SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Small Satellite Operations (3)

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THE SELF-TRACKING SMALL SATELLITE

Abstract

This paper presents a novel approach to the problem of tracking on board very small satellites: using the open-source code developed for this paper[1], it shows how a micro-controller on board a satellite can efficiently track that satellite's own position in real time and that even a very simple and conservative power-saving algorithm based on this information improves the power budget of a satellite by 15%[2].

Cubesats are much more useful if they operate with tracking information provided in real time on board the satellite. This information can be used to achieve mission goals (such as photographing certain parts of the world) and, perhaps most importantly, to lower power consumption by reducing transmission power over unpopulated areas.

In recognition of this potential, missions as early as CANX-1 have deployed GPS engines. However, this approach imposes hefty power demands, potentially negating the advantages that might be accrued from location-based transmission switching. The experience of COMPASS-1[3], moreover, shows that successfully deploying a GPS unit on board a 1-U cubesat is not an easy electro-mechanical task.

In this paper's alternative approach, an on-board micro-controller tracks the satellite itself in real time. This hardware draw only an average of 153 μwatts as it produces 1 subsatellite point per second. This datum is compared to a set of rectangles representing open ocean, and it lowers or raises an output pin accordingly. A very conservative scenario would have a cubesat transmitter drop its 120mW signal to a 30mW when over 20% of the earth. The tracker power budget is inconsequential, and virtually the whole 15% power savings is realized.

This approach does make some additional demands on the satellite's systems. A highly accurate realtime clock, able to handle difficult temperatures, is needed. However, these requirements seem handily met by the latest generation of realtime clock hardware, such as of the Maxim DS3232. (If this is included in the tracking power budget, the above budget savings is reduced to about 12%.) The satellite's own keplerian elements must be transmitted to it every 20 days or so. The author has devised a compressed format for TLEs stored in EEPROM and provides a Ruby program that generates this binary format. He also provides a C++ library for store and access keplerian elements in micro-controller EEPROM.

[1]`http://code.google.com/p/qrptracker/`

[2] A video illustrating this is available at
`http://www.youtube.com/user/VE9QRPp/a/u/2/QSUK7Jq3LCY`

[3]Scholz, A et al. (2009) "Flight Results of the COMPASS-1 Mission".
`http://www.raumfahrt.fh-aachen.de/compass-1/download/COMPASS-1`