## Université de Technologie de Compiègne – Thesis proposal

### Part 1: Scientific sheet

<table>
<thead>
<tr>
<th>Thesis proposal title</th>
<th>Vibrations Control for Smart Systems and Structures</th>
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<tbody>
<tr>
<td>PhD grant</td>
<td>Doctoral work contract based on a UTC Grant</td>
</tr>
</tbody>
</table>
| Research laboratory   | research team: Lab. Roberval de Mécanique, UMR 7337 UTC-CNRS  
Lab. Heuristique et Diagnostic des Systèmes Complexes, UMR 7253 UTC-CNRS  
(URL: http://roberval.utc.fr/, https://www.hds.utc.fr/) |
| Thesis supervisor(s)  | Adnan Ibrahimbegovic, Professeur des Universités,  
(http://roberval.utc.fr/Ibrahimbegovic-Adnan/ E-mail: adnan.ibrahimbegovic@utc.fr)  
Rogelio Lozano, Directeur de Recherche CNRS,  
(URL: https://www.hds.utc.fr/~rlozano/ E-mail: rlozano@hds.utc.fr) |
| Scientific domain(s) | Physics (Mechanical Engineering, Electrical Engineering)  
Mathematics, Computer science and information technologies |
| Research work         | Context of the study:  
Most current research related to interconnected technological systems requires a combined knowledge of more than one traditional scientific domain. This is the case of the present study, where computational mechanics skills in modeling overall large vibrations of structures (Ibrahimbegovic [2009]) and mechanical systems (Ibrahimbegovic et al. [2017, 2004]) are brought to bear upon the vibration control appealing to the latest advances in adaptive control (Landau, Lozano et al. [2010], Brogliato, Lozano et al. [2008])  
Various applications are of interest for this kind of computational tools. First, we are seeking to control the large overall motion and vibration of wind-turbines with flexible blades, in a novel system where the blades flexibility can be an advantage for starting the turbine operation, but a disadvantage for keeping the turbine operational in the case of strong winds. The same type of difficulty applies to vibrations of high-rise slender structures, induced by either wind or earthquake, which have to be controlled for their long-term safety.  
Doctoral thesis description:  
In this thesis we want to develop and test a novel approach where the studies of this problem will be placed within the framework of smart systems, which implies the systems with active and sensor-like capabilities. For the first application and model problem of wind turbine with flexible blades, we will thus formulate novel observers of the structural flexible states of a wind turbine, as well as of the wind incident on its rotor.  
Stochastic filtering processes will reconstruct on-line optimal estimates of the tower and blade states, by using readings from accelerometers and strain gages placed along the structural members. From these reconstructed states, another filtering process estimates the wind states which, improving on the commonly used mean hub-height wind estimates or the point measurements available from on-board anemometers, also include information on the wind-over-the-rotor distribution. The proposed procedure is able to approximate vertical and horizontal wind shear, yawed flow and a vertical wind component.  
The instantaneous estimates of the flexible states of tower and blades and of the spatial wind distribution can be used for enabling sophisticated individual-blade fatigue and load alleviating control laws. |
Very similar procedure will be applied to vibration control of high-rise buildings. Either model problem will be formulated and handled in agreement with passive control framework (Brogliato, Lozano et al. [2008]). The latter will provide the possibility to test and devise an optimal vibration control device, with changes either in stiffness, in mass or in damping for a particular structure or system.

Several existing codes for different mono-physics applications will provide the starting point of this implementation, including FEAP for Structural and Multibody Dynamics (e.g. Zienkiewicz, Taylor 2005), and OpenFoam for fluid mechanics, with the direct coupling between these existing codes as the key step in constructing the efficient multiphysics solvers (Ibrahimbegovic 2014). However, the proposed approach is not purely informatics problem, but requires equally revisiting the theoretical formulation, discrete approximation and solution algorithm for multi-physics problems.

References:
Brogliato, B., Lozano, R., Maschke, B., Egeland, O., Passivity-based control system analysis and design, Springer Series in Communications and Control Engineering, 2008

Key words
Vibrations / Control / Damping / Software Coupling

Requirements

Candidate’s profile:

The successful candidate will be engaged in modeling and numerical simulation of structural dynamics and vibrations of mechanical systems properties, with special attention to vibration control. Candidates with experience in computational methods, especially in vibrations and control, are encouraged to apply. The successful candidate must hold a Master degree either in Civil, Mechanical or Electrical Engineering, or other relevant discipline (Applied Mathematics or Computer Science). Computer programming experience is required.

Documents required to apply:
Send to adnan.ibrahimbegovic@utc.fr, rlozano@hds.utc.fr
• Curriculum vitae
• Motivation letter
• Eventual references and/or recommendation letters
• A statement of research experience and interests

Starting time
31 October 2017

Location
Laboratory Roberval UMR CNRS-UTC 7337
Université de Technologie de Compiègne (UTC)
## Part 2: Job description

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<tr>
<th>Duration</th>
<th>36 months</th>
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<tr>
<td>Additional missions available</td>
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<tr>
<td>Research laboratory</td>
<td>Laboratories of Mechanics, (and Lab. Heudiasyc)</td>
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<td>Material resources</td>
<td>office space, personal computer, access to laboratory equipment</td>
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<td>Human resources</td>
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<tr>
<td>Financial resources</td>
<td>Chaire Mécanique Numérique (titulaire: Adnan Ibrahimbegovic)</td>
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<tr>
<td>Working conditions</td>
<td>Weekly meetings with thesis supervisors</td>
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<td>Research project</td>
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<td>National collaborations</td>
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<tr>
<td>Contact</td>
<td>Tel: +33(0)344234534, <a href="mailto:adnan.ibrahimbegovic@utc.fr">adnan.ibrahimbegovic@utc.fr</a></td>
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**Please contact first the thesis supervisor** before applying online on [https://webapplis.utc.fr/admissions/doctorants/accueil.jsf](https://webapplis.utc.fr/admissions/doctorants/accueil.jsf)