Aerospace Control Systems
Exam project AA 22/23

Model description

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Robust design of attitude and position control system for a multirotor UAV

- The ANT-X quadrotor is a small quadrotor drone designed for research and education.
- Grey-box models of ANT-X have been identified from flight test data and are available for control law design.
- The project task is to design and verify a robust single-axis attitude and position control system for the ANT-X.

- This presentation provides the mathematical model for the dynamics of a single axis of the drone.
- Numerical values for the parameters of the model are included, as well as the corresponding uncertainties.
- For the detailed presentaiton of the project tasks see the recording of the presentation

Linear model for lateral dynamics

The lateral dynamics are given by:

$$\dot{x} = Ax + Bu$$
$$y = Cx + Du$$

where

$$u = \delta_{lat}, \qquad y = \begin{bmatrix} p \\ \varphi \\ a_y \end{bmatrix}$$
$$x = \begin{bmatrix} v \\ p \\ \varphi \end{bmatrix}$$

and

$$A = \begin{bmatrix} Y_v & Y_p & g \\ L_v & L_p & 0 \\ 0 & 1 & 0 \end{bmatrix}, B = \begin{bmatrix} Y_\delta \\ L_\delta \\ 0 \end{bmatrix}, C = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ Y_v & Y_p & 0 \end{bmatrix}, D = \begin{bmatrix} 0 \\ 0 \\ Y_\delta \end{bmatrix}$$

Lateral dynamics: parameters and uncertainties

The numerical values of the parameters are given by ($g = 9.81$)

Stability derivatives

$Y_v \ = -0.1068 \ \ 1/s$ (4.26%)

$Y_p \ = \ 0.1192 \ \ m/\ s\, rad$ (2.03%)

$L_v \ = -5.9755 \ \ rad\ s/m$ (1.83%)

$L_p \ = -2.6478 \ \ 1/s$ (2.01%)

Control derivatives

$Y_d \ = -10.1647 \ \ m/s^2$ (1.37%)

$L_d \ = 450.7085 \ \ rad/s^2$ (0.81%)

where uncertainty is given in terms of standard deviations (provided as percentage of corresponding nominal values) assuming a Gaussian density for each parameter.