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TEST RESULTS OF A MULTI-ARM ROBOT DEMONSTRATOR FOR IN-SPACE TELESCOPE SERVICING AND ASSEMBLY

Abstract

Largest space instrument abilities are constantly desired in many kinds of missions for obtaining additional performances. This has been addressed by either large monolithic spacecraft or complex semi-folding design, but structures are essentially constrained by the volume and mass lifting capabilities of the rocket

and limits tend to be reached with latest missions. New approaches suggest to split up the instrument structure and launch a group of separated and smaller components then, once in space, assemble to form a much larger structure. This applies particularly to space observation and exploration missions using large orbital telescope. However, on-orbit assembly of such instruments presents its challenges and key technologies such as robotics, docking mechanisms and system control will have to be developed to enable a future sustainable paradigm shift.

To this end, this paper deals with a robotic system called MAR (Multi-Arm Robot) for servicing and assembling large telescope in-space. The MAR is a dual arm modular robotic manipulator, able to relocate, transport and position hexagonal mirror tiles. It has been developed in the context of the Technology Research Program (contract No. 4000132220/20/NL/RA), funded by the European Space Agency (ESA), entitled "Multi-arm Installation Robot for Readying ORUS and Reflectors (MIRROR)".

To do so, the MAR is composed of three entities: two 7 degree of freedom (DOF) robotic arms, whose tips are equipped with standard interconnects, and a torso featuring three standard interconnects, two for connecting the arms and one for connecting payloads. The MAR entities can operate independently and together, benefiting from the mechanical, data and power transfers through the standard interconnects. Each entities also embeds its own power and data avionics, needing only high level command from a mission control center to operate.

Within the MIRROR project, a Technology Readiness Level (TRL) 4 ground equivalent demonstrator of the MAR has been developed, built and tested. The overall length of each robotic arm is 1.8 meters and the weight of the MAR is 110kg. Supported by an offloading system, the MAR is able to manipulate 12kg payloads in a 5mx3mx3m workspace. This paper describes the demonstrator, test plan and results of the laboratory test campaign while performing relocation and telescope tile assembly operations with various configuration of the modular robot. It also analyses and discussed the results in relation with the design choices, covering mechanical, avionics, sensors, actuators and control aspects to conclude on lessons learned collected along the activity.