Job offer: Post-doctoral fellow

Project Title: **Innovative numerical methods for the dynamic behavior of a structure in interaction with a free surface**

Research Fields: **Computational Fluid Dynamic; Fluid Structure Interaction; free surface; high order numerical method; temporal integration numerical scheme; Renewable Marine Energy**

Research Laboratory: **Institut de Recherche Dupuy de Lôme**

Work Place: **Lorient, FR**

UBL Research Department: **Industrie**

Heads of the Scientific Project: **Jean-Marc Cadou (HDR), Yann Guevel, Gregory Girault**

Offer type: **postdoctoral researcher 18 months (in which 12 months on UBL funding)**

Hiring Institution: **Université Bretagne Sud**

Monthly net salary: **2 300€**

Job Starting Date: **possibly from 1 nov. 2017 to 1 mar. 2018**

Environment

The post-doctoral fellow will be recruited for a period of 18 months within the FRE CNRS 3744 Institut de Recherche Dupuy de Lôme of the Université Bretagne Sud. This study will take place within the “Instability and Numerical Specific Methods” group of the thematic cluster "Structures and Interactions". This group has a long experience of perturbation methods such as the Asymptotic Numerical Method as well as ways to improve it. It is currently composed of 3 permanents associated professors, two doctoral students, one post-doctoral fellow, one A.T.E.R. and an engineer.
The modeling of the fluid-structure interaction and the monitoring of free surfaces will be based on existing and proven techniques. A part of the "Structures and Interactions" thematic cluster, particularly at ENSTA Bretagne, is specialized in this field. As far as the algorithmic part of this new temporal integration class is concerned, the members of the IMNS group have a long experience of perturbative methods such as the Asymptotic Numerical Method as well as means to improve it (Padé’s approximants, homotopy and high order transient solver) see [4,5,6,7,8].

Mission (scientific project)

This project falls within the domain of fluid-structure interaction and more particularly for the study of the response and the maintenance in operational conditions of the structures in marine environment. The efficient simulation of these phenomena constitutes an essential engineering step, particularly in the field of Renewable Marine Energies. Thus, the design of devices such as floating wind turbines is related to the ability to solve strong aerodynamic / hydrodynamic interactions with the structure. This step should take as little time as possible while determining as much relevant physical information as possible for a large number of cycles.

Engineering is based on relevant simplified models. Their validation usually involves a confrontation with a complete modeling which is costly in terms of implementation time and in terms of resolution time. In addition, these simplified models often reach their limit of use. The design process is then dependent on the effectiveness of a simulation based on a complete model.

We propose to work on the application of a new temporal integration schema class to the field of naval engineering. This type of analytical solver in time is based on the numerical resummation of divergent time series expansion, is promising. It has been successfully applied to academic examples such as solving the heat equation, Burgers equations and Navier-Stokes equations for a two-dimensional low-Reynolds flow [1,2,3]. The objective is to improve the engineering cycle by avoiding the notion of critical time step, by efficiently capturing the phenomena of non-linear dynamics, by carrying out large number of cycles while reducing the simulation time.

The post-doctoral student will establish the necessary adaptations of this new class of temporal integration schema to the problems of the fluid-structure interaction with the management of free surface and / or diphasic medium. The modeling of the fluid-structure interaction and the monitoring of free surfaces will be based on existing and proven techniques. He / she will try to solve problems involving a very large number of degrees of freedom in order to identify the capacities of the method and to test its robustness, but also to propose resolutions of representative models of real cases. Finally, for each problem of mechanics considered, comparative studies with the most commonly used methods will be conducted.

Progress of the project:

- ➔ Familiarization with the method on academic cases
- ➔ Choice of a modeling for the free surface and fluid-structure interactions
- ➔ Development in a code present in the laboratory or in an available open source code
- ➔ Confrontation of the demonstrator with classical methods on realistic case studies

Short term:
At the end of the 18-month period, a viable demonstrator should be available as well as scientific output in the form of articles and communications.

On the long term:
A business tool combining performance, robustness and precision must be available to the players in the shipbuilding industry in order to improve their design stage. Moreover, many fundamental aspects related to this class of temporal integrators will have to be studied further. Projects could be envisaged with the different actors of the industrial domain.

Required Profile

Doctor (PhD) in computational fluid dynamic ideally with free surface , maximum 3 years of experience after thesis defense[1]. A strong taste for applied mathematics and programming would be a plus. An international experience, minimum 12 months in the past 3 years, in research is required (during or after Doctorate). Candidates must not have supported their thesis in the hiring institution and not previously worked in the host research unit.

Skills required :
- Advanced knowledge of free surface for fluid mechanics
- Programming skills, numerical analysis and high performance computing
- Autonomy and decision-making
- English proficiency

Desired skills:
- Knowledge and / or experience in time integration schemes
- Knowledge and / or experience in naval hydrodynamics

Usefull References

[1] **Time integration algorithm based on divergent series resummation, for ordinary and partial differential equations.** Dina Razafindralandy and Aziz Hamdouni. Journal of Computational Physics, 236 :56 – 73, 2013.
[2] **Considering inverse factorial series as time integration method.** Razafindralandy, Dina, Deeb, Ahmad, and Hamdouni, Aziz. American Institute of Physics : ProcS, 1798 :318–327, 2017.
[3] **Time integrators based on divergent series resummation : applications in mechanics.** Ahmad Deeb. Thèse, Université de La Rochelle, December 2015.
[4] **Automatic detection and branch switching methods for steady bifurcation in fluid mechanics**, Y. Guevel, H. Boutyour et J. M. Cadou, Journal of Computational Physics, 230, 3614 – 3629, 2011.
[5] **Computation of Hopf bifurcations coupling reduced order models and the Asymptotic Numerical Method**, J. Heyman, G. Girault, Y. Guevel, C. Allery, A. Hamdouni et J. M. Cadou, Computers & Fluids, 76, 73–85, 2013.
[6] **Parametric analysis of steady bifurcations in 2d incompressible viscous flow with high order algorithm.** Y. Guevel, G. Girault, and J. M. Cadou. Computers & Fluids, 100 :185 – 195, 2014.
[7] **Numerical comparisons of high-order nonlinear solvers for the transient Navier–Stokes equations based on homotopy and perturbation techniques.**Y. Guevel, G. Girault, and J. M. Cadou. Journal of Computational and Applied Mathematics, 289 :356 – 370, 2015.
[8] **ANM for stationary Navier-Stokes equations and with Petrov-Galerkin formulation** JM Cadou, M Potier-Ferry, B Cochelin, N DamilInternational Journal for Numerical Methods in Engineering 50 (4), 825-845, 2001

1 The **thesis defense must have taken place after 31/08/2014**, except in rare exceptions. Periods of sickness, maternity or parental leave shall not be counted in this 3 years period.

How to apply ?

Please send the following documents by email to yann.guevel@univ-ubs.fr with CC to recherche@u-bretagneloire.fr :

- Short Curriculum Vitae and a covering letter showing your interest and especially addressing your professional project
- A list of your major works (2 pages max.) : scientific publications, patents and others scientific productions
- Letters of recommendation (not required)
- A copy of your PhD diploma[2]

The general selection process is described here :
https://u-bretagneloire.fr/dossiers/postdoc/candidatures

Further information

This Fellowship is cofunded by **Université Bretagne Loire** and **Région Bretagne**. The Université Bretagne Loire federates 7 universities, 15 “grandes écoles” and 5 research organizations in the West of France (Bretagne and Pays de la Loire). This community of universities and institutions aims to develop the scientific and academic potential of this territory at national and international level. Instilled with values that it defines as priority, the Région Bretagne's guiding principles are solidarity, sustainable development, openness to Europe and the world, female-male equality and better access to information technology in most of its missions. The Region has a policy of firm co-operation with other regions around the world to encourage Brittany's international openness. This strong co-operation can be seen in the development of shared actions within the Region's areas of competence.

2 For doctors graduated from a French establishment, a link to the thesis notice in the SUDOC Catalogue or the French official portal Theses.fr is sufficient.