Implementation of three axis attitude determination and control system for a double cubesat using the EQUEST method and magnetic torquers

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The NUTS (NTNU Test Satellite) is a satellite being built in a student CubeSat project at the Norwegian University of Science and Technology. The project was started in September 2010 as a part of the Norwegian student satellite program run by NAROM (Norwegian Centre for Space-related Education). The NUTS project goals are to design, manufacture and launch a double CubeSat by 2014. As payload an IR-camera observing waves in the air-glow layer is planned, as well as a short-range RF experiment. The satellite will fly two transceivers in the amateur radio bands. Final year master students from several departments are the main contributors in the project and most of the system components are designed and built by students.

Last term a new method for attitude estimation based on QUaternion ESTimation (QUEST) was developed by members of our project group. The Extended QUEST (EQUEST) method enables the fusing of vectorized and non-vectorized measurements making it more suitable for attitude estimation. Simulations showed that for cubesats, which often uses magnetorquers for both attitude estimation and control in addition to the often limited computational power, the EQUEST method offers several advantages over the well known Extended Kalman Filter.

Described in this paper is an implementation of the EQUEST method using magnetorquers for 3-axis magnetometer data, solar panels for sun sensing and a 3-axis gyroscope. This information is further combined with continuous computation of the geomagnetic field using the IGRF-model on a single 8-bit, 16MHz microcontroller unit to apply correct actuation to the magnetorquers through the use of well known controller algorithms.

Finally simulation and prototype test results are presented which confirms the adequacy of this simplistic approach for keeping the satellite within the stability requirements of our payload.

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