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METHOD OF MODEL REDUCTION FOR ELASTIC MULTIBODY SYSTEMS

V. Makhavikou*, R. Kasper[1], D. Vlasenko[2]

* Otto von Guericke University, Universitaetsplatz 2, 39106 Magdeburg, Germany,
valery.makhavikou@st.ovgu.de
[1] Otto von Guericke University, Universitaetsplatz 2, 39106 Magdeburg, Germany,
roland.kasper@ovgu.de
[2] Schaeffler AG, Industriestrasse 1-3, 91074 Herzogenaurach, Germany,
dmitry.vlasenko@schaeffler.com

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Simulation is an important part of development of modern technical products. It makes it possible to optimize design of the system and to identify possible operation problems without product construction.

In many modern technical products deformation effects considerably affect system dynamics, which requires taking them into account in modelling and simulation processes. In this contribution we consider simulation of elastic multibody systems. This term refers to a system of rigid and elastic bodies interconnected by joints or coupling elements, where the bodies may undergo large rigid body motion and small deformations. Dynamic formulation of elastic body usually exploits the finite element method that transforms a set of partial differential equations of motion into a set of ordinary differential equations. Finite element models of real industrial applications have tens of thousands of degrees of freedom. This significantly slows down simulation process. In order to solve the problem, engineers resort to the help of model order reduction methods, which describe elastic body dynamics more efficiently.

The traditional reduction methods are techniques based on condensation [1,2], modal truncation, and component mode synthesis [3,4]. More recently, a few alternative reduction methods have come from the field of control theory: methods based on singular value decomposition or Gramian matrices [5], and moment-matching by Krylov subspaces [6]. Nowadays, the application of these techniques for elastic multibody systems is on the focus of intensive research.

One of the drawbacks of traditional reduction methods is a lack of possibility to tune a reduced model for certain transfer functions and certain frequency ranges. In this paper we propose a new method of linear model order reduction that makes it possible to overcome these problems. The approach relies on the idea of line fitting of model transfer functions. In this contribution we apply the method to a test model and examine properties of reduced model in time and frequency domains. In addition, we compare the results with the results of the classical Craig-Brampton approach [3,4]. The tests show that the proposed method generates reduced models with lower order, higher accuracy, and better condition number of system matrices, but it takes more time for the construction of coordinate transformation matrix. However, the computational cost remains low for moderate dimensional models.

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