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Vous êtes cordialement invités à la soutenance de thèse de

Adrien GOMAR
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Lundi 14 Avril 2014 à 14h00, en salle de conférence, CERFACS, Toulouse

Multi-Frequential Harmonic Balance Approach for the Simulation of Contra-Rotating Open Rotors: Application to Aeroelasticity

Abstract: Computational Fluid Dynamics (CFD) has allowed the optimization of many configurations among which aircraft engines. In the aeronautical industry, CFD is mostly restricted to steady approaches due to the high computational cost of unsteady simulations. Nevertheless, the flow field across the rotating parts of aircraft engines, namely turbomachinery blades, is essentially periodic in time. Years ago, Fourier-based time methods have been developed to take advantage of this time periodicity. However, they are, for the most part, restricted to mono-frequential flow fields. This means that only a single base-frequency and its harmonics can be considered. Recently, a multi-frequential Fourier-based time method, namely the multi-frequential Harmonic Balance (HB), has been developed and implemented into the *elsA* CFD code, enabling new kinds of applications as, for instance, the aeroelasticity of multi-stage turbomachinery.

The present PhD thesis aims at applying the HB approach to the aeroelasticity of a new type of aircraft engine: the contra-rotating open rotor. The method is first validated on analytical, linear and non-linear numerical test problems. Two issues are raised, which prevent the use of such an approach on arbitrary aeroelastic configurations: the conditioning of the multi-frequential HB source term and the convergence of the method. Original methodologies are developed to improve the condition number of the simulations and to provide *a priori* estimates of the number of harmonics required to achieve a given convergence level. The HB method is then validated on a standard configuration for turbomachinery aeroelasticity. The results are shown to be in fair agreement with the experimental data. The applicability of the method is finally demonstrated for aeroelastic simulations of contra-rotating open rotors.

Keywords: Fourier-based time method, Contra-rotating open rotor, Aeroelasticity, Harmonic balance, Multi-frequential

Jury:

M. Christophe CORRE, Professeur, ENSE3, Grenoble (France)	Referee
M. Li HE, Professeur, University of Oxford, Oxford (Royaume-Uni)	Referee
M. Jean-Camille CHASSAING, Maître de Conférences HDR, UPMC, Paris (France)	Member
Mme Paola CINNELLA, Professeur, Università del Salento, Lecce (Italie)	Member
M. Pascal FERRAND, Directeur de recherche CNRS, LMFA, Lyon (France)	Member
M. Frédéric SICOT, Docteur, CERFACS, Toulouse (France)	Member
M. Clément DEJEU, Ingénieur, Snecma (Safran), Villaroche (France)	Invited

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