DEPARTMENT OF AUTOMOTIVE AND AERONAUTICAL ENGINEERING

Nonlinear Aircraft Dynamics and PIO

Project

Background

Textbooks and lectures on aircraft dynamics investigate an aircraft primarily with a set of linear equations. Especially the approach to describe aircraft dynamics in state space form is particularly efficient. But not all effects of aircraft behavior can be studied with the simplified linear description. The equations themselves are nonlinear and so is the aerodynamic behavior of the aircraft. The flight control system is nonlinear: a) with respect to signal transmission from cockpit to control surface and b) considering the control surface actuation. Furthermore, deflection maximum travel and deflection rates are limited. The nonlinear phenomena can lead to dangerous characteristics like pilot in the loop oscillation (PIO) also known as aircraft pilot coupling (APC).

Task

Start from linear aircraft dynamics and work your way through the topics as outlined above. Consider these key words on the way: definition of nonlinear dynamics, linear and nonlinear longitudinal and lateral dynamics, flying qualities, MIL-Spec and MIL-Standard, nonlinear set of equations, actuator dynamics, describing function, closed loop control, pilot model, pilot in the loop control, PIO basics, longitudinal PIO, lateral PIO, PIO prediction.

Always show example calculations related to the topics with MATLAB/Simulink. Use stability and control derivatives as internationally available e.g. in textbooks.

All relevant sources of information should be considered ranging from text books, internet resources, papers, dissertations, ...

The report has to be written in English based on German or international standards on report writing.