Paper ID: 18984
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20th SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Operations (3)

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PARAMETRIC CUBESAT FLIGHT SIMULATION ARCHITECTURE

Abstract

This paper presents a mathematical modelling architecture which simulates the dynamic, in-orbit behaviour of a CubeSat. The model captures time-dependent relationships between sub-systems and propagates forward a set of state variables through numerical analysis. Assessment is extended beyond that of just a typical orbit and attitude simulator, and examines the variation in other time-dependent system elements such as on-board data volume, solar cell efficiency, battery charge and temperature.

A parametric philosophy is considered vital to the flexibility and expandability of this architecture and is achieved through a combination of robust interface definitions and implementation of general solutions throughout. For example, sun shading on solar cells from neighbouring deployed panels is analysed as a function of a configuration matrix, which is built up of information gathered from user-friendly input parameters such as stowed position and deployment angle of the deployed panels. Due to the limited resources and physical constraints associated with the 'CubeSat' platform, this parametric approach enables iterative design to be carried out with minimal user input, extending this architecture to use as a design tool in addition to an operations simulator.

Operational mode states can be defined by the user, allowing the systems engineer to assess flight behaviour in typical (Nominal, Standby and Survival) and bespoke modes early in a mission programme. Selectable mission element capacity is also included which minimises simulation time for capturing the information of interest. For example, short term (several orbits) assessment of position, attitude, payload, communication, temperature and power is possible, whilst long term (several years) projection of orbit decay resulting from environmental disturbances can also be assessed with reasonable simulation times.

The operational simulator presented has been applied to the UKube1 mission, the UK's first CubeSat due for launch in 2013, in order to predict expected performance during flight. The models shall be validated using flight data once available.