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THREE-AXIS STABILIZATION OF A LOW EARTH ORBIT SPACECRAFT UTILIZING THREE MAGNETORQUERS AND REACTION WHEELS COMBINATIONS, ACCORDING TO ENERGY CONSUMPTION

Abstract

In this paper, Three-axis Stabilization of a microsatellite is studied; the aim is to propose an optimal configuration for attitude control of a microsatellite utilizing torqrods and reaction wheels as the active controllers. An optimal control law is used which its cost function desire is to maintain the state vector close to the origin without an excessive expenditure of control effort. By assuming no active controller, the simulation reveals the harmonic response of satellite dynamics. Through utilizing magnetic actuators and optimal control theory, the desired result has been obtained in point of view of accuracy; however, using only magnetic torques cannot insure the mission objectives because of the quite tedious time spending. The three-axis stabilization at a reasonable time has been achieved by adding just one reaction wheel to the system dynamics. Here, the number of reaction actuators is increasing gradually to study the tendency of energy consumption. So the reasonable combinations utilizing magnetic coils and one, two three reaction wheel are simulated and based on them the most appropriate configuration will be suggested. In addition, the squared integral of the actuators output torque is computed at any of arrangements as a scale to compare the energy consumption. When dealing with the magnetic attitude control system of a spacecraft, the geomagnetic field is the main source. In this regard, it is necessary to develop a precise model of the Earth magnetic field. A magnetic dipole model, which is used in many studies, is acceptable just as a preliminary estimation but not for fine attitude control applications. Therefore, in this paper, one of the most accurate methods is applied and the Earth magnetic field is modeled based on 10th generation of IGRF coefficients. The results had been verified with one of the most well founded references. According to our results, the attitude control operation has been achieved desired one, then the most appropriate configurations are presented, and the energy consumption is calculated as well for each combination. The simulations reveal that using more than one reaction wheel does not have a significant influence on the energy consumption. Utilizing more number of reaction wheels increases the primary cost; nevertheless, it can be suitable in energy consumption during the mission. Many simulations have been implemented to find the most appropriate configuration by utilizing reaction wheels and magnetic coils. The results are shown in graphs and tables.