Paper ID: 76753
student

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Specialized Technologies, Including Nanotechnology (8)

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DESIGN AND MANUFACTURING OF A MODULAR, LIGHTWEIGHT AND SCALABLE REACTION WHEEL SYSTEM FOR SOUNDING ROCKET ROLL CONTROL AND STABILIZATION

Abstract

The use of sounding rockets for microgravity and hypergravity experiments is becoming more prominent, especially for biological research. Given the expensive nature of these experiments, ensuring standard and replicable conditions is of the utmost importance. It is vital for all tests to experience the same acceleration, both on magnitude and direction. Longitudinal stabilization is generally achieved through the use of rocket fins. On the other hand, this method is not commonly employed for roll stabilization. This paper aims to develop and test a reaction wheel mechanism that allows for roll control and stabilization. The system will ensure a constant roll angular velocity of the rocket, allowing the replicability of the experiments under the same conditions of centrifugal acceleration. The system is designed to be lightweight and adaptable to different rocket sizes. It has been designed to work independently from the main on-board computer, with the exception of the sensor data received from it. Said data is employed to perform the calculations on its integrated computer and adequately modify the velocity of the reaction wheel. Control loops have been designed and simulated using Simulink. The system has been first tested in laboratory conditions to check the operation of the control loops against external disturbances. A launch test was carried out in a sounding rocket to certify the success of the roll control during a real flight. All tests included monitoring of the temperature of the motor driving the reaction wheels, to ensure that it did not overheat. In conclusion, this system will allow any sounding rocket to spin at a constant velocity. This is not only needed for on-board experiments but also proofs useful to stabilize the recordings of the rocket cameras, as well as other possible applications