Serdica Math. J. **28** (2002), 91-93

Serdica
Mathematical Journal

Bulgarian Academy of Sciences
Institute of Mathematics and Informatics

BOOK REVIEWS

Multibody System Mechanics: Modelling, Stability, Control, and Robustness, by V. A. Konoplev and A. Cheremensky, Mathematics and its Applications Vol. 1, Union of Bulgarian Mathematicians, Sofia, 2001, XXII + 288 pp., $ 65.00, ISBN 954-8880-09-01

The Union of Bulgarian Mathematicians starts a new series of publications: Mathematics and Its Applications. The first issue of the series is "Multibody System Mechanics: Modelling, Stability, Control and Robustness".

The authors are well known mathematicians with various published books and articles. Professor Vladimir Konoplev works in the Institute of Problems of Mechanical Engineering, Russian Academy of Sciences (St. Petersburg, Russia), while Professor Alexander Cheremensky works in the Institute of Mechanics, Bulgarian Academy of Sciences (Sofia, Bulgaria).

The book contains results of the development of a new computer-aided mathematical formalism of the multibody system mechanics which may be easily implemented by the use of computer algebra tools for symbolic computations and of standard software for numerical ones.

Its efficiency is determined by the following features:

• The algorithms are universal in the sense that analytical and numerical forms of multibody system mechanical models are constructed independently of each other, i.e., these algorithms may be used for constructing analytical and,

2000 *Mathematics Subject Classification:* 93-02, 93B51, 93C83.

Key words: Stability, Control, Robustness, Multibody systems, Computer-aided mathematical formalism, System design, Modelling.

independently, numerical forms of models by passing the stage of constructing scalar equations;

• The algorithms provide efficient solution of direct problems in mechanics of multibody systems (with the help of the sweep method);

• There are many efficient recurrent procedures;

• There is no need to derive previously analytical forms of any particular functionals (such as Lagrangian, Hamiltonian), the Gauss function, the Appel function and so on;

• There is no need to exploit symbolic differentiating tools, since the algorithms contain no such differential operators as Christoffel symbols, three-indexed symbols of Boltzmann, the Jacoby matrix and so on. All operations are performed with the use of readily available algebraic tools;

• If the bodies of a system are linked with external bodies, there is no need to derive equations of holonomic and non-holonomic (time-invariant and time-varying) constraints. Also there is no need of computer calculation of the corresponding Jacoby matrix. To this end, only the matrices, which are derived during the construction of motion equations, are used;

• The methodology provides the possibility of taking into account the presence of rotating bodies linked to bodies of a system in the case when the reverse linkage to carrier is absent;

• The derivation of Hooke-elastic multibody system motion equations is provided;

• A method of direct derivation of analytical forms of multibody system motion equations in Cauchy form is developed without computing any inertia matrix and inverting it;

• Practically full parallel processing is provided.

The second theme – *Stability, Control, and Robustness* – is provoked by the interaction between dynamics and control in advanced mechanical systems.

Since the stability of a reference or programme trajectory (in generalized co-ordinates and velocities) is the result of jointly acting forces of different natures (conservative and non-conservative position and velocity forces), any of these forces may be presented in a mechanical system. The authors revise known results and point out the structure of generalized forces that is suitable to ensure asymptotical stability of preplanned trajectories of mechanical systems.

Inserting control in a model one is forced to consider additional parameters that can change its structural stability (robustness). If some features of the model do not depend on small (in some sense) variations of its parameters then these features (or the model itself) are called robust (with respect to the given set of parameters). In particular, it is discovered that the presence of small non-conservative position forces leads them to increase the 'level' of conservative and dissipative forces stabilizing a programme trajectory.

Although the material in the book is complex, the exposition is built on transparent relatively simple principles and readers with less experience in the field of multibody system mechanics and system theory will find enough material to obtain good overview of the current state and applications.

The book will be useful for graduate students and researchers in multibody system mechanics and system theory.

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