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 -

Fault Detection and Identification for a Re-Entry capsule Propulsion System Using Machine Learning Algorithms

Fehlererkennung und -identifizierung für ein Wiedereintritts Kapsel Antriebssystem 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. Spacecraft, especially the propulsion systems, are complex machines made up of several systems. Accurate knowledge about the propulsion systems state and fast and reliable action in case of faults are essential for smooth operation, to prevent drastic system failure and maintain safety. One of the main components of this is the detection and identification of the occurring faults (fault detection and identification – FDI). The importance of a reliable and well-tuned FDI system was shown in the recent faults and report on the Boeing Starliner capsule.

Currently fault detection commonly is done by dynamic redlines, which act as an operational envelope that, when exceeded, signals a fault. Advanced data processing methods such as machine learning algorithms promise improved performance in fault detection and identification of failure modes. This can increase the reliability of engine testing and operation while providing additional information for data analysis and health monitoring.

The goal of this thesis is to implement machine learning algorithms for FDI to improve upon the performance of the conventional approach of redlines and provide insight into the type of fault occurring. The investigations are carried out in the context of a propulsion system for a re-entry capsule with multiple thrusters.

Tasks

1. Subdivision into work packages with sub-tasks and creation of a time plan
2. literature research on propulsion system faults and state of the art in FDI
3. Definition of requirements (e.g. fault scenarios, performance metrics, data constraints)
4. Development of a system model in EcosimPro
5. Integration and simulation of propulsion system faults based on defined requirements
6. Implementation of a machine learning FDI approach
7. Evaluation of the implemented FDI performance and comparison against redline methods
8. Documentation and presentation of results

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