SPACE PROPULSION SYMPOSIUM (C4)
New Missions Enabled by New Propulsion Technology and Systems (6)

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SOLAR SAIL PROPULSION SYSTEM IN CUBE SATELLITES FOR ORBIT MANEUVERING APPLICATIONS

Abstract

Space propulsion systems are costly and bulky. Presently available thruster technologies require high voltages and are exhaustive. A 3U satellite is proposed by the students of College of Engineering Pune's satellite initiative with a mission objective to demonstrate orbit maneuvering from low earth orbit to a higher orbit using solar sails. Radiation and charge particle density characterization at various altitudes and locations in space forms the utility of the satellite. This student project is divided into 6 subsystems for organization and concurrent prioritization of work. Individual subsystem design and their integration with the satellite is described in this paper. Sail storage and deployment mechanism are the major structural design considerations. Distribution of interior heat generation, firm mechanical contacts to prevent any vibration failures and coincidence of center of mass and center of pressure through interior and exterior component arrangement are some of the salient features of mechanical design. Numerous sail folding techniques with their corresponding strengths and volumetric efficiency are explored. Design with minimal mass to obtain more acceleration for same thrust is necessary. The on-board active attitude control system will orient the satellite to favor maximum orbit rise. This orientation increases the complexities in design of other subsystems by manifold. The challenges in harvesting sufficient power and supporting thermal systems necessitated innovative design. Deployable solar panels with maximum power point tracking increased power generation. An large beamwidth antenna design helped to establish continuous communication link. As a result of varying orbital height, communication link (transceiver and amplifiers)

is designed to handle high power with smart firmware incorporating error correction and data compression techniques. Inertial measurement unit, sun sensors and global positioning system(GPS) are employed for determination of satellite orientation and orbit. The success of the mission relies on the control mechanism, timing precision and accuracy of attitude determination sensors and control actuators. Fast response output of charge particle sensors is conditioned and reshaped by analog circuitry. High frequency pulse detection and source detection computations is implemented on field programmable gate array(FPGA). On-board computer is a microcontroller based, fault tolerant, interrupt driven system providing real time autonomous control. Tri modular redundancy with error correction code implementation makes it robust. Numerous computational simulations were performed for prediction, verification and optimisation of practical implementations. The technology proposed here is an experiment which will deliver a low cost and non-exhaustive alternative means of space travel which can form baseline for future satellite missions.