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Author: Ms. Desirée González-Rodríguez
University of Vigo, Spain, desiree.gonzalez.rodriguez@uvigo.es

Mr. Pedro Orgeira-Crespo
Universidad de Vigo, Spain, porgeira@uvigo.es
Dr. José M. Nuñez
University of Vigo, Spain, jnunez@cud.uvigo.es
Prof. Fernando Aguado Agelet
University of Vigo, Spain, faguado@uvigo.es
Dr. Carlos Ulloa
University of Vigo, Spain, carlos.ulloa@uvigo.es
Dr. Alejandro Gomez-San-Juan
Universidad de Vigo, Spain, alejandromanuel.gomez@uvigo.es
Ms. Uxía García Luis
University of Vigo, Spain, uxia.garcia.luis@uvigo.es

FEASIBILITY STUDY OF A COLLISION AVOIDANCE METHODOLOGY FOR CUBESATS BASED ON ITS ACTIVE ADCS SYSTEM

Abstract

Earth's low-earth orbit (LEO) is becoming ever more crowded due a growth in the population of functional satellites, mainly for commercial activities and, considering the deployment of the broadband mega-constellations, the number of operational satellites in orbit could double or even triple in the next five years. CubeSats are a class of nanosatellites that use a standard size and form factor to provide a platform for education and space exploration. In the last years, more than 1600 Cubesats were launched to LEO and the forecast is that over 2500 nanosats will be launched in the next 6 years. The overall collision risk from small satellites has been assessed low because of their low mass and small collision areas. In fact, there is currently no specific debris mitigation and prevention guidelines for small satellites. Anyway, the economic impact for the institutions behind these small satellites is huge if any of them results damaged (or destroyed) by a collision. Tipically, this type of satellites does not use propulsion and cannot maneuver to avoid collisions.

This research presents a methodology to reduce the probability of a collision involving a Cubesat without propulsion system, just using its active ADCS. Changing the orientation of the satellite, when the alert is received, will modify its cross section, increasing or reducing the drag force. This avoiding action will have a direct effect in the position of the satellite after a period of time.

To study the effectiveness of this methodology in CubeSats of different sizes (2U, 3U and 6U) are simulated in circular orbits with three different heights in the typical range of operation of CubeSats. The Lifetime tool of the STK software package is used to obtain the propagation of the orbit as a function of the cross section and the initial position of the satellite. As a result, the height variation of the satellite as a function of time is obtained for each orbit, which would allow to reduce the probability of impact against another object in case of a collision risk alert. Alert messages due to close approaches and collisions among satellites are obtained in the form of Conjunction Data Messages (CDMs). Finally, by applying this methodology, the height difference that can be achieved is analyzed using a real case scenario of an

active CDM of LUME-1, an operative Cubesat launched in 2018 by University of Vigo (Spain), with an apogee of 492 km.