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CATEGORY 3 - INTEGRATED SYSTEMS

Proximity Operations Considerations Affecting Spacecraft Design

by Steven K. Staas, McDonnell Douglas Space Systems Company

Proximity operations can be defined as the maneuvering of two or more spacecraft within 1 nautical mile range, with relative velocity less than 10 feet per second. The passive vehicle is non-translating and should provide for maintenance of the desired approach attitude. It must accommodate the active (translating) vehicle induced structural loads and performance characteristics (mating hardware tolerances), and support sensor compatibility (transponder, visual targets, etc). The active vehicle must provide adequate sensor systems (relative state information, field-of-view, redundancy), flight control hardware (thruster sizing, minimal cross-coupling, performance margins, redundancy) and software (reconfigurable, attitude/rate modes, translation and rotation fine control authority) characteristics, and adequate non-propulsive consumables such as power. Operational concerns must be considered. These include: (1) the desired approach trajectory and relative orientation; (2) the active vehicle thruster plume effects (forces, torques, contamination) on the passive vehicle; and (3) procedures for contingencies such as loss of communications, sensor or propulsion failures, and target vehicle loss of control.

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Guideline Requirements for Serviceable Spacecraft Grasping/Berthing/Docking Interfaces Based on Simulations and Flight Experience

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by A. B. Thompson, Martin-Marietta

The described efforts support a NASA Space Assembly and Servicing Working Group activity to draft guideline interface standards. The general requirements are to provide a simple, reliable, and durable system. Interface requirements developed include lateral position offset, axial and lateral velocities, and angular misalignment. A survey of concepts and simulation studies of spacecraft docking, existing docking/end effector performance criteria, and space proven, qualified docking data was conducted and evaluated, in order to provide recommended mechanical interface guidelines and interface tolerances for manual and autonomous capture operations. The criterion for the selection of the guidelines was maximum capability to handle malfunctions. Originally the guidelines for a zero velocity docking were considered to be covered within the grasping/berthing definition. It is acknowledged that perhaps a separate category needs to be established for this option. The draft standard has been delivered to the AIAA for review, revision, and issuance as the first U.S. national standard guideline on interfaces. The intent is to develop the guidelines into an International Standards Organization standard.

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Autonomous Docking Ground Demonstration

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The Autonomous Docking Ground Demonstration is an evaluation of the laser sensor system to support the docking phase (12 ft to contact) when operated in conjunction with the guidance, navigation and control software. The docking mechanism being used was developed for the Apollo/Soyuz Test Program. This demonstration will be conducted using the 6-DOF Dynamic Test System (DTS). The DTS simulates the Space Station Freedom as the stationary or target vehicle and the Orbiter as the active or chase vehicle. For this demonstration, the laser sensor will be mounted on the target vehicle and the retroflectors will be on the chase Vehicle. This arrangement was chosen to prevent potential damage to the laser. The laser sensor system, GN&C, and 6-DOF DTS will be operated closed-loop. Initial conditions to simulate vehicle