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MULTIDISCIPLINARY DESIGN OPTIMIZATION OF OCEANIC SATELLITES USING ANALYTICAL TARGET CASCADING METHOD

Abstract

Satellite is a complicate system with multiple coupled subsystems as structure, orbit, power, payload, attitude control, thermal control, etc. Usually it is very difficult to achieve an optimum design with various design parameters from all subsystems. With the increasing development of space industry, the traditional serial satellite design process can hardly meet the requirements in efficiency and performance. From the end of last century, researchers began to apply Multidisciplinary Design Optimization (MDO) technologies to satellite design, which showed that MDO is effective and efficiency in dealing with coupling relations between multi-subsystems. It also indicated that key problems in engineering application of MDO come to the modeling technique of practical problems and implementation of optimization strategy.

Oceanic satellites are for ocean observation. In order to improve the design performance of this type of satellite, multidisciplinary design optimization (MDO) technology is adopted during the overall design stage of oceanic satellites to compromise the complicate relations between multi-subsystems. A MDO model of the satellite is established by simultaneously considering four subsystems, which includes orbit, payload, structure and power. The objective is to minimize the total mass. In structural subsystem, finite element (FE) model is established and analyzed with general FE program Msc.Nastran. Analysis models of other three subsystems are also presented according to the satellite task for remote sensing. In order to restrict the times of FE analysis which might consume too much CPU time, a specific MDO strategy called analytical target cascading (ATC) method is used to coordinate the optimization procedure. To solve the MDO problem, a user defined module is developed on the platform of process integration and design optimization software iSIGHT. Finally, robust results are obtained even with random selected initial values for the MDO problem built. The total mass of the satellite decreases about 17.6% relative to that of Chinese HY-1 satellite launched. The calculation results also indicates that lowering both orbital altitude and aperture diameters of optical system can reduce payload mass significantly while satisfying design constraints. Besides, further analysis shows that the optimal value of satellite total mass will increase 9.3% if the repeat period of the obit is reduced to seven days from ten days.