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

Bachelor Thesis

Task description for Bachelor's Thesis of

- Name Surname -

Systematic Analysis on Fault-Tolerant or Adaptive Control Algorithms for Rocket Propulsion Systems

Systematische Analyse von Fehlertoleranten und Adaptiven Regelungalgorithmen für Raketenantriebe

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. The remoteness and complexity of these missions demand a high degree of autonomy in spacecraft control systems.

Spacecraft, and particularly their propulsion systems, are complex machines composed of multiple interacting subsystems. Accurate control of these systems is essential for mission success, especially during critical flight phases such as landing or ascent. The current industrial standard relies on hierarchical control architectures using conventional control algorithms, mainly due to their predictable behavior and the ability to guarantee system stability.
To address the limitations of these conventional architectures and ensure high reliability during anomalous events, the development of fault-tolerant systems is critical.

The goal of this thesis is to conduct a structured literature research on adaptive control methods to improve upon conventional approaches and provide insight into handling occurring system failures. The project will begin with a comprehensive research phase focused on identifying occurring faults within rocket propulsion systems and classifying their relevance for fault-tolerant architectures. Based on this classification, a specific set of relevant faults will be selected. The core of the thesis will then involve a structured literature review exploring adaptive control methods capable of mitigating this chosen set of faults. To ensure a rigorous, transparent, and reproducible methodology, the review process must adhere to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach.

Tasks

1. Subdivision into work packages with sub-tasks and creation of a time plan.
2. Literature research on propulsion system failure modes and classification of their relevance for fault-tolerant systems.
3. Definition of requirements for the chosen set of critical faults to be addressed by adaptive control.
4. Execution of a structured literature review on adaptive control methods according to the PRISMA methodology.
5. Analysis of the performance and applicability of the identified adaptive control methods based on the literature.
6. Documentation and presentation of results.

Supervisor: Jan Kayser, M.Sc.
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Prof. Dr.-Ing. Chiara Manfletti

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