Paper ID: 85715
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IP)

Author: Ms. Tirza Ohana Berger de Souza
Samara National Research University (Samara University), Russian Federation

Mr. Igor Lomaka
Samara National Research University (Samara University), Russian Federation

METHODOLOGY AND DEDICATED SOFTWARE DEVELOPMENT TO PROVIDE PASSIVE MAGNETIC ATTITUDE CONTROL FOR CUBESATS

Abstract

The growing number of small satellite launches, especially CubeSats, highlights the need to investigate and comprehend how their distinct characteristics affect orbital dynamics and attitude determination accuracy. Critical factors, such as the higher ballistic coefficient of CubeSats relative to larger satellites with comparable volume density, or the significant role of aerodynamic torque —which increases angular acceleration inversely with the side's size, draw attention to the need of a targeted and thorough modelling strategy. Additionally, given the constraints of CubeSat missions in terms of weight, size, power, and often budget, passive stabilisation methods emerge as a practical solution for ensuring attitude control. Among these, Passive Magnetic Attitude Control (PMAC) stands out for its reliability, durability, and minimal maintenance requirements.

Existing literature offers valuable insights, results, and mission analysis in the field of PMAC. However, progress and future research are hindered by a significant gap: the absence of comprehensive modelling tools that account for gravitational and non-gravitational forces, magnet material composition, positioning, volume, parametric resonance, timing for desired orientation, or even apparent permeability of hysteresis rods. Currently, there is no available methodology that integrates these factors with a detailed model of the Earth's magnetic field. This paper introduces a comprehensive methodology, developed by the Space Research Department of Samara National Research University, accompanied by dedicated software, to model and enable PMAC for CubeSats, thereby enhancing operational efficiency and reliability.

The methodology facilitates an in-depth understanding and consideration of the critical aspects of a magnetically stabilised CubeSat, from initial design projections to motion simulation. The dedicated software acts as a tool for selecting constructive and orbital parameters for CubeSat missions from 1U to 6U and altitudes of up to 800 km. The software also addresses the inverse problem by simulating satellite motion based on given inputs. The Earth's magnetic field model adopted was the IGRF13. The methodology is designed to enhance attitude modelling and support research facilities, especially educational institutions, during mission development where PMAC is considered, to assess its implementation and effectiveness. The efficacy of the methodology and software was validated through tests using data from SamSat-ION, a 3U CubeSat launched by the department in June 2023.

This work was supported by the Russian Science Foundation, project no. 23-67-10007, https://rscf.ru/project/23-67-10007/