Paper ID: 18970
oral

ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (2) (2)

Author: Dr. Mohammad Abdelrahman
International Islamic University Malaysia, Malaysia

SPACECRAFT SUN POINTING USING COPLANAR SOLAR PANELS DATA AND MAGNETIC FIELD MEASUREMENTS

Abstract

The orientation of the solar panels towards the sun is one of the major tasks for the ADCS. After separation from the launcher the sun-acquisition mode takes place. Following to the sun-acquisition mode the ADCS switches to the sun-pointing mode. Both modes can be handled either by active actuation and measurements using sun sensors, or passively, by investigating the sun angle w.r.t the spacecraft orbit and adjust the setting angles of the solar panels, area exposed to the sun, and spacecraft inertia such that during earth- pointing mode the solar panels can capture the required energy to fulfill the spacecraft power profile. The drawbacks of the passive approach are the requirement of relatively wide-area solar panels, complexity of the structure and the degradation of the solar power provided by the solar panels due to the degradation of the orbit and uncompensated change of the sun angle w.r.t the spacecraft orbit. The goal of this paper is to develop an algorithm for sun vector estimation without any explicit measurements from sun sensors. The developed algorithm is applied to a spacecraft designed as a passively sun-pointed spacecraft with coplanar solar panels. The design of the estimator follows the Extended Kalman Filtering EKF scheme. The estimator process dynamics are derived through the augmentation of the spacecraft nonlinear dynamics, quaternion kinematics, and sun-vector kinematics. Magnetometer measurements and its corresponding time derivatives are used to represent the estimator measurement model. The sun angle measurements from solar panels based on temperature, voltage data, and current data are added to the overall measurements model. The controller for sun-pointing mode is based MSDRE developed previously by the author to solve a trajectory tracking/model following problem. The spacecraft three-axis attitude, rate, and orbit information is provided by an Augmented Dynamics Extended Kalman filter. EgyptSat-1, is a remote sensing satellite in a near circular sun-synchronous orbit. The flight scenario of EgyptSat-1 does not include a sun-pointing mode; it utilizes four coplanar solar panels to provide the satellite with the required power. The proposed algorithm is applied to EgyptSat-1. The satellite switched from earth-pointing to sun-pointing mode using the estimated sun-vector. The algorithm successfully derived the spacecraft to track the sun vector with pointing accuracy within 5 degrees without any change in the hardware sizing. For the same power budget, the improvement in sun-pointing is interpreted as a reduction of the solar panels area and hence the overall mass budget.