Paper ID: 76643
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IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems (4)

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A FULL MAGNETIC SAFE MODE FOR SPACE RIDER MISSION

Abstract

SAFE mode navigation and control algorithms design and performance assessment are presented for the Space Rider System (SRS). SRS is the first fully reusable European space transportation system, able to be launched by the ESA VEGA-C launcher. The system complexity, the timeline and the various applications of SRS lead to a considerable number of degraded conditions, which could trigger SAFE mode activation. The SAFE mode provides minimum spacecraft capabilities to extend as long as possible survival period and allow the ground to recover the mission is the most reliable way. The goal of the GNC in SAFE mode is to reach and maintain a desired nadir-pointing configuration, which is chosen based on power-budgeting requirements and is gravity-gradient unstable, using minimum equipment. The Attitude Determination and Control (ADC) capabilities are provided by magnetic-only system design, based on a set of three orthogonal magnetorquers (MTQ) and a three-axial magnetometer (TAM). The well-known limits of magnetic only system, such as underactuation, uderdetermination, limited control authority and long time constants are studied in a framework large-size satellite. The observability and controllability of magnetic systems is guaranteed thanks to the (almost-periodic) time-variation of the field across the orbit. The target quasi-equatorial orbit put further constraints, as the direction variation of the magnetic field is limited, but it proofs to be sufficient to guarantee observability and controllability at the cost of large convergence times. The system requirements lead to a switching control logic architecture based on several algorithms which. The paper present and analyse the Space Rider attitude dynamics under the action of the closed-loop control when the spacecraft is in SAFE mode, relative GNC design and tuning. Stability, robustness and performances results are provided.