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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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MULTIDISCIPLINARY SHAPE OPTIMIZATION OF FUTURE RE-USABLE SPACE VEHICLE

Abstract

Transporting crew and cargo to the International Space Station frequently at low costs is a matter of concern. To improve the feasibility of future space transportation from Earth to International space station (ISS) and back, we require economical and re-usable space vehicles with the enhanced low impact safe docking and improved re-entry capabilities. The objective is to design an ambitious aerodynamically modified space vehicle to meet the mission requirements. The proposed orbiter design is equipped with retractable wings and base flaps at the rear end of the orbiter. The retractable wings along with flaps will aid gliding re-entry of the vehicle. The retractable wings, initially housed inside the orbiter during the launch phase will be deployed during the docked position at ISS to reduce impact on the spacecraft. The wings and the flaps will be actuated using advanced thermally protected electromagnetic actuators. The base flaps ensure maneuvering during the atmospheric re-entry phase, becoming active when the efficiency of the control surfaces increases with the increase in dynamic pressure. The gliding re-entry will thereby improve the effectiveness of reentry strategies by reducing complexity and risks. Parachutes may be considered as decelerators after touchdown. The orbiter's Attitude and Orbital Control System ensures to follow the optimized trajectory from the initial injection orbit to the ISS. The orbiter is capable to dock at the ISS and will be equipped with highly compatible space docking ring which ensures the docking with multiple ports available on the ISS. Multidisciplinary shape optimization is performed to meet mission objectives, considering the selection of aerodynamic shape for wings, base flaps and orbiter along with the propulsion system, AOCS, flight behavior of the orbiter for atmospheric flight and re-entry phase, thermal protection during re-entry and crew member safety in all phases of operation. Results indicate a significant improvement in space utilization of the launch vehicle as the wings are housed inside the spacecraft during the launch phase. The compatibility of the spacecraft to dock at multiple ports of the ISS further adds on to the benefits of the design. The flaps and wings improve the gliding re-entry capabilities. The multidisciplinary optimization results in spacecraft satisfying the mission requirements with low cost per launch with reduced risk.