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TIME-VARYING ERRORS FOR MAGNETOMETERS ON SMALL SATELLITES

Abstract

A three-axis magnetometer (TAM) is as an essential attitude sensor for low-Earth orbiting small satellites. Being light, small and inexpensive make TAM an ideal attitude sensor specifically for nanosatellite missions. Nonetheless, it is a known fact that the accuracy of the TAM sensor suffers from the electromagnetic interference (EMI) onboard the nanosatellites. Thus several researches have been conducted for real-time estimation and compensation of the magnetometer errors caused by the EMI.

Recent studies show that on small satellites the magnetometer errors vary over time. In situ experiences with the launched spacecraft missions also confirm this fact. Variation in the magnetometer errors may be a result of the change in the state of the magnetic torquers and, interference from the nearby electronics and ferromagnetic materials (soft irons). Despite a number of researches about time-varying magnetometer errors, the calibration algorithms are usually applied ad hoc after the launch since the researchers lack information about the error characteristics. Besides only the variation in the magnetometer bias terms is considered and all other errors such as scaling are assumed to be time-invariant. Detailed analyses and experiments are needed to model the time-variation of the errors and to be able to distinguish the different error sources. A proper real-time calibration algorithm may be designed only after the error variation is understood clearly.

This study presents the preliminary results for an ongoing investigation that aims real-time calibration of time-varying magnetometer errors. In this research, our first aim is to model the time-variation of the magnetometer error terms with experiments. The error is a function of several inputs such as the magnitude of the torque applied by the magnetic torquers, amount of the current for electronics (e.g. solar panels) and the location of ferromagnetic materials onboard the spacecraft.

In this paper we discuss our method to model the time-variation in the magnetometer errors. The theory is supported with the experiments that we conducted using an integrated TAM, gyro and accelerometer sensor which is suitable for nanosatellite applications. The experiment setup is introduced and the practical issues concerning a realistic magnetometer error model derivation are discussed.