

## **ESR9: Continuous & discrete adjoint for the in-house solver, GPU-enabled and one-shot adjoints, for unsteady flow optimization.**

Parallel CFD & Optimization Unit, Laboratory of Thermal Turbomachines,  
Fluids Section, School of Mechanical Engineering,  
National Technical University of Athens (NTUA)

### **The hosting group**

NTUA is a leading university in both theoretical and experimental research. There are approximately 10,000 graduate and post-graduate students participating in several scientific projects. There exists a wide range of computational facilities including almost 500 high-performance CPU and GPU cores.

The Parallel CFD & Optimisation Unit of NTUA, headed by Prof. K.C. Giannakoglou, has participated in several scientific projects sponsored by industries and the EC (FP5, FP6 and FP7 grants), concerned with CFD and optimization of aero/hydrodynamic bodies. The research focuses on the development of novel optimization methods for shape optimisation, topology optimization, optimal flow control, robust design, etc, based mainly on the adjoint approach. Both continuous and discrete adjoint methods have been developed, even for higher order derivatives.

### **The work**

This ESR will work on both discrete and continuous adjoint. He will focus on

- ⤴ M1-6: Familiarisation with the existing primal (steady and unsteady) and adjoint (continuous & discrete; steady) in-house code “puma”. Familiarization with CUDA and the use of multi-GPUs. 1M secondment to QMUL for familiarization with the discrete adjoint by QMUL.
- ⤴ M7-12: Implementation of checkpointing techniques in continuous/discrete adjoint to the “puma” code for unsteady flows. Minimization of checkpoints used. 1M secondment to INRIA to learn about checkpointing and use of TAPENADE.
- ⤴ M13-20: TAPENADE will then be used on “puma”, for comparisons with the existing hand-differentiated discrete adjoint. Selective/hybrid use of hand-differentiation and TAPENADE will be tried, aiming at minimum memory budget. GPU implementation.
- ⤴ M21-28: Implementation of continuous adjoint techniques to “puma” for unsteady flows; comparisons with one-shot variants of the same code and the use of truncated Newton methods. Adjoint harmonic balance methods for periodic flows.
- ⤴ M29-36: Industrial cases: runs. 2M secondment to VW for experience on realistic cases.

### **Required background**

**Essential:** You need to have

- a Masters degree (or equivalent) in Mechanical/Aerospace Engineering. Candidates with a Masters-level background in Applied Mathematics, Physics or Computer Science will also be considered if they have an acceptable background in modelling of fluid flow.
- experience with CFD code development (programming; not only usage).
- the ability to give presentations and write scientific publications
- the willingness and ability to attend the regular network training events in the EU and to spend 3 month secondments at network partners,
- the ability to program computational methods in C++

**Desired:** it would be good if you had experience with

- Linux operating systems,
- programming in C or CUDA,
- software development,
- numerical optimisation, adjoint methods
- turbulence models (use of)

## Language requirements

A very good knowledge of English is required.

## Salary, conditions and environment

The remuneration is 36.000 Euro per annum (living allowance), of which taxes, social contributions and pension payments have to be paid. Over and above, mobility allowance of about 9500 Euro per annum (at minimum; the exact amount depends on marital status) is foreseen.

The network will provide a range of workshops on scientific aspects relevant to adjoint-based optimisation that will be directly or indirectly relevant to the work in this research position, see the About Flow webpage for details. You will also be offered a range of skills complementary to your core research area such as project management, thesis writing and entrepreneurial skills.

NTUA and the About Flow project are committed to Equal Opportunities for all candidates and will follow the principles of the European Charter for Researchers.

## How to inquire and apply

Applications for the position are open. For informal enquiries about this position please contact:

Professor Kyriakos C. Giannakoglou  
 Tel: +30-210-7721636  
 E-mail: [kgianna@central.ntua.gr](mailto:kgianna@central.ntua.gr)

To apply please send a CV and two signed reference letters to the following address:

National Technical University of Athens (NTUA),  
 Attn: Prof. K. Giannakoglou  
 School of Mechanical Engineering,  
 Zografou Campus,  
 9 Heron Polytechniou,

15780 Athens, GREECE

or by email to [kgianna@central.ntua.gr](mailto:kgianna@central.ntua.gr)

Closing Date for applications: February, 28 2013 New Extended Deadline  
Estimated date for starting the PhD: April, 1 2013