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REAL-TIME MAGNETOMETER CALIBRATION USING A THREE-AXIS HELMHOLTZ COIL

Abstract

Attitude Determination (AD) is one of the main subjects which is studied in satellites that have pointing modes in their mission. In order to obtain satellite attitude with good level of accuracy, sensor selection will be a major task which should be done by Attitude Determination and Control Subsystem (ADCS) designers. The most common AD sensors which is utilized in satellites are: magnetometer, sun sensor, rate gyro and star tracker. The level of AD accuracy in each ADCS mode determine which sensors should be employed to accomplish the mission goal.

Magnetometer is the main AD sensor which is utilized in many satellites. It is used in most of the ADCS modes each requires different level of AD accuracy. Though, the accuracy of a three-axis magnetometer depends on three factors, namely biases, scale factors, and non-orthogonality corrections. Scale factors and non-orthogonality corrections occur because individual magnetometer axes are not orthonormal which is typically due to thermal gradients within magnetometer or satellite mechanical stress. Therefore, magnetometers should be calibrated during satellite life time to ensure that the best possible precision from magnetometer measurements are obtained.

In this regard, there are some approaches which use batch estimation methods for the problem of magnetometer calibration. However, in another approach which is applicable for real-time applications, an Extended Kalman Filter (EKF) is utilized to determine the calibration parameters. An advantage of this method over the other sequential centered approach is that bias vector and the matrix which contains scale factors and non-orthogonality corrections are directly estimated.

In this paper, a real-time magnetometer calibration method is presented. This method which is based on an EKF is implemented in a three-axis Helmholtz coil set-up. Then, magnetometer measurements are utilized in an attitude estimation test-bed which contains a three degree of freedom air bearing platform that is equipped with an Attitude and Heading Reference System (AHRS). Consequently, magnetometer parameters are estimated experimentally and precise measurements are utilized for attitude estimation whose accuracy is calculated using AHRS data.