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NONSMOOTH DYNAMICS AND VIBRATIONS

MATHIAS LEGRAND*, VINCENT ACARY†

*Assistant professor,
McGill University, Department of mechanical Engineering, Room 270, Macdonald Engineering Building, 817 Sherbrooke Street West, Montreal QC H3A 0C3, Canada
mathias.legrand@mcgill.ca; http://structdynviblab.mcgill.ca/

†INRIA Rhône-Alpes
Inovallée de Montbonnot, 655, Avenue de l'Europe, Grenoble, France
vincent.acary@inria.fr; http://bipop.inrialpes.fr/people/acary/

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ABSTRACT

This mini-symposium is dedicated to the computational methods for the dynamics of mechanical systems subject to unilateral constraints, impacts, friction, and nonsmooth contact laws in general with a special emphasis on nonlinear and nonsmooth vibrations of medium to large-scale structures. The overall idea is to make this mini-symposium a bridge between two communities: (1) the vibration community investigating the vibratory response of medium to large-scale flexible systems and (2) the nonsmooth dynamics community exploring multi-body dynamics with unilateral contact and friction conditions.

The vibration community commonly develops numerical strategies devoted to the efficient construction of reduced-order models of large-scale systems for thorough analyses mostly in a linear framework. Extensions to the smooth nonlinear setting are also available through the concepts of nonlinear modes of vibration. Nevertheless, mechanical systems experiencing nonsmooth unilateral contact and friction conditions are mainly explored through penalty-like regularizations yielding the usual numerical difficulties of stiff ordinary differential equations. On its side, the nonsmooth community develops sophisticated numerical solvers dealing with exact unilateral contact conditions with preference to time-stepping and event-driven techniques involving Signorini-Coulomb problem solvers, with possibly a very large number of contact points. Still, investigations of the dynamics of fully flexible large-scale systems remain challenging. It is here proposed to merge these two research areas since the implementation of robust and efficient algorithms have reached a maturity which allows further analysis of large-scale elastic systems experiencing unilateral conditions. They should benefit from each other along the following directions:

- Efficient numerical solvers for the Signorini-Coulomb time discretized problem. Discontinuous shooting methods and Periodic Boundary Problems in time. Associated weak formulations in time and space.
- Nonsmooth vibration modes: computation of families of periodic orbits satisfying unilateral contact conditions. Corresponding invariant-preserving

time-marching algorithms (time-stepping techniques able to efficiently capture the vibration modes). Extension to damped vibration modes through friction.

- Reduced-order models through Proper Decomposition Techniques: definition, construction and computation of ROM which capture the non-smooth dynamics around a fixed point. Application to elastic systems with a large number of contact points. Comparison to nonsmooth vibration modes.
- Continuation and stability analysis: extraction of the intrinsic signature of periodic orbits, *i.e.* frequency, through continuation and exploration of their stability through saltation matrices and related Floquet exponents.
- Comparison between compliant and rigid contact models.
- Inverse problems and identification of parameters such as friction coefficient, structural damping…