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# AUTONOMOUS CONTROL OF RESOURCE-CONSTRAINED FEMTOSATELLITES

**Abstract**

Femtosatellites (Femtosats) represent a new and emerging space technology, offering a novel platform for innovative space missions and heralding a new category of space system. Consecutively, Femtosats, characterized by their miniaturized size and constrained on-board resources lead to unique challenges such as intermittent and low bandwidth communication, data loss, unstable thermal management, and a limited power budget that affects autonomous control during space missions. As a single unprotected PCB, Femtosats are exposed to harsh environmental conditions and temperature extremes that cause limited life operations and impact basic performance. Autonomy plays a vital role in addressing these challenges by implementing top-level architectures for pointing, task allocation and data handling. This paper endeavors to advance the state-of-the-art in Femtosat technology by developing a range of on-board autonomous control strategies empowered by novel algorithms [1].

The primary focus will be on enhancing the adaptability and efficiency of Femtosat control in dynamic space environments where traditional control methods may be impractical due to the resource-constrained nature of the Femtosat platform [2]. The objectives include the development of autonomous decision-making enabling Femtosats to respond dynamically to changing mission requirements, and environmental conditions. The paper will explore adaptive control algorithms to deal with large uncertainties in the properties of the Femtosat. Thus, for pointing, the paper integrates MEMs attitude sensing and 3-axis magnetic actuation to provide coarse attitude estimation with robust pointing. The top-level strategies developed for overall spacecraft autonomy will prioritize energy efficiency, considering power limitations inherent in Femtosat platforms. The methodology to develop these strategies will involve simulation to capture the particular nuances of Femtosats. The paper will integrate various design considerations for swarm configurations towards the development of optimized coordination. This will enable decision-making algorithms for effective collaboration among Femtosats within the swarm. The paper is poised to contribute to emerging space missions using Femtosats and has broader implications for future space missions, where intelligent, adaptive, and energy-efficient control is imperative. The outcomes of the paper aim to pave the way for more effective and autonomous Femtosat operations, thereby, expanding the capabilities of these miniaturized spacecrafts in diverse space exploration.

[1] Zhongxu Hu, Thomas Timmons, Liviu Stamat, and Colin R McInnes, 'Development of a 10g femto-satellite with active attitude control.,'JBIS, VoL 73, pp. 123-129, 2020.

[2] Tracie R Perez and Kamesh Subbarao. 'A survey of current femtosatellite designs, technologies, and mission concepts.,' Journal of Small Satellites, 5(3):467–482, 2016.