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PROPOSITION DE SUJET DE THÈSE

Intitulé : Implementation and analysis of the aeroelastic coupling for aeronautical slender structures with rapid methods

Référence : **MAS-DAAA-2025-32**
(à rappeler dans toute correspondance)

Début de la thèse : October 2025	**Date limite de candidature :** May 2025

Keywords

Aeroelasticity, Reduced Order Models, Vortex Particle Method (VPM), Aeroelastic interactions, Large aspect ratio wings, Open Rotor And Stator (ORAS)

Profile and expected competencies

Enrolled in the last year of a Research Master or Engineering School, you have notions in structural mechanics and fluid mechanics and ideally in aerodynamics. You show an interest in aeronautics, research and innovation. You have a taste for programming and have skills in Python programming language. With excellent interpersonal skills, you will not hesitate to communicate with experts within ONERA. You demonstrate a good sense of critical analysis and an autonomy allowing you to adapt quickly to a technically demanding work environment.

Context

The aeronautics sector is increasingly involved in reducing the carbon footprint of aircraft. New ultra high bypass ratio (UHBR) turbofans and ORAS (Open Rotor And Stator) type propellers provide an improved performance up to a 20% reduction in carbon footprint. However, the physics phenomena of these configurations become more complex and require advanced tools for their design and analysis.

Figure 1 (G) Open Rotor diameter Vs current engines ©Safran; (C) Installed Open Rotor ©Safran; (D) Pathfinder ©NASA.

Nowadays, there are high-fidelity methods capable of representing the coupled aeroelastic response, however, their computational cost is very high for analysis and design activities in an industrial environment. Therefore, the use of rapid methods for both aerodynamic and structural analysis is complementary to high-fidelity methods.

Objectifs of the PhD

Therefore, the main objective of the PhD is the development of an aeroelastic coupling method with “rapid” methods that take into account the nonlinear vibrations of the slender aeronautical structures (e.g. high aspect ratio wings, Open Rotor And Stator type of propellers (ORAS)).

Thus, you will carry out a review of the existing literature in order to understand the theoretical bases of fluid/structure coupling, of projection based reduced order models (ROM) and of nonlinear beam models for the structural modelling and the rapid methods for the aerodynamic analysis of propellers (e.g. BEMT, Vortex Particle Method (VPM)). Then, a theoretical analysis of the VPM will enhance the existing code’s capabilities to consider the structural velocity in for unsteady aeroelastic analyses (vibrations). The capabilities of the coupling with rapid methods to reproduce aeroelastic phenomena will be assessed (e.g. forced response, flutter).

Depending on the advancement of the PhD, other technical questions could be addressed considering different modellings both for the structure and the aerodynamics (e.g. Body Force method in aerodynamics, parametrization of the nonlinear ROMs, cyclic symmetry).

The results of this PhD will allow maturing the rapid methods for the fluid/structure coupling for the design and the analysis of new configurations of aeronautical engines.

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