SPACE EXPLORATION SYMPOSIUM (A3)
Space Exploration Overview (1)

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PROVING AEROBRAKING WITH MARS EXPRESS AND VENUS EXPRESS

Abstract

In missions to Mars, Venus or Titan, aerobraking has proven to be an efficient solution to increase the payload into final orbit and maximize the potential science return of the mission. However, successful NASA's mission such us Magellan, Mars Global Survey (MGS), Mars Odyssey or Mars Reconnaissance Orbiter (MRO) have evidenced some drawbacks of using aerobraking, namely inherent risk and higher operational costs. The risk of aerobraking is mainly due to the complexity of the operational procedures augmented by the large variability of the atmosphere. This uncertainty demands round-the-clock operations (orbit determination, pass planning and risk mitigation) during the duration of the aerobraking, which takes typically several months, increasing the overall cost of the mission. To overcome this cost increase, higher on-board autonomy is required in the design of an aerobraking system. Aerobraking can be an enabling technology for future missions or a way to increase the scientific return, but it can also increase the return of already flying missions. In the case of Magellan, once the primary scientific mission objectives had been fulfilled, the spacecraft was commanded into an aerobraking phase that reduced the apoapsis altitude of its orbit from 8500 km to 540 km. This change in orbit made it possible to improve the resolution of the gravity data at high latitudes and therefore improve the gravity models of Venus and the scientific return of an already successful mission. Europe is currently planning several missions to Mars, such as ExoMars, MarsGen or MSR that could clearly benefit from the use of aerobraking (already baselined for some of them). Furthermore, ESA has two missions flying around Mars and Venus, Mars Express and Venus Express respectively. To this date Europe has not any practical experience in aerobraking and this two existing missions could serve as first step in the roadmap to be followed to acquire the aerobraking capability in Europe for next Mars missions. This paper presents an approach to test aerobraking strategies through the existing ESA Missions Mars Express and Venus Express. Focus will be put in the definition of the target orbits so that the scientific return is increased while relevant engineering experience is acquired. Key elements are the trajectory optimization to this final orbit and the GNC/AOCS and FDIR scenario and their impact on the overall system. The problematic of shared responsibilities between ground and space segment (level of autonomy) is also assessed.