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THE RENDEZVOUS GNC SUBSYSTEM FOR MARS SAMPLE RETURN MISSION

Abstract

The Mars Sample Return (MSR) mission, jointly run by the ESA and NASA, aims at making further headway in the exploration of Mars, bringing Martian soil samples back to Earth. Running from 2020 to 2030, the international mission will foresee three launches from Earth and one more rocket lift-off from Mars, with the purpose of collecting Martian soil samples, storing them in an orbiting sample container (OS) and bringing them back to the Earth, where a team of international scientists will be able to perform analysis otherwise not possible on Mars with the current technology. One of the most critical phases of the mission is the Rendezvous and Capture, during which the MSR Earth Return Orbiter spacecraft (MSR-ERO) will detect and track the Orbiting Sample (OS) previously released in Martian orbit by a Mars Ascent System (MAS), will estimate its orbit and will perform all the manoeuvres needed to approach and capture it. The rendezvous and capture is particularly challenging considering that the object to be captured (the OS) is very faint and fully uncooperative. GMV has been involved, under different ESA contracts, in the analysis, design, implementation and validation of the GNC subsystem for the rendezvous and capture of the MSR since the dawn of the mission, strengthening its experience on this critical and complex subsystem during more than 10 years. This paper will present the proposed Rendezvous and Capture GNC Subsystem architecture (RVS), the implemented GNC and Image Processing algorithms (both for far and short range) and the hardware approach, based on a pure optical navigation solution with two cameras (NAC and WAC) and an Image Processing Unit (IPU). The full RVS GNC/IP chain has been validated up to TRL-6 in different environments with increasing representativeness level (Model-In-The-Loop, Processor-In-the-Loop, robotic HW-In-The-Loop). The paper will show the most relevant results of this validation campaign, showing that, except in the cases where Sun-angle configuration and illumination conditions are unsuitable, the performance of the proposed optical-based RVS fulfils the rendezvous and capture requirements.