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AUTONOMOUS AEROBRAKING IN VENUS: CORRIDOR CONTROL STRATEGIES FOR ENVISION

Abstract

After the successful Venus Express mission, the European Space Agency ventured a Venus orbiter mission as one of the candidates for the Cosmic Vision Programme's M5 slot: EnVision. Expected to launch in 2032, EnVision aims to characterize Venus at an unprecedented scale of resolution. Relationship between the nature of Venus' geological activity and the atmosphere as well as its range of surface features, evidence of the past existence of oceans or whether Venus was once hospitable for life, are some of the main key science goals, in an attempt to understand why the most Earth-like planet and our closest neighbour in the Solar System took such different evolutionary path.

After a launch with Ariane 62, Envision will get to Venus after a 5 month interplanetary cruise. The insertion orbit around the planet will be a very eccentric orbit and a series of manoeuvres are required to get to the final one, with a shorter orbital period. The solution considered is the Aero-BraKing that, even if it is a more complicated and operationally demanding alternative than a fully chemical strategy, allows for large propellant budget savings by a sequence of free atmospheric passes. As the spacecraft passes through the outer layers of the atmosphere, the orbital energy is reduced by the aerodynamic forces acting on, mainly, the solar array.

Nevertheless, the effort of the ground segment for planning, commanding and monitoring operations remains high. To address this, performing on-board corridor control activities is proposed in order to extend the autonomy horizon of the S/C and decrease the operational workload. The present activity is intended to provide an assessment of autonomous corridor control techniques, highlighting the operational risks and benefits as well as the design implications at system, Guidance Navigation and Control (GNC) and Failure Detection Isolation and Recovery (FDIR) level.

As Airbus Defence Space UK subcontractor, DEIMOS Space has worked in the definition of a robust mission approach enabling autonomies up to one week, by means of an onboard Pericentre Time Estimator, an atmosphere estimation function and a precise timeline for onboard and ground activities. Innovative orbit control approaches, an autonomous GNC mode management for attitude control and several combinations of predictive/reactive approaches were proposed and tested at simulation level to meet the robustness and autonomy requirements. This paper will describe these new strategies in detail together with the results of the tests performed for their validation.