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ROBOTIC TECHNOLOGIES TOWARDS A SUSTAINABLE ON-ORBIT SERVICING ECOSYSTEM

Abstract

In recent years, the space sector has undergone a deep transformation. A few concepts from the "New Space" paradigm are playing a pivotal role: cost reduction through economies of scale, intensive use of COTS, standardisation and accelerated development cycles are among the most relevant ones. A second transformation wave will need from a comprehensive on-orbit transportation and servicing ecosystem. Enabling conditions for this are: firstly, the commitment to socially and environmentally responsible development of space activities (e.g. the adoption of a Zero debris policy); and secondly, the availability of technology capable of meeting the highly demanding needs both from performance and cost perspectives. This paper describes the latest technological advancements in space robotics (within the European context) that will enable the on-orbit transportation, servicing and debris removal ecosystem. In the field of sustainability, ESA is preparing the new generation of Earth Observation satellites for an eventual End-of-Life removal: the Copernicus Sentinel Expansion Missions have adopted the Design for Removal Interface Requirements Document by ESA and are being equipped with MICE (Mechanical Interface for Capture at End-of-Life). The robotic technologies for capture and removal at the servicer side, including a MICE-compatible end-effector, clamping devices, optical navigation, avionics and control functions are also in an advanced stage of development. All these elements are integrated within a unified system: CAT - the Return Capture Payload Bay. CAT is a specialized payload that works in coordination to a servicer vehicle GNC to perform the final approach navigation, capture, stabilization and securing of the stack for de-orbiting the failed/uncontrolled spacecraft. On-orbit servicing and assembly will also play a key role in the future space economy by optimising launch costs and enabling new scalable mission schemes. The deployment and assembly of large structures on orbit will be a recurring operation in this area. The Multi-arm Installation Robot for Readying ORUS and Reflectors (MIRROR) is an ESA-funded activity lead by GMV, that has produced the first-ever European prototype of a self-relocatable robotic system for on-orbit operations, particularly on-orbit large structure assembly and spacecraft servicing for maintenance, repairs or upgrades. The ability to provide on-orbit servicing could increase lifespan, enhance performance or even enable dynamic mission objectives reconfiguration. Modular spacecraft design and refuelling capacities are key enablers in this field. ASSIST is the first initiative towards standardisation of refuelling interfaces in Europe. Based on an Open Interface approach, is currently on the path towards its on-orbit demonstration.