IAF SPACE SYSTEMS SYMPOSIUM (D1)
Cooperative and Robotic Space Systems (6)

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CAESAR: SPACE ROBOTICS TECHNOLOGY FOR ASSEMBLY, MAINTENANCE, AND REPAIR

Abstract

Currently, there is a worldwide increasing interest in orbital services. This is not only driven by national agencies or defense organizations but also by private companies. E.g. Orbital ATK is developing the Mission Extension Vehicle (MEV). In 2019 it will dock an IntelSat asset in GEO providing life-extending services by taking over the orbit maintenance and attitude control functions. Space robot services are going far beyond that. Space robots are performing exploration, assembly, maintenance, servicing or other tasks that may or may not have been fully understood at the time of the design.

The Institute of Robotics and Mechatronics at DLR will present its development of the space robot system CAESAR (Compliant Assistance and Exploration SpAce Robot). In the mid-nineties DLR developed a new generation of light weight robots (LWR) with an excellent power to weight ratio as well as impressive control features, which made the system easy to use and safe for terrestrial servicing applications. The same hard- and software technology was verified in the ROKVISS (RObotic Components Verification on the ISS) experiment, from March 2005 to November 2010 platform on the outside of the Russian Service Module on the ISS.

With the development of the space-qualified robotic system CAESAR (Compliant Assistance and Exploration SpAce Robot), the Institute of Robotics and Mechatronics at DLR is continuing the work on on-orbit servicing that began with DEOS. The seven degrees of freedom (DoF) robotic system is intended to be capable of catching satellites in LEO/GEO, even ones that are in tumbling, and/or non-cooperative states. The dexterity and sensitivity of CAESAR enables assembly, maintenance, and repair of satellites.

The key to CAESAR's high performance is intelligent impedance and position controlled joints. Each joint is a building block for setting up diverse robot kinematics depending on the different mission goals. The scalability of the robot is determined by the number of joints and the length of the links. CAESAR's seven DoF enables it to meet the dexterity and the kinematic redundancy requirements. Extending the impedance controller, the CAESAR arm can behave compliantly, while maintaining TCP position. The compliant behavior is triggered if any part of the robot detects contact with the environment. Compliance is a significant safety feature in dynamic environments or in close vicinity to the astronauts.