IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IP)

Author: Mr. ASHOK KUMAR K
U R RAO SATELLITE CENTRE (URSC), India, kashok@ursc.gov.in

Mr. Aditya R
U R RAO SATELLITE CENTRE (URSC), India, adityar@isac.gov.in
Dr. MOHAN SUNDARA SIVA
U R RAO SATELLITE CENTRE (URSC), India, mssiva@ursc.gov.in
Mr. G.V.P. Bharat Kumar
Indian Space Research Organization (ISRO), India, bharat@isac.gov.in
Mr. P S Sura
U R RAO SATELLITE CENTRE (URSC), India, pssura@ursc.gov.in

A NOVEL APPROACH FOR DYNAMICS MODELLING, ANALYSIS AND SIMULATION OF BOOM MOUNTED REFLECTOR DEPLOYMENT PROCESS FOR SWEEPSAR IMAGING SATELLITES

Abstract

Advanced SAR Imaging Spacecraft are designed to meet wide variety of applications without compromise in the resolution so that they can capture entire features of Earth with short repeat cycles of a week or so. These missions use the technology called SweepSAR or 'Scan to Receive'. Here while the part of transmit antenna is used for imaging the return signal is focused to entire boom so that integrated energy strength is very high compared to noise. In these satellites, the Radar Antenna Reflector (RAR) of about 12 m is attached to a 9m Reflector Boom Assembly (RBA) and are stowed during launch. Post separation, and solar panel deployment, deployment of RBA and RRA will be performed before initiating science observations. This paper presents a novel approach for deployment dynamics modeling of the Spacecraft. The deployment of RBA is accomplished through complex 4-Hinge deployment followed by deployment of RAR deployment.

RBA consist of 4 joints namely wrist, elbow shoulder and root. Each joint in RBA deployed sequential followed by which reflector is deployed. Reflector is modelled as five lumped masses connected to boom using three degree of freedom translational joint. These joints have to follow a prescribed motion in order to capture high resolution dynamics. Hybrid multibody dynamics is used to model this deployment process as forces are defined on some joints namely six degrees of freedom base and reaction wheel for control application and constrained accelerations on others namely boom and reflector joints. Constrained accelerations for boom joints are derived using two-point boundary value problem where initial and final condition of boom angles are known. For reflector joints, an optimizer is used to generate position and thus acceleration profile in order to match high resolution dynamics output. The latching of each joint is modelled by posing additional constraints which modifies the motion sub-space matrix. External disturbance acting on each multi body system is modelled to capture the true spacecraft attitude motion during each stage of the deployment. After every deployment stage, Attitude control parameters are updated in order to maintain sufficient control margins and also avoid control structure interactions with solar arrays flex dynamics.

Detailed simulation of on-orbit scenario is done using above defined approach. The simulation results show the efficiency of the algorithm in terms of computations and the accuracy for predicting the complex deployment states.