Paper ID: 79994
oral
student

51st IAF STUDENT CONFERENCE (E2)
Educational Pico and Nano Satellites (4)

Author: Mr. Antonio D'Ortona
Politecnico di Torino, Italy, antonio.dortona@polito.it

Dr. Francesco Manconi
Politecnico di Torino, Italy, francesco.manconi@polito.it
Dr. Fabrizio Stesina
Politecnico di Torino, Italy, fabrizio.stesina@polito.it
Prof. Sabrina Corpino
Politecnico di Torino, Italy, sabrina.corpino@polito.it

PASSIVE ATTITUDE STABILIZATION STRATEGY FOR A 3U STUDENT CUBESAT

Abstract

CubeSats are increasingly being used for various space missions due to their low cost and fast delivery. While active attitude control systems, based on reaction wheels, are a valuable solution when precise pointing is required, they can be energy-intensive for a spacecraft with body-mounted solar panels and expensive for educational and fast-delivered missions. On the contrary, passive attitude control systems offer an attractive alternative that can reduce costs and improve reliability. This is particularly true when a reduced set of data should be sent to ground and the communication system can include low-directive antennas.

This study addresses the challenge of passive attitude control for a 3U CubeSat in a communication mission, mostly designed and developed by students of Politecnico di Torino, emphasizing the importance of simplicity and lightness in the design process. To this end, we propose a passive attitude control system that leverages hysteresis rods made of a magnetic alloy with a low resistance to magnetization that allows an easy induction in the magnetic material enabling angular velocity damping. Additionally, a magnet is utilized to generate a magnetic dipole of 0.11 Am^2 that aligns the satellite's long axis with the local magnetic field vector, simplifying the control system. The hysteresis rods and the magnet can be easily integrated into the satellite's structure, making the system highly robust and reliable.

The proposed system is rigorously validated via simulations conducted using MATLAB and Simulink, with the aim of comparing the results obtained with data from an Inertial Measurement Unit (IMU) integrated within the satellite. The simulations demonstrate that the proposed passive attitude control system can maintain the satellite's orientation within a few degrees of the desired position, even in the presence of external disturbances. Along the orbit, the attitude is stabilized with a misalignment of the body axis with respect to Earth's Magnetic Field of 10 deg. Lastly, the simulations highlight that the released energy is dumped in less than 10 days.

The proposed ACS configuration is mounted on board a 3U CubeSat planned to be launched in June 2023. It is expected to have results for the orbits to verify our solutions for the end of August 2023.