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Time stepping scheme for interactive medical simulations

Abstract

Time stepping schemes for interactive medical simulations need to fulfill some challenging requirements which SOFA can address:

- Computational budget for a physics frame around 20 ms (interactivity)
- The time stepping scheme needs therefore to handle large time steps
- Stiff and often non linear material laws, and sometime infinitely stiff (inextensibility, incompressibility)
- Dynamic boundary conditions to model attachments between during simulation at arbitrary locations
- Dynamic topologies to model incisions, but also to increase precision where needed
- Multiple contact laws (friction, adhesion, puncturing) to model tool/tissue and tissue/tissue interactions

This talk will emphasize on two aspects that we have found at InSimo to provide improvements over the existing time stepping scheme implementations available in SOFA:

- How changes in the topologies can be handled more efficiently when processed directly during the time stepping scheme instead of an operation that occurs in between time steps
- How we can factor large chunks of bilateral constraints along with the dynamic matrix to improve stability, while retaining the ability to use dedicated linear solvers for each set of independent degrees of freedom