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Attitude Dynamics (1) (1)

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A NADIR-POINTING MAGNETIC ATTITUDE CONTROL SYSTEM FOR TIGRISAT NANOSATELLITE

Abstract

In this paper is presented an active attitude control system for the TigriSat nanosatellite. TigriSat is a 3U CubeSat built as part of the "*High Level Postgraduate Course in Aerospace Engineering*", a course in Aerospace Engineering dedicated to Iraqi engineers provided by the School of Aerospace Engineering of Rome and the Italian Ministry of Foreign Affairs. The main payload of TigriSat is a sensor for dust storm detection, requiring a stable nadir-pointing attitude. For this purpose, a semi-active magnetic attitude control system has been chosen, achieved using three perpendicular electromagnetic coils (*magnetorquers*). The proposed attitude control strategy is a classic B-dot strategy coupled with a torque proportional to the nadir pointing error. It will be shown that using constant gains and restricting the attitude motion to the orbit plane, such a strategy effectively leads the spacecraft to nadir-pointing attitude for any planar initial condition. This is shown by the existence, under some restrictive constraints, of a Liapunov function. Then a heuristic strategy has been developed, consisting in a single switch of the gains that occurs in the transition from the required attitude motion acquisition and the attitude maintenance. The choice of the gain parameters must be done taking into account the maximum values of the magnetic dipole achievable on the satellite, on-board available power and mass distribution of TigriSat. For all of those control algorithms, some simulations have been run with Matlab-SIMULINK softwares, for the nominal orbit of TigriSat (midday-midnight Sun-Synchronous orbit), implementing also the effects of disturbances. The paper is completed by a performance evaluation in presence of parameter uncertainties and some "hardware in the loop" tests for the proposed algorithms. All parts of the work are developed thanks to the dedicated and skilled work of the fifteen Iraqi engineers of the Course.