

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Upper Stages, Space Transfer, Entry and Landing Systems (3)

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LANDING WITH SOLID PROPELLANT RETRO ROCKETS

Abstract

Among the possibilities used for final descent braking of a reentry vehicle, the use of solid propellant retro rockets has rarely been addressed. However, the CSTS reentry module jointly studied by Russia and Europe has renewed the interest in such alternative to usual final descent system such as parachutes with retrorockets or airbags. The first part will describe the principles of the guidance and control of such system based on one axis gimbaled retro rockets. Deviating from the axis in the same direction pairs of engines on a same diameter enables controlling pitch and yaw while deviating each one of the same pair in opposite direction allows controlling of the braking acceleration. The guidance algorithm is based on a neural network approach. A first application on a CSTS vehicle will be presented. It includes the sizing of the retro rockets and gimbaled engines and the results of 6 DoF Monte-Carlo simulations proving the efficiency of the system for an Earth reentry vehicle. A second application for Mars reentry will also be presented. The main difference is the initial velocity almost 300 m/s instead of 80 m/s. It will be compared to a more classical final descent system based on parachutes. The interest of the concept will be discussed in terms of performances, mass budget and reliability. A decisive advantage on Mars reentry is to eliminate the ballistic coefficient limitation due to the current technology of parachute, requiring decelerating before the opening of the parachutes to a velocity less than Mach 2 at 10 km altitude and, therefore, it greatly increases the mass of the landers than can be sent to Mars.