Post-doctorate offer (18 months):

Numerical prediction of cavitation: development of an HPC code

Research laboratory: Laboratoire des Ecoulements Géophysiques et Industriels (LEGI)
Address: Domaine Universitaire, BP 53, 38041 Grenoble Cedex 9, France
Research group: Modelling and Simulation of Turbulence
(MoST, http://www.legi.grenoble-inp.fr/web/spip.php?article322)

Keywords: fluid mechanics, numerical simulations, multiphase flows, cavitation, High-Performance Computing (HPC)

Salary: between 2400 and 3000 € gross / month, depending on previous experience.

Starting date: from autumn 2018

Applications: please send cv and motivation letter to giovanni.ghigliotti@univ-grenoble-alpes.fr

Context

Cavitation, liquid-vapor phase change due to a pressure drop in the fluid, is a ubiquitous phenomenon in hydraulic machines, especially in a context of performance optimization. However, cavitation, that can trigger strong vibrations of structures and the erosion of surfaces due to the implosion of vapor bubbles, can originate a rapid wear of components. In this case, the cavitation is defined as aggressive, with a big impact on machine performances and lifetime.

While the generation of cavitation bubbles themselves may be a relatively smooth phenomenon, their implosion when transported in a higher-pressure region of the fluid can be extremely violent. The collapse of a vapor bubble is accompanied by the surrounding liquid, whose inertia can lead to a very fast compression of the bubble, ultimately generating a shock wave. Therefore, the dynamics of the fluid has to be considered as compressible even for the liquid.

Due to the violence and aggressiveness of the flow (the collapse of bubbles near solid boundaries can induce major surface wear), in experiments it is challenging to access local quantities as fluid pressure near collapsing bubbles. Therefore, on one hand numerical simulations can bring a deep insight on the detailed dynamics around imploding bubbles. On the other hand, the space- and time-scale difference between the collapsing bubbles (millimeters and nanoseconds) and the system scale (meters and hours, or even years) poses a serious challenge from the computational resources point of view.

The MoST team at LEGI has a decades-long experience in High-Performance Computing (HPC), most notably in the domain of turbulence. Within the CNRS (French National Centre for Scientific Research) research alliance "SUCCESS" (http://success.coria-cfd.fr), bringing together eight laboratories around the development of HPC in the domain of turbulence and multiphase flows, the team MoST participates to the development the massively-parallel code YALES2, allowing the simulation of realistic geometries (http://www.coria-cfd.fr/index.php/YALES2). We have recently started the development of a cavitation model in YALES2. Also, an Arbitrary-Lagrangian-Eulerian (ALE) model implemented allows a fluid-solid coupling to be performed, with the aim of studying the impact of the fluid on solid boundary deformation.

Objectives

The objectives of the postdoctorate will be discussed with the candidate starting from the following propositions:

- improving the fluid modelling by bringing it closer and closer to the physical phenomena at play, by exploiting the possibilities offered by HPC.
- Assisting the code development for fluid-solid coupling, and exploiting the code for surface deformation at the bubble scale.
- Exploiting the code at the machine- or turbine blade- scale.