Chair of Space Mobility and Propulsion
Department of Aerospace and Geodesy
TUM School of Engineering and Design
Technische Universität München

Master's Thesis

Task description for Master's Thesis of

Name Surname

Modelling and Control of a Liquid Rocket Propulsion System using Machine Learning Algorithms.

Modellierung und Regelung eines Flüssigkeitsraketenantriebssystems mithilfe von Machine Learning Algorithmen

Topic

The space sector is currently gaining more and more interest due to the commercialization of Space (OneWeb, SpaceX Starlink) and upcoming human missions such as the return to the lunar surface and the goal to land humans on mars. The remoteness of these missions and their high complexity demand high autonomy in the spacecrafts control systems.

Spacecrafts, especially the propulsion systems, are complex machines made up of several subsystems. Accurate engine control is essential for mission success, especially for landing manoeuvres. The current traditional industry standard uses a hierarchy of conventional control algorithms, mainly due to their predictable behaviour and the ability to prove stability.

Recently, advanced machine learning and control algorithms such as reinforcement learning (RL) have shown promising results for autonomous control of complex dynamical systems, with real live implementations such as autonomous driving or plasma control in fusion reactors. At the same time these approaches show challenges in areas such as the enforcement of boundary conditions and guarantees for predictable behaviour.

The goal of this thesis is to implement an engine model to train a reinforcement learning algorithm for engine control in complex flight scenarios This ties into the ASCENT research project at the chair of space mobility and propulsion where a vertical takeoff and landing rocket hopper is being developed to function as a research platform for advanced control algorithms. The implementation of the engine model and the RL controller provides a foundation with which future investigation such failure tolerant and adaptive control will be enabled.

Tasks

1. Subdivision into work packages with sub-tasks and creation of a time plan
2. Literature research RL and enforcement of boundary conditions
3. Implementation of an engine model
4. Implementation RL agent
5. Implementation of different techniques to enforce boundary conditions
6. Analysis and comparison of the different implemented algorithms
7. Documentation and presentation of results

Supervisor: Jan Kayser, M.Sc.
Registration: XX.XX.2025
Submission deadline: XX.XX.2025

Prof. Dr.-Ing. Chiara Manfletti

München, XX.XX.2025