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AOCS DESIGN FOR NANOSATELLITE CONSTELLATIONS

Abstract

Technology miniaturization and wide usage of nanosatellites in the last decade has enabled nanosatellite capabilities to evolve to a new level, where they can be used for scientific experiments and commercial applications. Although technology miniaturization has increased the overall performance of nanosatellites, size and mass constraints often limit the satellite and its payload capabilities. Nanosatellite constellations address the problem by fusing data from multiple small satellites to increase accuracy, or by dividing workload between small satellites. In addition, constellations of small satellites would revolutionize those research areas which benefit from global coverage, frequent revisits and closely spaced measurement points. Work distribution between multiple satellites requires active and accurate control over all of the satellites, thus one requires accurate orbit and attitude determination and control to effectively fuse data from multiple satellites.

This work analyzes nanosatellite AOCS design differences between a single satellite and a satellite constellation. The main focus points for this paper will be to analyze AOCS requirements with different missions, the influence of these requirements on hardware and software design. Furthermore, this work uses real life experiences gained via the design process and lessons learned from the flight experience of Crystalspace, DelFFi, ESTCube-1 and other relevant small -or nanosatellite ADCS/AOCS.

Firstly, work on the requirements focuses on constraints that constellations and formation flying introduces into AOCS design. To investigate how mission complexity affects AOCS requirements different mission scenarios (such as telecommunications in remote areas, natural disaster management etc.) will be analyzed.

Secondly, the paper gives an overview of existing AOCS hardware designs and identifies the main design differences required by nanosatellite constellations. Furthermore, the relation of nanosatellite constellation AOCS hardware design to system software and specific requirements will be determined. In addition, the paper describes opportunities to improve existing AOCS design.

Finally, the article defines the main differences between single nanosatellite and nanosatellite constellation AOCS software architecture and design. The focus will be on algorithms, design considerations, computational complexity and communication issues.