2018-00518 - Effect of a shock wave on a structure with contact

Level of qualifications required: Graduate degree or equivalent
Fonction: PhD Position

About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 37 research teams and 9 support departments. The center's staff (about 600 people including 400 Inria employees) is composed of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrators. 1/3 of the staff are civil servants, the others are contractual. The majority of the research teams at the center are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Six teams are based in Montpellier and a team is hosted by the computer science department of the University of Bologna in Italy. The Center is a member of the University and Institution Community (ComUE) "Université Côte d'Azur (UCA)."

Context

The PhD thesis is proposed at Inria Sophia-Antipolis Méditerranée in project-team COFFEE with funding by ANR PRECIS grant, in partnership with Ecole des Ponts, Université Paris-Est and CEA. The goal of the PhD is to incorporate the modelling and numerical treatment of solid contact in the fluid-structure interaction code CELIA3D.

The PhD will be supervised by Laurent Monasse and Alexandre Ern.

Assignment

The effect of explosions on structures is a major point of interest in risk and safety analysis. The impact of an explosion is two-fold: the first hazard originates from the overpressure effect, while the ballistic projection of solid parts can be equally dramatic. In order to simulate these phenomena, the team has developed a numerical code, CELIA3D, which solves the interaction of a compressible fluid flow (compressible Euler equations) with a deformable elastic solid. The fluid is discretized with a high-order Finite Volume method, while the solid is discretized with particle methods (Discrete Elements). The coupling uses a conservative cut-cell immersed boundary method in combination with a conservative explicit partitioned time integration scheme.

Currently, the numerical scheme is capable of handling deformation and fragmentation of the solid, but it is unable to account for self-contact of the solid. The first goal of the PhD is to extend the numerical scheme to the treatment of contact between solid elements. The scientific hurdles consist in accurately tracking the evolution of the fluid/solid interface and transferring the fluid out of the contact zone. In addition, we expect that around sharp corners, the accuracy of the immersed boundary method is currently insufficient to capture the flow behavior. The second goal of the PhD would be to improve the convergence of the scheme. Several ideas can be explored in this direction: using one-sided Riemann solvers, higher-order non-oscillatory interpolation kernels, adequate stabilization of cut-cells, Robin-Neumann boundary conditions. Another promising idea would be to make use of the directional splitting of the Finite Volume scheme on the boundary conditions, which could lead to improved efficiency.

Main activities

Main activities:

- Modelling and incorporation of contact in a fluid-structure interaction scheme
- Study and improvement of the boundary conditions order
- Programming and test of the proposed improvements in code CELIA3D
- Write research articles
- Participate in congresses

Skills

The candidate should have a Master degree in Applied Mathematics. Notions on Finite Volume methods, hyperbolic equations, fluid and/or solid mechanics and knowledge of C/C++ language are
Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary per month: 1982€ brut per month (year 1 & 2) and 2085€ brut/month (year 3)