Paper ID: 11748
oral

15th SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Generic Technologies for Nano/Pico Platforms (6B)

Author: Mr. Craig Clark
Clyde Space Ltd., United Kingdom

A PLUG-N-PLAY ATTITUDE DETERMINATION AND CONTROL SYSTEM, INCORPORATING CONTROL ALGORITHM, FOR CUBESATS

Abstract

All CubeSats are based on the 10cm x 10cm x 10cm (or more) footprint, and remain within a fixed mass constraint, so that they can be launched from a standard CubeSat deployment system. Given that most CubeSats are essentially boxes of stacked electronics boards, the mass distribution within the CubeSat is almost always the same. This means that the dynamics of the spacecraft are well known and understood, making it possible to have a generic solution to controlling the attitude of the spacecraft.

This means, importantly, that not only can the Attitude Determination and Control System (ADCS) hardware be the same for every CubeSat, but the software in the ADCS Task can also be the same. In short, it is possible to design an ADCS system that can plug into the CubeSat bus and provide attitude control without the need to perform bespoke design of the system (i.e. control algorithms, computing capability, etc.).

The ADCS consists of a Motherboard, with the option to add additional sensors and actuators to achieve the desired performance. The motherboard is the heart of the system and provides the CubeSat with the basic attitude control. The motherboard is also programmed to provide a detumbling mode to capture the spacecraft in a nominal attitude after launch.

The mother board interfaces to the following sensors and actuators as a minimum for operation: coarse sun sensors, magnetometers, a 3-axis MEMs rate gyro and magnetorquers. For enhanced performance, achieving greater than +/-1deg pointing accuracy, more advanced sensors can be added to the system, including precision sun sensors and reaction wheels and a GPS receiver.

An FPGA runs the spacecraft control algorithm, providing local control and monitoring of the actuators and sensors. This means that the spacecraft does not need to have additional on-board computing on which to run the control algorithm, providing a form of distributed, modular on-board computing.

Furthermore, and if the above was not enough, we challenged ourselves to fit this complete system, including the advanced sensors and actuators, within one quarter of a 1U CubeSat (a height less than 30mm). We set ourselves this challenge so that we can help to maximize the payload volume on a CubeSat bus, and, with the ADCS unit having typically been the largest item on a CubeSat, this was an area in need of being addressed.

This paper describes the development and performance of this plug-n-play ADCS unit for CubeSat.