_c$ and commanded course angle χ_c to determine the desired course rate $\dot{\chi}_{des} = k_{\dot{\chi}}\dot{\chi}_c + k_{p_\chi}(\chi_c - \chi)$. The first gain (`Kff_course_rate`) will usually be set to one while the second gain (`Kp_course_rate`) can be set to zero if the guidance loop (e.g. Problem 1) does not provide a commanded course angle. Demonstrate that the new autopilot works by commanding the aircraft to achieve $h_c = 1805$ m, $V_{a,c} = 18$ m/s, and $\dot{\chi}_c = 18/600$ rad/sec. Initialize the aircraft with the trim state with the exception of the initial height of 1655 m, e.g. on the ground here at Boulder. Students will need to adjust the gains in order to make this work.

Problem 3

Repeat Problem 1 using the new autopilot (`CONTROL_FLAG = FEED`). Plot the results on the same figures as the results from Problem 1 (see the comment at the top of the RunHW7 script). Describe the differences in the results and provide explanations for these differences.