**Post-doctoral position - Recrutement Post-doc 2014-2015:**

**Design of reduced-order controllers using Port-Hamiltonian System parametrization, with experimental validation**

## Context

ISAE (Institut Supérieur de l'Aéronautique et de l'Espace) offers a post-doctoral position in Automatic Control and Applied Mathematics for the academic year 2014-2015

**Fields**: Port-Hamiltonian Systems, Fixed-structure control, Passivity-based control, Flexible structures, Fluid-structure interaction.

**Location**: ISAE [1], Campus SUPAERO (Toulouse, France)
**Duration**: 12 months, starting September or October, 2014

The research will take place within the Department of Mathematics, Computer Science and Automatic Control (DMIA [2]) and will benefit from the stimulating environment of ISAE. This is a research-only appointment (no teaching).
The position is funded by the Agence Nationale de la Recherche by the ANR project on *Hamiltonian Methods for the Control of Multidomain Distributed Parameter Systems*, HAMECMOPSYS [3], which also involves the laboratories FEMTO-ST (UMR CNRS 6174, Besançon), the Institute Elie Cartan UMR CNRS 7502 of the Université of Nancy, and the LAGEP (UMR CNRS 5007, Lyon).
The net salary will be 2200 euros per month, health insurance and social coverage included. Speaking French is not compulsory.

**Application**: please send us by email:

- a curriculum vitæ,
- a letter from your Ph.D. advisor.

Recommendation letters should be sent to the contact persons mentioned below, by email.

**Application deadline**: **August 15th, 2014**
**Contacts**: Denis Matignon (`denis.matignon@isae.fr`), Daniel Alazard (`alazard@isae.fr`)

[1] see `http://www.isae.fr/`
[2] see http://recherche.isae.fr/en/departments/dmia.html
[3] see https://hamecmopsys.ens2m.fr/

## Research activities

The modeling of physical systems based on the representation of intrinsic energy exchanges between different energetic domains allows a modular description of their (even complex) dynamic behaviour. In this context, the port-Hamiltonian framework represents a powerful modeling and control tool, see e.g. [7, 1, 4]. Port Hamiltonian systems are an ideal framework for the compositional modeling of finite- and infinite-dimensional physical systems, which might lead to high-order control systems, see e.g. [3, 5]. Different structure preserving reduction methods have been suggested for linear Port Hamiltonian systems, see e.g. [2, 6].

In this project the post-doctoral applicant will focus his research activity on the design of reduced-order controllers for Port Hamiltonian systems, taking into account the particular structures of such systems as constraint. The idea is to combine the recent advances in non-convex optimization (see e.g. [8] and references therein) and the intrinsic properties of port Hamiltonian systems to propose some new constructive control design methodologies for the control of high order/infinite-dimensional systems.

The proposed control design methodology will be applied on two experimental set-ups:

- first, on a toy-model: the testbed for modelling and control of flexible structures [4],
- second, on a fluid-structure interaction testbed, with sloshing.

The post-doctoral student will be welcomed in a research team composed of 4 permanent staff (Valérie Budinger, Denis Matignon, Yves Gourinat and Daniel Alazard and 1 Ph.D. student (Flávio Ribeiro) and lab engineers for experimental setup support.

## References


[1] V. Duindam, A. Macchelli, S. Stramigioli, and H. Bruyninckx. *Modeling and Control of Complex Physical Systems - The Port-Hamiltonian Approach.* Springer, 2009.

[2] S. Gugercin, R.V. Polyuga, C. Beattie, and A. J. van der Schaft. Structure-preserving tangential interpolation for model reduction of port-Hamiltonian systems. *Automatica*, 48:1963–1974, 2012.

[3] Y. Le Gorrec, A. Macchelli, H. Ramirez and H. Zwart. Energy shaping of boundary controlled linear port Hamiltonian systems. In Proc. *19th IFAC World Congress*, Cape Town, South Africa, August, 2014.

[4] Y. Le Gorrec and D. Matignon. Coupling between hyperbolic and diffusive systems: a port- Hamiltonian formulation. *European Journal of Control*, 19(6):505–512., 2013.

[5] Y. Le Gorrec, H. Zwart and B. Maschke. Dirac structures and Boundary Control Systems associated with Skew-Symmetric Differential Operators. *SIAM Journal on Control and Optimization*, 44(5):1864–1892, 2005.

[6] R. Polyuga, and A. J. van der Schaft. Effort- and Flow-constraint Reduction Methods for Structure Preserving Model Reduction of Port-Hamiltonian Systems. *Systems & Control Letters*, 61(3):412–421., 2012.

[7] A. J. van der Schaft and B. Maschke. Hamiltonian formulation of distributed-parameter systems with boundary energy flow *Journal of Geometry and Physics*, 42:166–194, 2002.

[8] Y. Wu, B. Hamroun, Y. Le Gorrec and B. Maschke. Port Hamiltonian System in Descriptor Form for Balanced Reduction: Application to a Nanotweezer. In Proc. *19th IFAC World Congress*, Cape Town, South Africa, August, 2014.


[4] see `http://personnel.isae.fr/sites/personnel/IMG/mpg/film_bamoss_ve.mpg`