Paper ID: 88520
student

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

Author: Ms. Tanya Krishna Kumar
Indian Institute of Technology Kanpur, India

Dr. Dipak Kumar Giri
Indian Institute of Technology Kanpur, India

AI-ENHANCED VISUALIZATION AND CONTROL OF SWARM SATELLITES UTILIZING GEOMAGNETIC ACTUATORS

Abstract

In the realm of space exploration, the utilization of geomagnetic forces presents a promising avenue for enhancing the attitude and orbit control of communication satellite swarms. This paper delves into the innovative approach of harnessing geomagnetic forces to achieve efficient and cost-effective control, resulting in increased satellite lifespan. By exploiting the inherent properties of geomagnetism, we endeavour to produce thrust and torque by dynamically varying the charge distribution on the satellite body, thus leveraging the Lorentz forces for precise control.

The primary objective of this research is to explore the potential of geomagnetic forces for the control and coordination of satellite constellations, enabling dynamic reconfiguration based on demand. This autonomous reconfiguration capability not only reduces the need for manual human intervention but also enhances the adaptability of the satellite swarm to evolving mission requirements.

To achieve robust and autonomous control, we employ artificial intelligence (AI) techniques, specifically leveraging reinforcement learning methods. These AI-based control schemes aim to minimize the need for extensive communication between satellites while ensuring stability and efficiency in the face of varying mission parameters. The application of reinforcement learning facilitates the discovery of control strategies that are not only adaptive but also resilient in dynamic space environments. Furthermore, this research addresses the challenge of achieving stable fly-around manoeuvres of satellites around a central satellite, a critical aspect for certain mission scenarios. Control algorithms are developed to enable precise manoeuvring and positioning, ensuring stable orbits and controlled fly-around scenarios.

In addition to control methodologies, the paper explores visualization techniques tailored for swarm control. These visualization tools aid in monitoring and comprehending the intricate dynamics of satellite constellations, contributing to improved decision-making processes.

In summary, this research advocates for the integration of geomagnetic forces, AI-based control, and advanced visualization techniques to enhance the overall efficiency, adaptability, and autonomy of satellite swarms. The proposed approach holds promise for revolutionizing the design and development of future satellite constellations, making significant strides towards a more sustainable and autonomous space exploration paradigm.