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Author: Dr. He Liao
China

Dr. Kaipeng Sun
Shanghai Institute of Satellite Engineering, China
Dr. Yanbin Zhao
China
Mr. Bo Liao
China

MODEL UPDATING OF THERMO-ELASTIC PLATES OF SPACECRAFTS IN THE HOT AND COLD SPACE ENVIRONMENTS

Abstract

Hot and cold space environments have a great influence on the spacecraft structures, could lead to significant temperature gradients on the surface or even in the interior of the structure, not only resulting in uneven distribution of thermal stress, but also to change the mechanical properties and boundary conditions of the structure, also may cause thermally induced vibration or thermal buckling. The precise modeling of thermo-elastic structures is an important but intractable problem. The objective of this study is to develop a strategy to identify the temperature-dependent parameters and update the model of thermo-elastic plates, which are representative structures of spacecrafts, in the hot and cold space environments, where time-varying material parameters and thermal stresses are taken into account. The updating procedure is based on a time-variant finite element model because the system matrices change over time due to the unsteady temperature environment. The temperature-dependent parameters are expressed as low-order polynomials first. Then, an integrated objective function is established by using errors of the instantaneous frequencies and the sum of the highest order of the polynomials for all the parameters. Subsequently, the particle swarm optimization is performed to minimize the above objective function to simultaneously determine the coefficient and the order of the polynomials. To demonstrate the effectiveness of the proposed approach, numerical examples are presented. The numerical verification shows that the identified temperature-dependent parameters well track the trends of the true values with high accuracy. The proposed approach is suitable for the model updating problem of thermo-elastic plates.