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Author: Dr. Mathieu Deremetz
Space Applications Services, Belgium

Mr. Maxence Debroise
Space Applications Services, Belgium
Mr. Marco De Stefano
DLR (German Aerospace Center), Germany
Mr. Hrishik Mishra
DLR (German Aerospace Center), Germany
Mr. Bernhard Brunner
German Aerospace Center (DLR), Germany
Dr. Gerhard Grunwald
German Aerospace Center (DLR), Germany
Dr. Maximo A. Roa
DLR (German Aerospace Center), Germany
Dr. Matthias Reiner
DLR (German Aerospace Center), Germany
Mr. Martin Závodník
Frentech Aerospace Systems s.r.o., Czech Republic
Mr. Martin Komarek
L.K. Engineering s.r.o., Czech Republic
Mr. Jurij D'Amico
Thales Alenia Space France, France
Dr. Francesco Cavenago
Leonardo Spa, Italy
Dr. Jeremi Gancet
Space Applications Services, Belgium
Mr. Shashank Govindaraj
Space Applications Services N.V./S.A, Belgium
Dr. Pierre Letier
Space Applications Services, Belgium
Mr. MICHEL ILZKOVITZ
Space Applications Services NV/SA, Belgium
Mr. Levin Gerdes
European Space Agency (ESA), The Netherlands
Mr. Martin Zwick
ESA - European Space Agency, The Netherlands

DESIGN AND INTEGRATION OF A MULTI-ARM INSTALLATION ROBOT DEMONSTRATOR FOR ORBITAL LARGE ASSEMBLY

Abstract

Space facilities for orbital exploitation and exploration missions are requiring increasingly larger structure to extend their capabilities. Dimensions of future outposts, solar facilities and telescopes will undoubtedly matter to expand our horizons, supply on-orbit applications or explore the universe. Due to the size of structures for such applications, a single self-deploying asset contained in standard launcher fairings is inadequate. Instead, these large structures may be broken down into modules that can be assembled in-orbit. Assembling large structure in space is a major challenge but technologies such as standard interconnects and dexterous orbital robotics open new horizons for such applications. In the presented work, we assume that the large spacecraft structure and modules are equipped with Standard Interconnects (SI) that provide mechanical, data and power transfer capabilities. The SIs allow the modules to mate to each other, and allow the robotic manipulators to capture, transport and install these modules. They are also the attachment points for the robot system, allowing it to relocate across the spacecraft structure and modules. This paper introduces the concept of a novel Multi-Arm Robot (MAR) dedicated to on-orbit large telescope assembly, and its ground equivalent laboratory demonstrator design. The MAR is a modular robot composed of three robotic subsystems: a torso and two symmetrical 7-degree of freedom (DOF) anthropomorphic arms. The robotic subsystems (torso and robotic arms) are functionally independent and can be connected by means of SIs. This modular approach of the MAR aims at reducing the complexity of the different robotic appendages and offers a set of robotic configurations that extends the range of possible operations and provides an intrinsic system redundancy that reduces the overall mission risk. To assess the MAR concept, a Technology Readiness Level (TRL) 4 ground demonstrator has been designed. It will allow showing that the multi-arm robot can execute its overall scope of operations in a ground laboratory environment. It comprises a testbed (dummy spacecraft structure, home base, storage area and mobile payloads) offering a space representative environment, a mission control center (computer, simulator and electrical/data support equipment) supervising the MAR's tasks, and a gravity compensation system (gantry crane and offloading system) for supporting the robot under 1-g. This study is funded by the European Space Agency (ESA) in the framework of the Technology Research Program (contract No. 4000132220/20/NL/RA) entitled "Multi-arm Installation Robot for Readying ORUS and Reflectors (MIRROR)".