46th STUDENT CONFERENCE (E2)
Educational Pico and Nano Satellites (4)

Author: Mr. Saurav K Shastri
PES Institute of Technology, India, sauravks1996@gmail.com

Mr. Kishore Chandrashekar
PES Institute of Technology, India, Kishorechandra07@gmail.com
Ms. Smriti Mishra
PES University, India, smriti12320@gmail.com
Mr. Daivik R Gourav
PES University, India, daivikgourav@gmail.com
Mr. Jimesh Bhagatji
PES University, India, bhagatji.jimesh@gmail.com
Mrs. Divya Rao A
PES Institute of Technology, India, divyarao@pes.edu
Dr. Vinod Kumar Agrawal
PES Institute of Technology, India, vk.agrawal@pes.edu

IN-ORBIT PERFORMANCE OF PISAT DETUMBLING AND ADVANCED B-DOT IMPLEMENTATION TO TACKLE CHALLENGES IN ACTIVE DETUMBLING MAGNETIC CONTROL SYSTEM OF NANOSATELLITES

Abstract

Recently, nanosatellites have gained popularity due to its easy experimentation, cost-effectiveness, better reliability and performance when compared to other traditional satellites. However, the tumbling rate acquired by these satellites when ejected from the launch vehicle into space can reach a maximum up to 55 deg/sec about each axis, by virtue of its smaller size and inertia. Hence, detumbling of satellite plays a pivotal role in satellite design and commissioning, especially when the satellite involves a directional control element. We present the design and implementation of detumbling for PISAT–a magnetically controlled three-axis stabilized imaging nanosatellite, launched by PSLV-C35. The detumbling and three-axis stabilization in PISAT were achieved using an active control system by employing magnetorquers, developed from Permendur 49 core. After the successful launch of PISAT, it was manually commanded to transit into three-axis magnetic control mode to perform earth imaging after an undesirable and anomalous functioning of detumbling was captured through PISAT telemetry. In this paper, we inspect and study this unforeseen behaviour and propose solutions for the same. On investigation, it was observed that the actuation of magnetorquers induced transients in on-board magnetometer measurements. Precautionary measures against these transients were implemented but were found lacking due to the longer settling time of magnetometer, thereby affecting the magnetic field measurements considered for B-dot algorithm. This gave rise to the aberrant patterns in actuation which hampered the detumbling performance of PISAT. Therefore, in this paper, we also propose a new detumbling controller design for small satellites, which accounts the magnetorquers' magnetic field during actuation, it's inevitable residual magnetic field after actuation and the magnetometer time constant. For the design specifications of PISAT, we mathematically model and simulate the cumulative effect of magnetic field and residual magnetic field of all three orthogonally placed magnetorquers on magnetometer for different polarity patterns using ANSYS Maxwell tool and MATLAB. Finally, to improve the performance of detumbling, a rate feedback

is provided to the controller to update the sampling intervals considered in the B-dot computation. Our results show that these proposed algorithms and techniques are generic and can be implemented to successfully detumble any other nanosatellite to be launched in future.