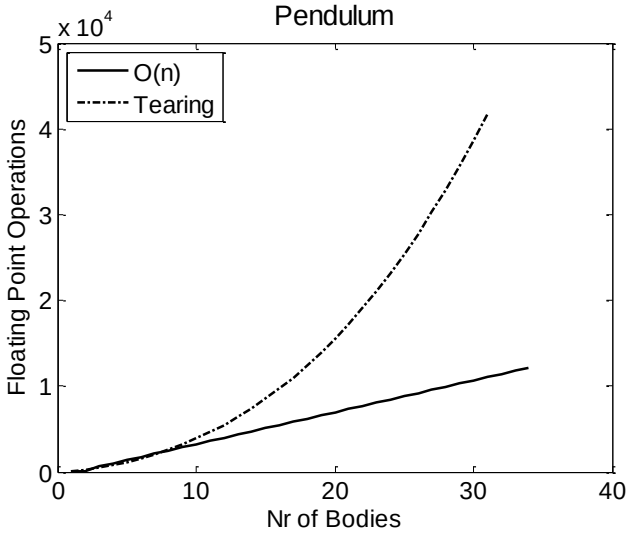
Achieving O(n) Complexity for Models from Modelica.Mechanics.MultiBody

Christian Schubert[a] Jens Frenkel[a] Günter Kunze[a] Michael Beitelschmidt[b]
[a]Professur für Baumaschinen- und Fördertechnik
[b]Professur für Dynamik und Mechanismentechnik
Technische Universität Dresden
01069 Dresden, Germany
{christian.schubert, jens.frenkel, guenter.kunze,
michael.beitelschmidt}@tu-dresden.de

When translating a model that uses elements from Modelica.Mechanics.MultiBody the Modelica Compiler has to deal with a large sparse linear system of equations. The application of *Tearing* [1] yields a dense linear system usually of size equal to the number of degrees of freedom. Solving such a system for the unknowns requires $O(n^3)$ operations.

From literature [2], [3] algorithms can be found that are able to solve a mechanical system in only O(n) operations. The way those algorithms have been formulated inhibited the application in a general equation based framework like Modelica.

This paper presents a graph theoretical generalization of those O(n) algorithms which has been implemented into the OpenModelica Compiler (OMC). The performance of the new algorithm has been compared to Tearing by looking at several test models. The figure below shows the operation count for simulation of a pendulum consisting of N bodies.



References

[1] H. Elmqvist and M. Otter: Methods for Tearing Systems of Equations in Object Oriented Modeling, Proc. ESM'94, European Simulation Multiconference, Barcelona, Spain, June 13, 1994, pp. 326-332.

[2] H. Brandl, R. Johanni and M. Otter: A very efficient algorithm for the simulation of robots and similar multibody systems without inversion of the mass matrix, In Kopacek, P., Troth, I. and Desoyer, K. (Eds.), Theory of Robots, Oxford, Pergamon Press, 1988, pp. 95- 100

[3] R. Featherstone: Rigid Body Dynamics Algorithms. Springer, New York, 2008