

REAL-TIME IMPACT CONTROL OF A SOLID ROCKET MOTOR STAGE DURING LAUNCHER ASCENT

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Abstract:

Unlike a liquid propellant stage which allows stopping the thrust at any time during the flight, when a solid rocket motor is used on a Launcher upper stage, the impact zone can be very large due to the atmospheric and propulsive dispersions on the current stage and the previous stages. In this case a stage impact control is required.

In this study, an active impact control strategy is presented. The strategy is based on a real-time estimation of the propulsive dispersion using a non-linear filtering method. This allows the estimation of both the flow-rate and the specific impulse scatterings.

Under certain assumptions (propulsive invariance properties), it is shown that the flow rate and the specific impulse scatterings are observable and separable and can be identified thanks to a robust least squares process.

The robustness aspects of the method are studied and an algorithm allowing a robust convergence of the estimation filter is developed. Finally, this algorithm is simplified and optimized to cope with on-board real time applications.

The active impact control is also presented. The impact point is limited to an authorized fall-down zone. The active impact control is included in a more general launcher guidance algorithm. The method is based on a prediction-correction approach (closed loop control type). After the estimation of the propulsive scattering in real time, the launcher trajectory and the stage impact can be predicted analytically. Thus the re-entry conditions and the stage impact can be controlled by some modification of the guidance parameters allowing a rapid change on the launcher trajectory without any excessive reduction of the launcher performance.

Finally the impact control accuracy and the launcher performance losses are evaluated.