IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Advanced Systems, Technologies, and Innovations for Human Spaceflight (7)

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DESIGN, DEVELOPMENT AND QUALIFICATION OF AN EUROPEAN INTERNATIONAL BERTHING AND DOCKING MECHANISM (IBDM)

Abstract

The next decade will see a boom of space exploration, with a mix of government agencies, international collaborations, and private ventures committed to establish new international space stations, come back on permanent basis to the Moon and bring the human beings for the first time to Mars. In this scenario, the berthing and docking mechanisms play an essential role, as they are the first contact point and the connection between spaceships, and the gate every astronaut, equipment and supplies will pass through from one vehicle to the other.

This paper presents the International Berthing and Docking Mechanism (IBDM) developed and qualified by Redwire Space NV under an European Space Agency project. IBDM is an androgynous low impact docking system that is capable of docking and berthing large and small spacecrafts. The docking mechanism comprises an actively force-controlled platform called the Soft Capture System (SCS), and a structural mating system called the Hard Capture System (HCS). The IBDM SCS holds 3 guide petals with mechanical latches installed on the soft capture ring. The SCS is steered by 6 linear actuators (i.e. LEMAs) to allow the soft capture ring to move in 6 degrees of freedom, similar to a Stewart platform. The IBDM HCS ensures the structural and pressurized attachment of the two vehicles by means of 12

mechanical hooks (Hard Capture Hook Units). Next, the HCS provides motorized connectors to support power and data transfer between the spacecrafts. The IBDM also integrates the avionics responsible for the control of both the SCS and HCS, by means of closed control loops comprising sensor data acquisition, algorithmic processing and actuator commanding phases.

During docking, the SCS platform is deployed and it waits for the target vehicle to approach. Following first contact detection, IBDM captures the target vehicle by actively steering the SCS platform to align the mating interfaces and damping the relative motion. Then, the SCS is centered and retracted, bringing both hosting and target vehicles close together. Finally, the hooks are closed ensuring hard mating and electrical connections are established. The tunnel is sealed and becomes the pressurized vestibule between the hosting vehicle and the target vehicle after mating.

A qualification model (QM) IBDM has been qualified including mechanisms and avionics unit level qualification, environmental tests, functional failure cases verification and closed loop docking tests against a target vehicle, while simulating the real time vehicle dynamics using a Kuka robot.