ASSIGNMENT #8

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Due Date: 04/08

1. Academic Integrity

You must write your own report, but this is a group assignment. You may share code and work with group members. I expect everyone to teach each other and share their own Matlab code, their own Simulink models, and their own writing.

If you are struggling with this assignment, please reach out to me or the T.A., Max (mtbbarnett@gmail.com). Post any and all questions on canvas, and I will answer them as soon as possible.

You may use any Matlab routines and techniques as long as you **cite your source**.

Please maintain your hard work, your integrity, and your gumption. I am so proud of y'all. You are rock stars.

2. Data Collection

Max Barnett and I collected data for you.

(1) We injected a symmetric bang-bang command, one virtual input at a time (throttle, aileron, rudder, elevator).
(2) With the UAV in a hover, we injected a chirp command, one motor at a time (n_1, n_2, n_3, n_4).
(3) For the assignment, it may be helpful to filter and post process data used for identification. Use your engineering judgement when filtering your data. There is a trade-off (just like with stability) that incorporating filtering decreases the resolution of the estimated information; it may, however, mitigate artifacts from noise. Some of the data we provided comes from our Kalman filter.

3. Assignment

(1) Construct 4 parametric representations of your UAV's linear, SIMO dynamics using the bang-bang command data.

Start from the assumption that the parameters in the aircraft model are as follows:

$$\frac{\mathrm{d}}{\mathrm{d}t}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & b \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ c \end{bmatrix} u \tag{3.1}$$

Let x_1, x_2, and u correspond to the following triples:

- Z_{ned}, vertical speed, throttle;
- pitch angle, pitch rate, elevator;
- roll angle, roll rate, aileron;
- yaw angle, yaw rate, rudder.

You will identify b, c in these models of the UAV using parametric identification. We use the assumptions from lecture to represent these dynamics discretely (ZOH, uniform I/O sampling) to digitally transform (3.1)

$$x_{i+1} = \bar{A}x_i + \bar{B}u_i,$$
$$\bar{A} = e^{A\Delta t}, \quad \bar{B} = \int_0^{\Delta t} e^{A(\Delta t - \sigma)} B \mathrm{d}\sigma$$

where $\bar{A}, \bar{B}$ were derived under the assumptions in lecture (ZOH, uniform I/O sampling).

(2) Use non-parameteric identification to identify a transfer function that represents the parrot's actuator, $H_i(s)$

$$\frac{n_{a,i}}{n_{c,i}} = H_i(s)$$

where $n_{a,i}$ is the achieved angular velocity of the ith motor and $n_{c,i}$ is the commanded angular velocity out of the control system. Utilize the chirp data set for this task. You will need to utilize your parametric estimate.

4. What to turn in

Please submit a report that includes all numbered items from the assignment section that explains how you derived your models.

(1) All Simulink models, codes, pertaining to this work
(2) Present the identified dynamics for the linear systems in the continuous domain
(3) Present the transfer functions identified for each motor
(4) Provide graphs that compare your work
(5) The report should cite and refer to sources (tools, methods, tutorials, etc...) used in your code

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