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Educational Pico and Nano Satellites (4)

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AN INTEGRATED ATTITUDE DETERMINATION AND CONTROL SYSTEM WITH SMALL VOLUME AND HIGH PERFORMANCE FOR NANOSATELLITES

Abstract

Nanosatellites have the advantages of small volume, low cost, and short development cycle. However, the small size of nanosatellites restricts the performance and reliability of the attitude determination and control system (ADCS). In this paper, an ADCS including star trackers, reaction wheels, magnetorquers, gyroscope, and sun sensor for nanosatellites is proposed. To improve the performance of attitude determination and the reliability of the ADCS, two star trackers are integrated into the ADCS. To reduce the volume of the ADCS without losing the accuracy, a novel deployable star tracker (DST) is proposed, which adopts the structure of multi-stage deployable baffles and special PCB structure. The DST has a very small volume when it is in the compressed state and can deploy the baffle successfully with high precision and no locking in extreme temperature after it works. The ADCS has an on-board computer (OBC) in which an ARM and RISC-V microprocessor are built based on system-on-chip(SoC) technology. The ARM microprocessor used for data transmission and the RISC-V microprocessor used for data computing respectively. The parameters identification and attitude control algorithm that is integrated into the OBC can identify the inertial parameters and control the attitude of the nanosatellites simultaneously, which increases the flexibility and applicability of the ADCS. So the ADCS can be applied for any nanosatellite simply, even if the inertia parameters are unknown. The outer dimensions and mass of the ADCS are 114x114x74 mm and 920 g respectively, and system performance is 0.02 degree pointing accuracy verified by numerical simulation and 5"(3σ) attitude knowledge verified by experiment.