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DEVELOPMENT AND EVALUATION OF THERMAL MODEL REDUCTION ALGORITHMS FOR SPACECRAFT

Abstract

This paper is concerned with the topic of the reduction of thermal models of spacecraft. It has been conducted in cooperation with the company Kayser-Threde GmbH with the goal to shorten and automatize the relatively time consuming and manual process of reduction of thermal models. The reduction of thermal models can be divided into the simplification of the geometry model for calculation of external heat flows and radiative couplings and into the reduction of the underlying mathematical model. For simplification a method has been developed which approximates the reduced geometry model with the help of an optimization algorithm. Different linear and non-linear model reduction techniques, typically used for these purposes, have been evaluated for their applicability in thermal model reduction. Thereby the compatibility with the thermal analysis tool ESATAN TMS is of major concern, which restricts the useful application of these methods. Different model reduction methods have been developed, which account to the constraints. The Matrix Reduction method allows the approximation of the differential equation to reference values exactly expect for numerical errors. With a theoretical derived extension of this method, it should be capable of optimal model reduction with a time-invariant system of differential equations. The summation method enables a useful, applicable reduction of thermal models, which can be used in industry. In this work a framework for model reduction of thermal models has been created, which can be used together with a developed graphical user interface for the reduction of thermal models in industry.