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DRAG-FREE CONTROL SYSTEMS MODELLING IN OPERATIONAL SIMULATORS

Abstract

Drag-Free Control (DFC) is a recent technology that enables extremely precise control over the spacecraft attitude and orbit. By tracking one or more free flying test masses inside the spacecraft, the DFC System can compensate all non-gravitational forces and torques, thereby making it possible for the spacecraft to follow a pure geodesic trajectory.

Operational simulators exist to train the flight control teams, and to verify flight procedures. In executing procedures, Operational Simulators also provide an independent means of verifying some of the spacecraft On-Board Software (OBSW). Modern operational simulators use the same OBSW as the real spacecraft. The OBSW is run in an emulated environment inside the simulator.

Traditionally, in operational simulators, there are few stringent requirements on the accuracy of the Payload modelling. When a DFC payload is active, however, the OBSW and the Payload are operating in a tightly closed loop; the thrusters are controlled based on payload sensor data without operator intervention. In order to validate the OBSW DFC algorithms, it is therefore desirable that the OBSW cannot distinguish the simulated environment from the real spacecraft environment. Thus, AOCS and Payload components that are part of the closed control loop should be accurately modelled.

This paper highlights the challenges inherent in incorporating a high-accuracy DFC model into an operational simulator framework. A simulator model is presented, which provides sufficient accuracy and smoothness that the DFC System may function continuously, produce reasonable actuator commands, and not trigger any undue FDIR action from the OBSW. The model presented represents a hybrid approach, which incorporates elements of classical dynamics models for attitude/position sensing and spacecraft actuation as well as classical functional models, thus increasing the potential for reuse.