Algorithms for Component-Based 3D Modeling

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The experimental, open source modeling environment *Modia3D*[1] is used to test and evaluate ideas to model and simulate larger and more complex 3-dimensional systems than it is possible with a pure equation-based modeling system such as current Modelica. Modia3D models 3D mechanical systems and utilizes ideas of multi-body programs and game engines. It is implemented with the powerful *Julia programming language*[2], which supports multiple dispatch, metaprogramming, and has excellent performance benchmarks compared to C. The basic idea is to combine 3D modeling techniques closely with equation-based modeling à la Modelica within one high level programming environment. *Modia*[3] is used for the equation-based modeling and is implemented with Julia's metaprogramming features.

The user's view of Modia3D was introduced in (Neumayr and Otter, 2018) to show the very flexible definition of 3D systems and to start an approach to cope with the underlying inherent Modelica issues. In this article, several key algorithms are discussed which have been developed for the Modia3D prototype. One of the algorithm groups Object3Ds, depending on their properties, into rigidly attached super-objects (Figure 1).

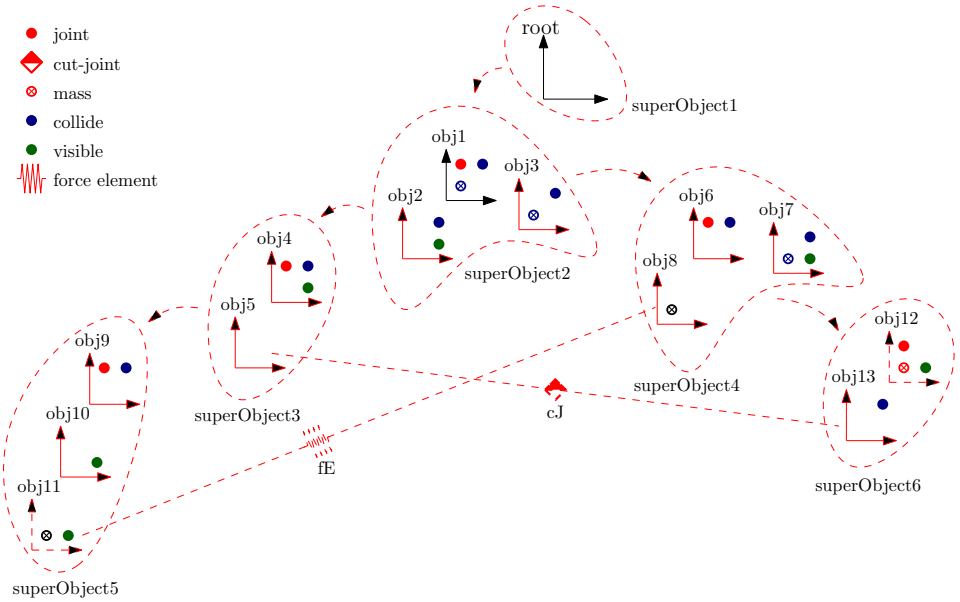

Figure 1. 14 Object3Ds with different properties like they are allowed to collide, can have a mass, are visible and/or can have a force element, are grouped into six rigidly attached general super-objects connected via joints and cut-joints.

Modia3D is still a prototype it is implemented for functionality and not tuned for efficiency. In the near future, Modia and Modia3D shall be closely integrated, e.g. using a Modia3D model in Modia or using Modia models in Modia3D. The overall goal is to apply the results of the Modia/Modia3D prototyping into the design of the next Modelica language generation.

A. Neumayr and M. Otter. Component-Based 3D Modeling of Dynamic Systems. In M. Tiller, H. Tummescheit, and L. Vanfretti, editors, *Proceedings of the American Modelica Conference*, Oct. 2018. URL https://elib.dlr.de/124126/1/2018_Modelica_Modia3D.pdf.

[1]https://github.com/ModiaSim/Modia3D.jl
[2]https://julialang.org
[3]https://github.com/ModiaSim/Modia.jl