### Title:
Structure and Linearization of Implicit Nonlinear Control Systems

### Subject:
The main purpose of the thesis is to study structural properties of implicit nonlinear control systems. In doing that, the PhD student should, on one hand, use the theory of implicit ordinary differential equations, and, on the other hand, nonlinear control theory. In particular, relating the fundamental notion of index for implicit differential equations with the extension algorithm and the notion of zero dynamics for nonlinear control systems will be essential. Relations with flatness are also to be investigated.

The second problem to solve is to characterize state-space and feedback equivalence of an implicit nonlinear control systems to a linear implicit system. Analogous results for explicit systems are fundamental achievements of geometric control theory.

Implicit systems appear in a very natural way in applications, for instance in the electrical circuit theory and in mechanics (systems with constraints or interconnections of systems). Therefore a part of this PhD Thesis project is to apply the obtained results to implicit physical (mechanical and electrical systems).

### Keywords:
- Nonlinear control systems, implicit systems, linearization, extension algorithm, flatness, mechanical systems, electric circuits
- Expected collaborations:
  - Prof. Witold Respondek has already established a scientific collaborations with China. In 2013 he is spending a month at the Zhejiang Unbiversity in Hangzhou, where he will give a series of lecture and will make research with Dr ShunJie Li on geometric control theory. He will also visit Shandong University in Jinan to deliver a lecture and collaborate with Prof. Daizhan Cheng. It is expected that the actual collaboration will become more intensive and fruitful due to the possibility of having a PhD student from China.
  - Background required from the applicant:
    - Very good knowledge of linear and nonlinear control theory and of mathematical methods applied to control theory: differential equations, algebra, and basic differential geometry.

### Existence of a PDF file detailing the proposal ("yes" or "no"):
Yes

(see guidelines on the website www-csc.utt.fr)