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LARGE SCALE MULTIDISCIPLINARY DESIGN OPTIMIZATION OF A DISTRIBUTED SPACE SYSTEM

Abstract

Distributed Space system (DSS) is being widely used due to the increased demand for challenging space-based operation and services. DSS consists of multiple satellites working collectively to achieve a common mission unattainable by monolithic satellite approaches. Technological advancements and miniaturization of satellites combined with low-cost launches facilitate the space market to break away from a single satellite paradigm towards an exciting DSS age. Multidisciplinary Design Optimization (MDO) techniques are recently being extensively used to deliver the most for a given cost. While these techniques optimize many variables across multiple engineering disciplines, they have not yet broken away from the single satellite paradigm. Generally, DSS optimization is performed by optimizing the constellation model and satellite system model separately or by fixing constellation parameters and optimizing the satellite system. This is because the DSS design involves discrete variables such as the number of satellites and the number of orbital planes in the constellation model and the continuous variables as solar panel area, radiator area in the satellite model. This results in a Mixed-Integer Non-Linear Programming optimization that is very hard to solve, especially when it involves a large number of design variables. This paper aims to solve the MDO problem of a DSS consisting of an Earth observation constellation to optimize constellation and satellite systems simultaneously. The constellation model and satellite subsystem models are modelled in OpenMDAO and optimized using A Mixed Integer Efficient Global Optimization algorithm - Multiple Infill via a Multi-Objective Strategy (AMIEGO-MIMOS). Then, these results are compared with the results from optimizing constellation and satellite system separately. The DSS is optimized with mass as its objective function. Preliminary optimization results show that the mass of the DSS is 16% lower than the mass obtained from optimizing separately. At the same time, the computational cost of this approach is 37% higher.