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PICO STAR TRACKER WITH HIGH ACCURACY AND HIGH DYNAMIC PERFORMANCE APPLIED FOR COMMERCIAL REMOTE SENSING SATELLITES

Abstract

With the development of space technology, small satellites and satellite groups are gradually undertaking more complicated space missions, such as satellite communications, earth observation, detection of space objects, and celestial navigation. The requirements for the attitude information are increasing simultaneously. Therefore, miniaturized star tracker with high accuracy, high dynamic performance, and low power consumption needs urgent research.

A pico star tracker with good performance is described in this paper. The star tracker has a mass of 85g (including the baffle), while the boresight accuracy is 5 (3), and the power consumption is less than 0.6W. We have conducted three research aspects to ensure above performance. The researches include: the hardware system, the algorithm in software and the experiment method. In the hardware system, the SOC (System on Chip) combined with flexible-rigid PCB is adopted. The SOC conducts real-time image processing by pipeline structure. Therefore, image exposure, background analysis, and pixel read out could be conducted at the same time. The image processing can be conducted during the image capturing, and little time delay for this processing method. As for the software design, the algorithms focus on mathematical morphological operation with variable operator, which is effective in star image denoising, and background estimation. Star spot-based optical flow approach is utilized to conduct fast star tracking. Meanwhile, a design method of the star tracker baffle and a background suppression approach are proposed to optimize the exclusive angles of the sun and the earth, and extend the on-orbit working range. The star tracker has been conducted sufficient experiments, and integrated experiment procedure has been established. The experiments involves accuracy measurement based on astronomical observation. Working performances of the star tracker under conditions of large angular velocity, large angular acceleration, close to dawn, and stray light interference are also tested. This type of star tracker has been in orbit in some LEO commercial satellites for remote sensing in china, such Jilin-1 commercial satellite (No1-No8), NS-2 nano satellite, CX-6 of CAS, NCI satellite by SPACETY and high-resolution microsatellite of CAS, et al. The experiment data show that the pico star trackers developed by Tsinghua university perform well, ensure high quality capturing of remote sensing images, and can guarantee the

smooth operation of small satellites in orbit. In the future, as the 'eye' of a satellite, the pico star tracker will provide more possibilities for small satellite tasks, and bring unimaginable opportunities.