Paper ID: 59944
oral
student

18th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Post Mission Disposal and Space Debris Removal (2) (6)

Author: Mr. Jimesh Bhagatji
PES University, India

Mr. Prashanth Murali
PES University, India
Mr. Amogh Anantha Murthy
PES University, India
Mr. Manoj Mydur
PES University, India
Dr. Sharanabasaweshwara Asundi
Old Dominion University, United States

REALISATION OF AN EFFECTIVE AND RELIABLE DEPLOYMENT OF SMART DRAG SAIL FOR PNMSATS TO DETERMINE/REFINE DTM IN ORBIT

Abstract

To reduce space debris, newly launched satellites require a deorbiting system. Also, for satellite and debris in LEO, orbit prediction and determination is crucial for reducing the error in predicting re-entry and collision avoidance for unmanned and manned space flights. A payload improving the existing Drag Temperature Model (DTM) will be of great value to improve the current debris/satellite catalog maintenance.

The authors propose an effective payload called PiSail for Pico/Nano/Micro satellites(PNMSats). It consists of a smart sail that has dual functions: Strain gauge based in-situ Drag Sensing (SiDS) and drag augmentation. The objective of the proposed payload is to enhance drag with the smart sail of area (3 m^2), fully contained in a 1U module for use in PNMSats. During deorbiting, the sail is equipped with sensing elements to determine in-situ data of the space environment, hence refining DTM.

PiSail is a realisation of the multi-function Drag Measurement System (mDEMS) with an effective deployment and smart sail with SiDS. The feasibility of the deployment mechanism of the payload is confirmed by developing a scaled-down (1:2) version of the smart sail in-house. The project is to be carried out in 2 stages:

In the first stage, the sail folding pattern is selected, and suitable strain sensor placement is identified to determine drag forces experienced by drag sail. The sensor configuration is selected by FEM analysis on ABAQUS with realistic boundary conditions. The pulling force required by smart drag sail for the unpacking of the selected folding configuration is experimentally determined. Based on sail deployment loading conditions, the carbon fiber boom is developed in house.

In the second stage, the lightweight (<500 g) module is designed with high packing efficiency, hence enabling an effective deployment for SWaP(Size Weight and Power) constrains for PNMSats. A high tolerance gear mechanism is developed for the deployment, thus having high reliability for the module at End of Life (EoF). The reliability of the system is further improved by the usage of a linear actuator to drive the deployment. The deployment structure is designed for vibration loads by FEM analysis.

Further, FEM modal analysis of the boom is conducted in ABAQUS and experimentally validated to ensure the reliability of the system. Thus, a 1U module for the deployment of a smart drag sail of 1.5 m^2 embedded with SiDS system is realised. It is tested at ground level for TRL-5.