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DEVELOPING, VALIDATING AND VERIFYING A FLIGHT RATED AUTONOMOUS GNC SYSTEM FOR THE ROSALIND FRANKLIN ROVER: ACHIEVEMENTS AND LESSONS LEARNT

Abstract

ESA's Rosalind Franklin rover - the main surface component of the ExoMars programme - will search for traces of life, investigate Martian geochemistry and geophysics, and demonstrate key technologies in support of future planetary exploration missions. To maximise the scientific returns of the rover the amount of operator intervention should be minimised, thereby making a high level of autonomous operation necessary. In response to this need, Airbus Defence and Space, being the prime contractor for the ExoMars Rover Vehicle, has developed an autonomous navigation system for the rover's Guidance Navigation and Control (GNC) subsystem. Autonomous traversal operations on the Martian surface are complicated by the irregular terrain, communications and bandwidth limitations, and environment and localisation knowledge errors. Ensuring the safety of the rover during an autonomous traverse whilst balancing computation time (and therefore traverse speed) poses a major challenge for the GNC system. In this context the development, verification, and validation of the GNC system are critical steps in ensuring the flight readiness of the rover as a whole.

The presented work details the achievements and lessons learnt during the development of one of Europe's first flight-rated autonomous GNC systems for planetary exploration rovers. The first part of this paper presents the rover's GNC system architecture, with a focus on the autonomous navigation and driving functionalities, including details of the main challenges induced by the mission constraints and requirements. The second part discusses the development process required to reach a flight-rated autonomy system, including the implementation on a flight representative LEON2 processor and considerations of memory and telemetry data volumes. The third part details the validation and verification (VV) philosophy, including the simulation and hardware campaigns that have confirmed the functionality and performance, and given confidence in the GNC system. The final part summarises the achievements and difficulties encountered during this work. It also presents lessons learnt for the development of such flight-rated autonomous system, extending these lessons towards future rover concepts.