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ATTITUDE DETERMINATION AND ONBOARD CONTROL OF SATELLITES USING SMART PHONES

Abstract

For proper Orientation of any spacecraft in its orbit, attitude determination sensors are being used of which the most common are Gyros, accelerometers, star sensors, GPS and Magnetometers. These devices are accurate but are highly expensive. For a student satellite this is not affordable. Smart phones of today have inbuilt high resolution cameras, Gyros, accelerometers and these can be used as star sensors along with other components which form the part of the attitude determination system. The phone consists of a baffle designed for filtering out earth shine and sun illumination. Optical filters are placed near the lens of the camera for narrowing the band of observations. The pointing error are tallied and kept under a permissible error range of a +- 1 degrees. The phone receives inputs for the attitude control system from the camera. After processing the image, the cell-phone's processor determines the attitude of the satellite. The phone optics based attitude control system relies on a correlation with the GPS data, magnetometer and a star chart. The star chart is stored onboard, in the form of a look up table. The actuators for the satellite can then rely on the filtered output from the onboard controller for the controlling the stability of the satellite. The software for identifying the stars are created from the pre-existing smart phone based applications that relied on image processing. Along with the phone there exist a secondary board for providing redundancy to the critical subsystems like the power sub-system, communications sub-system and the onboard drivers for the actuators. Health of the satellite is checked for suitable mission sequencing from within the satellite itself using the secondary board as a means of health monitoring system. Battery power checks are provided on the satellite using the phone based applications as well as the secondary board. As the operating system relies open source softwares, development of plausible mission plans is not a tedious task, leading to the software testing for the entire operation with the actual OS of the satellite much before actual hardware integration. This paper emphasizes a cost effective, highly accurate, miniaturized solution with more than one system for the attitude determination and subsequent control of small satellites using smart phones running on an open source platform with the usage of an optical based attitude control system for future satellite system platforms.