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USE OF IN-FLIGHT DATA TO VALIDATE MARS SAMPLE RETURN AUTONOMOUS RVD GNC

Abstract

During the last years, the number of studies having as objective rendezvous and docking/capture missions around Mars or other planets/asteroids has significantly increased. Following this tendency, a team led by GMV has developed HARVD (High Integrity Autonomous Rendezvous Docking Control System), an ESA-funded activity implementing a high integrity autonomous multi-range rendezvous and capture control system demonstrator for future exploration missions around Mars, Earth or potentially other planets, with a wide set of scenarios and particularizing on the MSR (Mars Sample Return) mission. HARVD is based on RF, camera and LIDAR measurements. It includes design, prototyping and verification at three different levels: algorithms design and verification in a Functional Engineering Simulator, SW demonstrator verified in Real Time Avionics Test Benching and Dynamic Test Benching. Moreover, the technology readiness of the SW demonstrator will enable to envisage as a next step the in-flight demonstration of an autonomous docking and capture GNC system. In this respect, PRISMA mission was identified as a suitable platform for validation of the HARVD-GNC system, and the development, calibration and testing of a vision based optical stimulator (ViSOS by DTU) to enhance the on-ground validation capabilities. After checking different alternatives for the proposed HARVD-GNC experiment with PRISMA resources, an efficient but cost-effective approach was chosen. The approach is based on designing MSR-like dedicated manoeuvres sequencing using the already existing on-board PRISMA GNC/AOCS system (based on relative GPS measurement for the closed-loop execution of the manoeuvres sequencing and acquiring RF and camera images as part of the HARVD-GNC experiment data). This option allows to download the sensor measurements and telemetry data from PRISMA to validate off-line essential functions of the HARVD-GNC, as well as calibrating and testing ViSOS system with real flight images. While the HARVD control system validation is limited by the nature of the off-line approach, it shall be highlighted that in this approach the on-board SW does not require modification. Such modifications are costly and complex. Therefore the results of the HARVD system validation can be maximized with respect to the involved effort. This paper presents the experiment definition and development of the HARVD-PRISMA experiment and the use of the in-flight data as an economic way to achieve the testing and validation up to TRL6 of essential functions of the HARVD-GNC in the off-line approach. The approach itself is suitable to be applied to other systems and using other experiment hosting platforms.