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LITESAT PERFORMANCE OPTIMIZATION GIVEN ATTITUDE CONSTRAINTS AND UNIQUE MISSILE SHAPE STRUCTURE

Abstract

State of the art earth observation satellites usually weights a few hundred kilograms and cost a few hundred million Dollars, therefore due to the cost including launch, high end earth observation constellations are not common. LiteSat is an earth observation microsatellite constellation under development, specially designed to meet high end imaging capabilities and affordable constellation. LiteSat is a 100 kg class satellite, it incorporates a unique design in order to meet the high imaging quality and yet maintain an affordable price. The unique requirements introduce structural, mechanical and attitude constraints in to the design. In order to achieve 70 cm ground sample resolution (GSR) LiteSat uses a very low 350 km altitude orbit. This affects the entire satellite design due to the need to minimize the drag force. LiteSat has a slender, missile shape design in order to minimize drug and thus minimize the propellant mass required for 5 years lifespan. Due to mechanical volume constraints caused by the slender design and the cost requirements, LiteSat uses a single star tracker but yet the reliability figure remains equal to bigger satellites. For redundancy LiteSat uses the camera as secondary attitude sensor in case the star tracker fails. Since the camera has a much bigger optics than a standard star tracker, the extracted attitude is much more accurate. The method of using the main camera as an attitude sensor with hardly any loss of mission performance is further described in the paper. Attitude constraint arises when using a single star tracker due to the need to keep the STR FOV away from the Sun and the Earth. For that reason dedicated attitude constraint avoidance algorithms were developed. Those algorithms can drive the satellite from one "legal" attitude to another "legal" attitude without violating any attitude constraint even if one exists on the path. Traditional attitude determination and control systems do not incorporate on-board autonomous attitude trajectory planning system that is capable of avoiding such hazards. Instead every scenario is checked in a ground based simulation prior to uploading commands to the spacecraft. In case an attitude violation occurs in space despite previously checked in a ground simulation, the spacecraft mode of operation is switched to safe-mode in order to protect the on-board equipment. In this paper an autonomous on-board method for handling attitude violations is described, and the use of this method for LiteSat performance optimization is given as an example.