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ESTIMATING SPACECRAFT ATTITUDE BASED ON IN-ORBIT SENSOR MEASUREMENTS

Abstract

AAUSAT3 was launched February 2013 as a science experiment for the Danish Maritime Safety Administration, for monitoring ship traffic in arctic regions. This mission has been a large success. AAUSAT4 is an enhanced version of the former satellite, and is expected to be launched in the winter of 2014/15. To better evaluate the performance of the payload, it is desirable to couple the payload data with the satellite's orientation. With AAUSAT3 already in orbit it is possible to collect data directly from space in order to evaluate the performance of the attitude estimation.

An extended kalman filter (EKF) is used for quaternion-based attitude estimation. A Simulink simulation environment developed for AAUSAT3, containing a "truth model" of the satellite and the orbit environment, is used to test the performance The performance is tested using different sensor noise parameters obtained both from a controlled environment on Earth as well as in-orbit. By using sensor noise parameters obtained on Earth as the expected parameters in the attitude estimation, and simulating the environment using the sensor noise parameters from space, it is possible to assess whether the EKF can be designed solely on Earth or whether an in-orbit tuning/update of the algorithm is needed. of the EKF.

Generally, sensor noise variances are larger in the in-orbit measurements than in the measurements obtained on ground. From Monte Carlo simulations with varying settings of the satellite inertia and initial time, attitude and rotational velocity, the EKF proves to be robust against noisy or lacking sensor data.

It is apparent from the comparison of noise parameters from Earth and space, that an EKF tuned using Earth measurements of sensor variances will attain an acceptable performance when operated in Low Earth Orbit (LEO). Tuning of the EKF in space will slightly improve the performance of the EKF but it is possible to determine the attitude of the satellite with a relatively low angular error without in-orbit tuning.