SPACE OPERATIONS SYMPOSIUM (B6)
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PRACTICAL ASSESSMENT OF JITTER CAUSED BY FUEL SLOSH DURING IMAGING FOR THE RAPIDEYE SATELLITES

Abstract

Planet Labs owns and operates the five satellite RapidEye Earth observation constellation that is capable of large area coverages in short periods of time. The satellites are approximately equally phased in a sun synchronous orbit, and are capable of collecting up to 5 million square kilometers per day of high resolution multispectral imagery per day. The satellites are now operating past their 7.25 year design life, but remain fully functional. The satellites are expected to operate at their current high level of imaging capacity until their Lithium-ion batteries reach approximately 50

One of the options being considered is shutting off the fuel tank heaters in the propulsion system. The RapidEye propulsion system is based on a warm gas resistojet thruster that uses Xenon as the propellant. The Xenon propellant is stored in a tank, which has heaters to ensure that the Xenon is always in a gaseous phase to prevent sloshing which could cause jitter during imaging. The power needed to keep the propellant gaseous represents a significant part of the orbit power budget. Shutting the heaters off can help to reduce the load on the battery, thereby extending the nominal operational life of the battery.

In this paper, a RapidEye satellite is modeled with a partially filled spherical fuel tank, and the slosh mode is included in the dynamic model using pendulum and mass-spring analogies. The control objective is to control the attitude of the satellite, while attenuating the slosh mode. The rigid body degrees of freedom and the fuel slosh degree of freedom needs to be controlled using only the controls acting on the rigid body. Following the modeling phase of this work, the fuel tank heaters will be shut off to assess the impact that the fuel slosh has on the attitude stability of the satellite during imaging. Images will be compared to archived images over the same regions to determine the level of jitter caused by the fuel slosh. The residuals from georeferencing the raw image data with ground control points will be used to quantify the magnitude of the jitter effect on the images.