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AIRBUS DS VISION BASED NAVIGATION SOLUTIONS FOR THE MARS SAMPLE RETURN – EARTH RETURN ORBITER MISSION

Abstract

Abstract: The Mars Sample Return (MSR) program is an ambitious concept led by the NASA to bring some Martian soil samples to Earth declined in four missions. With the collaboration of ESA, the Earth Return Orbiter (ERO) mission aims at autonomously detecting, capturing the Orbiting Sample (OS) container. The image processing is all the more challenging that the rendezvous concept chosen for the mission is mainly based on passive optical sensor for mass optimization and that the OS is small and non-cooperative. Two phases are defined for mission success; the most critical one is the far range during which the OS is detected from the separation with the Mars Ascent Vehicle (MAV), which places it onto low Mars orbit. The image processing solution developed for the terminal rendezvous shall satisfy mission performance and reliability requirements to safely track and capture the container. The mission is achieved with an alternative use of specific cameras, a narrow angle camera (NAC) for the detection and a wide angle camera (WAC) for the terminal phase of rendezvous. This paper describes the vision-based navigation solutions adapted for each mission phase by detecting and tracking the OS in the camera images.

Airbus is designing the vision-based GNC system for the rendezvous and capture of the OS, leveraging decades of experience in vision-based navigation. In OS detection phase, the most challenging aspect of the mission is to detect the weak signal of the OS with cameras in presence of radiations: Airbus developed a specific detection algorithm to solve these difficulties, building on previous successes in the context of space and aerial rendezvous image processing. The final approach phase of MSR-ERO mission is a new challenge, the main difficulties being dominated by the illumination conditions, the ambiguities created by the OS shape orientation and the noise level in the image. The proper validation of the involved GNC technologies is crucial for this kind of missions. Airbus Defence and Space validation strategy to reach TRL 5-6 in 2019 relies on the combination of various means. They include a massive validation campaign based on SurRender Software, Airbus' physically accurate image rendering tool dedicated to space mission, as well as Hardware-In-The-Loop (HIL) tests and cross validation activities, including robotics tests bench, space grade cameras and processors. This paper details the image processing solutions developed by Airbus and adapted for each mission phase, and presents the outcomes of the validation activities.