Comparison of numerical modelling methods for the dynamics of flexible multi-body systems in the presence of contact and friction.

About the research centre or Inria department

The Inria Grenoble research center groups together almost 600 people in 23 research teams and 7 research support departments.

Staff is present on three campuses in Grenoble, in close collaboration with other research and higher education institutions (University Grenoble Alpes, CNRS, CEA, INRAE, ...), but also with key economic players in the area.

Inria Grenoble is active in the fields of high-performance computing, verification and embedded systems, modelling of the environment at multiple levels, and data science and artificial intelligence. The center is a top-level scientific institute with an extensive network of international collaborations in Europe and the rest of the world.

Context

This post-doc will work in the TRIPOP team, which is a joint research team of the INRIA centre at Grenoble-Alpes University and the Jean Kuntzmann Laboratory (LJK). The team is mainly interested in the modelling, mathematical analysis, simulation and control of non-smooth dynamic systems. Non-smooth dynamics concerns the study of the temporal evolution of systems that are not smooth in the mathematical sense, i.e. systems that are characterised by a lack of differentiability, either of the mappings in their formulations, or of their solutions with respect to time. The team is one of the few in the world to have brought together researchers in applied mathematics, control theory, numerical mechanics and scientific computing in the field of non-smooth dynamics. In mechanics, the main examples of non-smooth dynamical systems are multi-body systems with one-sided contact, Coulomb friction and impacts, or plasticity.

The academic supervision of this post-doc will be carried out by Vincent Acary, INRIA Research Director, in close collaboration with Olivier Bru Die, Professor of Mechanics at the University of Lie'ge, specialising in flexible multi-body systems. Visits to the aerospace and mechanics department of the University of Lie'ge's Aerospace and Mechanical Multibody Systems Laboratory are also envisaged. Industrial support will be provided by Safran Tech, which is funding this project and will help to define the relevant industrial examples.

Assignment

The main objective of this post-doc is a comparison of numerical modelling methods for the dynamics of flexible multi-body systems in the presence of contact and friction. By numerical mo-dielling we mean both the mathematical formulation of the models, the methods of discretisation in space and time and their simulation using scientific computing codes. Flexible multi-body systems are ubiquitous in complex industrial systems, such as aircraft engine blades, landing gear, helicopter rotor mechanisms, deployable antennas, wind turbines, flexible robotics, etc.

While the dynamical numerical modelling of rigid systems is now well mastered, the integra- tion of flexible bodies, taking into account first and foremost their elasticity, remains a subject of active research. Taking into account one-sided contact, impacts and Coulomb friction adds a further difficulty to the problem. Several approaches have been proposed in the scientific literature and in computer codes to simulate these systems. The aim of this post-doc is to review the state of the art of these methods and to compare them on a series of test cases ranging from simple academic systems to more complex industrial mechanisms.

Main activities

The following activities will be carried out as part of this project:

- Drafting of a state-of-the-art report on numerical modelling methods: model formulations (choice of configuration parameters, framework for writing dynamics, contact and friction models), spatial discretisation methods (finite element methods, ANCF, FRBF, co-rotational and geometrically exact approaches) and numerical resolution algorithms.
- Definition of a series of relevant academic and industrial test cases.
- Comparison and validation on these tests of open source software (Siconos, Chrono, Odin) and commercial software (SIMPACK, MECANO, ANSYS).
- Publication of results in a scientific paper.
Skills
The candidate must hold a PhD in Mechanics or Mathematics applied to Mechanics. Skills in theoretical and numerical mechanics, particularly in non-linear dynamics, as well as a strong interest in scientific computing (implementation and use of calculation codes) are essential. Knowledge of multi-body systems and/or contact mechanics would be an additional advantage.

Benefits package
- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (90 days / year) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage under conditions

Remuneration
2788€ gross salary / month