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ATTITUDE CONTROL OF A 3U CUBESAT EQUIPPED WITH A LARGE LOOP ANTENNA

Abstract

SwampSat II is a 3U CubeSat designed to collect and characterize very low frequency (VLF) waves in low Earth orbit. To measure VLF waves in the 2 kHz to 32 kHz frequency range, SwampSat II utilizes a 4 x 4 m square loop antenna which must be oriented such that the antenna plane is perpendicular to the spacecraft's ram direction in order to capture the maximum amplitude of the VLF waves. Such a large antenna deployment from a CubeSat platform is a unique and challenging task, therefore, it is necessary to perform detailed attitude simulations to characterize and analyze the spacecraft's attitude behaviour.

Simulations were conducted for post-launch tumbling state through to deployment and operations. Since SwampSat II is in the design phase, actual inertia tensors are not available and are estimated based on the current design using SolidWorks models of the spacecraft represented as rigid bodies in each configuration. Following P-Pod ejection, the spacecraft is assumed to experience 3-axis tumbling motion and a B-dot proportional controller is used to detumble the spacecraft into a stable nadir pointing configuration. After detumbling, the payload antenna is deployed in discrete increments and at each state of deployment simulations are performed where the spacecraft's attitude is controlled using a reaction wheel based actuation system. Monte Carlo simulations based on a range of initial angular velocities representative of typical tip off rates experienced by 3U spacecraft were performed to validate the feasibility of mission's concept of operations.

To further ensure the success of this mission, a plan for extending the study to a non-rigid spacecraft is discussed.