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ON-ORBIT SERVICING AND ASSEMBLY USING THE COMPLIANT ASSISTANCE AND EXPLORATION SPACE ROBOT CAESAR

Abstract

Recent years have seen a surge on the number and ambition of space missions. Different to the history of space exploration, this increased activity is not driven primarily by national space agencies or defense organizations, but by private companies offering a variety of commercial services. An example is the set up of numerous satellite constellations. Space is becoming an attractive business scenario.

The increased presence of satellites calls for services for these assets. Lifetime extension of a GEO satellite, as demonstrated with the MEV-1 (Mission Extension Vehicle) mission, or active debris removal as in the planned ClearSpace-1 mission, are examples of services with very limited physical interaction capabilities. More ambitious servicing missions such as planned in the OSAM-1 (On-orbit Servicing, Assembly, and Manufacturing 1) or RSGS (Robotic Servicing of Geosynchronous Satellites) missions will use robotic manipulators for the interaction with the client/objective. Robot manipulators will facilitate maintenance, servicing or other tasks that may or may not have been fully understood at the time of the client design. Additionally, robots will offer new approaches for more ambitious goals, such as the deployment and assembly of infrastructure in space. However, few robot manipulators are until today qualified for such space missions.

This paper presents recent developments of the Institute of Robotics and Mechatronics at DLR on the field of On-Orbit Services. First, an introduction to the space robot system CAESAR (Compliant Assistance and Exploration SpAce Robot) is provided. The seven degrees of freedom (DoF) robotic system is intended to be capable of catching satellites in LEO/GEO, even those ones that are in tumbling and/or non-cooperative states. The dexterity and sensitivity of CAESAR enables additional tasks, such as assembly, maintenance, and repair of satellites. The latest advances in the Engineering and Verification Model of the arm, and an outlook on its space qualification, are provided here. The robot is a central component in the EU project EROSS+ (European Robotic Orbital Support Services), which aims to provide the basis for a servicing mission using robotic arms. DLR has also taken part in the EU project PULSAR (Prototype for an Ultra Large Structure Assembly Robot), which provided a demonstrator for assembly of the primary mirror of a telescope using compliant robotic technology. An outlook on potential applications of such technology in future missions concludes the work.