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Generic Technologies for Nano/Pico Platforms (6B)

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INNOVATIVE MULTI-FUNCTIONAL SOLUTIONS HELP TO RELIEVE DESIGN LIMITATIONS IN NANOSATELLITES

Abstract

Students at the French South African Institute of Technology (F'SATI) at the Cape Peninsula University of Technology (CPUT) are developing two CubeSats: a 1U CubeSat (1.3 kg) and a 3U CubeSat (4 kg). The 1U mission's main payload is an HF beacon that will be used to characterise a space weather radar antenna at the SANAE base in Antarctica. The beacon is being developed in collaboration with the Hermanus Magnetic Observatory (HMO). The 3U mission's main payload is a 5 megapixel matrix imager with a ground sampling distance of approximately 100 m. Secondary payloads include a UHF store and forward system and a data transponder using an L-band uplink and an S-band downlink.

Nanosatellite systems have severely constrained mass and power budgets. While these constraints limit the amount of redundancy that can be designed into the system compared to traditional space missions, nanosatellites serve a different class of applications. Originally developed by educational institutions for small budget missions, they allow substantially reduced overall cost, complexity and development time. With a novel design approach a significant level of redundancy can still be included in the system design.

FSATI's 3U CubeSat uses deployable paddles for aerodynamic roll control. The increased surface area may also be used to mount additional solar panels, thereby relieving the power budget. The L-band and S-band antennas are combined into a dual-resonant four element antenna system at the trailing end of the satellite, with its atmospheric drag providing passive aerodynamic stabilisation. The S-band transmitter is the primary payload downlink transmitter, with a secondary function as backup telemetry transmitter. The L-band receiver is used in conjunction with the S-band transmitter in an experimental data transponder, while also serving as backup telecommand receiver.

In the 1U CubeSat the HF beacon transmitter's carrier signal will be used to calibrate terrestrial radar antennas, but can also be ASK modulated to transmit low bitrate data, allowing it to be used as a backup telemetry transmitter. Additionally, the HF antenna, a 5 m long deployable tape, will be studied for its potential use as a deorbiting device by monitoring the satellite's increased atmospheric drag through its rate of orbit decay.

The F'SATI CubeSat missions accommodate a large number of student projects in complex, multidisciplinary systems, constrained by the inherent limitations of nanosatellites. Through an innovative design approach it has been shown that some of these limitations can be relieved.