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STUDY ON A NOVEL THERMAL MODEL MODIFICATION METHOD WITH DIMENSIONALITY REDUCTION BASED ON PARAMETRIC CORRELATION ANALYSIS

Abstract

With expanding end-user requirements, modern spacecraft becomes large and complex, leading to more uncertain factors and more computation cost for thermal simulation. In this paper, a thermal model modification method, which achieves high precision with low computation cost by reducing the dimensionality of the model based on parametric correlation analysis, has been proposed and studied. Key influence factors are resolved and classified by investigating the correlation between the factor and the model on the basis of principle component analysis. Then, the multi-dimension model can be simplified and described with low-dimension. Moreover, model modification can be focused on the key factors successively, thereby achieving higher efficiency. On the other hand, Monte-Carlo method, which is advantageous in treating with low-dimension model, is adopted to obtain high precision. To verify the validity of the method, a thermal mathematical model of a spacecraft has been developed and investigated. It is found that, parametric correlation analysis can classify the parameters and identify key influence factors effectively. The heat dissipation of devices, the optical properties of spacecraft surface coatings and the contact heat transfer coefficient impact the spacecraft temperature significantly. On this basis, the key parameters are modified successively with Monte-Carlo method. The results indicate that the proposed method can modify the model effectively with tiny error, and thus can be a promising thermal model modification method for the spacecraft with large scale and complex structure, etc.