SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Design and Technology for Small Satellites - Part 2 (6B)

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NARCISO: A MICROSATELLITE TAKING PICTURES OF ITSELF FOR SPACE ENVIRONMENT EFFECTS MONITORING

Abstract

In the early nineties the Group of Astrodynamics of the University of Roma "La Sapienza" (GAUSS), established the UNISAT program at the School of Aerospace Engineering of Roma with the aim to design, manufacture and operate in orbit small educational satellites involving students, researchers and professors in a real space project. In the framework of this program four satellites have been launched in 2000, 2002, 2004 and 2006 from Baykonour Cosmodrome using DNEPR launch vehicle. The efforts in reducing costs as well as weight and volume have always been directed to adapt innovative, terrestrial commercial off-the-shelf technologies to the space environment. UNISAT-3, launched in June 2004, is operative after more than four and a half years from launch. This experience showed that it is possible to use terrestrial technologies in orbit, including solar cells, electronic components and sensors. The approach of using low cost commercial off the shelf components permits to use UNISAT satellites as a platform for testing innovative systems and devices in orbit. In particular, UNISAT-5 attitude stabilization system will be based on the well known gravity gradient effect by exploiting a new kind of deployable boom. The design of this deployable boom, based on harmonic steel tape coil spring, is inspired to the booms developed for the SIRDARIA deorbiting system boarded on UNISAT-4. The same concept has been adapted to the attitude control of UNISAT-5, by increasing the boom length up to three meters. The design, realization and tests of the boom are depicted in the first part of the paper. The second part of this paper deals with design and realization of the tip-mass. It is a one kilogram, ten by ten centimeters, autonomous payload, capable to perform simple experiments such as taking pictures of the mother satellites, which will be transmitted to the mother satellite using a wireless connection and then downloaded to the ground station. The tip-mass, named NARCISO, is realized by rapid prototyping technique, in ABS plastic material. The rapid prototyping is a quite innovative technique which is used to manufacture plastic parts, by overlaying 0.3 mm melted plastic layers (plastic melting temperature is about 330 C). A complete structure capable of hosting all subsystems required by a small satellite, from electronic board to antennas and solar cells, can be manufactured in a short time (about 23 hours) with reduced costs. Moreover, almost any shape and mechanical detail within 0.3 mm accuracy (the height of the single layer) can be obtained. The numerical analysis carried out to evaluate the NARCISO capability to withstand static and vibration launch loads shows that ABS characteristics seem to be suitable to survive Low Earth Orbit radiation and thermal environment for a period of time compatible with usual university class satellite lifetime. The UNISAT-5

satellite and the NARCISO tip-mass will take pictures of each other. In this way, the UNISAT solar cells degradation can be photographed and the ABS degradation can be also monitored by remote visual inspection.