44th STUDENT CONFERENCE (E2)
Educational Pico and Nano Satellites (4)

Author: Mr. Amir Hosein Bahrami
Amirkabir University of Technology, Iran, am_h_bahrami@yahoo.com

Ms. Tayebeh Namayeshi
Beihang University, China, tayebehn89@gmail.com
Prof. Hai Huang
Beihang University, China, hhuang@buaa.edu.cn

BUSAT-1 ATTITUDE DETERMINATION AND CONTROL: A QB50 SOLUTION

Abstract

QB50 is a network of 50 CubeSats in a 'string-of-pearls' configuration that will be launched together in mid 2015 into a sun-synchronous circular orbit at about 350 - 400 km altitude. The BUSAT-1 project is one of the QB50's atmospheric CubeSats. It is independently designed by BUAA School of Astronautics of which the design philosophy is low cost, modular design and Plug and Play (PnP). BUSAT-1 is a 2U(nit) CubeSat, with science unit and a functional unit. The science unit accommodates "Set- 1" standard sensors (INMS) provided by QB50 for lower thermosphere/ionosphere research. The function unit includes the subsystems which supply the CubeSat platform service function. There is also an independent micro BeiDou receiver (Chinese BeiDou Navigation System) for the in-orbit space technology demonstration. The ADCS requirement of BUSAT-1 is to align the sensor head to the ram velocity direction with the accuracy of better than 10 degrees. At altitudes below 400 km, satellites experience a significant amount of aerodynamic drag that can be utilized to stabilize satellites to align with the relative wind direction. Designing a satellite such that the center of pressure is behind the center of mass provides an aerodynamic restoring torque, which in combination with active control system provides 3-axis stability and alignment with the satellite velocity vector. BUSAT-1 uses CubeSat platform and based on CubeSat standard, must fit inside a CubeSat launcher (POD), and the center of mass shall be located within a sphere of 2cm from the geometric center; so, all deployables shall deploy post orbit-insertion. We will describe completely passive aerodynamic solution for 2U CubeSats, with deployable solar panels as aerodynamic panels, a "shuttlecock" style design, and to shift the center of pressure aft of the center of mass. Passive aerodynamic drag torques stabilize pitch and yaw directions. Aerodynamic design and simulation calculations will be carried out with the free-molecular aerodynamic force model; which gives the normal pressure and the shearing stress on a surface of the satellite as functions of the dynamic pressure, the angle of attack, and various thermodynamic quantities. This model shows the fact that some impinging air molecules come to thermal equilibrium with the spacecraft surface and then get reemitted thermally, whereas others reflect specularly. Active magnetic and momentum-bias control system for greater (<10 Deg) ram vector alignment will be discussed. The system will be tested via simulation. Global stabilization will be evaluated for all altitudes below 400 km.