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DEVELOPMENT OF THE HYBRID MAGNETIC ATTITUDE CONTROL SYSTEM FOR THE VIOLET NANOSATELLITE MISSION

Abstract

Due to the unprecedented growth of the nanosatellite industry, there is a gap to fill for increasingly innovative, cost-effective, and novel attitude control solutions. Passive magnetic attitude control (PMAC) systems have the capability of aligning a spacecraft within 10 degrees of the local geomagnetic field vector while in flight and are a low-cost, robust solution for nanosatellite missions. The student-built 2U VIOLET CubeSat requires a control solution with more pointing options due to the area of the ionosphere to be imaged by the Spectral Airglow Structure Imager (SASI) payload. An innovative and cost-effective solution is being developed, dubbed the Hybrid Magnetic Attitude Control (HMAC) system. This system utilizes PMAC components (a permanent magnet and hysteresis rods) with the addition of air-core magnetic torque coils aligned with the body-fixed axes of the nanosatellite. The magnetic dipole produced by the permanent magnet alone will result in unwanted oscillations as the internal magnetic dipole of VIOLET aligns to the local geomagnetic field vector throughout the orbit. These oscillations can be dampened using ferromagnetic hysteresis rods. With the torque coils being powered, the main magnetic dipole of the nanosatellite will be deflected to an angle directly dependent on the vector sum of the passive and active magnetic dipoles present. This deflection angle will allow VIOLET's imaging axis to be roughly pointed to the limb of the atmosphere over a significantly greater latitude range than possible with only a PMAC system. The attitude dynamics of VIOLET are simulated by the Smart Nanosatellite Attitude Propagator (SNAP) Simulink toolbox, in which all relevant environmental and orbital conditions are considered.