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RELIABILITY-BASED MULTIDISCIPLINARY OPTIMIZATION FOR REMOTE SENSING SATELLITE DESIGN

Abstract

The traditional method of designing space systems, normally includes numerous design loops, which does not guarantee to reach the best optimal solution. In deterministic design approach of space systems all involved variables and parameters are considered to be certain which allows us to find the most optimum system configuration under various performance conditions. However, the major problem with this approach is the negligence of uncertainties (or tolerances) in design, manufacturing and operating process. It has been demonstrated that, the absence of uncertainties in the deterministic optimum design considerations may lead to unreliable systems. Space systems throughout their life cycles are normally confronted with uncertainties. Tolerances in orbital elements, environmental conditions, production, modeling and operation are the most important sources of uncertainties in these systems. It should be noted that neglecting uncertainties in the deterministic design methods usually results in a difference between the actual system and the deterministic optimum design which in many cases may lead to the missions failure. This paper focuses upon the development of an efficient method for the conceptual design optimization of remote sensing satellites under uncertainty. There are many acceptable optimal solutions for implementation of satellite subsystems in a space system mission. Every solution should be assessed based on the different criteria such as cost, mass, reliability and payload resolution. In this paper satellite mass and imaging payload resolution were considered as system level objective functions to obtain the system optimal solution during the conceptual design phase. Furthermore, various uncertainties involving environment, operation, geometry, subsystems, etc. were considered in a Reliability Based Multidisciplinary Design Optimization framework. In the present study, deterministic and non-deterministic approaches were evaluated and compared. The methodology was based on the utilization of Monte Carlo simulation method for accounting uncertainties in design process and applying genetic algorithms and sequential quadratic programming to system level and discipline level optimizers. Results obtained in this study, have shown that the introduced method provides an effective way of accounting uncertainty in a complex space system design such as the conceptual design optimization of a spacecraft.