SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 2 (3B)

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HIGH INTEGRITY CONTROL SYSTEM FOR GENERIC AUTONOMOUS RVD

Abstract

In the last years, the number of studies having as objective rendezvous and docking/capture missions around Mars or other planets/asteroids has significantly increased. These kinds of missions in fact have undeniably become one of the most important targets for many space agencies around the world, as a success would mean having the possibility to analyse, on Earth, uncontaminated samples coming from other celestial bodies of our solar system. As a consequence, it is surely worth dedicating effort to consolidate maturity of GNC technologies for such missions, in order to have on-board systems with a higher and higher level of autonomy, robustness and safety, with the final objective of decreasing costs and increasing the probability of mission success. Following this tendency, a team led by GMV and including, among others, TAS, has developed HARVD (High Integrity Autonomous Rendezvous Docking Control System), an ESA-funded activity implementing a GNC/Autonomous Mission Management/FDIR on-board software for rendezvous and docking/capture scenarios around Mars, Earth or potentially other planets. HARVD, based on RF, camera and LIDAR measurements, includes design, prototyping and verification at three different levels: algorithms design and verification in a High-Fidelity Functional Engineering Simulator, SW demonstrator to be verified in Real Time Avionics Test Benching and Dynamic Test Benching. Elliptic RdV has been specially addressed, demonstrating the technical feasibility and the potential propellant saving. Recently, the development and integration of the High-Fidelity Functional Engineering Simulator have been successfully completed, and an intensive test campaign has been carried out. Interesting results for different Mars Sample Return scenarios have been obtained, demonstrating how the strict mission requirements on performances, autonomy, safety and robustness have been fulfilled with high margins. A special attention has been dedicated to contingency scenarios (including different on-board system failures and collision risks detection and avoidance), for which the results obtained are very encouraging for the consolidation of higher Technology Readiness Levels. Mars Ascent Vehicle circularization failures have been also taken into account, resulting in a number of elliptic target orbit rendezvous scenarios for which HARVD has demonstrated to be fully ready. The development of RT test bench and the tailoring of the GMV DYN Test Bench have already started, and are foreseen to be completed in about one year. This paper introduces the HARVD main features, deeply analyses the results obtained during the High-Fidelity Functional Engineering Simulator test campaign and presents the status and preliminary results of RT and DYN Test Benches.