Student Research Project / Master Thesis

Impact of Finards on the Control Effectiveness of Grid Fins

Grid Fins are a proven means of controlling the re-entry of reusable first stages. Due to their short chord length, grid fins have several advantages over planar fins. On the one hand, they can be used to achieve much higher angles of attack even at high Mach numbers before stall occurs. On the other hand, their pressure point is very close to the axis of rotation across all Mach numbers, which means that the actuator system requires significantly less power and can be dimensioned accordingly smaller and lighter.

Current launcher developments usually feature additional strakes or finards for better aerodynamic control. Finards (combination of fin and canard) serve to stabilize the launcher during ascent and to increase glide properties and range for safe recovery during reentry. However, there are drawbacks to the configuration. The grid fins are located in the wake of the finards, depending on the inflow condition. This can cause the control characteristics to vary greatly during re-entry and possibly lead to loss of control. For this reason, the effect of finards on the control characteristics of grid fins during re-entry of reusable first stages will be investigated in more detail in this thesis.

The thesis is divided into the following work steps:

1. Literature research on reusable launchers, grid fins, planar aerodynamic control surfaces, flight simulations and CFD.
2. Definition of a re-entry scenario with corresponding inflow conditions and a reference launch vehicle with corresponding grid fin deflections
3. CAD modelling of the reference launch vehicle with corresponding grid fin deflections.
4. Acquisition of the aerodynamic control characteristics by means of CFD
5. Implementation and testing of the aerodynamic control characteristics in a predefined flight simulation environment in Matlab/Simulink
6. Critical analysis of the control characteristics and presentation of further potential for optimization

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Execution only after consultation of supervising university institute