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HOTDOCK: DESIGN AND VALIDATION OF A NEW GENERATION OF STANDARD ROBOTIC INTERFACE FOR ON-ORBIT SERVICING

Abstract

This paper presents the design and validation of HOTDOCK, a new generation of standard interface for on-orbit and planetary applications providing mechanical, power, data and thermal coupling capabilities between payloads and spacecraft, between spacecraft modules and as end-effector of robotic manipulators. The provision of standard interfaces in the design of spacecraft buses and payload modules will become essential to enable the emerging LEO/GEO on-orbit robotic servicing market. That includes payload management for spacecraft maintenance and reconfiguration, large structures assembly in space and de-orbiting operations. Standard interfaces are also highly interesting in support to robotic operations in future deep space missions (LOP-G, Moon and Mars surface operations). HOTDOCK features a compact and fully integrated androgynous and 90-degree symmetrical design, for coupling of identical devices. The external form-fit geometry supports mating trajectories in a cone of up to 130-degrees, allowing for simultaneous connection of three orthogonally mounted interfaces. The unique patented coupling mechanism, along the circumference, allows stiff mechanical structural coupling with high load transfer. A central connection plate, equipped with spring-loaded POGO pin connectors offer re-configurable and switchable electrical power as well as bi-directional high data rate transfer between connected subsystems.

HOTDOCK can be optionally equipped with a fluidic transfer capability for thermal cooling on top of the regular thermal conduction between two devices. In its nominal configuration called Active, HOTDOCK provides an actuation mechanism for the mating as well as integrated control and interface electronics. A purely passive version, without active components, has also been developed to offer a lower cost, volume and mass version. Both Active to Active and Active to Passive connections are possible, allowing in each case power, data and thermal transfer capabilities. HOTDOCK has been adopted as the reference Standard Interface in three projects of the European Commission's H2020 Space Robotic Technologies cluster (OG8 PULSAR, OG9 MOSAR and OG11 PRO-ACT). They respectively address large structure assembly in space, modular satellite reconfiguration, and collaborative robotic planetary operations. More than 50 units are currently being produced for integration in several ground demonstrators (TRL 4). Furthermore HOTDOCK will be used as part of the Michigan Technical University (MTU) "T-REX" project awarded by NASA (BIG Idea Challenge) and will undergo TVAC testing at that occasion. This paper presents the HOTDOCK interface, its integration and validation in representative ground demonstrators (along with test results), and the on-going design maturation process to reach a qualified model by 2021.