Paper ID: 34647
interactive

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Interactive Presentations (IP)

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METAMODEL-BASED SIMULATION OPTIMIZATION OF A TWO STAGE LIQUID PROPULSION BASED SPACE TRANSPORTATION SYSTEM

Abstract

Recently, engineering systems are quite large and complicated. Conceptual design process of space transportation systems is a multidisciplinary task which must take into account interactions of various disciplines and analysis codes. Current approach for the conceptual design of space transportation systems requires the evaluation of a large number of different configurations and concepts. With existing legacy codes, estimating the performance of all design combinations becomes very time consuming and computationally expensive. A possible solution to this problem could be employing of metamodels during design tasks. This paper describes an effort to optimize the design of an entire space transportation system to achieve a low Earth orbit, consisting of multiple stages using an efficient metamodel-based multidisciplinary design optimization framework with the goal of minimizing vehicle weight and ultimately vehicle cost. Furthermore, a combination of Response surface methodology (RSM) and Kriging methamodels has been used for building surrogate models. The disciplines of aerodynamics, propulsion, flight simulation, cost model, geometry, and mass properties, have been integrated to produce an engineering system model of the entire vehicle. In addition, the system model has been validated using the existing design data of flight vehicles and their subsystems. The cost module is mass based and uses extensive historical data and empirical relations to produce a cost estimating relationship for a liquid propellant space transportation system. For the design optimization, In order to ensure that the payload achieves the desired orbit, a hybrid algorithm has been used to minimize the differences between the actual and desired orbital parameters. The objective function of the optimization problem is to minimize the overall system mass, thus minimizing the system cost per launch. The proposed design and optimization methodology provides designers with an efficient and powerful approach in computation during designing space transportation systems and can also be developed for more complex industrial design problems with comparable characteristics.