Structural elements for flexible multibody systems

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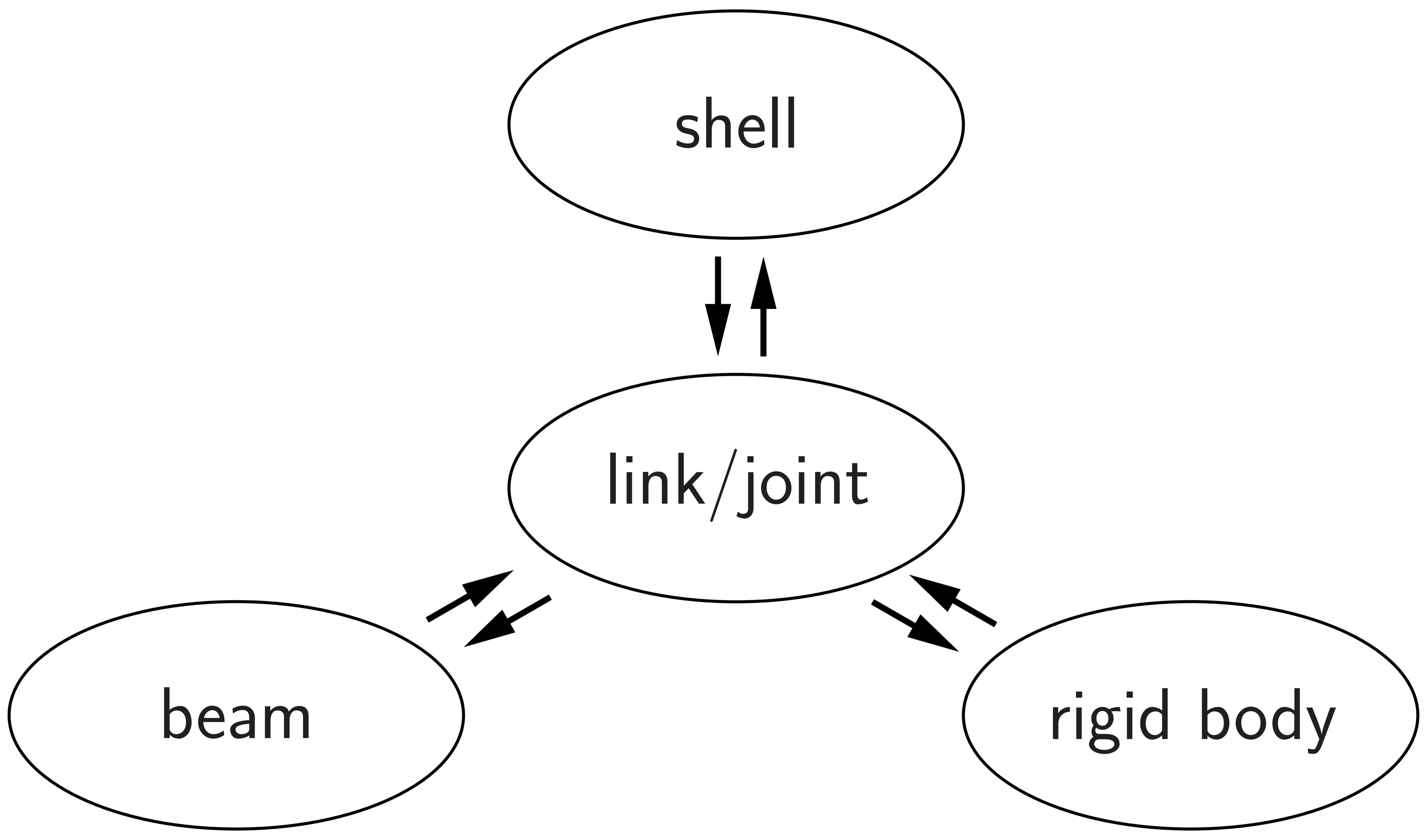
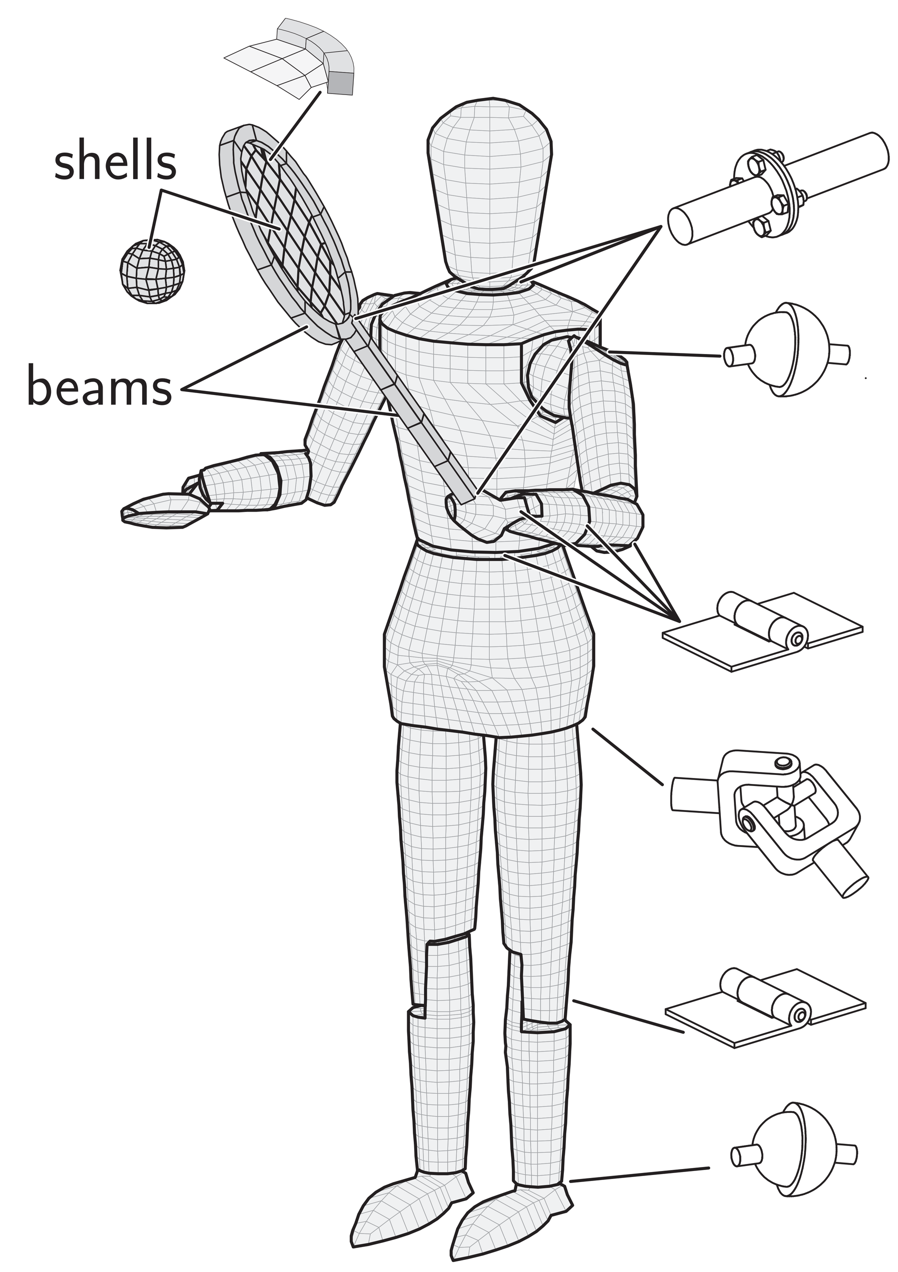
Introduction

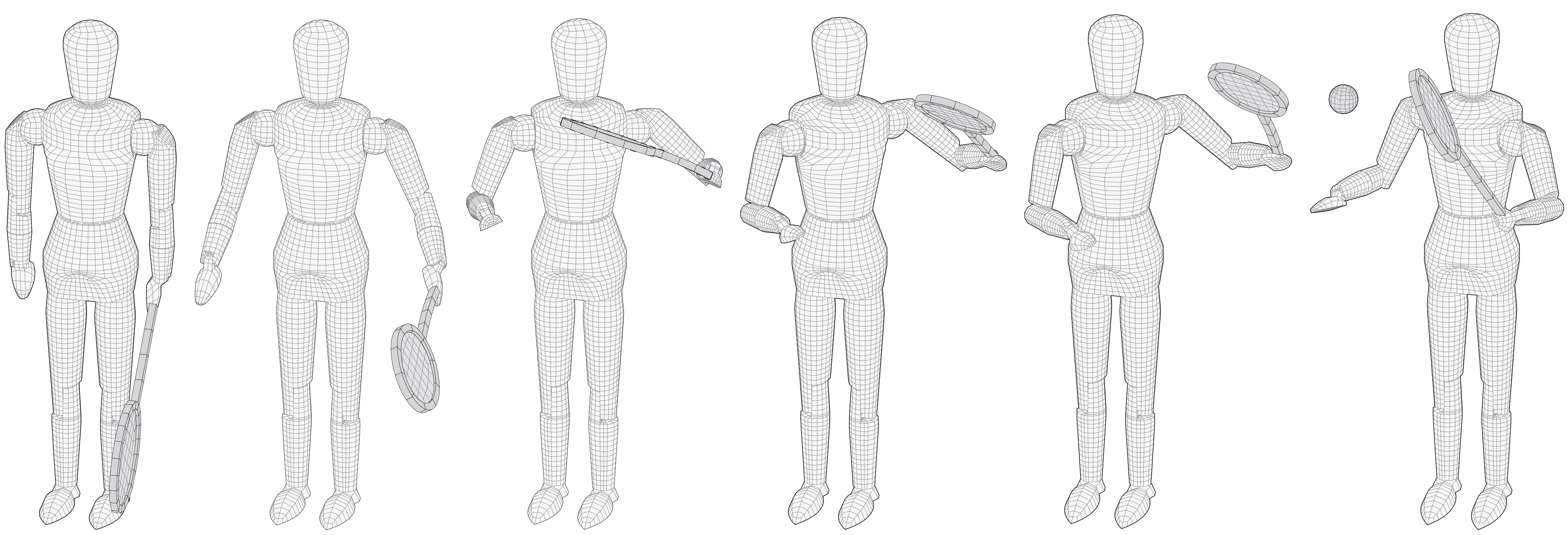


The development of numerical methods that can handle large deformations in the context of flexible multibody systems relies on merging non-linear continuum mechanics with classical multibody dynamics. The present approach relies on a specific rotationless formulation of structural elements. Structural elements that have been developed in this context are rigid bodies, geometrically exact beams and shells, as well as kinematic pairs. Recently the present methodology has been extended to domain decomposition, thermomechanically coupled problems and large deformation contact. Standard continuum elements fit into the present framework in a natural way.
An important feature of the present rotationless description is that flexible multibody systems can be implemented in a very systematic way. This leads to a generalization of the standard finite element assembly procedure. Since the present approach makes use of redundant coordinates, a considerable number of unknowns has to be dealt with. On the other hand, the resulting saddle point systems have a sparse structure and thus can be solved in an efficient manner. Moreover, the newly developed numerical methods exhibit superior numerical stability and robustness. These properties further contribute to the efficiency of the solution procedure.

Model problem



The newly developed numerical methods can be applied to the wide field of flexible multibody dynamics. Examples are the control and optimization of articulated systems. In the present example we address the modelling of biomechanical systems. In particular, the human locomotor system can be regarded as multibody system. The tennis player shown above is modelled as classical multibody system whereas the tennis racket and the tennis ball are modelled as flexible multibody components. The physically correct simulation of the motion of the tennis player including the contact between tennis ball and racket is a challenging topic.
The results of the simulation are shown below with a sequence of snapshots until the onset of contact between the tennis ball and the racket.



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