Dr Ludovic Renson
University of Bristol

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Analysis and Design of nonlinear dynamic structures: numerical and experimental methods

Dr Ludovic Renson is looking to recruit a PhD student to work in the field of nonlinear structural dynamics.

With the constant drive for better performance and efficiency, technological boundaries are being pushed to their limits. The result is that mechanical structures such as aircraft, satellites and rotating machines are becoming increasingly nonlinear – the system response is no longer proportional to the input. Whether anticipated or discovered at the end of product design, the presence of nonlinearity often leads to untimely delays and additional development costs because nonlinear systems can exhibit a wide range of complicated dynamic behaviours that have no counterpart in linear systems (bifurcations, quasi-periodic oscillations, chaos).

There is a clear and urgent need for rigorous tools that fully encompass nonlinear effects, which existing methods cannot. Furthermore, recent studies have shown that, if properly addressed, nonlinearity can be exploited to considerably improve design performance (for instance, in sharp acoustic switches and rectifiers, vibration absorbers and energy harvesters).

Depending on the interest of the candidate, the PhD project can focus on different topics in this area, ranging from the development of numerical algorithms to the establishment of nonlinear testing techniques. For instance, the project could address:

1. the development of effective algorithms for the bifurcation analysis of large-scale systems as those met in industry. Algorithm performance will be demonstrated on real-life aerospace structures including a full-scale aircraft and a satellite. Developed tools will eventually be exploited to establish innovative bifurcation-based optimization and design methodologies for nonlinear structures.
2. the further development of nonlinear model reduction techniques enabling the fast and accurate dynamic analysis of structures with distributed (geometric) nonlinearities. The reduction methods will be demonstrated on geometrically-nonlinear finite element models of academic (beams, shells) and real-life (aircraft wings) structures. Developed methods will then be extended to the case where sensitivity to physical parameters is needed.
3. the development of robust testing approaches for nonlinear systems based on feedback control techniques. In particular, the adaption of phase-locked loop techniques (extensively used in electronics) will be considered. Experimental demonstration will be performed on a series of benchmark structures available in our Dynamics Lab.

The successful candidate will be part of the University of Bristol's Dynamics and Control research group and have the opportunity to collaborate with other researchers from the Faculty. The candidate will also benefit from the momentum created by other research activities in the group addressing the analysis and design of nonlinear systems, such as the Engineering Nonlinearity and Agile Wing Integration projects.

Please contact l.renson@bristol.ac.uk with your up-to-date CV for inquiries.