Student Research Project / Master Thesis

Flush Air Data System for Reusable Nanolaunchers

Currently, GAIA Aerospace is investigating the reusability of nanolauncher first stages. For both the ascent and the controlled re-entry of the first stage, an appropriate air data sensor system is required to detect the existing flow conditions at the vehicle. Over the years, clusters of pressure sensors, so-called Flush Air Data Systems (FADS), have proven to be a viable solution for hypersonic missiles and re-entry experiments. However, for these vehicles, re-entry is usually performed without retropropulsion, thus requiring only a single FADS at the nose of the system. In addition, a rocket hardly offers suitable positions for a FADS due to its cylindrical shape at the tail.

One possibility, however, is to accommodate a FADS in swept fins at the rear of the launcher. In this case, however, the shock fronts that form in the course of a re-entry must be taken into account in particular during data acquisition. Furthermore, the system also has to withstand the redirected exhaust jet of the engines during a re-entry burn. Therefore, within the scope of this work, a double-sided FADS is to be designed which meets the special requirements of a reusable nanolauncher.

The work is divided into the following steps:

1. Literature research on the aerodynamics of rockets and control surfaces up to Mach 10, pressure sensors, flush air data systems and CFD analyses.
2. Identification and definition of requirements for the Flush Air Data System
3. Definition of ascent and re-entry scenarios
4. Design of a FADS using COTS components in the form of a CAD model and a mathematical model for pressure data processing
5. Acquisition of FADS pressure data in the defined scenarios using CFD
6. Implementation, testing and optimization of the mathematical FADS model in a predefined flight simulation in a Matlab/Simulink environment
7. Critical analysis of the final system and presentation of further potential for optimization

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Execution only after consultation of supervising university institute