language constructs (piece-wise continuous operators or complementarity conditions).

Extending Modelica to NSDS requires new structural analysis algorithms, adapted to the new structural analysis, implemented in most Modelica tools. The correct formulation of a NSDS has to follow a very strict structure, and modeling a CPS in this way faces the combinatorial explosion of mode enumeration.

The correct formulation of a NSDS has to follow a very strict structure, and modeling a CPS in this way often proves to be a challenging task. CPS models expressed in an equation-based language such as Modelica and SimScape are based on systems of algebraic differential equations (DAE). Although modeling is made scalable with the use of DAE, simulating large CPS is a challenge because of their exponential number of modes. Although the \[\text{structural analysis}\] of pure DAE systems is now well established and benefits from fast algorithms (based on graph theory or linear programming), the state-of-the-art structural analysis methods for \[\text{multi-mode DAE systems}\] either rely on overly restrictive assumptions on the structure of the model, or faces the combinatorial explosion of mode enumeration.

Assignment

Modeling languages such as Modelica and SimScape are based on systems of algebraic differential equations (DAE). Although modeling is made scalable with the use of DAE, simulating large CPS is a challenge because of their exponential number of modes. Although the \[\text{structural analysis}\] of pure DAE systems is now well established and benefits from fast algorithms (based on graph theory or linear programming), the state-of-the-art structural analysis methods for \[\text{multi-mode DAE systems}\] either rely on overly restrictive assumptions on the structure of the model, or faces the combinatorial explosion of mode enumeration.

The correct formulation of a NSDS has to follow a very strict structure, and modeling a CPS in this way often proves to be a challenging task. CPS models expressed in an equation-based language such as Modelica should not be expected to follow a predetermined structure. On the contrary, the model should rather be structured according to the physical structure of the system, in a component-based fashion. The mathematical structure of the model has to be discovered by the compiler, and this is the purpose of the \[\text{structural analysis}\], implemented in most Modelica tools. Extending Modelica to NSDS requires new structural analysis algorithms, adapted to the new language constructs (piece-wise continuous operators or complementarity conditions).
Main activities

This research topic encompasses both theoretical developments on the structural analysis of nonsmooth DAE systems (combining algebraic differential equations, complementarity conditions and/or piece-wise continuous operators), the design and implementation of efficient graph-theoretic structural analysis algorithms for these systems, and the generation of simulation code for NSDS numerical solvers (for instance, the \href{http://siconos.gforge.inria.fr/4.1.0/html/index.html}{Siconos} library).

Bibliography


Supervisors

Vincent Acary, INRIA tripop.
Benoit Caillaud, INRIA Hycomes

Complementary information

In the realm of the IPL ModeliScale initiative ( \url{https://team.inria.fr/modeliscale/} )

Keywords

Cyber-physical systems, Hybrid dynamical systems, Nonsmooth dynamical systems, structural analysis of DAE systems, Modelica

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration


Monthly salary after taxes : around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).