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AN EFFICIENT MOMENTUM DUMPING METHOD THROUGH AN ALTERNATIVE SUN POINTING STRATEGY FOR SMALL NEAR EQUATORIAL ORBIT SATELLITE

Abstract

The VELOX-II is NTU's fourth nanosatellite with experimental communication as primary payload which is scheduled to be launched in 2015. The VELOX-II will be launched into Near Equatorial Orbit (NEO). Typically, small satellite such as VELOX-II does not carry any propulsion system to mitigate the accumulated rotational momentum in reaction wheel. Instead, the accumulated rotational momentum is being "dumped" through the satellite's magnetic torquers and earth's magnetic field gradient. However, one of the main challenges of VELOX-II's attitude control system (ACS) is the rate of earth magnetic field variation in near equatorial region is much lower than the rate of earth magnetic field variation in either north or south pole. Furthermore, the sun direction during both spring and fall equinoxes is almost parallel to equatorial plane that could results at least one momentum axis of satellite is unable to be successfully dumped. All these conditions results a lower satellite momentum dumping efficiency. This is crucial for VELOX-II because it is a three-axis stabilized satellite. Failure or low efficiency in momentum dumping would results the satellite loses its attitude control capability.

To improve the momentum dumping efficiency in VELOX-II, an improved sun pointing algorithm has been considered. The proposed method utilizes a QUaternion-ESTimation (QUEST) based method together with a pseudo magnetic field vector in body frame, and both sun sensor and magnetometer measurements. This allows a higher momentum dumping efficiency where at least two satellite body axes can be guaranteed to be non-parallel with respect to earth magnetic field. Our simulation studies show that the VELOX-II is able to successfully perform momentum dumping using the improved method. However, the VELOX-II is unable to perform momentum dumping if the original sun pointing method is implemented.