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THE MULTI-DISCIPLINARY OPTIMIZATION OF SPACE EXPERIMENTAL DEVICE USING RADIAL BASIS FUNCTION IN MODELCENTER

Abstract

To achieve a high quality microgravity environment, a novel nested flying vehicle (NFV) of space science experiments is designed which assumed to be operated inside the Space Station.The overall performance of NFV is kept and improved by the electromagnetic actuators. The NFV is composed of an exterior follow-up structure, an inner system and an experiment device. The electromagnetic actuators between the exterior structure and the inner system are utilized to control the position and posture of the experiment device. The four electromagnetic actuators are distributed evenly on the inner system and control the relative position of the inner structure and exterior follow-up structure.

The main purpose of the paper is to explore an efficient method to optimize the electromagnetic actuators with the metamodel-based optimization method. Due to the experiment requirements and the limitation of inner operational space, the target is to reduce residual force, size, weight and heat loss while ensuring the rated exciting forces and stroke length.

The analysis of electromagnetic actuator is in fields of geometry, structural, electromagnetism and thermal. The ANSYS module of Mechanical and EMAG are adopted for the modeling and the analysis of structure and electromagnetism. The Design Structure Matrix (DSM) and analysis process are built in ModelCenter which is known as a widely used MDO framework. The optimization is done using different algorithms through ModelCenter. However, the result of optimization using the genetic algorithm led to an unaccepted time consumption, while other algorithms of ModelCenter are undesirable. The drawbacks that lacking of the metamodel influence the accuracy and efficiency of optimization.

In order to relieve the huge computational burden, the Metamodel-based Design and Optimization (MBDO) is used. With the advantages of using metamodels to replace computation-intensive model, the computational cost can be dramatically reduced. The Radial Basis Function (RBF) which is widely employed to approximate the expensive black-box function is used in this paper. The Lagrangian multiple method is applied to convert a constrained optimization problem to an equivalent unconstrained problem with bound constraints. In order to improve the optimization efficiency, an optimizer which is embed the RBF based optimization algorithm is developed and integrated to ModelCenter.

The result of using self-programmed optimizer will be compare with the algorithm supplied by ModelCenter. According to the results, the residual force has been reduced to 40% and the time consumption of optimization is decreased significantly.