Research Proposal for a Phd thesis

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- **Title of the thesis:** Nonsmooth dynamical systems: applications in mechanics and electronics.

- **Key-words:** variational analysis, nonsmooth analysis, dynamical systems, Moreau's sweeping process, Lyapounov's stability, simulation of electrical circuits.

- **Backgrounds:** The main objective of this thesis is the modeling, the mathematical study and numerical simulation of non-smooth dynamical systems. The main applications are derived from nonsmooth mechanics or power electronic converters. This thesis requires some skills in non-smooth and variational analysis, numerical optimization and Lyapounov's stability of dynamical systems.

- **Description:** In applied science and engineering there are many concrete situations where nonsmooth phenomena appear. This is the case for example in mechanical systems subject to unilateral constraints, and/or Coulomb friction, and/or impacts. In electrical engineering, nonsmooth i-v characteristics can be used to represent nonlinear elements like ideal diodes, DIAC, TRIAC, Silicon Controlled Rectifiers or Transistors. The mathematical formulation of the unilateral dynamical systems involved inequality constraints and necessarily contains natural non-smoothness. Due to the lack of smoothness, classical mathematical methods are applicable only to a limited amount and require naturally extensions for both analytical and numerical methods.
  This thesis deals with the stability of non-smooth dynamical systems with applications essentially drawn from mechanics and electronics. More precisely, we are interested in the stability analysis of non-smooth dynamical systems. The methodology that will be used comes essentially from the field of set-valued and variational analysis, Lyapunov stability theory, complementarity systems, differential inclusions, differential variational inequalities and Moreau's sweeping process. The complementarity or variational inequalities formalism will be used to model some simple DC-DC power converters like DC-DC Buck-Boost converters, Lagrange dynamical systems with Coulomb dry friction and Lure systems. For each model, we are interested in the study of well-posedness (existence and uniqueness of solutions) and the stability and asymptotic properties of the trajectories. We propose the use of the SICONOS software platform for the simulation of all systems studied in this thesis. SICONOS software is part of an European project involving many research teams (http://siconos.inrialpes.fr) and is dedicated to modeling, simulation, analysis and control of nonsmooth dynamical systems.

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