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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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DOCKING MECHANISM CONCEPTS FOR THE STRONG MISSION

Abstract

The main topic of the work is the design of innovative docking mechanism for application in the STRONG mission. The mission foresees the transport of a standard space platform carrying payloads from Low Earth Orbit into greater orbits by means of a space tug. The mission periodically also foresees the refueling of the space tug by a dedicated docking with an orbital tank. The task of the mechanism described in the work is to mechanically couple a Space Tug with LEO located space vehicles recovering the maximum position and attitude misalignments, due to the GNC performances, between the two spacecraft during the docking phase. To do this several concepts have been defined aiming to provide different solutions to the docking problem. Among these concepts the optimal solution will be found by defining some criteria and applying a trade-off procedure. Simulation tools have been created for each one of the concepts in order to analyse and evaluate their characteristics and performance. The concepts individuated are the following: a mechanism based on the Stewart-Gough platform, a passive central mechanism (probe-drogue), a mechanism formed by articulated arms transporting grippers to grip the Vega ring and a central active mechanism. The first mechanism is a 6SPS parallel manipulator that may operate following two different control approaches for the soft docking phase. The first control logic is characterized by a position control loop with an optical feedback. The second one instead rules the impedance of the platform. The second mechanism is a "classical" probe-drogue mechanism like the one present in the Russian Progress spacecraft. This mechanism consists of a rod mounted on the chaser that has to be introduced inside a conical seat on the target side. The third mechanism consists of one degree of freedom group of arms equipped with grippers able to grasp the mounting ring present in all the payloads launched with the expendable launch system Vega. Finally, the last mechanism is a central mechanism having three degrees of freedom. This mechanism is initially controlled in position with an optical sensor. The rod of the mechanism is introduced inside a small conical seat. Subsequently spring loaded elements perform the soft docking followed by an impedance control and then the hard docking. The paper shows the analysis carried out to provide a preliminary design of the mentioned concepts that will be the base of a trade off procedure to select the optimal one.