Chair of Autonomous Aerial Systems
Department of Aerospace and Geodesy
TUM School of Engineering and Design
Technische Universität München

Master's Thesis

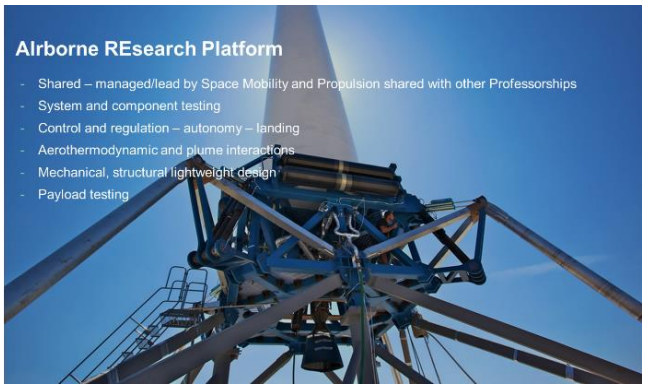
Task description for the Master's Thesis on the topic of

Optimal Flight Control for the Airborne Research Platform

Background

Testing rockets including the propulsion systems as well as flight control in flight is fundamental. Airborne flight testbeds allow this to be done. The chair of Space Propulsion is building up competence in the field of throttling and engine control, while the chair of Autonomous Aerial Systems is building up competence in the field of flight control, the chairs have set themselves the goal to develop a rocket for low atmospheric flights, also referred to as **AI**rborne **RE**search **P**latform (AIREP). It will be a unique feature of TUM as a university across Europe and worldwide giving university students and research unique opportunities. Building this rocket is complex and the design process is associated with several uncertainties. Therefore, an iterative approach is sought, which will significantly contribute to the rapid development of the rocket. The main features of the iterations are as follows:

Iteration 1	Hot gas propelled Pressure Fed Engine 1 Degree of Freedom (Altitude)
Iteration 2	Hot gas propelled Pressure Fed Engine 6 Degrees of Freedom
Iteration 3	Hot gas propelled E-Pump Fed Engine 6 Degrees of Freedom



Your task

While iteration 1 of the rocket will be guided along a traverse, iteration 2 will be free flying, meaning all 6DOFs need to be controlled to conduct a successful flight. To account for this, the underlying controller / planner needs to compute *safe trajectories*, without compromising the system's dynamics and other constraints, such as hardware limits or spatial bounds. Besides that, the computation of the control commands should be based on a *performance criterion*, e.g., navigation time or energy efficiency. In light of its capacity to compute optimal commands according to a cost function while incorporating constraints, *optimal-control* is a well-suited framework for this use-case. To summarize, the work-packages of this thesis break down into

- Literature study on specific types of optimal-control methods for the Airborne Research Platform
- Choice and theoretical derivation of an optimal-control method, providing theoretical guarantees for safety and low computation times (real-time applicability).
- Design of a simulation platform for testing and developing the (1) flight-controller and (2) its compatibility with the rest of the platform, such as the engine controller.

Your skills

Besides passion for space exploration and abstract thinking, candidates are expected to

- have a strong mathematical background with special interest in control and numerical optimization.
- be fluent in Mathworks (Matlab and Simulink) and programming on Python or C / C++.

Our offer

The chairs of Space Propulsion and Autonomous Aerial Systems are located at the newly founded TUM Campus in Ottobrunn (south of Munich) – next to many industrial partners. The campus is dynamically growing, interdisciplinary and offers the opportunity to shape the future of aerospace. We are offering:

- the chance to work side by side with a larger team of motivated students, focusing on the same project with similar topics
- a vibrant and passionate research environment with PhD students and two professors, willing to push the limits of space exploration
- the option to publish in top-tier conferences / journals
- delicious coffee

Contact

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