Paper ID: 21593
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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THE THOR SPACE STATION AT EML2: ANALYSIS AND PRELIMINARY DESIGN AN INNOVATIVE ADAPTABLE DOCKING SYSTEM.

Abstract

This study reflects the effort of the ISAE University of Toulouse to conform with the Global Exploration Roadmap (GER): it is focused on the analysis and the preliminary design of the innovative universal docking system of the THOR (Trans-lunar Human explORation) station located at the second Earth-Moon Lagrangian Point. The Roadmap brings under light a way of exploring a large array of destinations situated beyond low-Earth orbit by following a 'Moon' – 'near-Earth asteroids' and 'Mars' pathway. The THOR station consists of seven cylindrical (whose dimensional reference is the ATV) and two spherical modules: each part, with a specific role, will be launched separately. Nowadays, the dynamics of the docking is still in development: one option is to assembly the modules at LEO and another one is to have the spacecraft put together at EML2. By coping with design criteria imposed by the deep-space environment, the docking system has been designed.

The aim is to have an 'universal type of junction' between the stations and the re-supply – manned or unmanned – shuttles. At first, a detailed analysis of the kinematics of the rendezvous has been conducted, in order to identify the optimal time windows for the orbital transfer at EML2. The docking system must be able to perform a structural connection between the hubs and the cylindrical modules or external vehicles, to allow fuel, power and data transfer and, moreover, to function as passageway for crew and materials. It will be fitted on the spherical hubs in order to anchor the modules and the visiting vehicles in safe conditions. Thanks to movable surfaces and adaptable pins, this innovative system will allow diverse kind of modules to safely dock on the spherical hubs. Because of the severe constraints, the functioning of the docking system has been improved in order to consent the control the trajectory in the critical phases of the mission. Taking as reference the kinematics of the ATV and all the previous docking/berthing systems, the structural design of the subsystem has been performed and, adding up the kinematic analysis, a realistic video of the rendezvous has been produced.

This innovative system presents at the same time all the benefits of the docking systems and of the robotic arms: its adaptability to several visiting vehicles and the passive functioning are strong points that can pave a new road for the future of docking systems.