IAF SPACE EXPLORATION SYMPOSIUM (A3)
Space Exploration Overview (1)

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DESIGN AND IMPLEMENTATION OF A MODULAR MECHATRONICS INFRASTRUCTURE FOR ROBOTIC PLANETARY EXPLORATION ASSETS

Abstract

Traditionally, the robotic systems which aim to explore other celestial bodies include all instruments and tools necessary for the mission. This makes them unique developments. Usually, they are heavy, complex, costly and do not provide any interchangeable parts that could be replaced in the event of permanent failure. However, for future missions, agencies, institutes and commercial companies are developing robotics systems based on the concept of modular robotics. This new strategy becomes critical for planetary exploration because it is able to reduce load, costs and development time. In the German multi robot research project, ''Autonomous Robotic Networks to Help Modern Societies (ARCHES)", led by the German Aerospace Center (DLR), this modern design methodology is followed. Cooperation among robots and modularity are the core of its structure. These characteristics are present in the collaboration between the rovers and the uncrewed aerial vehicle (UAV) during navigation tasks, or when the Lightweight Rover Unit (LRU) interacts with changeable manipulator tools and payload boxes through its robotic arm and its standardized electromechanical interface. Examples of these modules include scientific packages (e.g. LIBS spectrometer and simplified LOFAR Radio-Telescope), power supply systems, communication and data acquisition architectures, soil sample storage units, and specific purpose end-effectors. The focus of this work is in the design and implementation of a mechatronics infrastructure (MI) which encompasses the docking interface, the payload modules, and the power and data management electronics board inside each box. These three elements are essential for the extension of the capabilities

of the rover and the enhancement of the robotics systems according to the tasks to be performed. This will ensure that robots can cooperate with each other either in scientific missions or in the construction and maintenance of large structures such as habitats, power grids and mining facilities. The MI's hardware and software developed in this project will be tested and validated in the ARCHES demonstration mission on Mount Etna, Sicily, in Italy between 14th June and 9th July 2021. The results of this validation campaign will be presented in this paper. Finally, it is important to highlight that modularity and standardization were considered at all levels of the infrastructure. From the robotics systems to the internal architecture of each payload module, these concepts can provide versatility and reliability to the cooperative robotic network. This will improve the problem-solving capabilities of robots performing complex tasks in future planetary exploration missions.