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SIMULTANEOUS STRUCTURAL/CONTROL OPTIMIZATION OF A LOW EARTH ORBIT SPACE STRUCTURE BY USING GENETIC ALGORITHM TECHNIQUE

Abstract

This work deals with the simultaneous structural and control optimization of a low Earth Orbit (LEO) large space structure (LSS) subject to the gravity-gradient torque. The objectives are to attain a low weight structure satisfying a constraint on the natural frequency of vibration and simultaneously, to optimize a control index related to the attitude control within an integrated approach. The implementation of the integrated optimization process is numerical and based on two different techniques to solve the structural and the control optimization, respectively. The genetic algorithm (GA) technique is used to optimize the structural weight, while the LQR technique is used to optimize a control index related to the attitude control. The LQR is a well know technique and is classical in the control area. The GA belongs to the field of Artificial Intelligence (AI) and Computer Science. The technique is a heuristic search that mimics the process of natural evolution. This heuristic search is normally used to generate useful solutions for optimization and search problems. The GAs belong to the larger class of evolutionary algorithms (EA) which use techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover. The results are the optimized weight for the structure subject to a constraint in the natural frequency and the control performance in terms of the control effort and the LSS attitude control. The computer program to solve the problem was built in Matlab language and implements a closed-loop approach running between two tasks, the structural and the control optimization. The MatLab® software package tools for GA and Control techniques are used to solve the complete problem and to generate the graphical illustrations for the attitude behavior of the LSS, the control effort, and control performance in controlling the LSS attitude motion.