ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (1) (1)

Author: Mr. RaviKumar L
ISRO Satellite Centre (ISAC), India, rkkumarl@isac.gov.in

Mrs. KanuPriya Govila
ISRO Satellite Centre (ISAC), India, kanug@isac.gov.in
Mr. Siva Mohan Sundara
Indian Space Research Organization (ISRO), India, mssiva@isac.gov.in
Dr. N K Philip
ISRO Satellite Centre (ISAC), India, philip@isac.gov.in

AUTONOMOUS ORBIT CORRECTIONS USING MODEL PREDICTIVE CONTROL UNDER CONSTRAINED REORIENTATIONS

Abstract

SARAL is an imaging satellite carrying Altika (Ka band altimeter), Laser Reflector Array (LRA) and the ARGOS-3 instruments. This mission requires precise, repetitive global measurements of sea surface height which calls for orbit corrections at regular intervals. In this paper autonomous orbit maneuver (OM) for SARAL spacecraft using model predictive control (MPC) is addressed to meet the reorientation constraints of actuators. In SARAL, Attitude control is carried out using four Reaction wheels in tetrahedral configuration and Orbit correction are carried out with Mono propellant thrusters. As the, thrusters are mounted on the positive pitch face of the spacecraft, attitude reorientations are called upon to reorient the thrusters along velocity vector for orbit correction and rotate back after the event for nominal Earth-Pointing. Since one of the reaction wheels failed, the attitude control is carried out with three wheels configuration by operating wheels at a small bias momentum. This has helped in avoiding zero-crossover and providing required accuracy during the payload operations. But during attitude maneuvers for OM orientation, the momentum transfer is called for in the plane normal to rotational axis. This results in zero speed cross-over. But the wheels once enter in stiction zone;, they got stuck there unless external torque is applied. As a result ground track starts drifting from the nominal track i.e. 1km. Hence attitude maneuver for OM orientation has to be done with thrusters. But Delta V requirement is very small compared to the Delta V imparted due to thruster firing for rotational maneuvers. It was a big challenge to plan the maneuvers so that the ground track has to be maintained within nominal value. Novel control algorithm has been designed using Model Predictive Control (MPC) which determines the maneuvering angles as well as predict the velocity change needed to maintain the required orbit. This approach attempts for minimizing error between the Required Delta-V and Predicted Delta-V. Orbit Models, spacecraft dynamics kinematic models and PWPFM outputs are used for predicting the Delta V during Forward and Reverse rotation maneuvers. The problem determines the required rotational angle as a function of Delta-V. The real time thruster firing data is used to minimize the prediction error in Delta-V. Once the required Delta-V is achieved, the Control loop will change over to Wheel Control. This approach has been demonstrated offline in SARAL mission for maintaining the track within 1km and orbit correction up to 10m in SMA.