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DESIGN OF ADCS SYSTEM FOR ENERGY-EFFICIENT SINGLE-POINT-FOCUS EARTH
OBSERVATION USING A 3-UNIT CUBESAT

Abstract

GWSat is a project led by George Washington University (GWU) in collaboration with the Costa Rica Institute of Technology (TEC) and the United States Naval Academy. It consists of using a 3U CubeSat to test GWU's Micro-Cathode Arc Thruster technology developed at GWU's Micro-Propulsion and Nanotechnology Laboratory. The Costa Rica Institute of Technology joined GWU to create a scientific application to the GWSat platform. This mission relates to earth environmental monitoring applied to the wetlands of Palo Verde National Park in Costa Rica. The idea is to use the satellite platform as a store and forward system of information transmitted from remote stations on the ground and remote monitoring of the wetlands using a camera on the satellite. For this reason, GWSat will have an advanced attitude control: a pointing mode that will allow the satellite to orientate its camera to Palo Verde National Park for remote monitoring purposes. The attitude orbit and determination system (ADCS) control of GWSat is based on the combination of thrusters and magnetometers only. In this paper, the design of the ADCS for purposes of Earth observation of GWSat is described. Here, simulations with hardware-on-the-loop show different control methodologies, from simple proportional-derivative.(PD) controllers to methods designed using artificial intelligence (AI) or port-Hamiltonian (pH) systems influence the system's performance from the point of view of energy usage. This performance is of utmost importance in this mission, given that the energy efficiency is directly correlated with the use of fuel of the thrusters. The results of this paper show the capabilities of 3U CubeSat for precise Earth observation using different control algorithms, allowing comparison on the performance of different methodologies from the point of view of energy usage. This comparison is not only helpful when propellant is used for attitude control (as in this case) but, in general, is valuable from the point of view of energy efficiency for ADCS.