Chair of Automatic Control

FAU

Announcement for Master Thesis

Data-driven aerodynamics modeling for model predictive flight control

Motivation

Source: Berend Verheijen, https://unsplash.com/de/fotos/JJwK379DdJw

Aerodynamics play an important role in modeling the dynamics of an aircraft and are represented by aerodynamic coefficients. Those coefficients are typically computed from look-up tables depending on the current flight state such as altitude, Mach number and angles of the control surfaces. Since we are interested in the model predictive control (MPC) of a fighter aircraft using the toolbox GRAMPC[1], the gradients of the dynamics, moreover the gradients of the aerodynamic coefficients are required. Instead of using finite differences to approximate these gradients, in this thesis an aerodynamics model should be trained from the look-up tables, such that the gradients can directly be computed from this model.

Task description

After familiarizing with flight dynamics, a simple model for the longitudinal dynamics of the ADMIRE[2] model as well as an MPC is implemented and tested using finite differences for the coefficients. It follows by the main part of this thesis, the modeling of the aerodynamics. Therefore, first different existing approaches (e.g. polynomial/spline fitting and neural networks) should be researched and evaluated on feasibility and usefulness for our application. Based on that, promising approaches are implemented, tested and compared to the finite difference-approach, ideally leading to an adapted or newly developed modeling approach for aerodynamics.

Requirements

Programming skills in MATLAB, MATLAB Simulink, and basic knowledge in C.
Knowledge in data-driven modeling, i.e. machine learning, curve fitting, polynomial regression
Basic knowledge in flight dynamics and experience with GRAMPC are of advantage.
Note that the thesis can be written in either English or German.

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References

[1] Englert, T., Völz, A., Mesmer, F., Rhein, S., & Graichen, K. (2019). A software framework for embedded nonlinear model predictive control using a gradient-based augmented Lagrangian approach (GRAMPC). Optimization and Engineering, 20(3), 769-809.

[2] Forssell, L. & Nilsson, U. (2005). ADMIRE The Aero-Data Model In a Research Environment Version 4.0, Model Description. User report, FOI – Swedish Defence Research Agency Systems Technology.