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RITD - Adapting Mars Entry, Descent and Landing System for Earth

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Abstract

A new generation of inflatable Entry, Descent and Landing System (EDLS) for Mars has been developed. It is used in both the initial atmospheric entry and atmospheric descent before the semi-hard impact of the penetrator into Martian surface. The EDLS applicability to Earth's atmosphere is studied by the EU/RITD [1] project. Project focuses to the analysis and tests of the transonic behaviour of this compact and light weight payload entry system at the Earth re-entry.

1. EDLS for Earth

The dynamical stability of the craft is analysed, concentrating on the most critical part of the atmospheric re-entry, the transonic phase. In Martian atmosphere the MetNet vehicle stability during the transonic phase is understood. However, in the more dense Earth's atmosphere, the transonic phase is shorter and turbulence more violent. Therefore, the EDLS has to be sufficiently dynamically stable to overcome the forces tending to deflect the craft from its nominal trajectory and attitude.

The preliminary design of the inflatable EDLS for Earth will be commenced once the scaling of the re-entry system and the dynamical stability analysis have been performed. The RITD-project concentrates on mission and applications achievable with the current MetNet-type (i.e. "Mini-1" category) of lander, and on requirements posed by other type Earth re-entry concepts.

2. Entry Angle Determination for Mini-1 – lander

For successful Earth landing, the suitable re-entry angle and velocity with specific descent vehicle (DV) mass and heat flux parameters need to be determined. These key parameters in determining the Earth re-entry for DV are:

q_{max} (kW/m^2): maximal specific heat flux,

Q (MJ/m^2): specific integral heat flux to DV front shield,

m (kg): descent vehicle (DV) mass,

V (m/s): re-entry velocity and

Θ (deg.): flight-path angle at Earth re-entry

For Earth re-entry, the calculation results in the optimal value of entry velocity for MetNet ("Mini-1" category) -type lander, with mass of 22kg, being V_{SOL} = 5268 m/s. Using the basic pre-defined parameters for MetNet-type of lander in Earth atmosphere, we get the optimal angle of Θ = -3.06 degrees for Earth re-entry.

3. Payload Mass for Earth Entry DV

One of the key elements in Earth entry lander is the amount of available payload mass. The payload mass depends on, e.g., the lander size, landing type (soil or water), heat shield durability and additional landing gear.

The payload mass will have an impact to the center of gravity of the lander. The payload with a "low" CoG (compared the the lander structure) has a larger tolerance than the payload with "high" CoG. In cases where payload CoG causes instability, the extra balance mass can be used to adjust CoG. This balance mass will reduce the available payload mass. A major limitation for payload mass is the heat shielding.

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References

[1] http://ritd.fmi.fi