A Hybrid Parallelizable Low Order Algorithm for Dynamics of Multi-Rigid-Body Systems: Part I, Chain Systems

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Mathematical and Computer Modelling vol. 30, 1999, pp. 193-215.

Abstract

The paper presents a new hybrid parallelizable $O(n)$ algorithm for the modeling the dynamic behavior of multi-rigid-body chain systems. The method is based on the cutting of certain system interbody joints so that largely independent multibody subchain systems are formed. These subchains in turn interact with one another through associated unknown constraint forces $\underline{f_c}$ at the cut joints. The underlying feature of this new hybrid low order algorithm is the increased parallelism through cutting the joints and explicit determination of associated constraint loads combined with sequential $O(n)$ procedure. In other words, sequential $O(n)$ procedures are performed to form and solve equations of motion within subchains and parallel strategies are used to form and solve constraint equations between subchains in parallel. It is shown that the resulting algorithm is coarse grain parallelizable up to the total number of bodies in the system. Also, the algorithm can easily accommodate the available number of processors while maintaining high efficiency. An $O[\frac{(n+m)}{N_p} + \frac{m^{(1+\gamma)}}{N_p} + m^{\gamma} log_2 N_p]$ $(0 < \gamma < 1)$ performance will be achieved with N_p processors for a chain system with n degrees of freedom and m constraints due to cutting of interbody joints.

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