Mathematical and Computer Modelling of Dynamical Systems

Volume 20, Issue 1, 2014

Object-oriented modelling of general flexible multibody systems

Gianni Ferretti, Alberto Leva, Bruno Scaglioni

Accurate and efficient computer simulations of flexible multibody systems play an important role in the design and performance evaluation of many complex technological systems.

However, multibody dynamics is frequently just one of the physical domains involved. For example, the design of mechatronic systems requires an integrated approach to mechanical, electronics and control design [1].

In order to master the complexity of a multidomain physical modelling, a modular approach is thus required, where the complexity is confined to the development of the equations of the single component, and system-level model organization is managed by means of the definition of standard component interfaces.

This paper presents a general approach to object-oriented modelling of flexible multibody systems, based on the floating frame of reference (FFR) formulation. The data describing a flexible body can be computed analytically, having defined its shape functions matrices, or calculated by several FEM packages as a result of a modal analysis. By the proposed approach, a modular model is then obtained in an object-oriented language, namely Modelica. This allows to integrate very realistic descriptions of distributed flexibility in multi-domain models, with significant advantages for a variety of simulation studies. After describing the general methodology, the paper presents some simulation results, to validate the approach with respect to benchmark cases considered in the literature.

Flexible multibody analysis in object-oriented simulation tools can now be applied to real-world cases. In particular, the modelling of machine tools and automotive systems is currently underway, and will be addressed in future works.

Mathematical and Computer Modelling of Dynamical Systems: Methods, Tools and Applications in Engineering and Related Sciences, 20:1, 1-22, DOI: 10.1080/13873954.2013.80743

[1] G. Ferretti, G. Magnani, and P. Rocco, Virtual prototyping of mechatronic systems, IFAC J. Annu. Rev. Control. 28 (2004), pp. 193–206.