70th International Astronautical Congress 2019

Paper ID: 48992
oral
student

47th STUDENT CONFERENCE (E2)
Educational Pico and Nano Satellites (4)

Author: Mrs. Divya Rao Ashok Kumar
Simon Fraser University, Canada, divya_rao_ashok_kumar@sfu.ca

Ms. Ridhima Mahajan
Bharat Petroleum Corporation Limited, India, ridhima.ic.10@gmail.com
Prof.Dr. Krishna Vijayaraghavan
Simon Fraser University, Canada, krishna@sfu.ca
Dr. Vinod Kumar Agrawal
India, vinod-cse@dsu.edu.in

ANALYSIS OF OPTIMAL REACTION WHEEL CONFIGURATIONS FOR INTEGRATED THREE AXES CONTROL FOR ON-ORBIT SERVICING NANOSATELLITES

Abstract

Satellites are designed to reach space and serve their mission objective for designed mission life. However, certain fully operational satellites are often decommissioned due to depletion of onboard fuel. In addition, other satellites fail in orbit due to unforeseen faults which can cause system failure representing the loss in the billions of dollars. On-orbit servicing (OOS) satellites approach the faulty satellite and execute the repairs, replacements or refueling to regain operations of the faulty satellite. The main purpose of the paper is to understand the possibilities to demonstrate the OOS capabilities with reduced cost nano-satellites. This paper will provide scope for using nano-satellites for refueling, repairing, maintenance and orbital debris removal. OOS using nano-satellites is challenging as we aim to design the satellite with commercially off the shelf (COTS) sensors and actuators. Miniaturization of actuators (thrusters and momentum wheels) also provide scope for agility and orbit modification capability in servicing satellites. This study provides the feasibility analysis on using the COTS reaction wheels and magnetic torquers for the attitude and angular rate control of OOS nanosatellites. OOS missions aim to have precise attitude and orbit control systems onboard. The attention on appropriate actuator configuration selection is required due to compact size and lesser scope of component placement and integration in nanosatellites. It is well known that a combination of magnetic torquers and four reaction wheels is suitable to establish a reliable attitude control of the satellite. However, sizing and selection of actuators plays an important role in nanosatellite design. The paper provides the trade-off analysis in consideration of reaction wheels configuration based on availability, cost, power and size. The restrictive design choices of the actuator especially reaction wheels, leads to execute extensive trade-off analysis. The failure of one or more reaction wheels in the conventional configurations has been taken into picture which brings out the importance of having redundant actuators for an autonomous control of the nanosatellite. The study also aims in analysis of torque distribution under the circumstances of reaction wheel failure and autonomously decide the contingency action under actuator failure for a given trajectory. The paper provides the detailed calculations of attitude accuracy achieved in different failure scenarios. The continuous and smooth control of satellite upon failure of one or more wheels has been studied with simulations providing the attitude control possibilities using magnetic torquer rods under wheel failure.