Abstracts

Talk 1: Thorsten Schindler (Thorsten Schindler, Svenja Schoeder, Heinz Ulbrich)
Discussion of the Gear-Gupta-Leimkuhler method for unilateral contacts
In multibody simulation, the Gear-Gupta-Leimkuhler method for only persistent contacts yields a robust numerical discretization of differential algebraic equations avoiding the drift-off effect. It enforces constraints on position and velocity level at the same time. We carry over these benefits to impacting mechanical systems with unilateral constraints. A timestepping scheme based on Moreau's midpoint rule enables to achieve not only compliance of the impact law but also of the non-penetration constraint. However, adding the position level constraint to a timestepping scheme on velocity level is not just more robust – for impacting mechanical systems, it maintains physical consistency of the impulsive discretization. First, we show that the choice of a decoupled and consecutive evaluation of the respective constraints can be interpreted as a projection to the non-penetration constraint at the end of each time step. This strategy turns out not to be energy-consistent. Second, we suggest an implicit coupling of position and velocity level which yields satisfactory results. An implicit evaluation of the right hand side improves stability properties without additional cost. We use the prox function formulation to gain a set of nonsmooth equations. It is solved by a Newton scheme. Results from simulations of a slider-crank mechanism with unilateral constraints demonstrate the capability of our approach. The results are being submitted for publication [2] and will soon be available as a preprint [1].
References
[1] Svenja Schoeder, Heinz Ulbrich, and Thorsten Schindler. Discussion of the Gear-Gupta-Leimkuhler method for impacting mechanical systems. Preprint 2012, http://sites.google.com/site/tsschindler/.
[2] Svenja Schoeder, Heinz Ulbrich, and Thorsten Schindler. Discussion of the Gear-Gupta-Leimkuhler method for impacting mechanical systems. Multibody System Dynamics, to be submitted 2012.

Talk 6: Nathan van de Wouw (Nathan van de Wouw and Remco Leine)
Robust impulsive control of motion systems with uncertain friction
In this presentation, we consider the robust set-point stabilization problem for motion systems subject to friction. Robustness aspects are particularly relevant in practice, where uncertainties in the friction model are unavoidable. We propose an impulsive feedback control design that robustly stabilizes the set-point for a class of position-, velocity- and time-dependent friction laws with uncertainty. Moreover, it is shown that this control strategy guarantees the finite-time convergence to the set-point which is a favorable characteristic of the resulting closed loop from a transient performance perspective. The results are illustrated by means of a representative motion control example.

Talk 7: Remco Leine
Synchronization of impact oscillators ensured by convergent dynamics
An intriguing nonlinear phenomenon is the synchronization of weakly coupled nonlinear oscillators. The mathematical techniques to prove or to assure synchronization rely on differentiability properties of the dynamical system, which are typically lost in the presence of unilateral constraints.
The aim of the presentation is to show that unilaterally constrained mechanical systems which obey certain maximal monotonicity conditions exhibit the convergence property, being a concept from nonlinear system theory. A system that is excited by an input (e.g. a forced nonlinear oscillator) is called convergent if it has a unique and bounded steady-state solution which is globally asymptotically stable thereby attracting all other solutions, regardless of their initial conditions. The convergence property will be used in this presentation to achieve master-slave synchronization between mechanical oscillators with unilateral constraints.