Chair of Space Mobility and Propulsion (Prof. Manfletti)
TUM School of Engineering and Design
Technische Universität München

Semester Thesis / IDP

Implementation of a systems level Simulation Environment for a Rocket Hopper

Topic:

The space sector is currently gaining increasing 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 and complexity of these missions demand high autonomy in the spacecraft control systems.

Spacecraft, 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 industry standard uses a hierarchy of conventional control algorithms, mainly due to their predictable behaviour and the ability to prove stability.

For landing manoeuvres, optimal control algorithms have shown promising results by making use of knowledge of system dynamics and by being able to enforce boundary conditions. These algorithms are being actively investigated in the ASCENT project at the chair of Apace Mobility and Propulsion. There, a vertical-take-off-vertical-landing (VTVL) rocket hopper is being developed as a research platform. The hopper uses a pressure fed engine cycle with liquid oxygen as oxidizer and ethanol as fuel. The chairs research focuses on "engine level" control and fault detection and identification. The goal of this thesis is to assess *system-level* impact of *engine level* behaviour by extending the existing toolbox and implementing a physics-based simulation environment of the complete rocket hopper system. To date, the chairs investigations have used EcosimPro and Python for engine simulations, and Python/-CasADi for the development of control algorithms.

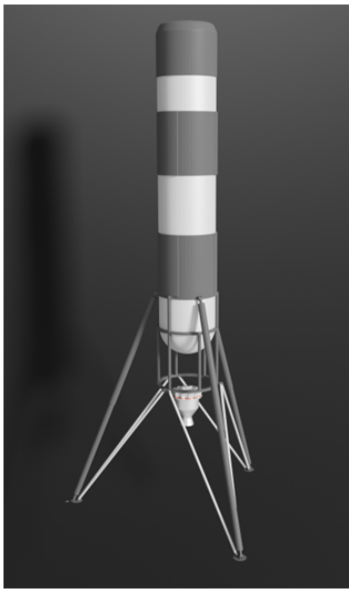

Figure 1: Rocket Hopper

Tasks:

- Subdivision into work packages with sub-tasks and creation of a time plan
- Formulation of Requirements
- Comparison, evaluation, and selection of simulation environments
- Implement a representative physics based simulation environment
- Develop a rocket hopper model including

  - Representative dynamic behaviour
  - Virtual instrumentation
  - Interchangeable engine dynamics/models
- Simulation of representative hopper flight scenarios
- Evaluation of the impact of engine level faults on system level behaviour
- Documentation and presentation of results

Your Profile:

- Background in Informatics, Aerospace Engineering, Mechanical Engineering or a related field
- Interest in simulation methods and aerospace applications
- Experience of Python programming
- Experience with object-oriented coding

Contact

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