Development on the EQUEST method for attitude determination

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Abstract

A new extended quaternion estimatior (EQUEST) method is being developed for the Norwegian University Test Satellite (NUTS). The attitude is calculated by minimization of a cost function relating sensor measurements with known references. The method is intended for use in the ADCS of a CubeSat.

The satellite is being built in a student CubeSat project at the Norwegian University of Science and Technology. The project was started in September 2010 and is 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.

The work is based on a quaternion estimator (QUEST) method which is extended to include non- vectorized measurements, such as gyroscope data. The main idea behind this extension is to modify the cost function by including terms for the gyroscope measurements and attitude prediction. An early version of the algorithm used quaternion subtraction for evaluating error in attitude in the cost function. This cost function has been developed further by changing the quaternion subtraction terms into quaternion products. When multiplied, the quaternions will represent proper rotations, and form new attitude quaternions. Ways of minimizing the new cost function are analyzed. Because of the limitations of CubeSats, the electronic components need to be optimized in regard to size, financial budgets and power use. This in turn influence which estimation method to use. The quaternion product is more computational expensive than the quaternion subtraction, but the former leads to a more accurate mathematical model. For the intended hardware and sampling time for the satellite, the added number of software operations for the quaternion product are not expected to be a problem.

Preference for presentation: oral
Most suitable session: Attitude determination and control (Session 6)

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